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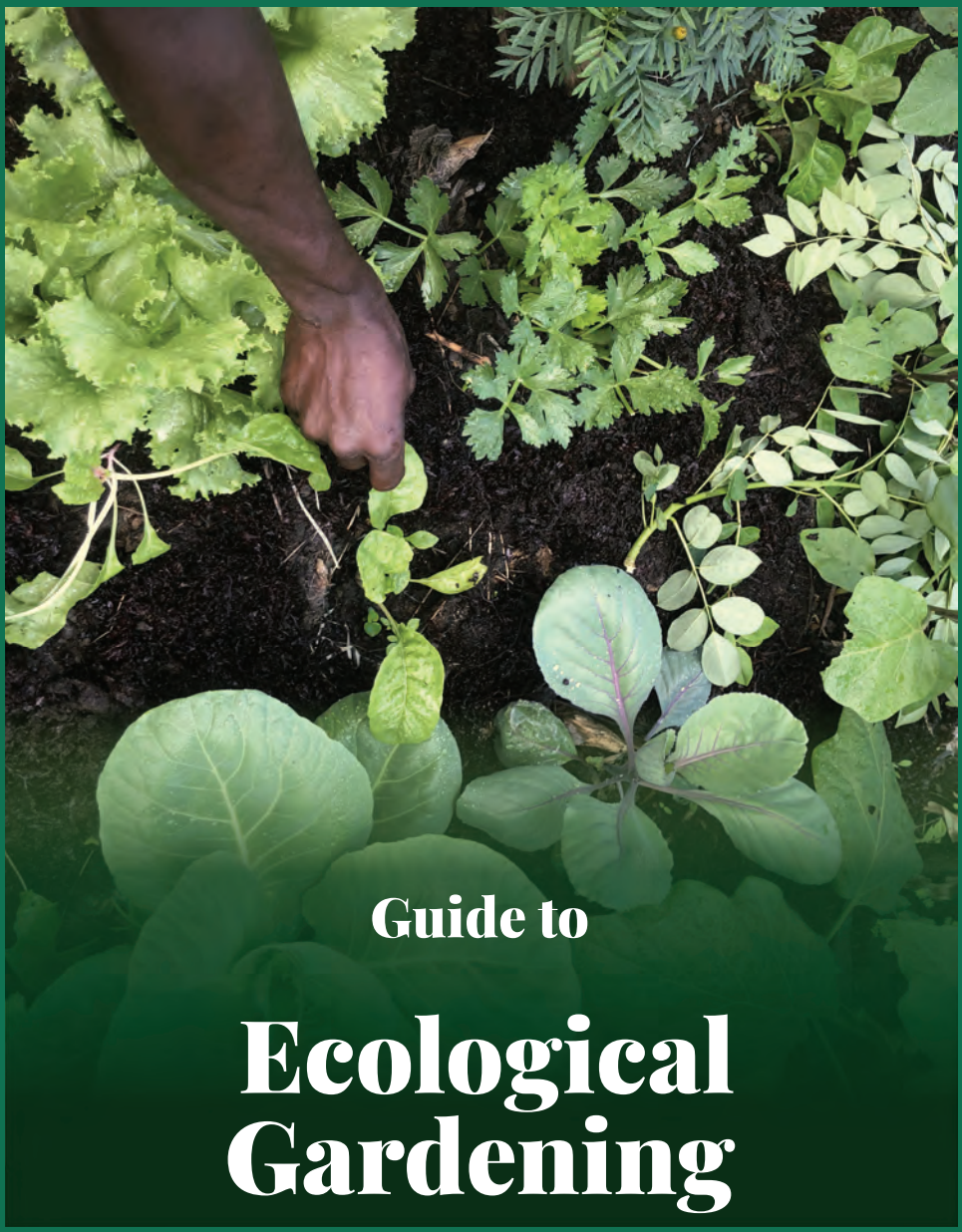

Guide to Ecological Gardening

in St Vincent and the Grenadines

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Richmond Vale Academy
Guide to Ecological Gardening
in St Vincent and the Grenadines

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Richmond Vale Academy
Guide to Ecological Gardening
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*In this manual, **the RVA team** shares their experience in designing and building ecological gardens. The manual is to be used both as a theoretical and practical guide on how and why to create your own sustainable backyard garden.*

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RICHMOND VALE
ACADEMY

Chapter 1

Introduction

The current world civilization is technologically more advanced than at any previous time in recorded history, with the current level of high-tech advancement being largely unimaginable 50 years ago.

This rapid technological progress has its origins in the **industrial revolution**, but has for the most part been based on the discovery, extraction and processing of finite fossil fuels (gasoline, diesel, kerosene, etc.).

Dependence on fossil fuels has permeated every aspect of our lives, from synthetic materials such as plastic, to synthetically derived pharmaceuticals and agro-chemicals, to electricity and fuel for vehicles. Many of the synthetically derived chemicals have toxic effects on the human body, such as being carcinogenic (i.e. cancer causing).

It is not enough that we are totally dependent on a finite resource that is destined to run out.

It is not enough that our oceans and lands have been polluted with these synthetic products that take hundreds of years to degrade.

It is not enough that microplastics are being found everywhere, from the flesh of fish to the breast milk of nursing mothers.

On top of all of this, the burning of fossil fuels has been directly attributed to the **changing climate**, including the rising average temperatures, rising sea levels and extreme weather events. The current agro-chemical method of producing food relies on **synthetic poisons and fertilisers**. These are produced using large amounts of fossil fuel energy; they are destructive to the soil food web (SFW) and ecosystems generally. The use of these agro-chemicals in farming leads to degraded land and diminishing soil fertility.

In a world of increasing population and decreasing viable land for food production, we need **an alternative approach to agriculture** that satisfies three criteria: socially, economically and environmentally sustainable.

In response to the negative effects of "fossil fuel farming" there is an emerging body of knowledge that seeks to produce food in a way that increases the diversity of species, brings dignity and fairness to the human beings in the production process and gives a viable economic return on investment.

This "new" or "alternative" approach to farming is typically referred to as **Ecological or Regenerative Farming**, but other names such as Carbon Farming are also expressions of this renewed approach to sustainable food supply lines. It is essentially a farming system that is **process-based rather than input-based**. That means that the ecological farming system works with the natural system and its inherent processes to deliver long term sustainable production.

The input-based system relies on chemical or organic inputs, usually imported from distant countries and incurring large carbon footprints. These inputs are subject to price and availability fluctuations making any enterprise based on them insecure. When this insecurity relates to food—both its availability and its quality—then it is critical that we, as a nation, secure our food sovereignty.

The Pass-It-On Backyard Ecological Garden project

This project initiated by the **Richmond Vale Academy (RVA)** has sought to introduce communities around St. Vincent to the principles that underpin ecological gardening. The RVA team has designed and implemented over 100 backyard gardens over the past five years, and is well on the way to achieving **the first target milestone on this journey of 200 backyard gardens**. Model garden participants have thus far primarily been selected from villages along the leeward coast. Ten gardens have also been implemented in Fancy, the most northern village on the windward coast.

The participants are involved **from design to implementation.** They are also required to take part in a series of workshops that seek to plant the seeds of understanding soil life, its relationship to what goes on above the ground, and how we can work with the natural processes to create fertile soils and abundant food production.

The Pass-it-On Backyard Ecological Garden Project is, as the name suggests, a model of self-resilient gardening. Once understood and practised, it is to be passed on by the people themselves, where each one can teach one.

In this manual, **the RVA team** shares their experience in designing and building ecological gardens. The manual is to be used both as a theoretical and practical guide on how and why to create your own sustainable backyard garden: how to choose the best location for your garden, building gardens that nourish the **Soil Food Web (SFW)** in order to grow fertile, healthy and abundant soils. The importance of trees for the system and how to make your own compost are just some of the topics that this garden manual focuses on. The understanding and implementation of the knowledge presented in this manual will help you to become independent of chemical inputs whilst producing healthy, abundant crops.

Chapter 2

Ecological Home Garden Design

The Richmond Vale Academy (RVA) team has used the permaculture design approach in the design of the Pass-It-On Ecological Home Gardens. Permaculture design looks at ideas and methods for creating long-term, sustainable, self-maintaining systems for agricultural land, animal systems, houses, projects, and communities.

"Permaculture (permanent agriculture) is the conscious design and maintenance of agriculturally productive ecosystems that have the diversity, stability and resilience of natural ecosystems."*

It is the harmonious integration of landscape and people. Providing their food, energy, shelter, and other material and non-material needs in a sustainable way.

* Bill Mollison, Permaculture Founder

Permaculture Ethics

Permaculture design is based on ethics. Traditional peoples have always had an ethical basis for their relationship with their surroundings. This has been based on millennia of experience often passed down from one generation to the next via myth, custom and superstition, and has served to **protect and maintain** the natural surroundings. Permaculture has condensed traditional ethical behaviors into **three main ethics**:

1. Care of the Earth
The earth is the basis of all life and as such, provision should be made for all life systems to continue and increase.

2. Care of People
Community is the cornerstone of co-operation and as such, we need to ensure that the human element within communities is provided with those resources necessary for their existence.

3. Return of Surplus
When, through our endeavours or good fortune, we have a "surplus" above what we need, then this ethical principle requires us to reinvest it in the first two principles.

For instance, if we increase our water storage by constructing a water catchment feature such as a dam, then this builds resilience for our household and farm/garden, whilst also providing habitat for many life forms. Another example of return of surplus, as regards community, would be contributing any excess resource to a playing field that would benefit the community, giving an open space for community gatherings.

Design Principles

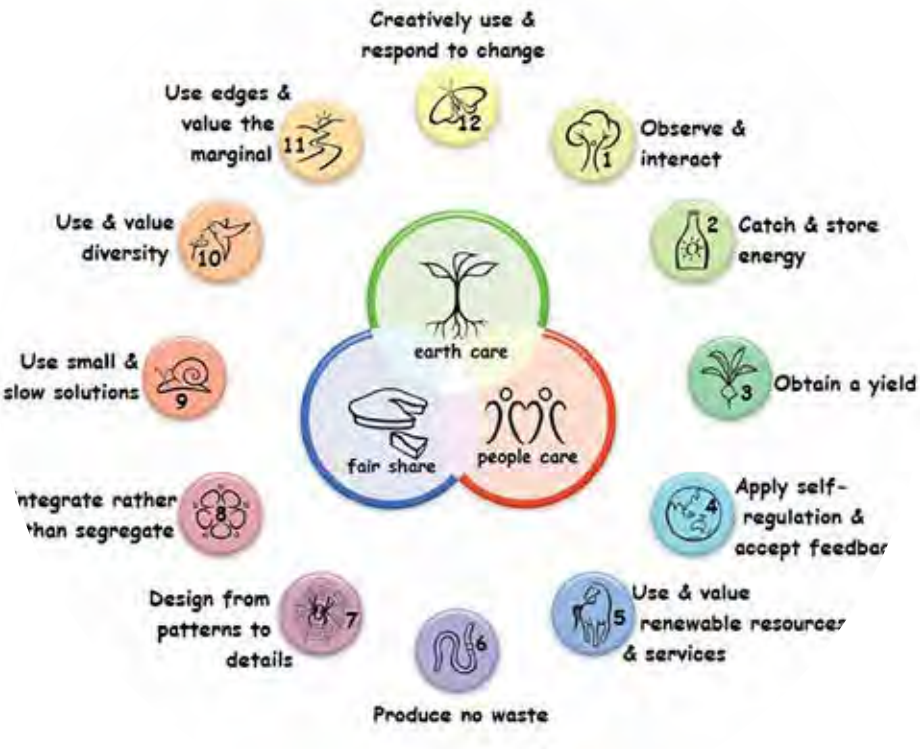
Permaculture has ethics to guide design decisions in favor of a sustainable and holistic outcome. However, for more specific directions on how to construct design systems there are **Design Principles**, and these can be condensed into 12 principles.

Permaculture Design

To design is to create, plan, invent, and arrange. It is how **permaculture takes different elements and brings them together** as an integrated, whole system, the same as a natural ecosystem. Thoughtful designing with permacultures' principles as the base will create resilient, diverse, sustainable, efficient, and very productive systems.

A permaculture design is a **complete long-term plan for a site**, whether it is a large or a small farm, a family home, a community, or a business; however, the design is implemented in stages. It is important to begin with the right steps. In permaculture you design the space and you design the time frame.

In a permaculture design system, the individual parts are referred to as **elements**, such as a fence, chicken coop, nursery, tree, or pond, etc. An element is one of the components making up a system; for instance, a hedge system that functions as a windbreak may have a number of elements in the form of trees in it e.g. neem, gliricidia, mango, etc.



Schematic by David Holmgren, Permaculture Co-Founder.

Once we have identified the main elements for our design, we have to ask the questions:

Where does this element go?

How can it be placed for maximum benefit in the system?

Element:
chicken

Can be harnessed with the right design

Needs:

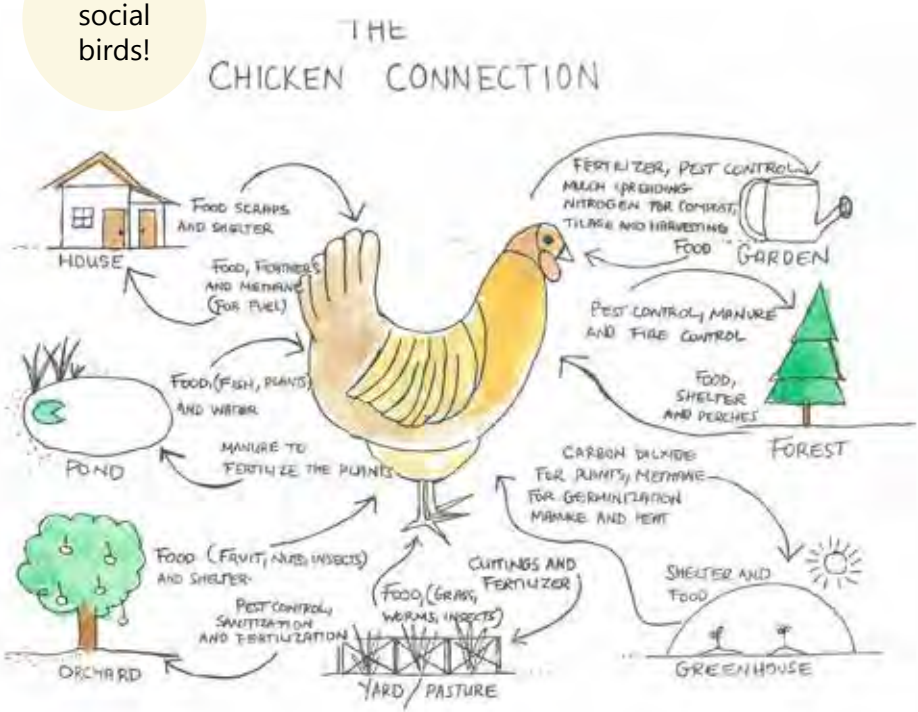
laying box
water
food
house
shade
protection from predators
more chickens

They are social birds!

