Food and Agriculture Organization of the United Nations

Crop production manual

A guide to fruit and vegetable production in the Federated States of Micronesia



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A guide to fruit and vegetable production in the Federated States of Micronesia

Compiled by:
Sayed Mohammad Naim Khalid

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Preface

This manual is intended to be a guide to the agriculture extension personnel, horticultural producers as well as agricultural institutions in their endeavor to improve productivity in the horticultural sub-sector. This manual will raise awareness and provide decision support information about opportunities at farm and how to do basic farming for subsistence and market and ultimately increase the income of farmers and improve their livelihoods.

Pohnpei and Yap States currently produce limited amount of food locally and export is also limited. The imports of substantial quantities of vegetables, fruits and root crops is amounting to millions of dollars annually. This is partly owing to the fact that the necessary information on crop production locally is not readily available to assist producers in their production.

This manual is designed to provide guidelines on seedling production and management, plant spacing, cropping program, soil fertility and crop protection. It is hoped that this manual will contribute modestly to the goal of improving vegetable production in the country.

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Farming basics

Farming basics

Introduction

With so much emphasis today on eating natural, organic foods – not to mention the rising costs associated with buying them, many people are considering growing their own vegetables in a home garden. It's very easy to grow your own vegetables, and at harvest time, vegetable gardening is a very rewarding pastime.

All your garden really needs is sunshine (6–8 hours of sun each day, in the summer), some soil, fertilizer, and a little attention to watering, weeding and pest management.

As a gardening beginner, your first vegetable garden will require the largest amount of work, but don't let that dissuade you – the work you put in up front won't have to be repeated next year, and the rewards speak for themselves.

Why start your own farm?

Across the world, many people are having little farms. In FSM most people have access to land and the climate is suitable for crop production. And for the cost of seeds, tools, and water, they're enjoying food that's as fresh and local as it can possibly be, all while spending less time shopping for groceries and more time at home, connecting with their family and friends.

As you can see, there are many great reasons to start your own farm. Apart from allowing you to grow your own food, conserving energy and saving money, own farm will also help to control runoff from rainfall and guard against flooding. A farm can act as a sound buffer, lowering noise levels in your neighborhood. Your farm will attract a variety of local and migratory wildlife like birds and butterflies, not to mention helping to conserve important creatures like bees – who are vital to our ecosystem – and helping to reduce CO_2 in our atmosphere, replacing it with oxygen. Additionally, a farm is a great space for both children and adults to experience the outdoors, and get off the sofa. A garden can create ground shade, helping with cooling, and can work as a filter for dust and pollutants.

Picking a good spot for your garden

Now that you've decided to start your farm, the first step is to find the perfect location. There are several things you should keep in mind:

Start Small. As we mentioned, your first farm is typically the most work to set up, so starting small is a good idea. Set up a manageable area for your garden bed(s), whether they are in the ground, raised beds, or in containers, and know what you're

going to plant (and the space requirements of those plants) ahead of time.

Sunlight. Sunlight is the most important thing for any farm. Vegetables require at least six hours of sun each day – and if you can get 8 hours, that's better. Don't worry too much about afternoon or morning sun, as long as the garden gets at least six hours total, you're golden.
Good Soil. As farmers, we know that good soil means good plants! When looking at the soil in your own ground, darker tends to be better, but just about any soil is workable – as long as it's not full of rocks, roots, or other obstructions. Even mediocre soil can be improved with minerals, manure, and sand to make it excellent. And, if all else fails, a raised bed with formulated soil is always an option.

Water source. Apart from sun and soil, water is the third piece of the puzzle to make a healthy garden. Choose a location close to a water source – like river, rain water collection, a hose, well, or other hydrant where you can easily make sure the garden stays watered – and while we're at it, plants don't grow in totally soaked soil, so avoid areas that tend to collect rainwater. Higher ground is best!

Wind shelter. This one is especially important on a rooftop, or out in an open plain. Find natural windbreakers in the surrounding area or consider building a fence to protect your plants from the wind to minimize damage from wind exposure.

Choosing what crops to plant
Now that you have a location, it's time to decide what to plant. You'll want to maximize your space and grow plants suited to your local area, as well as considering the time vs. reward – corn, for example, is delicious, but takes up lots of space and takes months to get a single harvest, while pole beans are quire space-efficient and produce beans for weeks.

Easy to grow. For the beginning, having vegetables that are basically

Figure 1: seedling production in trays

foolproof is a great plan. Plants like Chinese cabbage, tomatoes, gourds like squash and eggplant, greens such as lettuce or Swiss chard, and root vegetables like taro tend to be very simple.

Suitable for your region. When planning your farm, pay a visit to your farmer's market and find out what's already grown locally. This will help you to ensure you aren't fighting an uphill battle in getting a plant that isn't exactly suited to your area to thrive – plus, by growing what other farmers are growing, you can always go to those folks for help if needed.

Companion planting. Companion planting can help ensure that all your plants thrive by assisting with pest control. By planting companions next to each other, the idea is that we want all the natural pests attracted to the first plant to be repelled by the second, and vice-versa.
For example, onion pairs well with tomatoes and leafy greens like lettuce, but if planted next to beans or peas you may run into pest troubles.

Finding seeds/seedlings
Buying/receiving seeds can be pretty overwhelming for farmers because of the sheer volume of different companies and varieties out there. The best advice is, "Read the label" or, "Ask your extension officer". This will let you know how difficult the plant is to grow, when to plant, and what's required.


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Figure 1: Seeding production in trays

Planning your farm
Farmers usually make mistake here. First time farms can easily get out of hand, or unwieldy, or fall victim to neglect, wind, waterlogging, or pests. To prevent your farm experience from being a disaster, take some time to plan the farm.

Layout
No matter what kind of layout you end up using for your farm, the first thing to think about is location. Choose a basically level area in higher ground if possible, for good drainage. Take in mind that sun is a concern (6–8 hours) as well as protection from wind.

Raised beds


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Figure 2: An example of raised bed

Raised bed gardening has become one of the most popular way of growing vegetables today. The way they allow you to control space, soil, water levels, and location make them ideal for many gardeners.
If you go with a raised bed layout, construct beds that are no more than 3–4 feet wide, with space for walking paths in between. This will ensure

that you're able to properly attend to – and harvest – every plant.

Traditional rows

For those who have the space, traditional row gardening can be a great option. Planting vegetables in long rows allows you to increase the space between plants, improving air flow around them and giving them more space to grow.

Here's a rule of thumb for row gardening – try to plant the taller plants toward the west, and shorter toward the east. That way your shorter plants don't spend those vital sunshine hours in the shade of the taller ones.

Square foot gardening

For beginner farmers, square foot gardens often tend to be a great way to begin. Larger gardens are prone to weeds and can be overwhelming for the novice. Square foot gardening is similar to raised bed gardening, but it is further subdivided into individual square-foot plots.

Mulching

For farmers, the purpose of mulch is fairly straightforward: mulch is like a barrier keeping sunlight and ambient air out of the soil. Mulching allows soil to stay cooler, meaning less stress on your plant roots from heat, and in cooler months.

On the other hand, it does create cool, dark spaces that are the favored environments of Giant African snails, slugs, earwigs, and other undesirables – so only use a thin layer. Mulch should not touch the stem of plants.

When to plant

When considering the question of when to plant, you'll have to go back to the question of *what* to plant. Remember, reading all those labels on your seed packets will ensure that you're planting things at the right times.

Choose seeds that make good companions, and thrive at similar intervals for the best beginner gardening experience.



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Figure 3: Production in furrows and rows



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Figure 4: An example of mulch with straw

If you want to think ahead, consider growing something that thrives in heat and can be harvested early – like Chinese cabbage, and then replacing them as the weather cools with a cool-weather plant like broccoli. Of course, if you'd rather simply do one planting and one harvest, especially as a beginner, that's just fine too.

Improving the soil

Most soils are entirely capable of growing a vegetable garden – and even mediocre soil can be improved. For a really successful garden, some soil improvements is a must. Let's take a look at some of the ways you can improve your soil.

Testing the soil

Now, brace yourself, because we're going to talk a little chemistry. Don't panic, you don't need to be a scientist. So, as you may remember from chemistry or biology class, pH is a measure of the acidity of a substance – remember, 7 is neutral, and a pH lower than 7 is acidic, while a pH above 7 is basic.

Soil is no exception, and it has a pH value, and unsurprisingly, plants tend to like neutral soil. For more information and help please contact the extension agents and local agriculture department.

Clearing weeds

The amount of time you'll spend worrying about weeds, in a sense, depends on which style garden you use. While square-foot gardens and raised beds using controlled soils can remain fairly weed-free, a traditional row garden can inherit weeds from plant life that inhabited the soil before it was tilled.

A good way to prevent weeds from starting is to smother them. After clearing the ground for your garden, just leave the clippings of the grass and weeds that were there previously, and cover the area with newspaper.

Keep the newspaper damp by watering it each day, and walk over it to keep everything pressed down. This will discourage the more stubborn weeds from re-growing.

As the plant matter from your clippings begins to decay, earthworms will be attracted, and they will aerate the soil and add nutrients – a bonus!

Compost

Compost is a great way to create extremely nutrient-rich soil, and it couldn't be easier to make. Just create some layers of organic material – dry leaves, kitchen veggie scraps, shredded paper, plant clippings, and just a little bit of soil.

Over time, this will turn into something called humus, and it's excellent for building soil. Further details on how to make compost is presented in ***Annex 1.***

Manure

In addition to composting, plenty of fertilizers and other synthetic soil enrichment methods are around to help improve soil. However, for many gardeners, nothing is better than the tried-and-true method of manure.

In comparison, manure contains a little less nutrient content than the sparkly synthetic fertilizers, but nothing is better at providing carbon and carbon compounds. This is organic material that helps build and fortify the structure of soil, and that's something no fertilizer can do.

Planting the crops

Now that you have your garden laid out, your soil prepared, and your seeds at the ready, it's time to get to the good stuff: planting your garden. Planting time is the second most exciting time to be a gardener (the first is, of course, harvest time) – this is when you can finally put all the hard (but worthwhile) work of building your first garden behind you, and really begin the enjoyable process of growing your own food. Plants can be cultivated by direct seeding or transplanting.

How to plant the seeds

The first step to actually utilizing your garden to grow delicious vegetables is to plant your seeds. If you ask ten gardeners how they plant their seeds, you'll likely get ten different answers, as everyone develops their own routine. But, as a general guide, here's our preferred method of starting seeds for beginners. Seeds can be directly planted in soil or grown in nursery and then transplanted to prepared beds.