Products:

eggs
labour they provide
meat
pest control ability
feathers*
manure**

*high in nitrogen
**high in nitrogen and phosphorus



To assess where an element should be placed within a design, we conduct a **Needs and Products Analysis** for each element. This is done by using existing knowledge and research to list all the needs and products for each element. If we use the example of the chicken, often considered a gateway element for a productive system, we can make a list as shown on the left.

Every element chosen should have at least **two functions** and should be placed so that the waste of one element provides for the needs of another. This helps create self-maintaining, integrated systems that make the most of what you have and reuse waste.

Permaculture Combines Techniques and Strategies

Techniques are how to do things.

Strategies are how and when to do things.

Design is about making a pattern with the elements; working with the land to create a system.

The Design Process creates a plan for the whole area, from the overall picture down to the fine details.

Permaculture **connects and integrates different strategies and techniques of living and agriculture**, so that they support each other and become as self-maintaining as possible. These include aspects such as houses, water supply, health, waste management, agriculture, fruit trees and tree crops, aquaculture, rivers, forests, animals, etc.

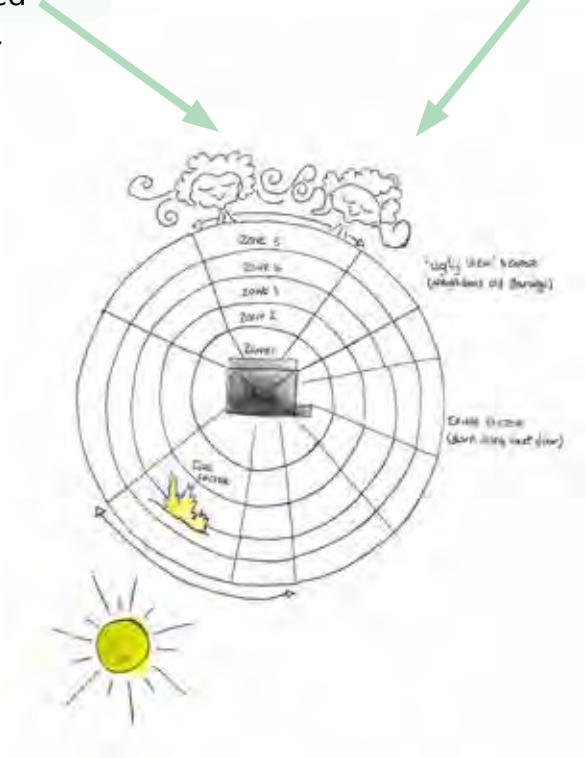
Energy Plan

Another important design approach is to have an **Efficient Energy Plan.** This is a Master Pattern for placing elements according to which **Zone** they fit in. We can determine the placement of elements by asking the following questions:

A) How often do we need to use the element?

B) How often do we need to service the element?

Zone 0 is the home.
The elements that are used often should be placed as close as possible to this zone along with those that need attention regularly.



For instance, a kitchen garden needs to be located in Zone 1 close to the kitchen as it will be used daily whenever meals are being prepared. Also, kitchen gardens need regular attention (e.g. young, vulnerable seedlings may need watering), so its placement close to the home allows the gardener to give the necessary attention in a timely manner, as it is often said, "out of sight is out of mind".

Permaculture lists the type of elements found in each zone, from Zone 0 out to **Zone 5, which is the wilderness or untouched zone**. Typically, the Ecological Home Garden Movement works in backyards with limited space where there may be only one to two zones in the design. Larger rural properties and farms will typically have all 5 zones.

Wild Energies

In addition to using zoning to place elements, we also need to conduct **sector analysis,** which takes account of the **wild energies** coming on to the site from outside, such as solar energy, wind energy, fire and water. It also includes view sectors, where we identify on the design the views we do not want to block. Other sectors may also be identified such as the pollution sector. When we know the way in which these "wild energies" move through the design site we are better positioned to design for them.

Sunlight

Sunlight is critical to plant growth, and as the earth spins on its tilted axis around the sun, the particular design site will receive varying amounts of sunlight—the sun being in its most southerly point on December 21st (**winter solstice**) and at its most northerly point, relative to the design site, on June 21st (**summer solstice**).

To know the track of the sun is important when designing a garden, as there may be certain times of year when a part of the garden is shaded as the sun moves behind an object such as a hill, structure, tree, etc. **Observing the sun and the shadows it casts over the course of a year** allows us to design accordingly, placing sun-loving plants where they will receive most sun and shade-loving plants in the more protected sites.

We rarely have the luxury to observe the effect of the sun on the garden over a year, so there are other methods we can use to calculate the sun's location. With some basic maths we can calculate the location of the sun relative to the design site and find the location of the sun at **solstices** and **equinoxes**. Online applications such as suncalc and sunchart can also be used to easily find the sun's location and the shade cast by it over the course of a year.

Sun profiles can be critical
to garden success!

Wind and Windbreaks

Wind is an energy that blows through a site. We can either reduce its speed and effect by constructing wind breaks or we can, for example, channel it to a wind turbine. For design we need to **identify the prevailing wind direction(s)**. This can often be ascertained from observing trees in the area and seeing whether there is any wind flagging (permanent bending of trees caused by a strong prevailing wind). Also, local knowledge can be invaluable when assessing garden sites and factors such as wind and water flows. Strong prevailing winds can have a negative effect on plant and animal development.

Strong winds stress plants through the shear force as the wind blows, but the wind also dries out the soil (known as the **clothesline effect**) and this in turn further stresses plants.

Wind breaks should be 40-50% permeable. They can provide many benefits to system productivity.

We can use 30% of land for windbreaks with no loss in yields.

We must assess areas for wind events and adjust our designs to deal with the results.

Slope and Water flow

The slope of the land and the water flows over the site are important to consider when designing. Slopes of over 18 degrees should be in permanent tree cover. If such steep lands (over 18 degrees) are the only option for cultivation, then a system such as **S.A.L.T (Sloping Agriculture Land Technology)** can be used.

Water is the element for which we should design first; if we don't control water flows, they can wash away our valuable topsoil and much more. **Our first step in any design is to control water through the design site**. We need to observe any patterns of erosion, where the water enters the site and where it flows. We must bear in mind that water always flows downslope at right angles to contour.

Mapping

When designing it is of great value to have a birds' eye map of the site (2 dimensions) that is scaled. The map should

Show Property Lines;
Buildings;
Access Roads or Walkways;
Hardscape Elements you are sure will stay (e.g. arbors, fences, outbuildings);
Large trees and important or noteworthy off-site features (e.g. large trees that block the sun or buildings near property lines).

Define a Scale (e.g. 1 cm = 1 m)

Include a Legend

Indicate North with an arrow (solar orientation)

Several Approaches when Creating a Base Map for a Site:

1. Trilateration

- Use two known locations in order to plot a third
- Pick two fixed features (e.g. two corners of the building) and measure to the third feature (Tree 1) from both fixed points
- Create a scale (e.g. 1cm = 1m)
- Convert measurements taken in the field to scale on a map (e.g. 9m in the field = 9cm on the base map)
- Using a compass, separate its legs to the scaled distance
- Place the compass spike at each corner of the building in turn and using the relevant scaled distances draw an arc from each corner
- Where the arcs intersect is the position of the third element

2. Estimate distances and sketch a map

- Measure the size of each section with equal-sized steps or paces
- Count the number of steps for each measurement
- Compare the area or number of steps for each section: For example, a wall that is 20 paces should be drawn twice as long as one that is 10 paces. A garden bed that is 25 paces long should be drawn 5 times as long as one that is 5 paces
- Draw each section with the size of the area written next to it
- Measure the distances between the different elements on the land

3.

Google Earth Pro

Google Earth Pro can typically provide very accurate satellite images of the design site. Images can be printed and used as a base map on which to place elements. The Google Earth Pro application also offers the possibility to overlay contours on the map, a very helpful feature.

Bringing together all the available information to make plans and designs has many **benefits, both for now** and the future.

Permaculture achieves its "permanence" by constantly changing, moving and improving. Permanence is never achieved by staying the same; it involves continuous learning, using new techniques, and applying new experiences. This allows sustainable lifestyles, food sovereignty, and resilience to grow, leading to better and stronger families, communities and societies, and a healthy environment.

Permaculture's ethics and principles guide the designs people make and the strategies and techniques they use. **They guide people to be more responsible for their own lives:** with responsibility comes more control over their own destinies.

Permaculture strategies and techniques **recognize and respect the value of every living being and that everything is connected, including humans**. What we do to one being has impacts on many other beings including ourselves—every person, every animal, every insect, every tree, every plant, every fish, even the fungi and bacteria in the soil. Every living being has its role to play and its function. This must be considered and respected in creating a truly sustainable society, the benefits of which will flow into the future.

Chapter 3

Richmond Vale Academy Ecological Model Garden Project

The Pass-It-On: Sustainable Model Garden/ Backyard Garden/Home Garden. This approach forms part of Richmond Vale Academy's St. Vincent Climate Compliance Conference 2012–2031. The 20-year conference aims to make St. Vincent and the Grenadines more climate-compliant in terms of food, water and energy security.

What were the reasons we started this project and why do we encourage others to do the same?

St. Vincent still relies heavily on agriculture for rural livelihoods and development. At the same time local agricultural systems are adversely affected by land degradation and climate change that threaten food production. Weather patterns are changing and more serious environmental hazards are expected, such as an increase in the frequency and strength of hurricanes, torrential rains and droughts. This changing world poses the challenge of **adapting agricultural techniques** to more sustainable, resilient systems that are ready for the extreme weather ahead.

Climate change and global instability are rooted in our addiction to fossil fuels, which are the main causative factor of

- extreme and unpredictable weather patterns
- rising prices, food insecurity and poor nutrition in our families and communities.

Much of the food available locally is imported and laden with chemically derived additives. This approach to the provision of our food is not healthy for Vincentians, the environment or the local economy. This project aims to **revitalize backyard gardens** as part of a broader vision to help improve food sovereignty and encourage healthy lifestyles.

Sustainable model gardens (backyard gardens) are an empowering, crucial element to protect and promote biodiversity. The majority of commercial farming in St. Vincent is based on **monocrops** and as this is not something that is likely to change quickly, starting with home gardens and assisting those who are eager to change is a good step to get more people involved in ecological farming practices and the principles that direct them.

The Pass-It-On Ecological Model Garden Project has encouraged both men and women to get involved in sustainable ecological food production with an emphasis on **single female households**, as these have been identified to be the most in need of assistance. The high cost of imported fertilisers, pesticides, herbicides, and fungicides along with their inherent unsustainability means that this ecological garden movement is a good way to promote both **gender equality** and sustainable ecological farming practices.

What are the benefits for individuals and for the community from the project?

The project uses **ecological principles of production** as a means of adapting to, and mitigating against, the effects of climate change while also using agriculture as a vehicle for wider environmental protection. The benefits include:

- protecting soil from heavy rains/droughts/ heat (ability to adapt to climate change)
- giving a meaningful lifestyle to the stewards of such gardens
- increasing the capacity of the soil to hold water
- reducing problems of pests and diseases
- sustainable food production
- improved soil structure
- reduced costs
- healthier diets

What is the goal of the project?

The ultimate objective of the Pass-It-On Model Garden Project is to **build the capacity of the local communities** to live more sustainably, cost-effectively, and healthily by creating model gardens for family households, with the intention to pass on what they have learned and grown and to inspire others to start up their own gardens. These home gardens are intended to encourage self-resilience, good health and nutrition, and to create opportunities for entrepreneurship.

Descriptions of Pass-It-On Sustainable Model Gardens

The model gardens being proposed are to be established on the basis of an average of **800 square feet of land** or a plot measuring 20 x 40 feet (6 x 12m).

Perennial Support Species & Fence

The **Agro-Ecological Intensification approach** being taken in the design of these model gardens requires the system to have **perennial support species** that can be harvested periodically to provide on-site organic matter.

The **fence** will be established using approximately 28-32 **gliricidia posts** spaced 4 feet (1.2m) apart with three lines of barbed wire encircling the garden area. In addition to the gliricidia, the design has **two leucaena trees** that can be allowed to grow during the dry/hot times of the year to provide a dispersed shade system, and coppiced during wetter and more humid times of the year for additional organic matter.

The third main type of support species is **vetiver grass** that can be used interchangeably with the culinary-applicable lemongrass variety. Both of these grasses provide excellent and abundant mulch for the intensive annual garden; thus, they provide all the benefits of mulch including improved soil structure, reduced evaporation of critical soil moisture and, very importantly, reduced weeding-requirements.

Multifunctional gliricidia trees are an excellent source of organic material high in nitrogen, and they can be chopped and dropped to mulch fruit trees or added to compost. Also, they can be used to support climbing species such as passion fruit, lima beans or christophene.