Begin by marking out rows with stakes on either side of the garden, and stretching string between them. Alternatively, you can use a long, straight piece of wood as a guide. Whichever method you use, use a hoe or trowel along your guide to cut a furrow into the soil. It should look like a V-shaped indentation a few inches deep – refer to your seed packets for more specific depth requirements.

Now that you have your row defined, you can distribute the seeds along the row, taking care to distribute them

more or less evenly in small groups, or individually for larger seeds. Don't be afraid to use additional seeds. This will help cut down on loss should some of your seeds fail to germinate. Finally, once your row has been populated with seeds, use your trowel or hoe to pull fine soil over the seeds – take care to avoid large clods of soil and rocks. Finally, give the soil some taps with your tool of choice to firm it and ensure that moisture in the soil has good contact with the seeds, and to help the soil to retain moisture.

Once you've planted and covered your seeds, use a gentle shower from your garden hose to water them – be gentle here, you don't want to disturb the seeds or the soil. Keep up the practice of making sure these seeds are watered to ensure healthy germination until you see sprouts.

Once the seeds have sprouted, look for them to develop into seedlings. They will start to sprout leaves, and in the case of multiple plants, wait for one of the plants to develop three well defined sets of leaves.

Once the third set has developed, then do a little thinning – you'll want to thin out the smaller, weaker plants so that only the stronger ones are left. This ensures that the smaller plants aren't stealing moisture and nutrients from the champions of the batch.

It's best, and easiest, to thin while these seedling are small, so that pulling them up doesn't disturb the roots of the stronger plants.

Succession planting

As a gardener, you may wish to simply garden for a single season: plant, tend, harvest, and then leave the garden beds be until next summer. That's totally fine, but if you'd like a garden that really works for you year-round, consider succession planting. Succession planting isn't difficult, and it will truly maximize the rewards you get from your home vegetable garden. By using succession planting, you could double or triple the volume of fresh vegetables you harvest from your garden.

By continuously planting and harvesting each season in spring, Summer, and Fall, with weather-appropriate plants, you can turn your garden into a very efficient food source.

Crop rotation

Those of us who have been gardening for years all have a story about a bumper crop one year leading to a minuscule harvest the next.

Bountiful plants followed by punier versions is a very common tale among gardeners, and the culprit isn't the validity of your (or our) green thumb – the answer to fighting this boom-and-slump cycle is crop rotation.

Crop rotation is, essentially, an extension of the work you did in initially laying out your garden, and deciding where to plant what.

Moving the plant groups that you have placed together to new locations – and new soil – every year is something that some gardeners don't do, but it can be a huge improvement to nearly any garden, in several ways.
First of all, rotating crops year after year helps to keep that soil that we spent so much time worrying about healthy and fertile. By planting the same plants in the same soil each year, those same plants are going to drain the same nutrients – in the same way – year after year, and over time that soil will become less effective.
Additionally, rotating your plant groups helps to mitigate soil diseases and pests mainly nematodes.
What are those? These are conditions like verticillium wilt and rootworms that prefer certain types of plants – so planting the same thing in the same location each year helps them set up a permanent foothold.

It is recommended that crop locations are rotated to a different plant family after each planting over two years.
Some examples are as follow:
Night Shade: Tomato, Eggplant, Pepper
Morning Glory: Sweet Potato
Legumes-Bean: Long Beans, Wing Beans

Maintaining the garden
Once you've planted your seeds, it's time to get to maintaining those plants. Garden maintenance isn't difficult, it just requires a little attention every day. This is what, for many of us, makes gardening so enjoyable.
It gets us out of the house and into the warm sun each day, carefully watching and tending to the plants as we see the fruits – sometimes literally – of our labor thrive.

Watering
When, how often, and how much water to give a garden is one of the most common questions beginner gardeners ask. Watering your garden can be as simple as watching rain falls, or as complex as installing automatic irrigation systems. Finding the happy place somewhere in between is where most beginner should flourish.
In terms of how much water your garden needs, that really depends on many factors. The plants, your location, the type of soil you have – all of these are factors in how much you'll need to water your garden.
In terms of soil, sandy soils tend to (of course) hold less water than heavier dirt or clay soils. So, consider how long it takes that soil to dry out.
This is another reason that soil building with compost or manure is highly recommended – this creates healthy soil that drains rainwater sufficiently while retaining just enough water for plants.
As a rule of thumb, your garden soil should be just moist. If the weather is rainy, you may not need to add any

water at all. If it's hot and dry, then you'll want to bring out the hose. Watering in the morning tends to be best, so that evaporation is reduced, but watering in the afternoon is okay, too. If you water later in the day, try not to let the plants get too wet – this can encourage fungal growth if the dampness persists into cool evenings.

Weed control

Weeds compete for sunlight, water and nutrient.

If you've taken steps to prevent weeds when you created your garden, weed control on an ongoing basis should be fairly manageable – particularly if you're using raised beds or square-foot gardening methods, which tend to not inherit weeds.

Weeds can surprise you – even in a weed-free patch of soil, you may find that once you plant, you start seeing weed growth, too.

This is because the seeds for those weeds can remain deep under the soil, where they don't get enough sun or moisture to grow, until they're dredged up toward the surface by your tiller, hoe, or trowel. For this reason, you should keep an eye on your garden for weed growth.

When you do see weeds popping up, don't wait for them to become a bigger problem. Young weeds are much easier to deal with than older ones. Once you've pulled them, just toss them on the ground – as they decay, they will help add nutrients to your soil.

Pest control

The best thing you can do for pest control is companion planting, as discussed earlier. Another good practice is to plant flowers in addition to your vegetables – this will attract bees and other insects, which will act as natural pest deterrents.

Still, even with plenty of preparation, sometimes pests like aphids, corn earworm, leaf footed bug, mites, scale and others will appear. The best pest control method depends on your plants, and the type of pests you have. Few natural pesticides that you can make at home are presented in ***Annex 2.***

For advice on pest management contact your Extension Agent

Fertilizer

So, you've composted and mulched and manured – your soil is in tip-top shape. But, as we've mentioned, even manure doesn't have the nutrient content of a good fertilizer, so it may be good to consider using some (especially if you don't use manure). There are 3 major kinds of fertilizer:

- **Organic fertilizers** are just what they sound like: they're made from natural materials, and have to be broken down naturally by microorganisms in your soil,

resulting in a slow, gradual release of nutrients.

- **Water-soluble fertilizers** are mixed with water and **sprayed** onto soil and plants as a liquid, rapidly feeding nutrients to the plants.
- **Synthetic fertilizers** are nutrient-rich chemical compounds that attempt to emulate the effects of organic fertilizers on a more rapid, and more nutrient-rich, basis. Plants get food from the ground, sunlight, air and water. For best growth, plants often need more food than is in the soil, especially after the first crop. They will need another source of food from fertilizer or compost.

Harvesting the crops

This is the time you've been waiting for! All throughout the season you've weeded, you've watered, you've nurtured and you've fertilized. Now those veggies are ripe, and it's harvest time. Here are some tips for harvest time to help you make the most of your home garden.

First of all, resist the urge to harvest all in one day. Vegetables ripen at different times, and some plants produce harvestable vegetables continuously for weeks.

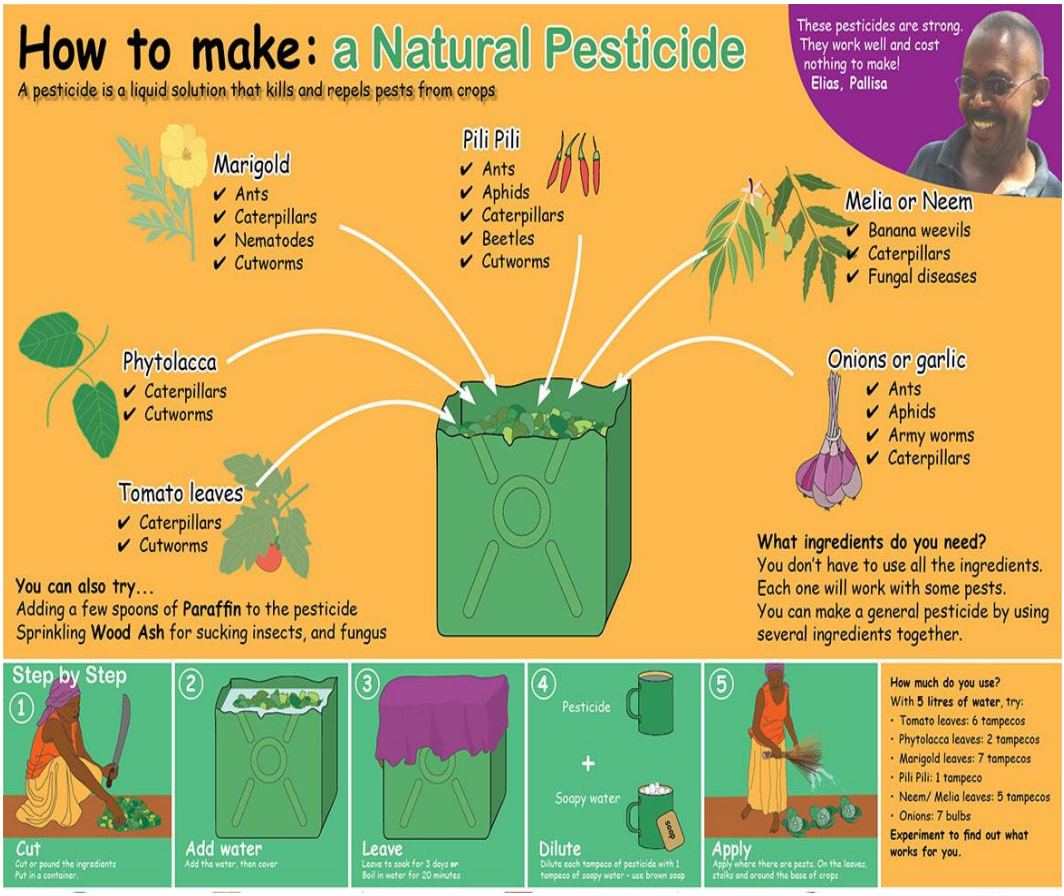
Make harvesting part of your daily garden routine – harvest veggies as they ripen. This ensures that you get a constant supply of fresh, ripe veggies, and it encourages production in the plant (since it isn't wasting energy and nutrients on a vegetable that's already ripe anymore).

Always harvest fruits and vegetable when they are ripe do not allow over ripping or rotting, over ripe fruits and vegetable can become breeding places for pests (e.g. fruit flies) Do not allow rotten or bad produce on the ground again this will great breeding places for pests.

For leafy vegetables, cut through the whole stalk at an angle – harvest these in the cool morning time if you can. For summer squash, you can harvest by holding the vine in one hand while holding the squash in your other hand. A gentle pull is all it takes. In the case of winter squash, cut the vines about 3 inches from the squash.

For root vegetables like onions, carrots, and potatoes, loosen the soil around them with a garden fork before pulling – you don't want to damage the veggies by trying to pull them through solid soil! If you can, try to leverage the veggies out with the fork after loosening the soil, rather than by pulling alone

Organic pest control



Root crops production

Sweet potato (*Ipomoea batatas*)



© FAO/ S. Sherzard

Soil:

- Can be grown in loamy soil with a pH range of 5.6–6.6

Season and planting:

- All year round
- Plant the terminal vine cuttings (80 000/ha) at 20 cm spacing
- The cuttings should be 10–15 cm in length with 2–3 nodes and to be collected from matured vines aged 3 months and above

Preparation of field:

- Plough the field to fine tilth. The soil depth should be at least 30 cm. Form ridges and furrows 60 cm apart or beds

Irrigation:

- Irrigate before planting, on 3rd day and then after once a week
- Stop irrigation one week before harvest
- No irrigation needed if soil is moist

After cultivation:

- The field should be kept clean by hand weeding till vines are fully developed
- Earth up the field on 25th, 50th and 75th day after planting

Pest management

- Remove previous sweet potato crop residues and alternate host i.e., Ipomoea sp. And destroy them
- Use pest free planting materials

Harvest

- Immediately after maturity and destroy the crop residues

Yield:

- 20–25 t/ha of tubers in 110–120 days

Swamp taro (*Cyrtosperma merkusii*)



© FAO

Value:

- The Swamp Taro is one of the few subsistence crops that grows well on atolls
- The main product is the corm
- The young leaves and inflorescences can be eaten as vegetables and the petioles yield a fibre suitable for weaving
- The big leaves are used as a food wrapper and also to cover the earth oven

Propagation

- This species is propagated using setts, which are suckers, the top of the corm with about 30 cm
- (12 in) of petiole, or cormlets, which are young, immature corms produced by a more mature plant

Cultivation

- Grown in fresh water and coastal swamps
- Grown in purpose-built swamp pits in low-lying coral atolls

Climate

- It needs a constant supply of fresh water & organic material e.g. leaves and can be grown in slightly brackish water, thrives in freshwater swamps and can even be found in swiftly flowing rivers and streams
- Mean annual temperature ranges from 230 °C to 310 °C

Food value

- High concentrations of iron, zinc, and calcium and the yellow corm varieties are usually higher in Beta-carotene

Cassava (*Manihot esculenta*)



© FAO/ K. Hartfield

Recommended varieties

- Beqa
- Yapia Damu
- Vulatolu

Seed rate

- Mechanised: 20 000 cuttings/ha.
- Traditional: 20 000–30 000 cuttings per ha

Spacing

- Ridges-1 m between rows
- Plants within rows 50 cm
- Cutting 30 cm in length
- Mounds: 0.5 m/in diameter
- Traditional-1 m x 1 m

Weed management

- Hand Weeding

Harvest yield

- Early Varieties: Mature in 8–10 months.
- Late Varieties: Mature in 12 months

Yield

- 20–30 tonnes/ha

Food value

- Source of Vitamin A & Vitamin C

Taro (*Colocasia esculenta*)



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Recommended varieties:

- Sawa Toantoal, Pasdora, Sawhn korsae, Sawa Pwetepwet, kuat, Sawa mwahng, Sawa Alahl, Sawa likodopw

Seed rate:

- Traditional Farming System: 10 000 suckers/ha
- Mechanize System: 16 660 suckers/ha

Planting time:

- July to January
- Off Season: March to June
- Wet Zone: Throughout the year
- Intermediate Zone: Sept to March

Spacing:

Traditional System:

- Between rows: 1 m
- Plants within rows: 1 m

Mechanize Systems:

- Between rows: 1 m
- Plants within rows: 60 cm

Fertilizer:

- Poultry Manure: 10 tonnes/ha. Broadcast and mix well with soil before planting

Weed management:

- Hand weeding

Disease management:

- Corm Rot: Improve drainage & Have soil test for Nutrient status
- Shot Hole Spot: A seasonal disease; which disappears when the weather changes
- Remove infected leaves & burn.
- Good husbandry: - regular weeding and timely fertilizer application minimize loss

Harvest yield

- Harvesting at 6–7 months for Hybrid
- Varieties whilst traditional varieties are ready at 9 months for harvest

Yield:

- 20–25 tonnes/ha

Food value:

- Contains large amount of
- Vitamin A, Vitamin B1, Vitamin B2 and Vitamin

Arrowleaf elephant (*Xanthosoma saggitifolium*)



© FAO

Cropping season:

- All year around

Recommended varieties

- Vula
- Dravuloa

Seed rate:

- 10 000 plants/ha

Planting time:

- January to December

Spacing:

- Between rows: 1 m
- Plants within rows: 1 m
- Planting depth: 30 cm

Weed management:

- Hand Weed.

Harvest

- Harvest 12 months after planting

Yield

- 15–20 tonnes/ha.

Food value:

- Source of Vitamin B, Vitamin C, Starch and Protein

Ginger (*Zingiber officinale*)



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Recommended varieties:

- White Ginger
- Red Ginger

Seed rate:

- Immature: 7 500 kg
- Mature: 5 000 kg
- Planting Time: September

Spacing:

Slope Land:

- Immature: 60 cm between rows & 15 cm within rows
- Mature: 60 cm between rows & 20 cm within rows

Flatland:

- Immature: 90 cm between rows, 15 cm within rows
- Mature: 90 cm between rows & 20 cm within rows

Fertilizer:

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with soil 4 weeks before planting

Disease management:

- Remove infected plants
- ensure good drainage system

Insect management:

- Hot water treatment of Planting materials at 51 °C for 10 minutes
- Crop rotation with Cassava & Dalo
- Sanitation
- Proper selection of seed materials

Harvest

- Immature: Harvest at 5 months from planting
- Mature: 10 months from planting

Yield:

- Immature: 20–25 tonnes/ha
- Mature: 25–30 tonnes/ha

Food value:

- Good source of Energy, Potassium,
- Calcium & Sodium

Turmeric (*Curcuma longa*)



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Cropping season:
- August to November

Recommended varieties:
- White
- Yellow

Seed rate:
- 10 to 12 tonnes/ha

Planting time:
- September to October

Spacing:
- Between rows: 60 cm
- Plants within rows: 40 cm

Germination:
- Require free drainage

Weed management:
- Hand weed or hoe regularly

Disease management:
- Hot water treatment of planting material at 51°C for 10 min
- Crop rotation with cassava & Dalo
- Sanitation-remove all rhizomes from the field after harvesting
- Proper selection of seed-choose healthy seeds

Harvest
- 10 months after planting

Yield
- 15 to 25 tonnes

Food value
- (Powder) Dietary fibre, Potassium, Iron, (very high), Calcium, Calories, Magnesium, Vitamin C, Thiamin, Riboflavin, Niacin
- White turmeric has medicinal value

Yam (*Dioscorea alata*)



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Recommended varieties:

- Abya, Gabrach, Wonbey, Rowal, Nagbchey, Surney, Pohnape, Alien, Gamed, Tenmen, Dugyeb, Defrow, Yu Ban, Chugum

Seed rate:

- Ridges: 4.2 tonnes/ha (16 670 setts/ha)
- Mounds: 3.1 tonnes/ha (12 500 mounds/ha)

Planting time:

- Early Varieties: Between October–December
- Late Varieties: Between Jan–March

Spacing:

- Plant Spacing: Ridges–1 m between ridges
- & 0.6 m within ridges
- Mounds: 1 m between mounds and 0.8 m within mounds

Fertilizer:

- Poultry Manure: 10 tonnes/ha.
- Broadcast and mix well with soil before planting

Weed management:

- Hand weeding

Disease management

- Rotate with non-host plants like Cassava, Vegetables (Cabbage, Lettuce)

Insect management

- Use clean material
- Practice Crop rotation

Harvest

- October to March Harvest Index is when leaves start to senescence & are falling off

Yield:

- 15 to 20 tonnes/ha

Food value:

- Fibre, Potassium, Modest amount of Vitamin B1, Vitamin C & fair amount of Iron

Vegetable production

Capsicum (*Capsicum grossum*)



© FAO/ S M. Naim Khalid

Recommended varieties:

- Yolo Wonder A
- Yolo Wonder B
- Blue Star

Seed rate:

- 300 grams/ha

Planting time:

- Cool season (April to Sept). Can be grown all year around under green house

Land preparation:

- Field should be well prepared, 2 ploughing & 2 harrowing is recommended

Spacing:

- Between rows: 65 cm–75 cm
- Plants within rows: 30–40 cm

Germination:

- 6 to 10 days after sowing

Transplanting

- Transplanting during cloudy days or late in the afternoon
- Seedlings raised in seed trays can be planted any time of the day
- Water the plants after transplanting and continue afterwards

Fertilizer

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with 2 weeks before planting

Weed management:

- Practice inter-row cultivation, hoeing or hand weeding

Disease management

- Use resistant varieties,
- Uproot affected plants & pack in bags, bury and burn. Practice crop rotation of non-host plants
- Destroy affected plants and control Mites & Aphids. Use clean planting materials.
- Avoid planting during wet weather. Remove all infected plants. Avoid damaging the crop during weeding. Use disease free seedling

Harvest

- Fruits are ready for harvest at 3 months after planting and picking continues for 2–3 months

Yield:

- 8–12 tonnes/ha

Food value:

- A rich source of Vitamin A and Vitamin C

Chillies (*Capsicum annuum*)



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Recommended varieties:

- Red Fire - Long Red Cayenne
- Bird's Eye
- Bongo Chilly

Seed rate:

- 300 grams/ha

Planting time:

- Best to plant during hot weather season from
- September to February. Can be planted all year around

Planting methods:

- Plant seeds in seedbeds or seedling trays
- transplant to field at 3 leaf stage

Spacing:

- Between rows: 75 cm
- Plants within rows: 30 cm

Germination:

- 5 to 10 days after sowing

Transplanting:

- Transplanting during cloudy days or late in the afternoon
- Water the plants after transplanting and continue afterwards