Water Tank & Intensive Vegetable Garden Beds

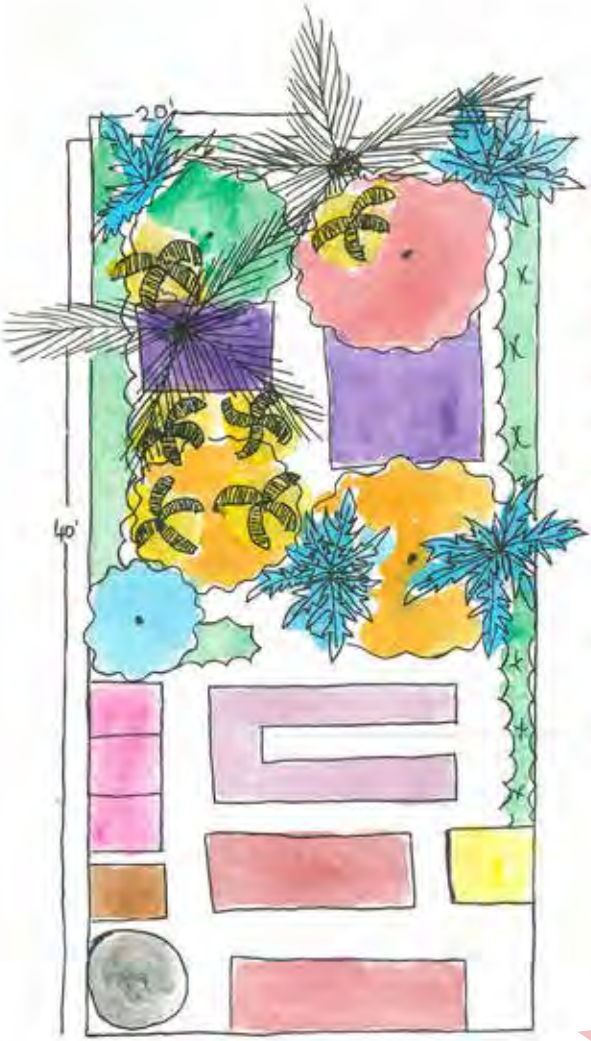
As can be seen in the proposed map, a **600 gallon water tank** is placed on a 4x4x4 foot (1.2x1.2x1.2m) concrete block foundation that collects water from the house roof. From this water collection point, we have 64 feet of drip/soak irrigation lines feeding 132 square feet (12.3m2) of **intensive vegetable garden beds.**

Of this, 48 square feet will be for **annual crops** that need trellis support such as climbing beans, cucumber and cherry tomatoes. The long (yard) bean is long-lasting and combines well on the trellises with either cucumber or cherry tomatoes. The long-term trellis support will be achieved using 7 foot (2.1m) half inch (1.2cm) steel rods that cross and allow for a biodegradable mesh support for climbing species.

Compost System

The intensive vegetable garden beds will receive their fertility from the **compost system** consisting of three compost bins measuring 27 square feet (2.5m2 each 3x3 feet (1x1m)). The compost bins will have a galvanised roof cover measuring 36 square feet (3.3m2). The manure from the **chicken layer/rabbit component** will be fed into the compost along with kitchen scraps, grass cuttings, coppiced gliricidia and leucaena, as well as other organic matter from diverse perennial sources.

To get an idea of potential yield, we can estimate that the two intensive vegetable garden beds can give us approximately 130 heads of lettuce every 2 months along with 36 roots of chives (soon after). Okra, eggplant and hot peppers are other recommended potential plantings on these beds.



Please refer to the map of the proposed model garden design for a visual location of elements.

Seed Table

A 2x3 feet square **seed table** covered with a shade net will be placed in close proximity to the house and a water source, as more frequent intervention will be needed to care for the young seedlings. The seed table will help homeowners to be more independent by producing their own seedlings and thereby reducing the overall cost of their food production.

Animal Component

Depending on the household and their preference, the animal component will consist of **a coup for raising rabbits (2) or layer chickens (5)**. The coup will measure 4x6 feet (1.2x1.8m) and will be raised off the ground for better aeration and easy collection of manure from underneath. For chickens there will be 2/3 boxes for layers, providing a high protein egg yield for the household. Rabbits can be raised to supply a meat supplement for the household along with invaluable high fertility manure.

Hedge Rows & Swale Systems

An important feature of the design are **two contour hedgerows/swale systems**, depending on the need of the particular site, located at the head of the land and at the mid-way point of the garden. These systems are critical in controlling erosion and water flow through the land. Swales in particular allow water to be harvested passively where it counts most—in the soil. They simultaneously provide additional water for the long-term perennial plantings that are critical in mitigating climate change by sequestering carbon dioxide.

Perennial Plantings & Staple Production

These **perennial plantings** include important species such as coconut (2), avocado (1) and cocoa (1) that provide important vegetable oil and protein sources for the chosen households. Papaya (5) and banana roots (6) provide a consistent year round harvest of the important fruit element.

Underneath and around these important perennials will be a diversity of useful species such as aloes, turmeric, tania (taro), pineapple, pigeon peas (also perennials), as well as flowering annual/biannual species such as cow peas, dill, basil, and marigolds amongst other possibilities.

The area designated for **staple production** is approximately 124 square feet, which will diminish by approximately 24 square feet as the larger perennials take their allotted space over time. This area can be planted to sweet cassava (18 roots) intercropped with sweet potato (50 roots) possibly rotated with other root crops such as carrots or eddoes and pigeon peas in their turn, which build soil as they provide important support species functions such as nitrogen fixation. Alternatively, it can be planted to pineapple (27) or plantain roots (5/6) as a more perennial form of the system requiring less management whilst providing important yield potential.

The system as outlined above is intended to improve the household diet by providing a diverse year-round supply of nutritionally rich fruits and vegetables along with an animal protein supplement. In addition to a healthier diet the household can significantly reduce costs associated with their weekly food budget. The proposed design is intended to increase organic matter production and hence fertility whilst protecting and stabilizing the soil.

The design, based on **diverse, multi-functional species**, also helps reduce problems associated with pests and diseases. In addition, the intensive nature of the design means there is less room for weeds and more potential mulch for the very important function of protecting the soil from heavy rains and the effects of intense heat that damages the living soil as organic matter is "burnt off" rapidly under the tropical sun. Increased organic matter can provide a buffer against both extreme rain and extreme dry/heat conditions. Hence, the systems **adapt** to changing climatic conditions as well as **mitigate** these conditions by sequestering carbon dioxide.

The system we proposed can be modified according to your property size, shape, food preferences, and time you can spend in the garden.

Whatever your situation,
don't delay making your dream garden.

In the following chapters, we will show you how to make your dream come true with practical step-by-step guidelines, and we will also explain why we do it this way so you can understand the connections and the forces behind the production of healthy and tasty food.

Chapter 4

Garden Location and Tools

A site analysis helps you make a good garden design that leads to a productive, efficient garden. A little planning now saves a lot of time and energy later.

A site analysis is important for new gardens. You should observe, consider and record all of the natural and unnatural factors at your garden site. Think about the positive and negative impacts on your production from each factor: location, weather, land characteristics, sun, water, soil, wind, and the size of your garden. Design your garden to gain maximum benefits from these factors while preventing any negative impacts.

Location

Most food gardens in St. Vincent are far from the house. Gardens around the house often just have beautiful plants rather than productive ones; however, gardens can be beautiful **AND** provide food, herbs, spices, and medicine.

We recommend that whenever possible you locate the garden **near the home** where it will be more convenient to care for and where vegetables can be picked just before cooking when they are at their peak of freshness, flavour and nutrient density. The farther you must go to weed the carrots or pull some greens for dinner, the greater the chance you won't.

Weather

Extensive heat, floods, hurricanes, and strong winds are the potential threats in our region. The placement of a garden, even within the framework of a small lot, can significantly determine how much energy you'll have to expend battling the elements. Generally speaking, hillsides are better locations than either the hilltops, where wind and heat can stress plants or the base of the hill where soil erosion occurs most severely, where water tends to accumulate, pooling and creating anaerobic conditions that inevitably result in soil borne diseases.

Land Characteristics

The characteristics of your land determine what type of garden beds you create and what you can grow. For every type of land, your goal is to retain and improve your soil over time.

A south-facing slope gets the most sun and is generally the best location for a garden site.

Flat Land -->
Raised Garden Beds (pg. 70)

Gently sloping land -->
Terraces and/or swales with some raised beds (pg. 58)

Steeply sloping land -->
terraces and/or contour plantings using tree legumes to help secure the soil (e.g. S.A.L.T systems).

Swamp land and flood-prone land -->
Raised garden beds with good water drainage.

Sunlight

The garden should be located where it will receive sun most of the day. You should make sure that your crops can get at least **six to eight hours of direct sunlight** each day. Plants need sunlight to grow well and produce bountiful harvests. They absorb sunlight and change it through the process of photosynthesis into plant exudates that are traded with the soil food web for plant available nutrients. Some plants produce well in some shade, but most plants prefer full sun. The sun damages plants at the hottest time of year before the wet season starts and also during the hottest time of the day (9am-3pm).

Water

As the garden will need watering from time to time, it should be near to a source of water, such as a water tank, stream or river. A water supply is one of the most important factors to increase garden production. It is important that the water used in the garden is not treated with any antibacterial substances such as chlorine, as such substances are detrimental to the **Soil Food Web** (SFW).

Look at where you can create dispersed shade during hot periods to reduce stress on the plants and assist them to thrive (e.g. Dispersed Shade Systems).

Soil

Find a balance between an area with good quality soil, close proximity to the house and a water supply. Dig up a spadeful at each potential site. Handle it, squeeze it and smell it. Crumbly, loose, and sweet-smelling earth will be easier to work with than soil that feels like modelling clay, or sand that sifts through open fingers.

You can also make a **soil jar test** for more precise understanding and planning. Fertile soil will produce more crops and need less water. Yet, **most soils can be improved** quickly with periodic amendments of mulch and aerobic compost (with the exception of heavy clay and waterlogged soils that need specific techniques and time to make them productive). Therefore, water is a more important factor to consider than soil quality when locating a garden.

Water is a more important factor to consider than soil quality when locating a garden.

Wind

Vegetables, especially seedlings, must be protected from strong winds that dry out the soil thereby depriving plants of moisture. **Windbreaks and living fences** reduce the water needs of your garden, and protected plants have a healthier, more abundant growth habit than those exposed to wind stress.

What Size Garden Is Most Applicable for You?

Think big—dream of future orchards, vine-covered walkways, and stone walls—but start small. The size will depend on what is being grown and how much time is available to work on it. A small, well-cared-for garden is more productive than a large, neglected one. A compact garden will allow you enough time to get to know your piece of earth and the plants and other life forms that share it with you.

Gardening Tools

Equip yourself with at least the basics, some of which you may already have. Useful tools include a wheelbarrow, hand spade, cutlass, garden fork, spade, hoe, rake, pruners (for harvesting and pruning), and a watering can for watering by hand. You'll also need a hammer, pegs and twine for laying out lines and patterns, plant tags, a file for keeping a sharp edge on things, buckets, and an assortment of empty containers (coffee cans, milk jugs and such reusable containers).

Think big—dream of future orchards, vine-covered walkways, and stone walls—but start small.

Chapter 5
Fencing

This chapter introduces the different fencing options to respond to the many variant threats posed to a backyard ecological garden.

The importance of fencing cannot be overemphasised when implementing a backyard garden. A garden fence can be **multi-functional**, operating as a barrier to animals, but is also useful for:

- Erosion control (providing a human-made edge)
- Trellis structure for vine plant production
- Small animal and bird habitat
- Nitrogen Fixing Species
- Shade (micro-climate)
- Biomass Production
- Pollution barrier
- Windbreak

Animals are typically the main threat to a garden, with chickens being the most difficult and persistent threat the RVA team has encountered when implementing gardens in the village communities. Chickens, by nature, scratch in search of insects, lizards and other sources of food, and as such **they love an ecological garden as it provides them with a diverse and abundant diet**.

However, as ecological gardens are well **mulched**, chickens can be very destructive, scratching away vegetable roots in search of food, whilst also covering other plants with scratched mulch. Within the village context it can be a political challenge to control neighbourhood chickens, and may often lead to disputes between neighbours. Therefore, it is critical that where chickens are a potential threat, a **suitable fence** is chosen to keep them out.

The RVA team has found that posts from the gliricidia are the best choice for living fence posts.

Gliricidia Fence - The Basic Structure

The RVA team has found that posts from the **gliricidia** (Gliricidia sepium) are the best choice for living fence posts and are the preferred choice when constructing fencing for the following reasons:

Nitrogen-Fixing

Gliricidia trees have the capacity to fix their own nitrogen, allowing them to grow in poor soils without added fertilisers. This capacity also allows the tree to be robust in its growth, resprouting quickly even after repeated **coppicing**.

Easy to Find

Gliricidia are widely available as they have been used traditionally to fence animal pastures.

Rich in Protein

The foliage of the gliricidia is high in protein and makes an excellent animal forage.

Living Fence

Gliricidia posts shoot and establish roots quickly from cuttings, thus providing a good basis for a living fence. Once the fence posts succeed in setting roots, they can stay there for decades.

No Costs

They incur little to no cost to procure: usually, the labour to cut and carry the gliricidia posts is the only cost involved in obtaining them.

Attracts Pollinators

The gliricidia flowers are loved by bees and make a great floral tasting honey.

Source of Charcoal

The gliricidia trees, when mature, are cut and used for making charcoal, a traditional practice. Adding small amounts of charcoal to your garden is important for a number of reasons including habitat for microbes, improving the passage of air and water through the soil, and increasing the soil's ability to retain water and nutrients.

In the ecological home garden, the biomass of the gliricidia is pruned and returned to the soil as mulch or composted. Such practice is also known as **chop and drop**. When conditions are dry, the branches of chopped gliricidia can be piled, and within a few days all the leaves separate from the branches making them easy to collect and spread around the garden as a **high nitrogen mulch**. The sticks, depending on their maturity, can be used for tomato stakes or if greener can be composted/mulched.

How to install a gliricidia fence

1. Cut the posts

Cut posts that are 5-6' (1,5-2m) in length and at least 2 1/2+ inches (6.75+ cm) thick.

2. Post distance

Place posts 4' (1,20cm) apart along the fence line.

3. Dig holes

Dig holes for the posts to a depth of 1' (30cm).

4. How to plant the poles

Place the posts in the ground so their natural growth direction is kept (plant the part that was connected to the mother stem).

5. Choose your fence material

These posts planted around the garden site provide the basic structure on which different types of fences can be attached. See next page for examples of different materials that may be used.

Barbed Wire. When the threat to the backyard garden is from larger animals such as cattle, donkeys, etc., then gliricidia posts can be grown as fence posts and pollarded (pruned above where the animal can reach) to avoid overgrazing. The number of strands of barbed wire used and the distance between strands will depend on the type of animal to be kept out. Smaller animals such as sheep or goats will require a spacing of about 8" (20cm) between strands, with as many as 4-5 strands being necessary.

Used/Damaged galvanised roofing sheets. When galvanised roofing begins to rust and deteriorate it is often replaced. This used galvanise that is no longer viable for roofing can be used along the base of the fence and combined with one or two lines of barbed wire above it. A vine of passion fruit or luffa gourd can be trellised on the fence to further conceal the garden from marauding chickens.