Fertilizer:

- Poultry Manure: 10 tonnes/ha Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Practice inter-row cultivation

Harvest

- Fruits appear 90–120 days after planting and harvest weekly for one year

Yield:

- Fresh 16 tonnes/ha, Dried 4–6 tonnes/ha

Food value:

- Dried - Dietary Fibre, (Very High)
- Calcium; Vitamin A, Riboflavin and Niaci

Chinese cabbage (*Brassica chinensis*)



© FAO/ K Hartfield

Recommended varieties:

- Pak Choy
- Kwang Moon
- Wong Bok

Seed rate:

- 300 grams/ha

Planting time:

- Cool season but can be grown throughout the year

Planting methods:

- Sow seeds in prepared seedbeds or seedling trays
- Transplant at 3 leaf stage

Spacing:

- Row to row: 50–75 cm
- within rows: 30 cm

Germination:

- 4 to 6 days after sowing

Fertilizer:

- Poultry Manure: 5 tonnes/ha Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Practice manual weed control

Disease management:

- Crop rotation
- Remove and destroy diseased plants by either burning or burying, as soon as symptoms appear
- Select only healthy planting material

Harvest

- Usually takes 30–60 days to get ready depending on variety

Yield:

- Fresh 12 tonnes/ha

Food value:

- Source of Vitamin A, Vitamin B & Vitamin C

Corriander (Coriandrum sativum)



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Recommended varieties:

- Small round seeded
- Large oblong seeded

Seed rate:

- 10 kg/ha

Planting time:

- All year round but better in April to August

Spacing:

- Between rows: 22.5 to 30 cm
- Plants within rows: 4–6 cm

Germination:

- 6 to 10 days after sowing

Fertilizer/manure:

- Poultry manure: 5 tonnes/ha
- Broadcast, mix well into the soil before planting

Weed management:

- Hand weed or hoe when necessary.
- Carry out inter-row cultivation

Disease management:

- Maintain good drainage to prevent root rot

Insect management:

- Generally it is pest free

Harvest

- Regular harvest when the plants are 15–20 cm about the ground

Yield:

- 6 to 8 tonnes/ ha. Use in flavoring, curries and soup

Food value:

- (Leaves) Calories, Protein,
- Iron, Vitamin A, Thiamin, Riboflavin, Niacin, very high in Vitamin C, Potassium, Calcium, Magnesium. Nutritionally a good source but the quantities eaten are too small to be significant

Cucumber (*Cucumis sativus*)



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Recommended varieties:

- Early Set
- Cascade
- Bountiful No. 2
- Space Master
- Early Perfection

Seed rate:

- 2 kg/ha

Planting time:

- All year around, fruits best during cool season

Planting methods:

- Seeds are sown directly into well cultivated soil

Spacing:

- Between rows : 1 m
- Plants within rows: 30 cm (trellising) – 50 cm (ground creeping)

Germination:

- 5 to 7 days after sowing

Fertilizer:

- Poultry Manure: 5 tonnes/ha Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Hand weeding or hoeing is necessary
- Weeds are removed when plants are still standing
- Inter-row cultivation using horse drawn scarifies can be used

Disease management:

- Use healthy seeds of resistant varieties
- Avoid planting at high density

Harvest:

- Harvest at 50–60 days after planting, continue picking of fruits for 3 weeks

Yield:

- Fresh 12–15 tonnes per hectare

Food value:

- Vitamin C

Eggplant (*Solanum melongena*)



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Recommended varieties:

- Chahat
- Pritam/Long Purple

Seed rate:

- 300 grams/ha

Planting time:

- All year around but best the hot and wet season

Spacing:

- Between rows: 1.5 m
- Plants within rows: 50 cm

Germination:

- 5 to 10 days after sowing

Transplanting:

- Transplant at 3 leaf stage
- Seedlings raised in seed trays can be planted any time of the day

Fertilizer:

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Inter row cultivation.
- Practice of hoeing in between the rows and within the plants

Disease management:

- crop rotation
- Uproot infected plants & burn.
- Plant on well-drained soil.
- Field sanitation
- Keep field weed free

Harvest

- Harvest 60–90 days after planting
- For the local market, harvesting can continue for over a year

Yield:

- 20–25 tonnes/ha

Food value

- Dietary Fibre, Vitamin C

French bean (*Phaseolus vulgaris*)



© FAO

Recommended varieties

- Contender
- Butter Bean
- Labrador

Seed rate

- 45 kg–50 kg/ha

Planting time

- Best yields from April to September

Spacing

- Between rows: 50 cm
- Plants within rows: 15 cm–20 cm

Germination:

- 3 to 6 days after sowing

Fertilizer

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with soil 2 weeks before planting

Weed management

- Practice of hoeing
- Inter row cultivation

Disease management

- Plough plant remnants after harvest & rotate with Mildew resistant vegetable like
- Tomato, Cabbage & Eggplant

Harvest

- Harvest tender pods 40–60 days after planting
- Picking continues for 4–6 weeks

Yield:

- 7–10 tonnes/ha

Food value

- Dietary Fibre, Vitamin C

Lettuce (*Lactusa sativa*)



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Recommended varieties:

Head Type:

- Great Lakes
- Boxhill

Leafy Type:

- Green Mignonette
- Butter crunch
- Rapid

Seed rate:

- 300 grams/ha

Planting time:

Head Type:

- March to October

Leafy type:

- All year round

Spacing:

- Between rows: 75 cm
- within rows: 30–40 cm

Germination:

- 5 to 8 days after sowing
- Raised the seedlings in seed trays/seed bed and transplant at 3 to 4 leaf stage
- Seedlings raised in seed trays

Fertilizer:

- Poultry Manure: 5 tonnes/ha
- Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Manual weed control
- Inter row cultivation

Disease management:

- Practice crop rotation
- Avoid planting with high density
- Remove all left over crops

Harvest

- Leafy Lettuce matures in 50–80 days
- Head Type matures in 12–15 weeks

Yield:

- 8–10 tonnes/ha

Food value:

- Dietary Fibre, Source of Vitamin A,
- Vitamin B and C

Long bean (*Vigna sesquipedalis*)



© FAO/ S. Sherzard

Recommended varieties:

- Local White
- Yard Long (Dark Green)

Seed rate:

- 7 kg/ha

Planting time:

- Performs best during hot and wet season

Spacing:

- Between rows: 65–75 cm
- Plants within rows: 15–20 cm

Germination:

- 3 to 6 days after sowing

Fertilizer:

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Hand weed or hoe when necessary
- Inter row cultivation

Disease management:

- Plough plant remnants thoroughly after harvesting, rotate with Vegetables like Cabbage, Eggplant and Tomatoes

Harvest

- Harvest at 50–60 days from planting, pick pods when still tender and harvesting continues for about 2 – 3 weeks

Yield:

- 7–10 tonnes /ha

Food value:

- Dietary Fibre, Vitamin C, Niacin, Vitamin B Complex, Iron and Zinc

Okra (*Abelmoschus esculentus*)



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Recommended varieties:

- Clemson Spineless
- Local Long White
- Dwarf long Pod

Seed rate:

- 8 kg/ha

Planting time:

- All year around but better during hot months

Spacing:

- Between rows: 75–1 m
- within rows: 20–30 cm

Germination:

- 3 to 6 days after sowing

Fertilizer:

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Hand weed or hoe when necessary and
- practice inter row cultivation

Disease management:

- Rotate with crops
- Plant with other vegetables of different families

Harvest

- Harvesting of tender pods at 60–90 days from planting; and is carried out 2 to 3 times a week and continue for 1 year

Yield:

- 15 tonnes

Food value:

- Dietary Fibre, Potassium, Calcium, Magnesium, Vitamin C

Pumpkin (*Cucurbita maxima*)



© FAO/ K. Hadfield

Recommended varieties:

- Queensland Blue
- Butternut
- Local Selection

Seed rate:

- 1.5 kg/ha

Planting time:

- All year around

Spacing:

- Between rows: 1.5 m
- Plants within rows: 1 m

Germination:

- 3 to 6 days after sowing

Fertilizer:

- Poultry Manure: 10 tonnes/ha
- Broadcast and mix well with soil 2 weeks before planting

Weed management:

- Hand weed or hoe when necessary but do not damage the stem
- Inter row cultivation is also recommended

Disease management:

- Rotate with crops of different family such as Eggplants

Harvest

- Harvest at 12–15 weeks from planting

Yield:

- 10–15 tonnes

Food value:

- Dietary Fibre, Potassium, Vitamin C & Vitamin A

Radish (*Raphanus sativus*)



© FAO/ R. Rorandelli

Recommended varieties:

- Long Whiteside
- Awa Cross
- Everest

Seed rate:

- 10 kg/ha

Planting time:

- Can be planted all year round

Spacing:

- Between rows: 50 cm
- Plants within rows: 5 cm
- Broadcast then thin out to 5 cm apart 2–3 weeks after germination

Fertilizer:

- Poultry Manure: 5 tonnes/ha
- Broadcast and mix well with soil before planting

Weed management:

- Pull out weeds or use a hoe

Harvest

- Harvest at 30–40 days from planting

Yield:

- 8–15 tonnes/ha

Food value:

- Dietary Fibre & Vitamin C

Spring onion (*Allium cepa*)



© FAO/ K. Hadfield

Recommended varieties:

- White Lisbon
- Yellow Bermuda

Seed rate:

- 4 kg/ha

Planting time:

- At the start of the cool season.

Spacing:

- Between rows: 50 cm
- Plants within rows: 8 cm

Germination:

- 6 to 10 days after sowing

Fertilizer/manure:

- Poultry Manure: 5 tonnes/ha
- Mix well in the soil 2 weeks before planting

Weed management:

- Mulch with straw materials.
- Hand weed or hoe when necessary; spray pre emergence herbicide

Harvest

- 8 to 12 weeks after planting

Yield:

- 10 to 12 tonnes/ha

Food value:

- Source of Iron, Zinc, Vitamin C and Thiamin

Tomato (*Lycopersicon esculentum*)



© FAO/ K. Hadfield

Recommended varieties:

- Alton
- Redland
- Summer taste
- Alafua Large

Cropping season:

- May to October

Seed rate:

- 300 grams/ha

Planting time:

- Main season in the cool months

Spacing:

- Between rows: 0.75 m to 1.0 m Plants within rows 30 to
- 40 cm for staked varieties
- Between rows: 1.5 m
- Plants within rows
- 30 cm for indeterminate varieties grown in open fields

Fertilizer manure:

- Poultry Manure: 12 tonnes/ha
- Broadcast 2–3 weeks after planting. Soil analysis should be done before fertilizer application

Weed management:

- Hand weed
- Inter row cultivation
- Mulching

Disease management:

- Dig, remove and destroy infected plant
- Improve drainage
- Use a two-year rotation
- Use resistant varieties

Harvest

- 10 to 12 weeks after transplanting and picking continues for 5 weeks

Yield:

- 10 to 15 tonnes

Food value:

- Source of Potassium, Calcium, Sodium, Dietary fibre and Protein

Zucchini (*Cucurbita pepo*)



© FAO/ M. Salustro

Cropping season:
- Cool dry but can be grown all year round

Recommended varieties:
- Marrow
- Black jack

Seed rate:
- 3 kg/ha

Planting time:
- Cool season

Spacing:
- Between rows: 1 m
- Plants within rows: 30 cm

Germination:
- 5 to 10 days after sowing

Fertilizer/manure:
- Poultry Manure: 12 tonnes/ha Broadcast, mix well before planting

Weed management:
- Hand weed or hoe when necessary
- Practice mulching to control weeds and retain soil moisture

Harvest
- 6 to 8 weeks after planting

Yield:
- 8 to 10 tonnes/ha

Food value:
- Dietary fibre, and Vitamin C

Fruit production

Acid lime (*Citrus aurantifolia*)



© FAO/ K. Hadfield

Varieties:

- PKM1, Vikram

Soil and climate:

- Tropical and sub-tropical
- Deep well drained loamy soils are the best

Season:

- December–February and June–September

Planting:

- Space: 5 m x 6 m
- Pit: 75 x 75 x 75 cm pits

Irrigation:

- Irrigate copiously after planting
- After establishment at 7–10 days interval
- Avoid water stagnation

Manures and fertilizers

- Farm yard manure
- compost

Intercropping:

- Legumes and vegetable crops can be raised during pre-bearing age

Insect/pest management

- Aphids: Spray neem oil at 3 ml/lit
- Shoot borer: Prune the withered shoots 4 cm below the dried portions
- Citrus Butterfly: Spray two rounds of Bacillus thuringiensis at 1g/lit or neem oil at 10 ml/lit during new flush formation

Disease management

- Twig blight: Prune dried twigs
- Scab: Spray 1 percent Bordeaux mixture

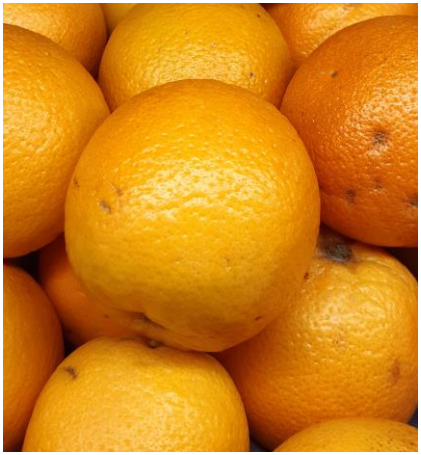
Harvest:

- Starts bearing from 3rd year after planting

Yield:

- 25 t /ha /year

Sweet orange (*Citrus sinensis*)



© FAO/ K Hadfield

Varieties:

- Sathugudi

Soil and climate:

- Deep well drained loamy soils
- pH - 6.5 to 7.5
- A dry climate with about 50–75 cm of rainfall from June–September and with well-defined summer and winter season is ideal

Season:

- July to September

Planting material:

- Budded plants (Root Stock: lime is best, now Rough lemon is also preferred)

Preparation of field:

- Dig pits at 75 x 75 x 75 cm in size at 7 x 7 m spacing
- Fill up the pits with top soil and 10 kg of FYM. Plant the budded plants in the centre of the pits and stake it

Irrigation:

- Immediately after planting irrigate copiously
- Once in 10 days

Manures and fertilizers

- Farm yard manure
- Compost

Intercropping:

- Legumes and vegetable crops can be raised during pre-bearing age

Harvest:

- Starts bearing from 5th year after planting

Yield:

- 30 t/ha

Mandarin orange (*Citrus reticulate*)



© IAEA / L. Potterton

Varieties:

- Coorg Orange and Kodai Orange

Soil and climate:

- Sub-tropical climate
- 150 cm–250 cm rainfall is required.
- Deep well drained loamy soils are the best
- Soil pH should be between 5.5–6.5

Season:

- November–December
- Planting: Seedlings and budded plants
- Spacing: 6 x 6 m, pit size 75 x 75 x 75 cm. planting during May–June and September–October

Manures and fertilizers:

- Manures are to be applied in the basin 70 cm away from the trunk and incorporated

After cultivation:

- Remove water shoots, root stock sprouts, dead and diseased shoots
- Remove laterals of the main stem up to 45 cm from ground level
- Basins should be provided for each tree with gradient slope

Pest management

- Aphids : Spray neem oil 3 ml/lit or Fish oil rosin soap at 25 g/lit
- Bag the fruits with polythene bags punctured at the bottom
- Apply smoke and set up light traps or food lures (pieces of citrus fruits)
- Prune the withered shoots 4 cm below the dried portions

Harvest:

- Budded plants start bearing from 3–5 years after planting while seedlings take 5–7 years

Yield:

- 15–20 t/ha/year

Sapota (*Manilkhara achras*)



© Orgpick

Varieties:

- Oval, Cricket Ball, Kirtibarti, Guthi, CO 1, CO 2, CO 3, P KM 1, PKM 2, PKM 3, PKM 4, PKM (Sa) 5 and Kalipatti

Soil and climate:

- It can be grown in all types of soils

Planting materials:

Grafted on *Manilkhara hexandra* (Pala) rootstock

Season of planting:

- June–December

Spacing:

- 8 x 8 m (156 plants / ha) for conventional planting.
- Adopt high density planting at 8 x 4 m (312 plants/ha) for high productivity

Planting:

- Dig pits of 1 x 1 x 1 m in size.
- Fill up with top soil mixed with 10 kg of FYM

Irrigation:

- Irrigate copiously immediately after planting and on the third day and once in 10 days afterwards till the graft establishes

Manures and Fertilizers

- Manures may be applied 45 cm away from the trunk
- FYM – 10 kg
- After cultivation: Remove the root stock sprouts, water shoots, criss-cross and lower branches

Inter cropping:

- Legumes and short duration vegetable crops may be raised as inter crop during pre-bearing stage

Harvest:

- Collect when fruit brown in colour. Immature fruits it is green
- The mature fruits are harvested by hand picking

Yield:

- 20–25 t/ha year

Avocado (*Persia americana*)



© FAO/ K. Hadfield

Fruiting season:
- March to July

Recommended varieties:
Local Selection

Seed Rate:
- 123 plants/ha

Planting time:
- All year round

Spacing:
- Plant 9 x 9 m apart and away from other trees and buildings

Germination:
- Seeds are quick to germinate

Fertilizer/manure:
- Heavy mulch around the base of the plant ensures steady growth
- Soil analysis should be done before fertilizer application

Disease management:
- Root Rot: Maintain good drainage. Prune regularly

Insect management:
- No significant insect pests of concern

Harvest
- Normally fruits appear after 6 to 7 years from planting but grafted/budded plants come into bearing earlier at about 4 to 5 years

Yield:
- About 10 to 15 tonnes/ha from an orchard of about 10 to 12 years.
- Prune regularly

Food value:
- Dietary fibre, Potassium & Vitamin C

Passionfruit (*Passiflora edulis*)



© FAO/ N. Tohovaka

Recommended varieties
- Local Yellow

Seed rate
- 1111 Seedlings/ha

Planting time:
- cool and dry months

Spacing:
- Between Rows : 3 m
- Plants within rows : 3 m
- Posts: 3 m within rows 6.2 m within rows
- Seeds germinate in 10 days after sowing, ready for transplanting within 6-8 weeks

Fertilizer:
Use compost

Weed management:
- Ring weeding during early stages of growth.
- Hand pollination to be practiced to obtain high yield, to be carried out in the afternoon; after 2 pm
- Integrate apiculture farming with passionfruit for pollination purpose

Disease management:
- Collar Rot: The disease can be controlled by good site selection & planting on raised bed

Insect management
- Red Spider Mite: Controlled by spraying

Yield:
- 1st Year: 12–18 tonnes/ha
- 2nd Year: 20–25 tonnes/ha
- 3rd Year: 10–12 tonnes/ha

Food value:
- Good Source of Iron and Vitamin C

Pineapple (*Ananas comosus*)



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Fruiting season:

- Main Season November to April
- Off Season: February to October

Recommended varieties:

- Smooth Canyenne (Large juicy fruit)
- Ripley Queen (Small sweeter fruit - thorny leaves)

Seed rate:

- Sloppy Land (37 037 suckers/ha)
- Flatland – 48 000 suckers/ha

Planting time:

- Dry season
- Use raised beds on flat land
- Practice phase planting for all year round production

Spacing:

- Sloppy Land: 1.2 m between ridges, 0.6 m between rows per ridge & 0.3 m between plants (Double rows)
- Flat Land: 1.4 m between ridges, 0.4 m between rows per ridge and 0.2 m between plants (Double rows)
- Best planting material are suckers weigh 250–300 or 25–30 cm in height

Fertilizer

- Use compost

Weed management:

- Manual Weeding
- inter row cultivation

Disease management:

- Planting during dry season with good field drainage

Yield:

- Planted Crop: 40–70 tonnes/ha at 1–1.5 kg/fruit
- 1st Ratoon: 30–40 tonnes/ha with ~ weight of 1.0–1.5 kg
- 2nd Ratoon: 20–25 tonnes/ha with ~ weight of 1–1.2 kg

Food value:

- Good source of Vitamin C and Vitamin B1
- & Fibre

Watermelon (*Citullus lanatus*)



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Recommended varieties:
- Charleston Grey
- Sugar Babe
- Farmers Giant

Seed rate:
- 1.5–2 kg/ha

Planting time:
- April to September during the cool season but can be grown all year round

Spacing:
- Between Rows: 3 m
- Plants within Rows: 1 m
- Germination: 6–10 days after sowing

Fertilizer:
- Poultry Manure: 10 tonnes/ha
- Mix well in the soil 2 weeks before planting

Weed management:
- Hand weeding of hoeing as necessary
- Practice of mulching to retain moisture and control weeds

Disease management:
- Have soil analyzed for level of K, and Ca
- High level of N and low level of K & Ca causes blossom end rot
- Keep your crop free from insects to avoid spread of viral diseases