Used Onion Sacks. This is a creative solution that uses the widely available onion sacks that have holes. They can hang on a fence made from gliricidia posts and be strung with three lines of barbed wire.

Used fishing net. Where available this is a good option for recycling materials and good protection against chickens.

Round-wood or bamboo stakes 4-5' (1.2-1.5m) long can be woven through 3 lines of barbed wire, an inch (2.5cm) apart along the fence line as an impenetrable barrier to animals. Such a solution requires a considerable amount of post material which can be costly in terms of the time taken to procure it. These materials will decompose relatively quickly in humid/wet conditions and as such are a better solution for the dryer areas.

Prefabricated wire mesh fencing is very effective against animals and chickens but is a relatively expensive and high embodied energy option for backyard garden fencing.

In both the fishing net and onion sack solutions the chickens may become entangled in the net-like structure of these fence solutions.

Living Fence

Living fence is ultimately the best fencing option for a garden as it can provide food, mulch in the form of organic biomass, animal forage, plants to attract beneficial insects, and plants to deter pests, amongst other possibilities.

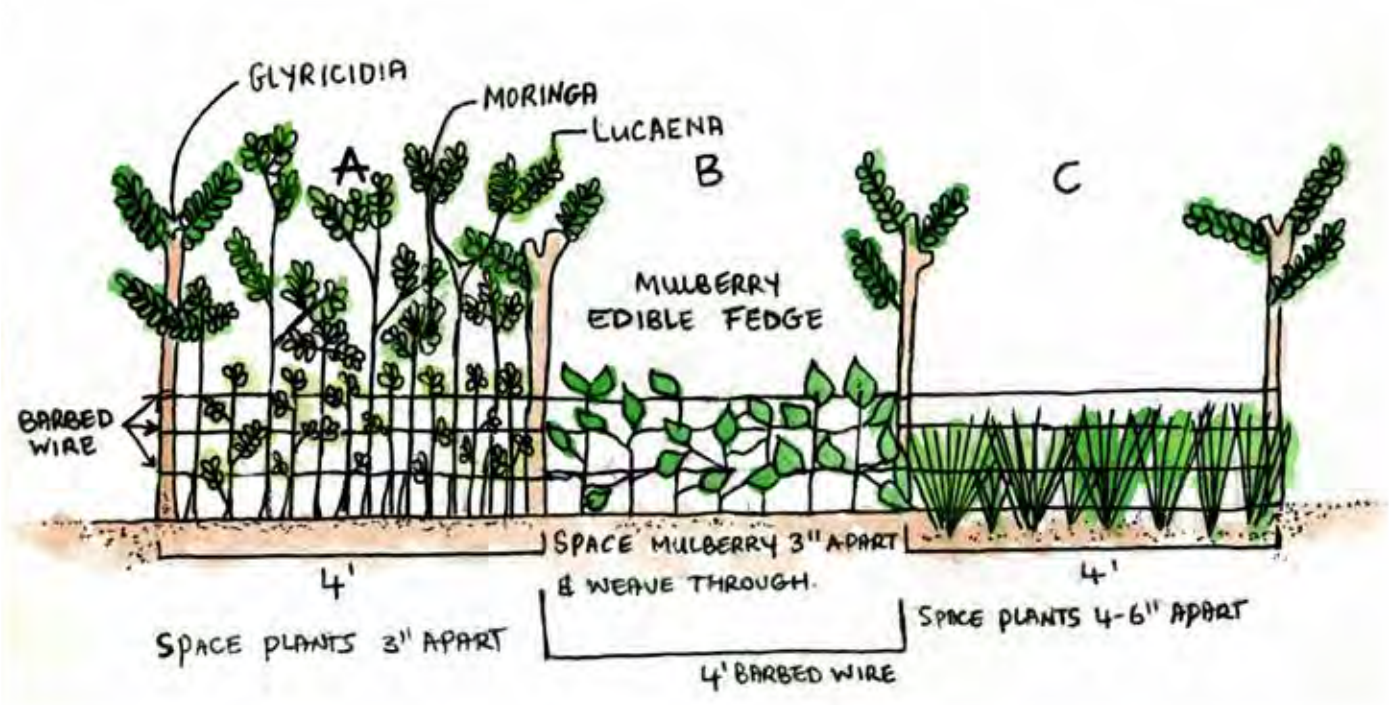
A living fence may take a few seasons to be adequately established and therefore often requires **a temporary fence** to be established whilst the living fence grows. Typically, living fences in the tropics need to be created from multiple species **inedible** to animals, or pollarded out of their reach, whilst also providing an impenetrable barrier to them.

A list of species that can be considered when designing a living fence

Moringa oleifera
Gliridicia
Neem Tree
Acerola Cherry
Hibiscus
Pineapples
Leucaena
Vetiver Grass
Lemongrass
Noni
Fencing bamboo (Thyrsostachys siamensis)
Galangal
Chaya (tree spinach)

The width of the living fence will depend on species but is typically between 3-6 ' (1-2m). When **legumes** (Nitrogen Fixing Trees) are included in the living fence, they can provide multiple functions; most importantly they "fix" atmospheric nitrogen through their roots in a symbiotic relationship with specialized bacteria in the soil.

When the branches are **pruned**, as is necessary during the rainy season due to their rapid and resilient growth, the tree floods the soil with exudate encouraging nutrient cycling and the provision of plant available nutrients. This process along with the robust nature of nitrogen fixing trees allows rapid growth of valuable biomass material. Whilst the pruned branches can be used to feed the soil as a chop and drop mulch, they can also be harvested and fed to animals as forage.

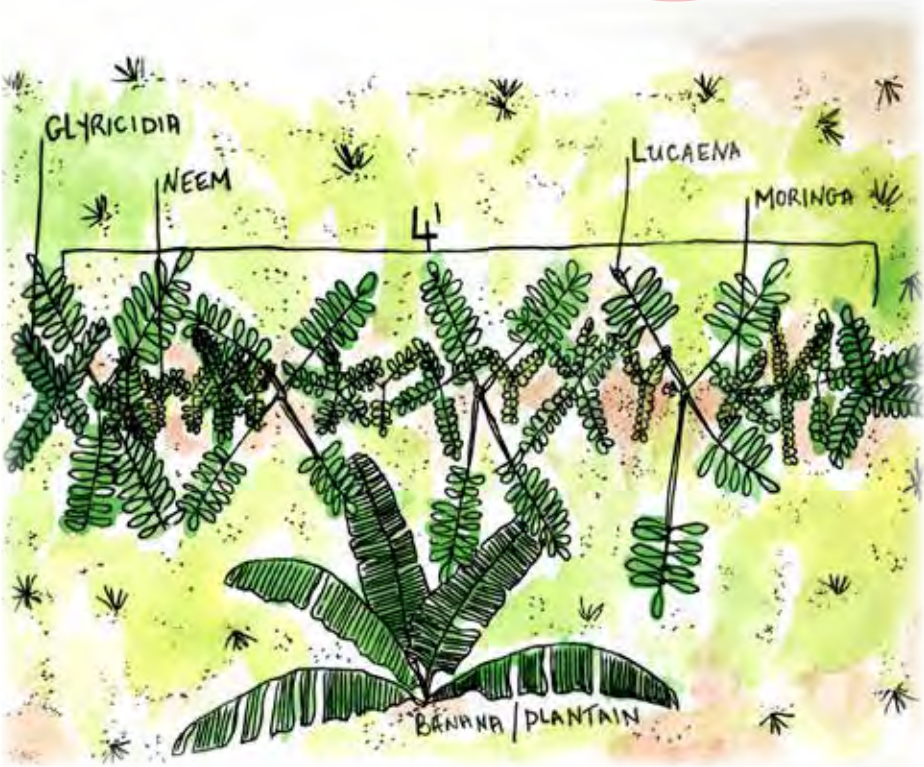


Living fence protecting our bananas/plantains from animals, thieves and wind.

Different Types of Living Fence.

Gliricidia, moringa and leucaena should be placed 3'' apart, mullberry 3'', and vetiver and lemongrass 4-6'' apart.

Note: Pruning should take place when rainfall is higher than evaporation, in other words, during the rainy season.



Chapter 6

Levels and Levelling

This chapter will teach you about contour farming: How to make the most of the water passing through your property and how to protect your valuable soil nutrients from being washed away.

Water is a wondrous, life-giving substance, but it is also incredibly destructive if not well managed, both to the landscape and human settlements. **Controlling and pacifying water's erosive force** is the first objective of ecological farming. Until this is achieved, any soil built by ecological approaches can be eroded and washed away in one flood event.

St. Vincent is characterised by a mountainous landscape with steep slopes. When there are prolonged and heavy rains, **large quantities of soil are washed into the rivers** and end up turning our estuaries and bays brown, as can be witnessed after storm events. This **erosion** is caused by farming methods that do not value the soil as a source of fertility but rather as a medium to support the growth of plants fed on chemically synthesised nutrients.

Contour farming is a sustainable way of farming where farmers plant crops or build structures (beds, swales) following the contour line across or perpendicular to the slope of their field. This arrangement breaks up the flow of water and makes it harder for soil erosion to occur.

Farming methods employed on our mountainsides do not place an emphasis on soil protection and regeneration, and as a result, they are ultimately unsustainable for continuous annual production.

Why use contour lines in our farming?

In order to control water flows in the landscape, it is necessary to understand that water always flows at a right angle to contour, effectively the **shortest route downslope** that is possible.

Methods of contour farming, such as implementing **swales** on contour, planting dense lines of **vetiver grass** along the contour or simply building **garden beds on contour**, help to manage erosive flows of water. As the water approaches the contour at a right angle it is slowed down by the chosen method of contour farming and spreads out along the contour line. This gives enough time for the water to sit and soak into the ground, where it benefits the water table and the soil food web that thrives where water is available.

On slopes cleared of vegetation with no designed contours, water cannot be absorbed as it runs off rapidly; this results in erosion carrying away valuable topsoil, leaving degraded land in its wake.

What is a contour line?

Contour lines are lines on a map that join points of equal height above sea level. The lines of a contour map indicate that along that line all points are on the same level.

For more information on how to build contour line beds see Chapter 8 Garden Bed Design

For more information on how to build a swale on contour see Chapter 7 Swales

What are the **main benefits of** contour farming?

1. Avoids "harmful" runoff that causes erosion
2. Prevents topsoil loss
3. Captures and directs rainwater

How to find a contour line

In order to find the contour line, we must be able to accurately measure and outline it. This can be done in a number of ways: using a laser level, a water (bunyip) level, or an A-frame. Without access to a laser level, we build a simple but accurate **A-frame level**.

How to make an A-frame level

An A-frame level is a tool that can help you find contours. The A-frame can be made from varying types of materials such as store-bought wood, bamboo, straight sticks, metal poles, etc. You need the following materials:

2 sturdy sticks 3-6 feet (1-2m) long and 1 inch (2.5 cm) thick to form the legs, and 1 stick about 1.5-3 feet (0.5-1 m) long for the crossbar.

3 nails/screws long enough to go through 2 sticks so that the end sticks out. Alternatively, use a rope to fasten the sticks together.

1 bottle with a twist cap or cork, or a stone to use as a weight (about 1⁄2 kilo, or 1 pound).

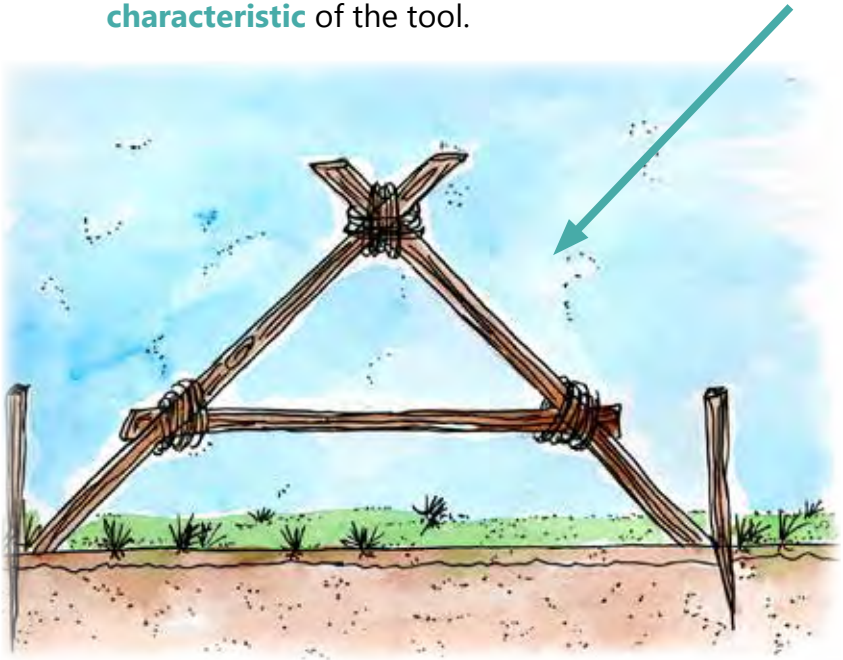
A 2-meter long string with a knot tied at one end.

1 pencil or pen, a hammer or stone, a machete or saw, and a tape measure.

The distance between points on a contour line can be greater on larger properties and smaller in more limited spaces. Correspondingly, larger-sized A-frames should be used for larger areas and smaller A-frames for smaller sites.

Step 1 Fasten the 2 legs together in a triangle shape with about 2 metres (for larger A-frames) between the feet.

Step 2 Fasten the crossbar to the legs with a cross brace half-way up the height of the legs. This forms the **A shape characteristic** of the tool.