Harvest
- Harvest at 70–120 days from planting

Yield:
- 15–20 tonnes/ha

Food Value:
- Vitamin C

Banana (*Musa sapientum*)



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Recommended varieties:
- Kudud
- Mocao
- Mangat Kingit
- Peleu
- Utin wai
- Utin Lihli
- Others (etc)

Seed rate:
- 1 666 suckers/ha

Planting time:
- Recommended from October to March otherwise all year round

Spacing:
- Between Rows: 3 m
- Plants within Rows: 2 m
- Planting Materials: Select healthy and disease free as planting materials

Fertilizer:
- Apply compost around the plant based on canopy diameter

Weed management:
- Ring weeding

Disease management:
- Remove infected plants & bury.
- Field sanitation
- Good planting materials,
- Hot water treatment for Nematodes

Insect management:
- Keep plantation clear of any plant debris & weeds
- Use suckers from non-infected areas
- Practices good husbandry practices

Harvest
- Fruits appear after 9–10 months from planting & ripens about 3 months from fruit set

Yield (dry):
- 1666 bunches in 1st year, 2500 bunches in 2nd Year if two suckers are maintained per stool

Food Value:
- Potassium, Vitamin A & Vitamin C

Cocoa (*Theobroma cacao*)



© FAO/ K. Hadfield

Recommended varieties:

- Amelonado
- Trinitario
- Keravat

Seed rate:

- 2500 plants/ha

Planting time:

- Can be planted all year
- Dry Zone: Mid September to December
- Wet Zone: October to December

Spacing:

- Between Rows: 2 m
- Plants within Rows: 2 m

Planting materials:

- Select healthy and disease free as planting materials

Fertilizer:

- Compost
- Apply fertilizer around the plant based on canopy diameter

Weed management:

- Ring weeding

Disease management

- Canker: Remove & destroy diseased plants
- Sanitation: Remove disease parts away from the Cocoa field, burn & bury. Plant the recommended variety
- Remove black pods regularly & bury or burn outside the plantation
- Prune shade trees & overgrown Cocoa branches

Harvest:

- Harvest at 3 years after planting

Yield:

- 2.5 tonnes/ha Wet beans.
- Or 2.0 tonnes/ha Dry

Food value:

- Source of Thiamin, Niacin & Vitamin B12

Coconut (*Cocos nucifera*)



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Recommended varieties:

- Rotuman Tall
- Niu Leka
- Niu Magimagi
- Niu Drau
- Niu Kitu
- Niu Yabia
- Malayan Red Dwarf x
- Rotuman Tall
- Malayan Yellow Dwarf x
- Rotuman Tall

Seed rate:

- 123 plants/ha
- 6 to 7 months old seedlings are used as planting materials

Planting time:

- Best time for planting is at the onset of the rainy season - October to April

Spacing:

- Triangular : 9 x 9 m
- Square : 10 x10 m

Fertilizer:

- Compost

Weed management:

- Ring weeding

Disease management:

- Remove and destroy diseased seedlings and destroy diseased plants

Insect management:

- Rhinoceros Beetle
  - Biological control using virus, fungus & pheromone traps
- Stick Insects - Cultural method, Good field sanitation

Harvest

- Bearing
- Tall: 5–7 years to bear nuts
- Dwarf: 3–4 years to bear nuts
- Hybrid: 3–4 years to bear nuts

Yield: in dried copra

- Tall : 0.7 1.3 tonnes/ha Dwarf: 0.7–0.8 tonnes/ha
- Hybrid 2–3 tonnes/ha

Food value:

- Vitamin C, Vitamin B1, B2 & Iron.

Kura (Noni) (*Morinda citrifolia*)



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Cropping season:
- All year round

Recommended varieties:
- Local Selections
- Small fruit varieties are preferred

Seed rate:
- 625 seedlings/ha

Planting time:
- Can be planted all year round but best during October to March enhance plant growth

Spacing:
- Between rows: 4 m
- Plants within rows: 4 m

Germination:
- Seeds germinate in 25–30 days and within 12–16 weeks, plants are ready for transplanting

Fertilizer/manure:
- Kura is grown naturally (organically) to be planted in new areas
- Soil analysis should be done before fertilizer application

Weed management:
- Ring weed round and in between the plants during establishment stage
- Pruning of main shoots to dwarf the trees for ease of harvest

Disease management:
- No economic diseases

Insect management:
- No economic pests

Harvest
- Fruiting will start at 13–15 months after transplanting

Yield:
- 1.0 to 1.5 kg/tree/week under optimum management practices

Food value:
- Vitamin C

Mango (*Mangifera indica*)



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Recommended varieties
- Kensington
- Tommy Atkins
- Mexican Kent
- Parrot
- Mango Dina

Seed rate:
- 125 plants/ha

Planting time:
- Planting is recommended during the Wet
- Season (November to March)

Spacing:
- Between Rows: 9 m
- Plants within Rows: 9 m

Germination:
- Grafted seedlings enhance early flowering & fruiting
- Grafted plants can be produced from reliable nursery few days before transplanting

Fertilizer:
- Compost

Bearing trees:
- 2 –3 kg annually

Weed management:
- Manually control weeds

Insect management:
- Set up protein bait traps
- Good field sanitation
- Bury all fallen fruits to prevent pests population build up

Harvest
- Grafted plants start to fruit within 3 years
- Yields vary depending on the varieties age of tree & weather conditions

Yield:
- Improved Varieties: 25–80 kg/tree in 5th–7th year
- 70–150 kg/tree in 8th to 15th Year

Food value:
- Rich in Vitamin A as well as Vitamin C

Papaya (*Carica papaya*)



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Recommended varieties
- Sunrise Solo (Export Variety)
- Waimanalo (Local markets)

Seed rate
- 1 667 plants/ha

Planting time:
- Can be planted all year round.

Spacing:
- Between Rows: 3 m
- Plants within Rows: 2 m

Germination:
- The seeds germinate in 10 to 12 days after sowing. In cooler seasons it takes longer 18 to 21 days
- The seedlings are grown in plastic pots for 6 to 7 weeks after sowing before transplanted in field

Fertilizer:
- Compost

Weed management
- Plastic mulching controls weeds

Disease management
- Plant papaya in well drained fields

Insect management
- Good field sanitation, remove and bury fallen fruits

Harvest
- Fruit ripens at 8 to 10 weeks after flowering. Maximum yield of
- 60 to 80 tonnes/ha

Food value:
- Excellent source of Vitamin A and Vitamin C

Soursop (*Annona muricata*)



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Fruiting season:
- October to April

Recommended varieties:
- Local Selection

Seed rate:
- 500 plants/ha

Planting time:
- Can be planted all year round
- Planted during November to March enhance plant establishment

Spacing:
- Between rows: 4.5 m
- Plants within rows: 4.5 m
- Germination: Propagated by seeds, cuttings or grafted on same rootstock
- Seedlings are grown in nursery and transplanted in to the field at 8 to 10 leaf stage

Fertilizer/manure:
- Compost & farm yard manure

Weed management:
- Ring weed the plants - hand weeding

Disease management:
- Root rot can be a problem if grown in waterlogged areas
- Avoid planting in poorly drained sites

Insect management:
- Birds and Bats eat ripe fruits on the tree
- Harvest fruits before full ripeness

Harvest
- Fruiting starts in 2 to 4 years after planting

Yields:
- 8 to 10 tonnes/ha/year after 3 years from planting
- Economic life 10 to 12 years

Food value:
- Fair source of Protein, Dietary fibre, Potassium and Calcium

Vanilla (*Vanilla fragrans*)



© Apolima edge

Recommended varieties:
- Bourbon vanilla

Seed rate:
- 1 111 plants/ha

Planting time:
- Can be planted all year round

Spacing:
- Between Rows: 3 m
- Plants within Rows: 3 m
- Cutting: 1.5 m long sprout in 15–20 days after planting

Fertilizer:
- Require heavy mulching: 20–30 cm around base. (Coconut husk, dry leaves & rotten decaying timber can be safely used as mulch)
- Poor Soils: Apply 20–30 g of Nitrogen &Phosphorus, 60–100 g Potash per Vine per year beside the organic mulch
- Soil analysis should be done before fertilizer application

Weed management:
- Hand weeding or use of brush cutter at least four times a year

Disease management:
- Remove & destroy infected plants.
- Use healthy and disease free planting materials
- Wash hands after handling infected plants
- Wait for a month for the virus to die, then replant the area

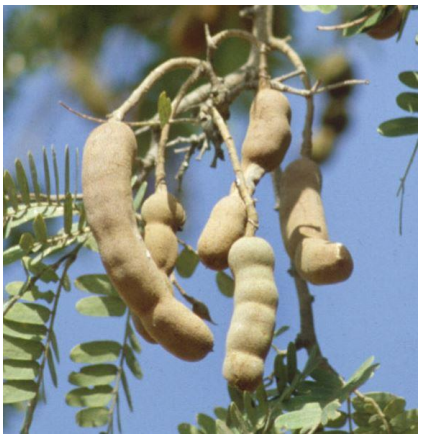
Insect management:
- Slugs & Snails: Control by hand picking and use Snail bait
- Keep area clean

Harvest
- Harvest at 3 years

Yield:
- 300–600 kg cured beans

Food value:
- Food flavor

Tamarind (*Tamarindus indica* L)



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Varieties
- Tamarindo

Propagation
- Seed, vegetative and tissue culture propagation methods

Soil and climate
- Often known as the hurricane-resistant tree
- sodic and saline soils
- It can grow well between 21°C and 37°C

Season
- evergreen

Planting
- Plant in rainy season
- Plant deeper than 1.5 cm.
- Transplant the seedling when 10 cm to a pit of 1 x 1 x 1 m
- Spacing 4 x 4 m or 5 x 5 m.

Irrigation
- Annual rainfall of 500–1500 mm.

Intercropping:
- Legumes and vegetable

Manure and fertilizers
- None

Insects
- Shot hole borers, leaf feeding caterpillars, mealy bugs and scale insects

Diseases
- Tree rots, stony fruit disease, bark parasite and bacterial leaf spots

Post-harvest
- Fresh fruits are often dried using small-scale dehydrators, however in most countries rural households dry pods in the sun

Yield
- Young tree yields 20–30 kg fruits per year
- Yield 150–200 kg/tree/year

Products
- Tamarind juice, concentrate, tamarind pulp and pickles

Dragon fruit (*Hylocereus undatus)*



© FAO/ N.Tohovaka

Varieties
- Yellow dragon, Purple haze, Costa Rican sunset

Propagation
- Seed, vegetative and tissue culture propagation methods

Soil and climate
- Well drained red yellow podzolic, lateritic soil and reddish brown earth
- It can grow well between 20°C–30°C. pH 5.5–6.5

Planting
- 60 cm cutting.
- Open areas with more sun light is preferred
  - Spacing: 3 X 3 m
- Pit: 30 cm deep and 20 cm wide

Irrigation
- Annual rainfall of 1700–2500 mm
- Mulching is necessary to reduce moisture loss

Trellising:
- trellis and train vine

Manure and fertilizers
- Organic manure 100 g/plant of (compost)/each 4 months

Insects
- Generally insect free.