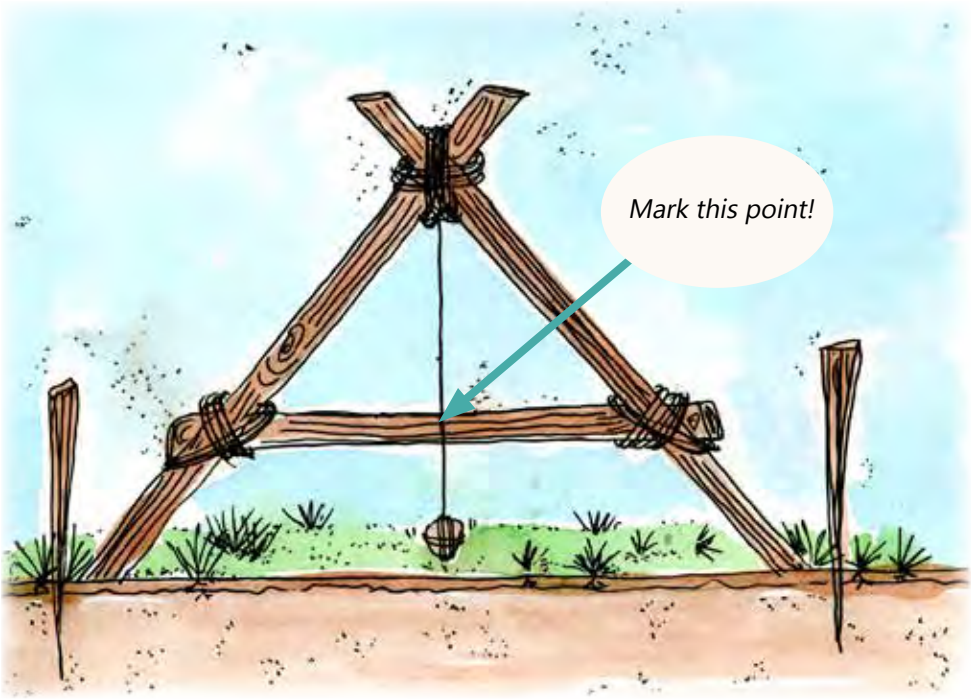


Step 3 Drop a line from the high point of the frame to a few inches below the crossbar of the A-frame - This line can be made of twine, string or any material in place of twine or string such as wild mahoe stripped bark.

Step 4 Attach the weight (bottle or stone) to the string, hanging at least 2 inches (5cm) below the crossbar. If the bottle is plastic, fill it with water, sand or soil and cap or cork it. The string with a weight on the end is called **a plumb line**.

Calibrating the A-frame

Calibrating can be done by placing the A-frame on a level surface (determined with a spirit level) and marking the point on the crossbar where the weighted line intersects the crossbar. This point indicates that the two legs are on the same level.

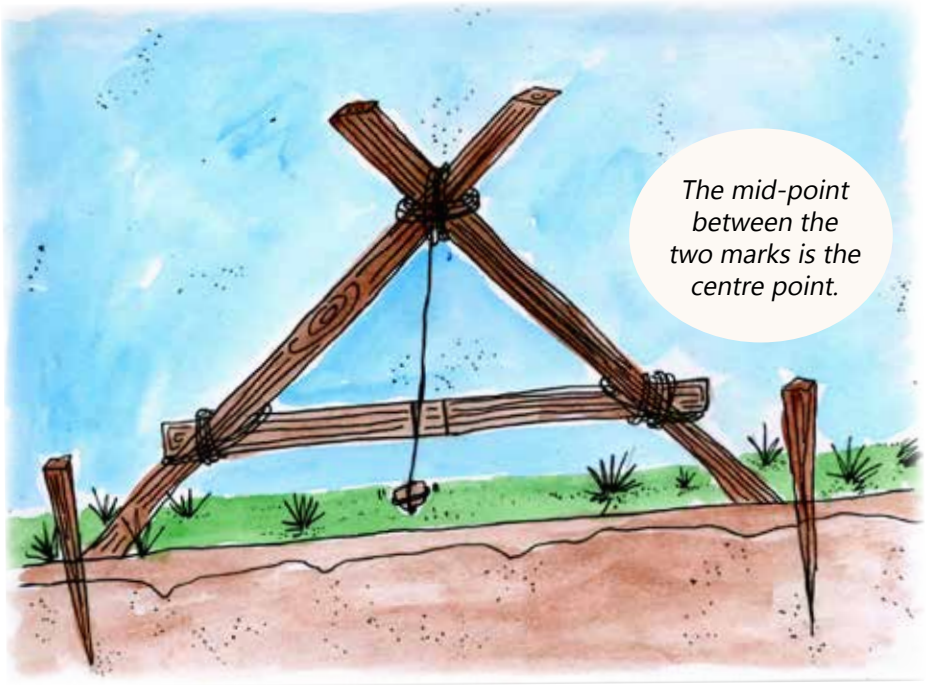


If no level surface is available, then the A-frame can be calibrated using the following method:

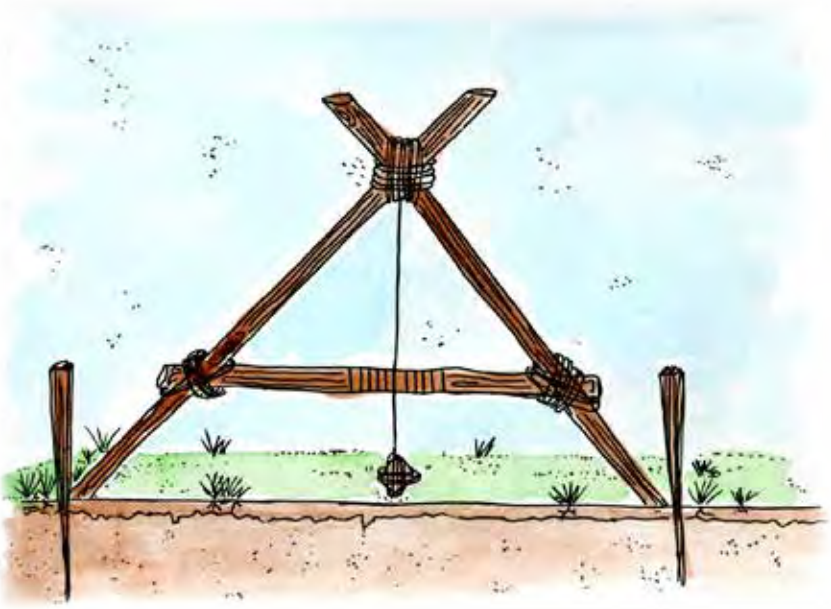
1. Set the A-frame on the uneven or slightly sloped land. Mark where each leg stands. Make sure the plumb line can move freely, and then let it settle. Once the string stops moving, make a mark where the string touches the crossbar.

2. Turn the A-frame so the first leg is where the second leg was and the second leg is where the first leg was. Mark where the string crosses the crossbar. You will now have 2 marks on the crossbar.

3. The mid-point between these two marks is the centre point of the A-frame and indicates that the legs are on level ground.



For angles of tilt: The A-frame can be further calibrated by using a Smartphone or similar device with an app that shows the tilt of the phone in degrees. The device can be placed on the A-frame crossbar and then tilted together with the frame. The corresponding angle shown on the Smartphone can then be marked on the crossbar.



Calibrated A-frame with various marked points to indicate degrees of slope. Calibrating the A-frame in this way allows diversion drains, for example, to be dug at the required angle to allow water to drain slowly off the land without erosive effects.

How to Mark Contour Lines

The next step is finding the contour lines.

1. At the top of the slope where you want the first barrier, swale or bed, place your A-frame so it goes across the hill, not uphill or downhill. Put one leg of the A-frame where you want the contour line to start. Move the other leg of the A-frame until the plumb line hangs over the centre mark. The contour is where the feet of the A-frame are when the plumb line is on the centre mark.
2. Put a stake next to the two legs of the A-frame.

3. Turn the A-frame to find the next level place across the hill, keeping one leg of the frame aligned to the last stake used, and repeat the first step. Continue to the end of the field or slope, marking every new step with a stake.

4. Move to the next place you want a barrier, swale or bed and repeat the process.

When using the A-frame it is a lot easier and faster with two people. One person can operate the A-frame while the other can mark out the contour line with the stakes.

Tips for using the A-frame

Do not place either end of the A-frame on rocks, on small mounds or in small holes. This makes the lines inaccurate and causes problems later.

When the swale has been dug to the required depth, it is very important that we use the A-frame on the base of the swale to ensure that it is even along its entire length. Otherwise, we can get pooling at one end of the swale leading potentially to a swale break and the resultant damage caused by such an event.

Guidelines for Building on Contour

Once contour lines are measured and marked, and as you decide what kind of **earthworks** are best for your land, keep these general guidelines in mind:

1. Preserve or plant trees and other perennials.

If the slope is very steep, the trees already growing there or the trees you plant will protect it from collapsing. Grasses and plants with strong roots (e.g. vetiver grass) will help to hold soil in place and retain water.

2. Fix problems as soon as they happen.

Heavy storms may cause a contour trench to collapse or a wall to break. Fix it right away to prevent further erosion.

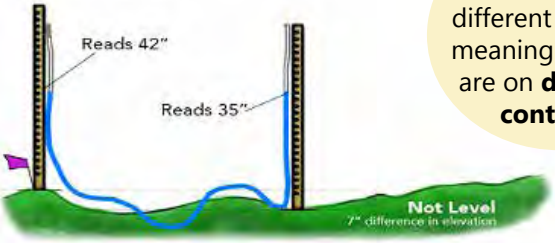
3. Start from the top.

Water runs downhill. By starting at the top, you protect everything below and can utilise many small barriers.

Water Level or Bunyip

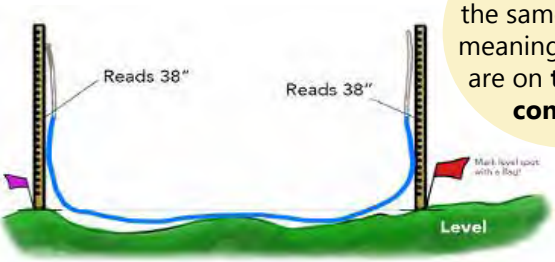
Another simple yet invaluable tool for measuring contour, slope and distance between contours is the water level known often by its Australian name, **Bunyip water level**. This simple tool requires two equal lengths of stakes with the incremental measurements marked on them so both stakes are the same.

A clear hose pipe of determined length is then attached to the marked stakes and fastened with wire or other suitable material.



Non-level: The stakes have different readings, meaning that they are on **different, contours.**

The hose is then filled with water or colored liquid to half-way up the marked stakes.



Level: The stakes have the same reading, meaning that they are on **the same contour.**

When the liquid is at equal points on the marked stakes, then the two points are even. If the points read the same on the two stakes, the points are on the same contour. If the water in the pipe reads differently on the two stakes, then the difference indicates the drop in elevation. This can be measured in metric or inches, so the exact difference between levels can be ascertained.

Chapter 7

Swales: Passive Water Harvesting

For most farmers, good yields are dependent on water from rain or irrigation systems, but there are strategies that can extend the wet season, by infiltrating more rain water into underground water storages.

All farmers can store and retain water in their soils. Mulch eliminates evaporation by keeping the moisture in the soil, thus preventing damage to the soil. Biologically healthy soil is also important for water storage as it holds at least 50% more water than soil lacking the necessary biology. This can reduce water usage in the dry season by more than 50%. Swales catch and store water, **increasing the underground water storage**, and at the same time providing mulch materials and improving the soil quality.

> In our ecological farming, we seek to solve problems in the landscape by working with nature and using strategies and techniques that are appropriate for the sites

What is a swale?

A swale is a **trench** that is dug on a contour level, the same level from end to end across a slope. The soil dug from the trench is put on the low side of the trench to form a long mound (also known as a berm or spoil) on which are planted a diversity of species that perform various functional roles, such as nitrogen fixation or fruit provision.

One of the prime functions of a swale is to **reduce the erosive effect of overland water flow**, by

Stopping the flow of water;
Spreading the water, and
Sinking the water into the ground.

STOP – SPREAD – SINK

This effectively hydrates the earth and makes more water available for life processes, including the growth of trees.

Benefits and Functions of Swales

Swales provide many important benefits for the landscape and for agricultural crops:

Stops **erosion.**

Restores **groundwater** levels.

Catches, spreads and sinks **water runoff**

Improves **soil quality** by trapping and holding nutrients.

Protects and even renews **natural springs**.

Reduces or prevents **flooding.**

Water that leaves the swale system via **overflow points** (spillways) can then be directed for further use e.g. irrigation, aquaculture ponds, storage tanks, banana pits, or soaked up by tree crops.

Pathways: Swales can be used as convenient access ways, particularly on steeper slopes. Depending on landform type, swales can accommodate varying sizes of transportation, from footpaths on narrower swales, to wheelbarrow tracks, to a tractor and other larger vehicular type access ways.

Windbreak: Swales also can function as windbreaks where the prevailing wind is at right angles to the swale. It is recommended that every 6th to 10th swale is planted to a windbreak. Ridges are exposed to the greatest wind shear and should be prime sites for windbreaks.

Swales are primarily **tree cropping systems** that can be effectively utilised in reforestation and land regeneration projects.

Creation of new **microclimates** on the land.

Trees in the System

Swales are **tree-growing systems**, and trees are vital to their success. Typically, trees are planted on **both sides** of the swale, with the top side usually planted to nitrogen-fixing trees; more productive, higher nutrient-demanding species are planted on the lower side of the swale spoil where the excavated mound is.

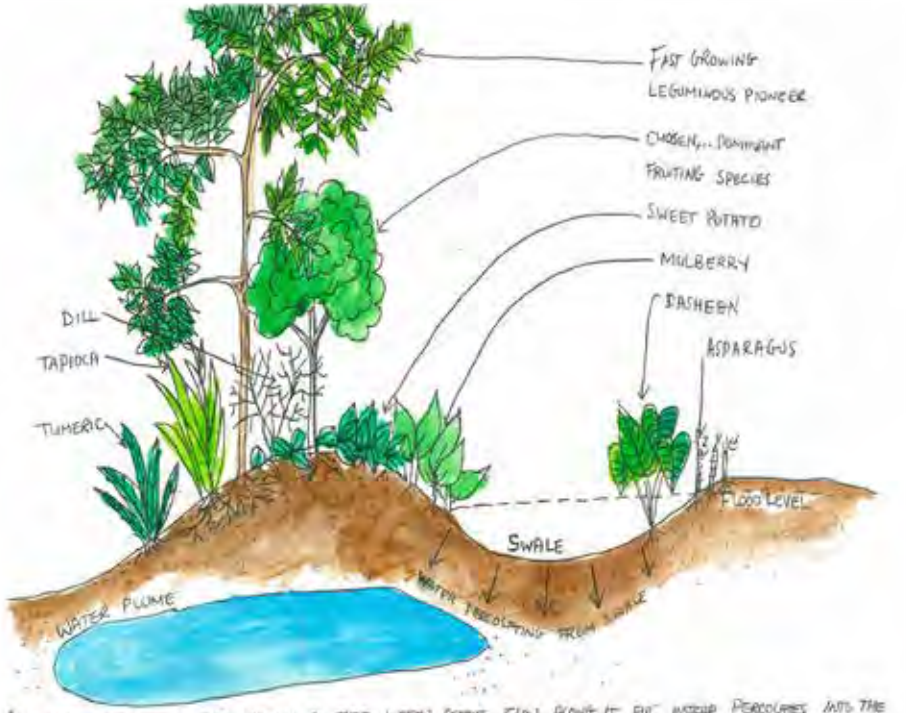
Trees' deep and extensive **root systems** help to create soakage lines for the water captured and held in swales, enabling water to soak more quickly into the earth. Trees stabilise the banks of swales and act as **water and nutrient pumps**, returning water to the atmosphere through **evapotranspiration**.

This critical function of trees to cycle water from the earth to the atmosphere prevents the soil from becoming waterlogged and the subsequent depositing of salts by rising groundwater levels. This **"salting" of the earth** leads to the inability to grow most plant species and results in desertification of the landscape.

Without trees performing the function of pumping water from the ground to the atmosphere through evapotranspiration, areas of deforestation can experience a **rainfall deficit** as the locally derived rains are reduced by the corresponding loss of trees and their evapotranspiration function.

Likewise, **trees mine nutrients in the subsoils** and use these nutrients to produce leaves, branches, bark, etc., which then form the detritus of the tree and contribute to the health and fertility of the topsoil.

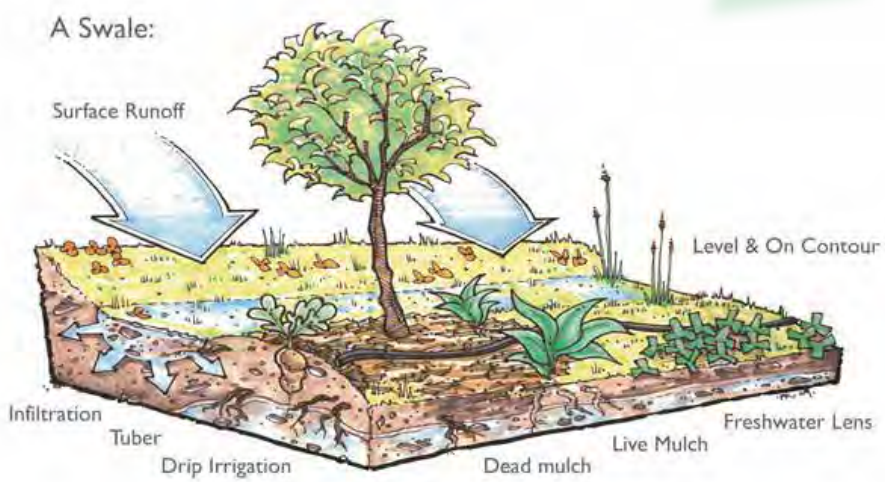
Trees also reduce evaporation from the swales by over-shading them, creating a **microclimate** with its associated benefits.



A SWALE, LAID OUT ON THE CONTOUR SO THAT WATER DOESN'T FLOW ALONG IT BUT INSTEAD PERCOLATES INTO THE SOIL, FORMING AN UNDERGROUND STORAGE RESERVOIR. SWALES CAN BE 1-4 FEET OR MORE ACROSS, WITH A BERM DOWNSLOPE ROUGHLY THE SAME SIZE MADE FROM THE SOIL FROM THE SWALE.

Veins of Fertility in the Landscape

Organic matter gets trapped in swales conveyed there by water and wind, with the trees and the life associated with those trees also providing organic materials, such as: leaves, twigs, branches, insect and bird faeces, to name but a few. The swale thus becomes **an accumulation point** for water and organic matter. This will result in a rich vein of fertility in the landscape having cascading positive benefits over time, as the water that soaks into the swale plumes downwards through the earth. See below.



Over time, this can result, in **spring lines** emerging on the lower slopes. In effect, swales like contour plantings of vetiver can result in the creation of entirely new spring lines in the landscape.

The efficiency of this incredible passive water harvesting system **increases over time** as trees grow their roots deeper, and increased deposits of organic materials improve soils, leading to quicker and easier infiltration of overland water flows.

Swale Characteristics in Different Climates

Drylands/Arid Climate

In arid climates, swales can be used very effectively to **trap the infrequent, heavy downpours** associated with such climates and infiltrate them into the subsoil. This charges the groundwater table, increasing the availability of water for plant and tree growth. In arid lands, swales tend to be large, **2+metres wide** and **as long as possible**, as they need to capture as much water as they can during the rare rain events.

The swale interplant is the area between two swales. In dry climates, this area may be sparsely planted due to the lack of rainfall, with the area acting more as a catchment for rainfall that is directed to the relatively fertile swale lines. The leaves of trees act as excellent condensation surfaces for slow-moving cold air that condenses on the leaves at night. Leaf drip is a significant contributor to precipitation figures in drylands and can account for as high as 86% of total precipitation in such climates.

The use of swales in **regenerating drylands** is relevant to those of us living and gardening in the Grenadines and the dryer areas of the mainland, where the average rainfall on the coasts is approximately 75 inches (190cm) per year; as much as 150 inches (380cm) fall in the mountains of the interior. In contrast, in Bequia less than 40 inches (100cm) of rainfall is recorded on average per year. In such circumstances, **it is imperative to passively harvest this water in swale systems**, whilst growing trees to cycle this water to the atmosphere where it can contribute to increasing local rainfall figures. This harvested water also increases groundwater levels, which supports more life processes and greater diversity, including the critical tree component.

Humid Tropical Climates

In humid tropical climates where rainfall is plentiful, **swales are located closer together** than in dry climates. The swale inter-plant in the humid tropics is usually densely planted with many species being support species and subject to repeated **chop and drop** throughout the wet months.

The regular pruning of support species cycles nutrients to soil microbes that rapidly break down pruned materials in the hot wet tropical climate.

Swales: Types, Sizes and Spacing

The size and spacing of swales depend on the type of land form present at each particular site, where guidelines, but not definitive rules, are appropriate.

Some figures that can be considered in swale construction:

The average width of the base of a swale: 1 1/2-6' (0.5-2 m)

As a **general guideline**, swales should be a minimum of 18"wide x 18" deep (45x45 cm).

Swale Spacing

On gentle slopes, swales are larger in size and made approximately 30' (10m) apart, depending on the situation. On steep slopes, swales are smaller in size and made closer together. This is because water runs faster on steep slopes and must not be allowed to build up and become an erosive force.

Higher rainfall areas will have swales closer together, while low rainfall areas will have them further apart.

Inter-swale space: 9-54' (3-18 m)

Determinants of Swale Width and Depth

Size of Property: with larger properties having larger swales and smaller properties, smaller swales.

Slope: with steeper slopes requiring narrower, deeper swales, while more gentle slopes will have shallower, wider swales. In a flat country, no mound may be apparent as the material has been spread out.

*Swales should **not** be constructed on **slopes over 18 degrees**. Following this rule prevents mudslide problems that steeper gradients could cause, and that may potentially be devastating to your property.*

Speed of Infiltration: this is determined by soil type, with sands infiltrating water quickly and clays slowly. Swales made in sandy soils will tend to be wider and shallower, than those made in clay soils, which will be narrower and deeper.

Crown Spread: crown spread of the trees, planted on either side of the swale ditch affects the width of the swale. The crowns of these trees should meet and cross, thus providing the important function of cooling and reducing the evaporation from the swale, which in turn means more water being passively harvested into the earth.

Swale Implementation - Step by Step Guide

Step 1 **Observe** and walk over the land where you plan to dig the swale(s). Make sure you know where a significant source of water will be coming from before putting in the effort of building the swale. And make sure that this water will enter your swale system.

Step 2 **Identify the position**. Ideally, a swale will be installed at the highest point possible but still low enough, downslope, to catch water runoff. Usually, the longest highest contour line determines this point. The longer the swale can stretch, the wider-reaching the water absorption will be; and the higher its placement the more space in which the water will have to expand underground. Include in the design how many swales you want to make and where they are to go.

Step 3 It is very important that the swales are on level. **Use the A-frame** to stake out the contour line and the exact route the swale will be taking. This will likely not be a straight line, but rather a curvy one that'll give the system some character. Then the width of the swale can be measured downhill from this point. Mark the entire swale dimensions out, including a safe area (spillway) for water to passively overflow in the event the swale fills up completely.

Step 4 The marked area is then **dug out,** with the soil excavated and placed downhill to form the berm or spoil.

See pg. 50 for how to build an A-frame

Step 5 **The base of the swale will need to be levelled** (with an A-frame or other levelling tool), so that water spreads evenly over the entire swale line.

If the swale is level, the water sits in the swales and soaks into the ground evenly. If it is not, the water runs along the swales and breaks it at the ends or at its lowest point. This can cause a lot of damage.

Step 6

The swale base may need to be forked on very compacted soils or those with high clay content. If you have the needed and available materials, the base can be gravelled so that water doesn't settle but percolates through the gravel leaving the base suitable for traffic. Sand can also be used at the base of swales to improve absorption and improve the track for farm traffic. Small swales can be mulched to the top with organic matter, and the resulting compost can be returned to the swale spoil for greater fertility.

Step 7

Another important aspect of making a swale and, particularly, avoiding possible problems is to **create a passive overflow.** The best way to do this is to have a sizeable spot, at least equally as wide as the swale, that is perfectly level and below the top of the berm.

In heavy rain events, the water can overflow into a safe place, either a pasture or another swale or a water catchment like a pond or dam. At one (or both) ends of each swale, make the mound lower than the rest of the swale—just below ground level is best so you can direct where the overflow water goes. When the water reaches a certain height in heavy rains, it will then overflow where you want it to and not continue to build up and break the swale mound.

Step 8

The swale berm/spoil area is then **planted with trees** and other productive perennial species, while a pea/bean leguminous ground cover is established to enrich and protect the soil underneath the perennial species. These plantings can be established in a mulch, or if not available, without it. It's important to plant on the berm immediately to prevent it from eroding.

The top side of the swale can also be mulched and planted with deep-rooted grasses initially (e.g vetiver grass, lemongrass) to slow water flow and provide mulch. Then nitrogen fixing trees can be planted to provide nitrogen and organic matter as well as overshade the swale from the top side. The planting distance between the trees depends on the type of productive trees you use.

Swale Maturity

Maximum efficiency of the swale system is achieved at year 7. Eventually, trees take over the function of the swales, as in maturity they are able to reduce and absorb the impact of heavy rainfall, creating a no erosion zone, as in a forest.

Around year 7 when the swale system has matured, additional runoff can be directed into the swale from hard surfaces such as roads and car parks. Additional overland flows can be directed to the swale system as well.

Place rocks around your overflow points to stop erosion. Plant grasses, such as vetiver grass or small bamboo and ground cover plants, next to the overflow points to help further secure the soil.

Swales are the precursor to the rehabilitation of the forest.

Integration of Animals in Swale Systems for Improving Soil Fertility

With the appropriate fencing strategies, animals can be incorporated into swale systems. Chicken and duck pens can be positioned over swales where the chicken dung component, including the urine element, falls through the pens flooring to the swale excavation below. When water runoff enters the swale, the manure is dissolved and spread by the water as it fills the swale. This effectively manures the entire tree line along the length of the swale

Animals such as sheep and cattle can graze the swale and the backside of the swale, as long as there is appropriate fencing to stop their advancement to the swale spoil. As with the chicken/duck system described above, manure and urine left by the grazers is again diluted and spread by the water flows, effectively fertilising the plants along the swale system.

Swales also provide other important benefits:

They catch, store and move large amounts of water and are excellent for collecting extra water for small **dams, fish ponds and in-ground water storage tanks.**

They improve reforestation project success rates, especially **in remote areas where it is difficult to water tree saplings.**

Swale systems above houses and communities prevent **most flooding by holding and moving the water away**

Chapter 8

Types of Garden Beds

Once you have designed the land for Water, Access and Structures (WAS), you can start designing your garden beds. The shape of your garden beds varies according to the shape and slope of your land. Your guideline is to work with the land, not against it. Instead of making garden beds in straight lines, be creative. Remember that beauty and natural patterns are also important; but make sure you don't compromise practicality and convenience for aesthetics.

What to Consider

When selecting the type of garden bed to construct in your backyard garden (or on a small farm), it will depend on certain factors.

1. Seasonal Climatic Factors
2. Soil Type
3. Frame Materials
4. Topography of Landscape

Raised beds are a great way of boosting drainage and can be used to introduce or create a different soil type in the garden (see diagram on page 81).

1. Seasonal Climatic Factors

Climatic factors such as a wet and dry season will affect the type of bed to be constructed. During the rainy season, particularly on flatter lands, heavy rains can inundate the cultivated area leading to potentially devastating consequences for crops. A useful strategy to remedy this problem is to create **raised beds.**

In climates where the dry season may mean less than 4" (10cm) of rain over the whole dry season (6 months) such as on a few of the islands of the Grenadines which are part of the St. Vincent archipelago, the strategy is to create **sunken beds** for growing vegetables. During the rainy season, these sunken beds can be planted with taro plants (dasheen, edoe) which adapt to wet conditions.

2. Soil Type

Whether a soil has a high clay or sand content will affect the type of raised bed we choose to implement.

Soil with high clay content

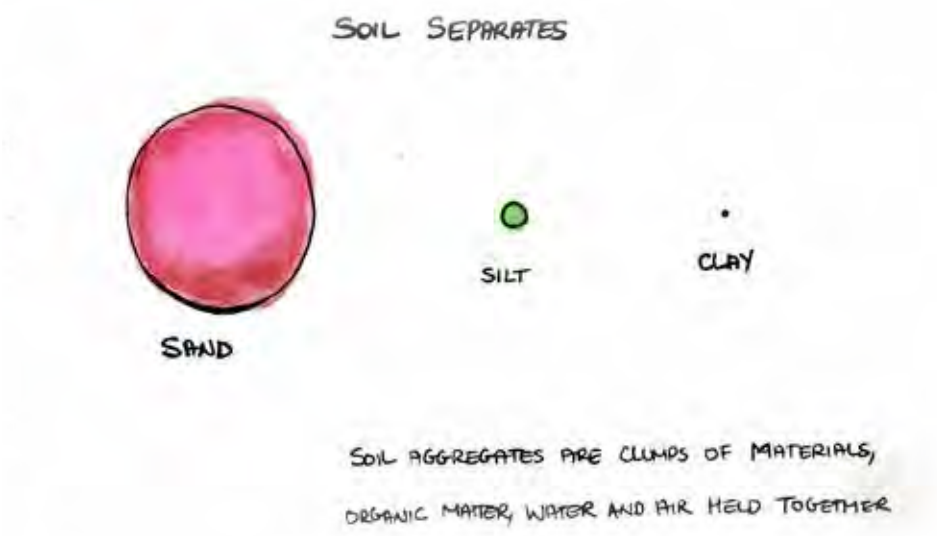
If the soil has a high clay content, then the beds when cut/shaped will maintain their shape even on sloping land much more effectively than beds with high sand content or a loamy mixed content. However, clay has very fine soil particles and doesn't drain well. To counteract this, particularly on flatlands, the garden beds can first be **double dug** and filled with organic materials.