Weeds
- Manually remove creeping weeds
- Intercropping

Harvest
- Selective harvesting at full maturity
- Pink red color is indicator of maturity

Post-harvest
- Shelf life is up to 10 days.
- Store at 15–20°C at 85–90 percent relative humidity.

Yield
- Around 12 000 kg/ha

Nutritional value
- Vitamins and fiber

Star apple *(C. cainito L.)*



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Soil and climate
- Grows on any type of soil.
- pH 5.5–6.0 is desirable

Seed preparation
- Select seeds from healthy, sound and ripe fruits
- Plant 1 cm deep & 2–3 cm apart
- Cultivate in shaded area

Transplant
- When 3–5 leaves have developed, transplant the seedlings

Propagation
- Sexually by seeds and asexually by marcotting, inarching, grafting and budding

Land Preparation and planting
- Clear land & plow deeply
- Spacing: 10 X 12 m row x hill
- Put 500 g to 1 kg organic fertilizer or animal manure in each hole

Intercropping
- pineapple, root crops, perennial leguminous crops and vegetable crops

Irrigation
- Water newly cultivated plants
- Water plant while fruiting to keep their juiciness

Fertilizer
- Organic fertilizer.
- 0.5 –1 kg of chicken or cow manure

Pest management
- Twig borers, carpenter moth, mealy bugs, scales, fruit flies, ants and bats

Harvesting
- It bear fruits at the age of 3–5 years
- grown tree bear 1 000 fruits
- Ripe fruit change color and are soft

Food value
- Used as ingredient of ice-cream and sherbet

Mangosteen (*Garcinia mangostana*)



© FAO/ A. Pierdomenico

Soil and climate

- humid tropical lowlands, RH 80–100 percent
- deep soil, permeable soils with high moisture and organic matter
- Need dry seasons
- Temperatures below 5°C and above 38°C can be lethal

Propagation

- Choose large-sized seed and early ripening fruits, to avoid selecting for an inherited late-fruiting
- Soak seed for 24 hrs in water then cultivate
- Transplant at 2-leaf stage
- Grafting, air layering, budding, cutting, inarching and saddle grafting are other methods of cultivation

Planting

- Tree spacing: 8–10 x 8–10 m
- holes measuring 1 x 1 x 1 m deep
- Fill holes with compost, well decayed manure and topsoil
- Training and pruning

Fertilizer

- Limited information available

Irrigation

- Limited information available

Weed management

- Mix cropping
- Use cover crops and intercropping
- Use mulch

Harvesting

- Hand harvest is preferred
- Yields of between 200 and 2000 fruits per tree, or 4–8 t/ha
- Fruit on 5–8 year after transplanting

Food value

- Rich in carbohydrate. The fruit rind contains tannin and dye

Lanzones (Lansium domesticum C)



© Apolima edge

Soil and climate
- sandy loam to clay loam soil, well drained, slightly acidic (5.3 to 6.5)
- needs ample amount of water

Seed
- Seeds from ripe fruits are harvested and extracted after soaking in water for 1–2 days to soften the aril

Transplanting
- produce 2–3 seedlings per seed
- transplant in 7 X 11 polybags

Propagation
- The seedlings can be asexually propagated within 7–12 months from transplanting.
- cleft grafting, marcotting, cutting, inarching and top working

Planting
- Plant in rainy season
- Use compost in the hole and then add top soil

Irrigation
- No water, no fruit
- Irrigate frequently
- Use well drainage system

Fertilizers
- Use organic manure

Training and pruning
- Do not cut top of the erect seedling
- Remove water sprouts of the grafted plants
- Paint all wounds

Pest management
- Ants, mealy bugs, aphids, mites, borers, fruit flies scale insects

Harvesting
- Collect fruit when cluster of fruit is ripe
- Fruit stalk color changes from green to brown when fruit ripen

Food value
- dessert fruit, high in phosphorus and potassium

Rambutan *(Nephelium lappaceum Linn.)*



© Apolima edge

Soil and climate

- Deep, clay-loam or rich well-drained sandy loam rich in organic matter
- pH 4.5–6.5

Seed

- Select well-developed seeds from mature ripe fruits for rootstock

Propagation

- Rootstocks are ready for asexual propagation or cleft grafting in 6–8 months
- Cleft grafting

Planting

- Spacing: 10 X 10 m row X hill, 100 trees/ha
- Hole size 30 X 30 X 30 cm.
- Put 1 kg organic matter in each hole before planting

Weed management

- Shading, intercropping, cover cropping and mulching

Irrigation

- When no water, there is no flower and fruit
- Irrigate frequently
- Use well drainage system

Fertilizers

- Use organic manure at 10–30 kg/year/tree

Training and pruning

- yearly pruning of the dominant or apical shoots and lateral branches

Pest management

- Fruit borer, leaf eating loofer, thrips, mealy bugs, mites

Disease management

- Powdery mildew, vein necrosis, sooty mold

Harvesting

- Tree bears fruit on 3–6 year old
- When color changes from green yellow or red, fruit is ripe
- Cut clusters, use sharp knives

Food value

- Source of vitamin A, C and fiber

Barbados cherry (*Malpighia punicifolia* L.)



© Apolima edge

Soil and climate

- The tree does well on limestone, marl and clay, as long as they are well drained
- The pH should be at least 5.5.
- Mature trees can survive brief exposure to 28 F (-2.22 °C)
- It can tolerate long periods of drought, though it may not fruit until the coming of rain

Seed

- Select well-developed seeds from desirable clones

Propagation

- Air layering, cutting, seed and grafting

Pruning

- It is bushy shrub or small tree (to 15 feet)
- Multiple or single trunks which can be trained
- Occasionally, bushes appear to be composed of canes
- Branches are brittle, and easily broken

Pest management

- Caribbean fruit fly, fruit worm

Disease management

- Root-knot nematode , burrowing nematode, leaf spotting

Harvesting

- Manual picking of fruit
- 13.5–28 kg/tree or 10–15 tonnes/ha

Food value

- source of calcium, phosphorus and vitamin A

Annex 1: A guide to backyard composting

What is Compost?

Compost is a natural fertilizer and soil conditioner. You can make it at home from organic materials such as kitchen scraps and garden waste. When put into a pile, these materials naturally decompose, turning into a rich, soil-like material called compost or humus. Composting is basically a way of speeding up the natural process of decomposition.

The Keys to Good Compost

Balanced diet: For optimal decomposition, the carbon–nitrogen ratio in a compost pile should be about 30:1. Carbon-rich ("brown") materials include dry leaves, corn stalks, and sawdust. Nitrogen-rich ("green") materials include food scraps, coffee grounds, and grass clippings.

Temperature: Compost piles are most active at temperatures of 44 to 52 °C. Decomposition drops with the ambient temperature, and stops altogether if the pile freezes.

Oxygen: Compost depends on the production of aerobic (oxygen-loving) bacteria, which do the work of decomposition.

Moisture: Compost should be moist, but not wet-excess water will decrease oxygen levels, slowing down decomposition.

Ten Easy Steps to Making Compost

1. **Select a site:** In a sunny, well-drained location, measure out an area to site your bin. Three square feet is an ideal bin size, and is the minimum size necessary to generate the required heat in the shortest possible time.
2. **Purchase a bin:** Contact your municipality, a local store, or build your own rodent-proof compost bin.
3. **Form base layer:** In the bottom of the bin, arrange a six-inch layer of coarse materials such as sticks, pruning, and bark pieces. This will allow air to filter into the center of the heap without smothering the soil surface.
4. **Alternate layers:** After the base layer is formed, you can start using your compost bin daily. As you accumulate kitchen or yard waste, add it to the bin in layers, starting with 2 to 4 inches of "green" organic matter. Follow this with more carbon-rich "brown" matter, and continue to alternate between green and brown, ensuring that no organic layer is ever more than 15 inches deep.

5. **Moisten:** Lightly water the pile if necessary-compost ingredients should be damp, not soaking.
6. **Cover:** The compost pile should always be topped by a thick carbon (brown) layer. Using a lid will discourage rodents and other animals.
7. **Monitor:** Each time you add material to the bin, give it a look and a sniff. If the pile has an unpleasant odor, or does not appear to be gradually shrinking, this indicates a problem with the pile.
8. **Add more layers:** The pile will shrink as its contents decompose; continue adding material.
9. **Check:** Compost is generally ready to use after about 2–3 months. This can vary depending on things like temperature and the materials used. Once your bin starts to get full, check to see if the bottom portion of the pile is ready to harvest in order to make room at the top.
10. **Harvest:** Begin harvesting when the compost at the bottom and center is decomposed. Dig out the compost with a shovel, using the door at the bottom of a commercial bin. If you have built your own bin, remove the top new layers and dig the compost from the center.

Further information:
A guide to backyard composting.
https://www.evergreen.ca/downloads/pdfs/Backyard-Composting-Guide.pdf

Annex 2: Natural and homemade pesticides

Name of insecticide:	**Oil spray insecticide**
What pests can be controlled by it?	aphids, mites, thrips
How to make it?	Mix 1 cup of vegetable oil with 1 tablespoon of soap (cover and shake thoroughly), and then when ready to apply, add 2 teaspoons of the oil spray mix with 1 quart of water, shake thoroughly.
How to use it?	Spray directly on the surfaces of the plants which are being affected by the little pests. The oil coats the bodies of the insects, effectively suffocating them, as it blocks the pores through which they breathe.

Name of insecticide:	**Soap spray insecticide**
What pests can be controlled by it?	mites, aphids, earwigs, leafhopper, spider mites, whiteflies, beetles, and other hungry little insects
How to make it?	mix 1 1/2 teaspoons of a mild liquid soap (such as castile soap) with 1 quart of water
How to use it?	Spray the mixture directly on the infected surfaces of the plants. It is always recommended to NOT apply it during the hot sunny part of the day, but rather in the evenings or early mornings

Name of insecticide:	**Neem oil insecticide, fungicide**
What pests can be controlled by it?	powdery mildew, aphids, thrips and whiteflies
How to make it?	Start out with a basic mixture of 2 teaspoons neem oil and 1 teaspoon of mild liquid soap shaken thoroughly with 1 quart of water. Neem oil can be extracted from the seeds of the neem tree.
How to use it?	Spray on the affected plant foliage. It is capable of disrupting the life cycle of insects at all stages (adult, larvae, and egg). Neem oil acts as a hormone disruptor

	and as an "antifeedant" for insects that feed on leaves and other plant parts.

Name of insecticide:	**Diatomaceous earth as a natural pesticide**
What pests can be controlled by it?	snails and slugs as well as other crawling insects
How to make it?	Fossilized algae (diatoms), buy from shops/supermarkets.
How to use it?	Simply dust the ground around your plants, or even sprinkle it on the foliage. This material works not by poisoning or smothering the insects, but instead by virtue of its abrasive qualities and its affinity for absorbing the lipids (a waxy substance) from insects' exoskeleton, which then dehydrates them to death. In order to be an effective, diatomaceous earth needs to be reapplied after every rain.

Name of insecticide:	**Garlic insecticide spray**
What pests can be controlled by it?	Different insects aphids, ants, borers, caterpillar, slugs, whiteflies,
How to make it?	Take 2 whole bulbs (not just 2 cloves) and puree them in a blender or food processor with a small amount of water. quart of water. Let the mixture sit overnight, then strain it into a quart jar, adding 1/2 cup of vegetable oil (optional), 1 teaspoon of mild liquid soap, and enough water to fill the jar.
How to use it?	Use 1 cup of mixture with 1 quart of water and spray liberally on infested plants. Deterrent and killer of insects.

Name of insecticide:	**Pyrethrins**
What pests can be controlled by it?	Toxic to a broad spectrum of pests. Flea, potato, and bean beetles.
How to make it?	Derived from the painted daisy, *Chrysanthemum cinerariifolium*.
How to use it?	Apply dust during cloudy weather or early evening. A nerve toxin, often combined or DE. Degrades rapidly.

Name of insecticide:	**Chile pepper insecticide spray**
What pests can be controlled by it?	Different pests.
How to make it?	Chile spray can be made from either fresh hot peppers or chile pepper powder. To make a basic chile spray from pepper powder, mix 1 tablespoon of chile powder with 1 quart of water and several drops of mild liquid soap. To make chile spray from fresh chile peppers, blend or puree 1/2 cup of peppers with 1 cup of water, then add 1 quart of water and bring to a boil. Let sit until cooled, then strain out the chile material, add several drops of liquid soap to it and spray as desired.
How to use it?	Spray on the infested plant. It is insect repellent. [Caution: Hot chile peppers can be very potent on humans as well, so be sure to wear gloves when handling them, and keep any sprays made from them away from eyes, nose, and mouth.]

Name of insecticide:	**Tomato leaf as a natural insecticide**
What pests can be controlled by it?	aphids
How to make it?	chop 2 cups of fresh tomato leaves (which can be taken from the bottom part of the plant) into 1 quart of water, and let steep overnight. Strain out the plant material
How to use it?	spray onto plant foliage

Name of insecticide:	***Bacillus thuringiensis* –*or* Bt.**
What pests can be controlled by it?	Toxic primarily to caterpillars, Cabbageworms and cutworms, Colorado potato beetle.
How to make it?	Purchase from an agricultural shop/store.
How to use it?	Available as spray or dust. Apply late afternoon and reapply after rain. Mix with insecticidal soap for better coverage. Bacterial toxin; causes caterpillar death usually within 24 hours. Dissipates in 2 days or less.

Annex 3: Synthetic fertilizers

There are 16 main nutrients or elements that plants require for normal growth and development. These nutrients are divided into two main groups, the macro-elements that are required in relatively large quantities and the micro-elements or trace elements, which are required in very small quantities.

The macro-elements are carbon (C), hydrogen (H), oxygen (O), Nitrogen (N), potassium (K), phosphorous (P), calcium (Ca), magnesium (Mg) and sulphur (S).

The trace elements are iron (Fe), copper (Cu), boron (B), molybdenum (Mo), chlorine (Cl), manganese (Mn) and zinc (Zn).

N, P and K are the most well-known elements that plants require, the remaining macro elements (phosphorous (P), calcium (Ca), magnesium (Mg) and sulphur (S)) are also important.

What follows is a short discussion of the main reasons why each nutrient is important. There is also a discussion on how to identify their deficit.

What fertilizer?	**Nitrogen (N)**
Why does a plant need N?	• Nitrogen is essential for the synthesis of proteins in plants. • N is necessary as a building block for genetic material. • N is an essential part of the green pigment chlorophyll. • N is good for leafy vegetables or as a general tonic to boost plant growth.
Where do we find N?	• Plants use nitrogen in two forms, these are ammonium and nitrate • Ammonium will stimulate leafy growth. • Applying nitrate or urea as a foliar spray very quickly stimulates crop growth. • Nitrogen is also found in organic matter, such as lawn clippings, compost, manure as well as blood or bone meal.
N deficiency diagnosis?	• Plants are stunted • Leaves become pale green or yellow (chlorosis) • Yellowing is normally seen on older leaves first

	• Yellowing starts at the tip of the leaf progressing down the middle of the leaf to the leaf base, spreading across the leaf blade as a whole.

What fertilizer?	**Phosphorus (P)**
Why does a plant need P?	• Plants require phosphorous all the time • There is a strong relationship between phosphorous and nitrogen requirements • If there is no N, the plant cannot take up P from the growth medium • P is essential for growth and development of stems, roots, seeds, flowers and seedlings • In crops P improves crop quality, increases root growth and leads to earlier crop maturity.
Where do we find P?	• Phosphorous deficiency can be corrected by adding phosphorus to irrigation water in the form of e.g. potassium phosphate, or a foliar application of ammonium phosphate. As with nitrogen scorching of leaves could occur • A more long-term source of phosphorous is super-phosphate which is applied to the soil
P deficiency diagnosis?	• Plants are stunted x Leaves take on a purplish color. • The undersides of the leaves become characteristically purple especially on the veins. • Fruits mature late and seeds do not develop properly • The change in color usually develops on older leaves first.

What fertilizer?	**Potassium (K)**
Why does a plant need K?	• Makes plant structure • Improve plant growth. • Aids in the plants overall vigor, strength, water uptake and disease resistance. • K plays a role in maintaining plant water balance, controls transpiration, and activates enzymes. • K improves the plants' flower, fruit and seed quality.

Where do we find K?	• Potassium deficiency can be overcome by foliar application of potassium Sulphate or potassium nitrate. A more long-term source of potassium is potash worked into the soil.
What does a plant that is deficient in K look like?	• The first sign of potassium deficiency is that the leaves turn dark green x In time leaves become a purple brown colour. • This discoloration is followed by yellowing of leaf edges leading to a browning dying off (necrosis) of the tissue. • Weak stems, with yellowing or browning around the edges and tips of older leaves are a tell-tail sign of K deficiency.

What fertilizer?	**Calcium (Ca)**
Why does a plant need Ca?	• Calcium is a major constituent of cell walls. • Ca is involved in nitrogen metabolism and activates enzymes. • Ca helps to build strong stems.
Where do we find Ca?	• The effects of can generally be reversed. • This is done by a foliar application of compounds such as calcium nitrate. Calcium is also found in agricultural lime, super-phosphate and gypsum.
What does a plant that is deficient in Ca look like?	• Common symptoms of calcium deficits are stunting, wilting and dark green discoloration. • Leaf margins become scorched x Roots are poorly developed and the root tips die off. • In fruit crops like tomatoes, cucumbers and peppers calcium deficiency causes blossom end rot. This condition is irreversible.

What fertilizer?	**Magnesium (Mg)**
Why does a plant need Mg?	• Magnesium is essential a part of the green pigment chlorophyll and is thus an extremely important element.
Where do we find Mg?	• Magnesium deficiency is common and can be corrected by foliar application of Epson salts. Magnesium is found in a number of commercial fertilizers.
What does a plant that is	• A plant is deficient in magnesium develops yellow leaves • Usually the older leaves of the plant, rather than the new young leave develop this symptom.

deficient in Mg look like?	The margins of leaves turn yellow, spreading to the leaf blade as a whole.

What fertilizer?	**Sulphur (S)**
Why does a plant need S?	• Sulphur is important for the production of chlorophyll • S is also important as a protein constituent.
Where do we find S?	• Mg is found in super phosphate and gypsum.
What does a plant that is deficient in S look like?	• A sulphur deficiency affects the quality and flavour of fruit and vegetables. • It is seen as a light purple discoloration of petioles, stems and veins, with the leaves turning pale yellow. • Dead spots and patches may develop on leaves.

What fertilizer?	**Iron (Fe)**
Why does a plant need Fe?	• Iron plays a vital role in the formation of chlorophyll during photosynthesis.
Where do we find Fe?	• Iron can be applied as iron chelates and iron salts. • Deficiency develops if the growth medium pH is too high or if anaerobic conditions develop in soil or too much magnesium is found in the in the rooting medium.
What does a plant that is deficient in Fe look like?	• Iron deficiency symptoms are similar to those of magnesium. • The major symptoms are yellowing of young developing leaves. • The veins remain green but the rest of the tissue becomes yellow, causing a mottled leaf.

What fertilizer?	**Manganese (Mn)**
Why does a plant need Mn?	• Mn is Essential for the manufacturing of “sugars” • Mn is required for nitrogen metabolism.

Where do we find Mn?	• Manganese can be applied as manganese sulphate • Care must be taken however as this element is toxic at high concentrations.
What does a plant that is deficient in Mn look like?	• Develops first on young tissues and can easily be confused with iron deficiency. • The distinguishing factor is that Mn deficits cause more overall leaf discoloration and may also cause necrotic spots and lesions. • In severe cases leaves become distorted.

What fertilizer?	**Copper (Cu)**
Why does a plant need Cu?	• Plays a role in the activation of several enzymes, effects cell wall formation • Plants require very little Cu to be present.
Where do we find Cu?	• Copper deficits can be remedied by the application of copper sulphate.
What does a plant that is deficient in Cu look like?	• Cu deficiency causes stunting of the plants leading to shortened inter-nodes and small leaves. • Chlorite blotches develop on older leaves, gradually spreading to younger leaves. • Affected leaves turn dull green to bronze with the edges curling upwards.

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