If the soil is very saturated, then the **beds can be raised** to 2 feet (60 cm) or higher with the first 8" inches of the double dig bed being filled with logs to encourage a more fungal dominated soil and better soil structure resulting in improved drainage.

See 'Creating Double Dig Raised Beds,' on page 80.

Soil with high sand content

Grains of sand are huge when compared to clay particles; this allows water to drain much more freely in sandy soils. This difference in particle size also affects fertility with the finer clay particles having a much higher **Cation Exchange Capacity (CEC).** than sandy soils, which translates to greater fertility in clay soils than sandy soils.



When constructing raised beds on sloping land with sandy soil, it is necessary to make the support frame to hold soil. The beds may require support even on gentle slopes.

Due to the lower fertility of soil with high sand content, it is also necessary to double dig the beds and incorporate as much organic material as possible with a strong emphasis on decomposing wood, as this is the best food source for fungi, an essential component in building long term soil structure.

See more on Lasagna Bedding see Chapter 9.

The top of the beds should be covered in 8-12" (20-30cm) of lasagna bedding. These measures will ensure bed stability and increase soil fertility.

3. Frame Materials

The materials used to support the edges of the raised beds will depend on what is available locally and what is sustainable. When designing and implementing ecological gardens and farms, it is necessary to assess the material inputs required to complete the project and determine a sense of the **carbon footprint** of the materials.

Imported wood, having travelled long distances, treated with toxic chemicals, and in most cases harvested unsustainably, is not suitable for use in ecological gardens and farms. The approach is to source as many biological resources as possible **locally** that require little to no transportation.

Options for Bed Frames: Bamboo, Wood and Stones

Bamboo is a great resource for the construction of raised beds. It has the record for the fastest growing plant in the world, with one species **growing up to 31 inches (80cm) per day**. It can usually be sourced locally and therefore the main expense is the labour to cut, clean and carry the bamboo.

Bamboo is best cut during the **dark moon** and left with branches and leaves on in the bamboo stand for approximately 2 weeks before being cleaned and transported. Bamboo harvested in this manner has a number of advantages:

- less attractive to insects
- longer lasting
- less heavy to transport
- faster drying

The downside of this great resource is that it **decomposes within 2 years** when in contact with the earth or exposed to weathering. When replaced, the decomposing bamboo can be flattened and used to mulch pathways.

Wood can also be a great option when constructing raised beds. Trees contain compounds called **lignins** that are rubbery in texture and resist decomposition. These compounds are beneficial in the development of good long-term soil structure. The wood needs to be local, from trees that are relatively fast-growing, resprout when **coppiced,** and provide relatively straight branches approximately 3-4 inches (8-10cm) in diameter.

Fast-growing legume or **Nitrogen Fixing Trees (NFTs)** are a good option as they grow rapidly and contain high levels of nitrogen. Two good options in the tropics are **Leucaena leucocephala** and **Gliricidia sepium**. These trees are very resilient and fast growing with certain varieties of leucaena growing up to 60 feet (18m) in 5 years.

Coppicing *means cutting back a tree or a shrub to ground level periodically to stimulate growth.*

The advantage of wood over bamboo relates to it being **more durable**. It may last several years, and when it decomposes it assists in building a better soil structure than bamboo.

Stones found in the field or gathered from around the area are a valuable resource in constructing raised beds. The benefit of using stones is that the garden beds can be stabilised for long periods of time. Dry **stone walls** in Europe date back many hundreds of years.

The downside is that **stones don't decompose** and thus there is no cycling of nutrients back to the earth as there is with wood and bamboo.

Gliricidia sepium

4. Topography of Landscape

Whether you are making garden beds on a slope or on flat land will affect the type of bed you choose to construct.

Beds on a Slope: Contour Terrace Beds

Contour terrace beds are annual and/or perennial vegetable garden beds that conform to the natural pattern of the landscape. Being on contour means that the **paths and beds themselves are level** and follow the lay of the land. Not only does this create an attractive pattern on the landscape, but more importantly, this technique allows us to **slow, spread, and sink** water into our garden in a similar way that swales do. This approach will also limit soil erosion due to the pacification of any surface runoff.

Read more about swales in Chapter 7

When working on slopes of over 12 degrees it is necessary to support the raised beds, otherwise, when it rains and the soil gets heavy the beds may collapse.

The primary reason for raised beds is to **define pathways easily** so that the beds are not walked upon, as this causes soil compaction leading to a deterioration in soil quality and fertility. The beds also serve the purpose of **channelling water through the garden in flood events**. They are a useful way to garden if you have restricted mobility, as they reduce the need to bend.

Preparing to build a garden bed

Step 1

The first step to building our beds will be to use an **A-Frame** to find the top contour of the land. This contour serves as the starting point for the first bed.

For more information on how to find the contour, see chapter 6.

Step 2

Step two is to choose the size of the beds and the pathways.The width of the bed will depend on the slope of the land, **the steeper the slope, the narrower the bed will be**. We can say that an average of 3 feet (90cm) in width is a good size for a terrace bed.

Step 3

Step three is to select and **prepare the available materials** for the construction of the beds. Materials such as bamboo, wood, stones, or concrete blocks can be used to support the construction of the raised bed.

In the photo, the bamboo is supported using sticks as stakes. Typically we use gliricidia stakes, but hardwoods such as fiddlewood (Citharexylum spinosum) can also be used effectively.

Bamboo Contour Terrace Beds

After choosing the size of our terraces, preparing the available materials for the frame and finding the top contour that will guide the shape of our beds, it's time to construct them.

Step 1

Following the contour line, install the front bamboos, levelling the soil below them. The height of the bamboo frame depends on the slope—**a steeper slope will require more bamboo**. Generally, 3 bamboos on top of each other are enough.

A carpenter level can be used to ensure the raised beds are constructed level to contour.

Step 2 Support the frame with **stakes**. Make sure to hammer the stakes as deep as possible so they are solidly supporting the structure.

Step 3 Install the **side bamboos**, making sure they are at the same level as the front ones.

Step 4 If needed, install bamboo **on the back of the terrace bed** at the same level as the front and the side. This bamboo will also designate more clearly where the edge is between the bed and the pathway.

Step 5 Once the support is erected, **organic materials** can be used to fill the space between the bamboo. According to the soil quality, you can decide if a double digging strategy is necessary (see next page).

Step 6 Top up the organic materials with soil that is dug from the bed itself (before the organic materials are implemented) and from the pathway above the terrace bed.

Step 7 Make sure that the pathway is at least 4 inches (10cm) below the top of the terrace bed frame.

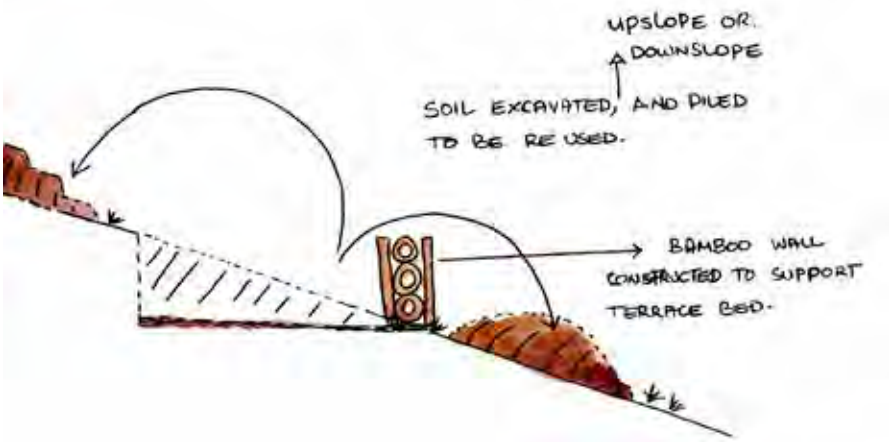
Step 8 Cover the soil with a lasagna layer.

For more information on Lasagna beds, see chapter 9.

Double-Dig Beds

If building raised beds on steep land, we will need to incorporate organic materials to enrich the soil. The same applies for building on degraded land. In both cases we can **double dig the bed**.

To implement this type of bed we first have to build **a support frame**, typically out of a bamboo (see the illustration below), wood, concrete block, or field stones. The soil is then dug out of one section of the bed to about 18" (45cm) deep and piled to one side.



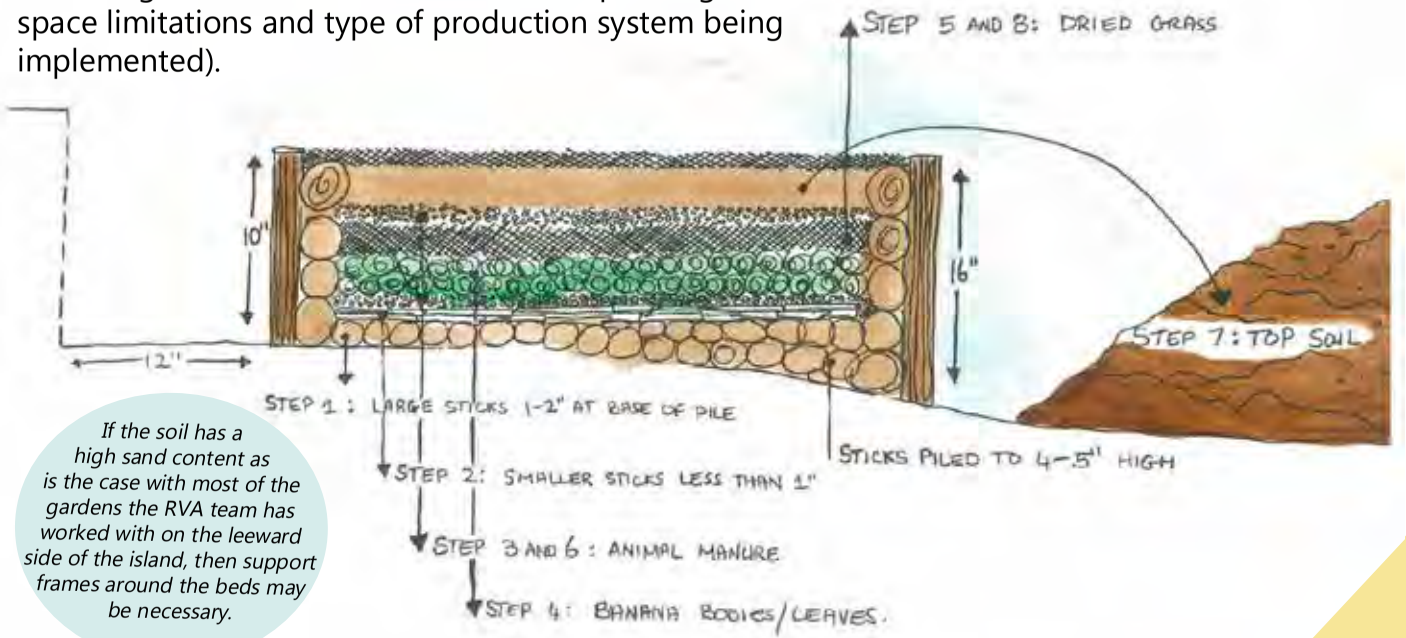
The dugout section of the bed is then filled with organic materials—decomposing wood/sticks < 5" (12.5cm) at the bottom, then green sticks, manure sprinkled, dry leaves/weeds, banana bodies/leaves in layers, manure, dry grass—alternating until you reach 2" (5cm) below the top bamboo. Finish with 6" (15cm) of soil topped with compost or lasagna bedding.

Due to the decomposition of organic materials, **the bed may sink significantly in the first three months**, and more soil will need to be added as it sinks. The decomposing materials inside the raised bed will encourage soil microbes, which in turn will cycle nutrients from the decomposing organic matter in to a plant available form, resulting in healthy, productive crops.

Beds on Flat or Gently Sloped Land

Flat or gently sloped land offers the opportunity to be creative using different effective patterns and strategies.

When constructing **raised beds on gently sloping to flat land** they can be built by mounding soil 8-10" (20-25cm) high and 3-4' (90-120cm) wide (depending on space limitations and type of production system being implemented).



If the soil has a high sand content as is the case with most of the gardens the RVA team has worked with on the leeward side of the island, then support frames around the beds may be necessary.

Double-Reach Beds

For those looking to grow more food in the same amount of space, double-reach rows might be the answer.

As you are building the garden, keep adding water to the different layers.

What is a double-reach bed?

Rather than being narrow like conventional garden rows, **double-reach beds are wider**. The idea is to make them the right distance, an arm's length, to reach to the middle from either side. This enables gardeners to tend and harvest from the growing space without stepping into it.

Why are double-reach beds better?

Where conventional rows are generally about 1 foot (30cm) wide with a foot between rows, **double-reach rows are about 3-4 feet (90-120cm) wide** with about 1 foot between each. In essence, that means there is an extra foot-width of planting space between every couple of conventional rows, which means a big increase in yield per square foot.

The wider space of double-reach rows is perfect for mulching, whereas with conventional rows, mulch material tends to slough off (if mulch is used at all). Moreover, wider rows mean it becomes easier to cluster plants, while thinner rows don't really work as well.

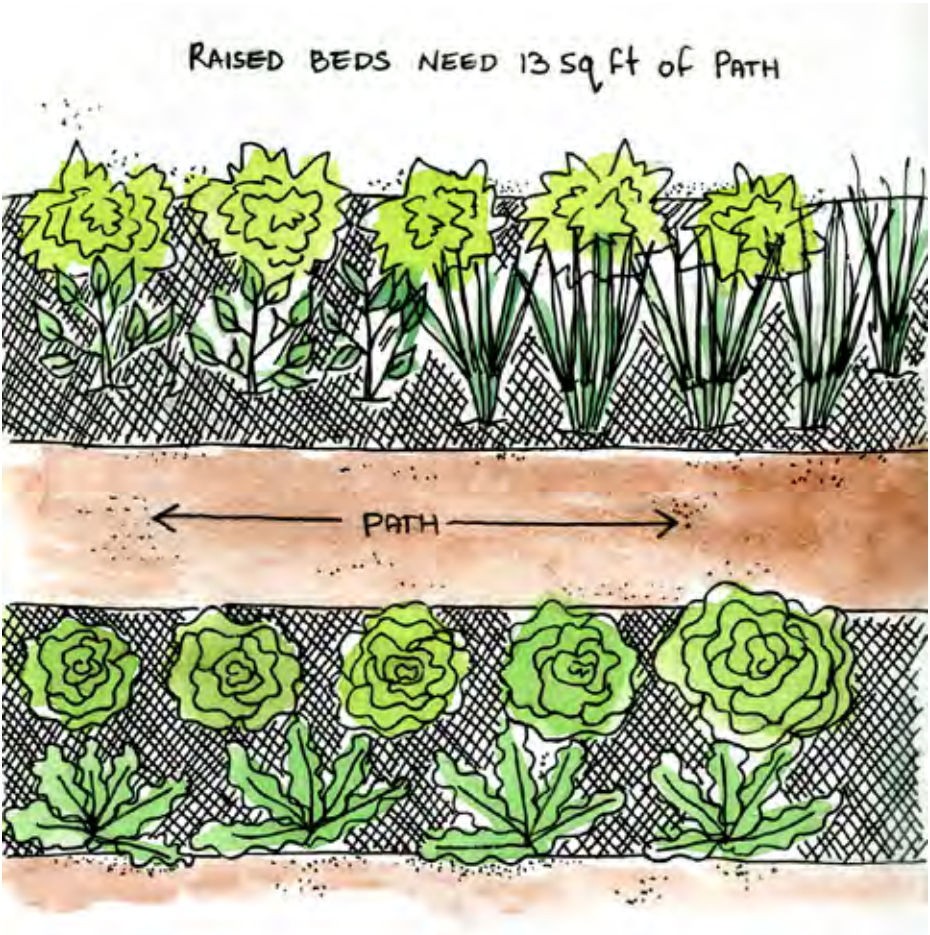
Companion planting *is grouping certain plants together so they benefit each other. For example, basil helps thwart pests from tomato plants but doesn't compete with the tomatoes for growing space.*

Keyhole Garden Beds

The shape of a garden determines how much of its area can actually be used to contain plants, as opposed to paths to let us reach those plants.

Changing the shape of a garden bed—**working with patterns**—can reduce the area lost to paths, as seen in these beds, each containing 50 square feet (4.7m2) of planting space.

The most basic garden bed contains single rows of plants with paths between each row. In this layout, paths consume about half of the soil area. A raised-bed garden, in which paths fall between every three or four rows of plants, is an improvement, **sacrificing only about 30 percent of its ground to walkways** while leaving the beds narrow enough for the gardener to reach the centre. Here, a simple change in geometry has eliminated almost half the path space. But we can do better and create an eye-pleasing design while we're at it.



A Horseshoe Bed. *Planted with cabbages, tomatoes, and path-side greens and herbs in a space 8-10 feet (2.5-3m) in diameter.*

If we bend that rectangular raised bed into a circle—or, more accurately, a **horseshoe shape**—even more pathways will disappear. By a simple trick of topology, the path shrinks to a tiny keyhole shape, which gives this space-saving garden layout its name, keyhole bed.

If we wrap a typical 4x15-foot (1.2x4.6m) raised bed into a U shape with a small central opening for a path, we cut the path down from about 22 square feet (figuring an 18-inch (45cm) wide path down one side of the raised bed) to 6 square feet (0,56m2). Less than a quarter of the ground is surrendered to paths.

How to Make a Keyhole Garden

Step 1 To make a keyhole garden bed you should mark out the garden on the ground or with sticks and rope.

Step 2 Make a circle 10 feet (3m) in diameter.

Step 3 Identify the best place for the entrance keyhole and mark this. The entrance should be wide enough for a person to walk to the middle.

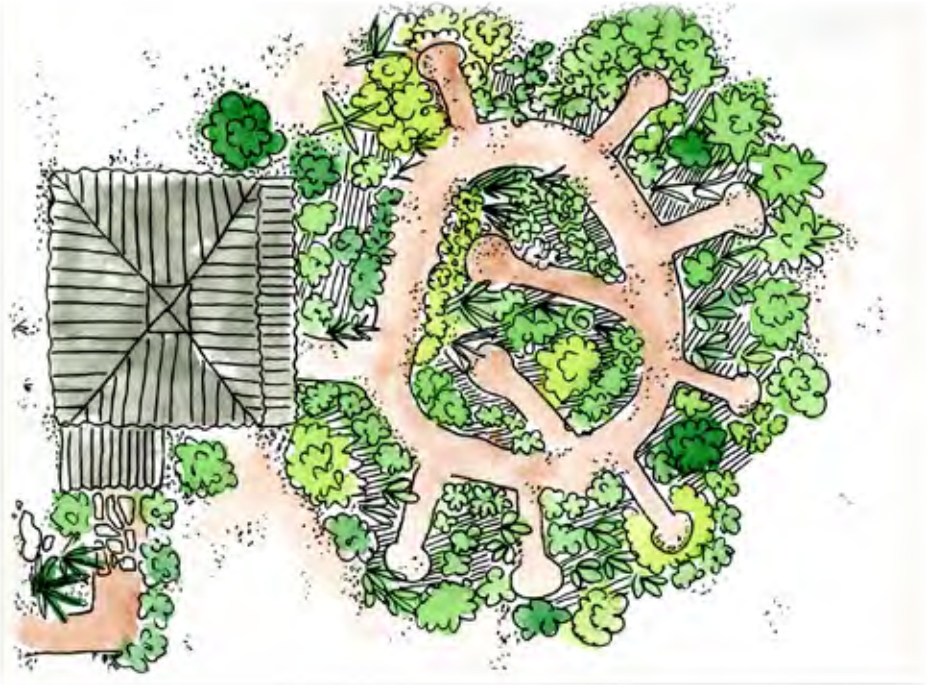
Step 4 The materials you are going to use for building the bed and filling it inside are the same as those we described in the topography and landscape strategies shown on the illustration on page xx.

Keyhole beds are round, whereas most yards are square. So what about the margins, those little triangles of unused ground at the corners of these beds—isn't that wasted space? Not at all.

Every garden needs insect-attracting flowers such as Mexican sunflower, or perennial nitrogen fixers such as pigeon peas or a good wind-and-weed barrier at the edges to stop weed seeds blowing in from your neighbour's less-than-immaculate land. We could fill the margin with robust mulch providers such as lemongrass or vetiver grass. It could be a perfect spot for a small fruit tree, banana or papaya.

Planting more than one keyhole bed expands the possibilities. Keyholes can extend to the left and right of a central walkway. An undulating path flanked by keyhole beds can make for an attractive Zone 1 garden.

Several keyhole beds can extend from a central path to create a garden with pleasing curves and plenty of accessible bed space.



Mandala Garden

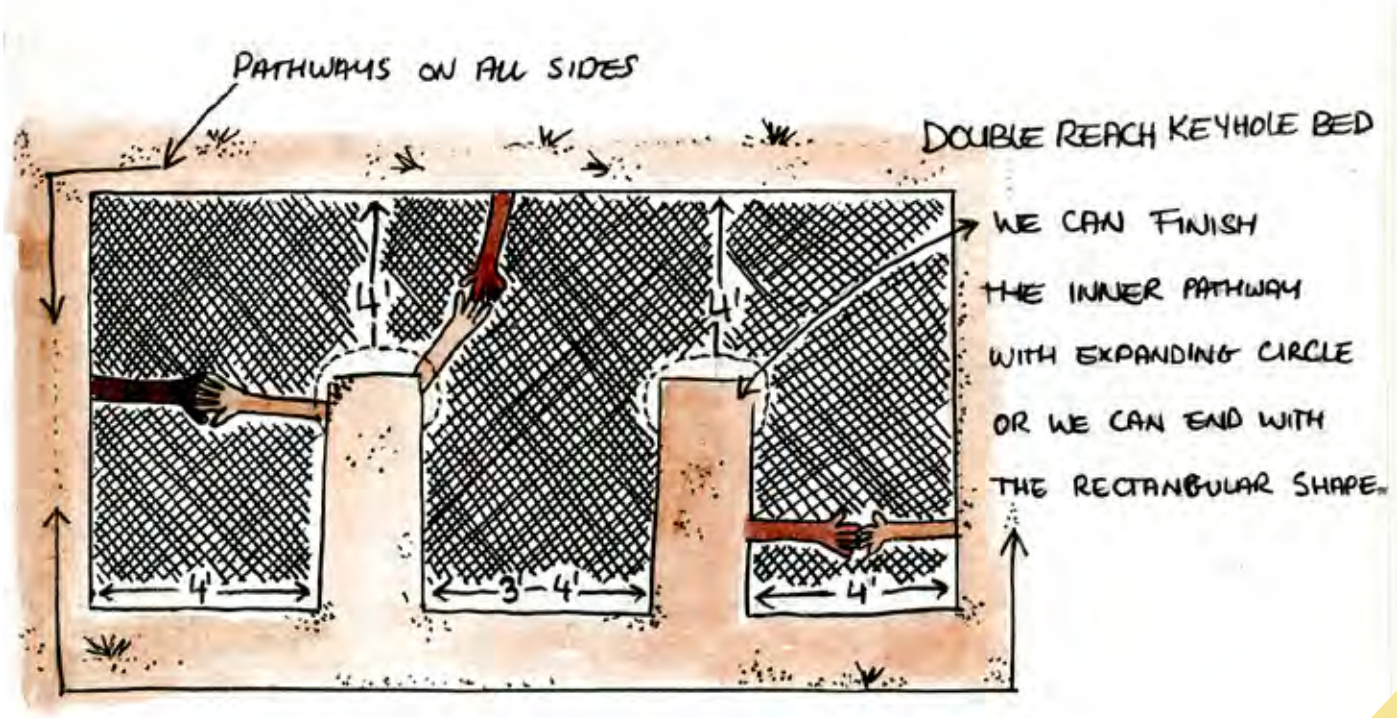
A further modification of the keyhole scheme is the mandala garden, a set of four to eight keyhole beds arranged in a circle with one more bed in the centre, and a path entering the mandala from one side. A mandala garden combines beauty and efficiency to create a magical effect. Few designs can fit more growing space into less area, and the more mystically inclined would say a mandala shape brings a spiritual aspect to a garden.

Mandala Garden

A circular pattern of nested keyhole beds is both beautiful and space-conserving.

Keyhole Modifications: Rectangular Keyhole

From the experience we have gained in making ecological backyard gardens over the last five years in SVG, and due to space constraints and bamboo shape, we can say that **one of our most used bed patterns is the rectangular keyhole bed**. There's no rule that says a keyhole bed can't be square rather than round; it's the central path that defines it. It follows the same principles as the round keyhole—reduced pathways and increased growing area.


PATHWAYS ON ALL SIDES
DOUBLE REACH KEYHOLE BED
WE CAN FINISH
THE INNER PATHWAY
WITH EXPANDING CIRCLE
OR WE CAN END WITH
THE RECTANGULAR SHAPE.
4'
4'
4'
3-4'
4'

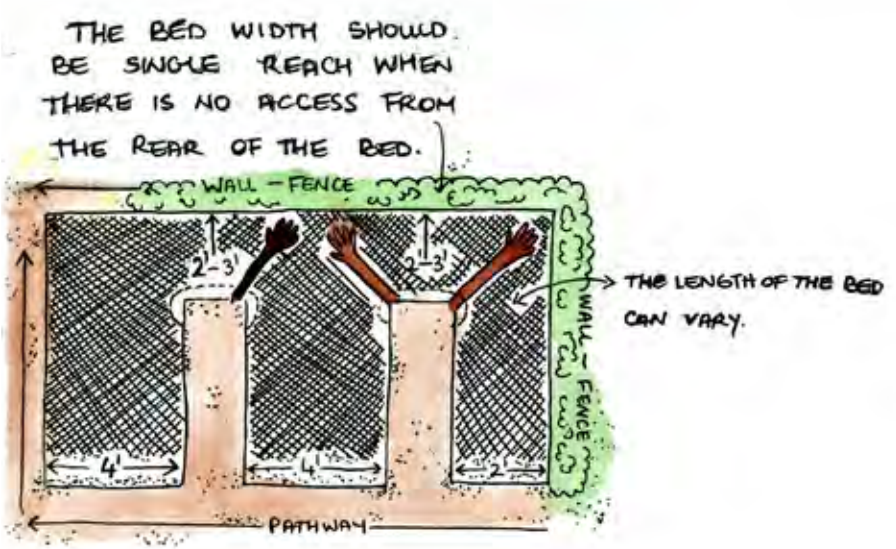
Tips for Building Rectangular Keyhole Beds

The inner keyhole pathway can finish with an expanding circle or square. This space will give us a place where we can put our tools or harvesting basket. This also helps us to reach some of the corners not accessible from any other side. We can also finish without any modification of the 12 inches (30 cm) pathway.

Before you start building, first draw on the ground or mark the edges of the bed with a rope or stick.

According to the **arm's length** of the person who will take care of the garden, measure whether all corners of the bed can be reached. Then adjust the layout and start building.

If there is no possibility to access the garden bed from all sides, then we should make sure that we can reach all parts of the garden bed from the available pathways (see illustration below).



Container Culture

Growing plants in containers is popular, particularly where space is at a minimum. Containers can be made out of a variety of materials (e.g. clay, plastic, metal, block, etc.) and can be of varying shapes and sizes.

These containers have sides and a bottom and therefore will require holes to be made in the bottom to allow excess water to drain out. Container culture offers benefits such as:

- The ability to set up a garden where there is an impervious ground surface such as concrete.
- Reduced pest and disease issues, as the containers offer physical protection from such problems.
- The opportunity to culture in small (urban) spaces.
- The opportunity to reuse containers destined for the landfill and turn them into productive planting pots.
- The opportunity to focus on soil improvements within the limited space of a container.

Garden Access and Paths for Beds on Steep and Flat Land

Design the main paths wide enough for a **cart or wheelbarrow access**, 2-3 feet (60-90cm) and room for walking on side paths, 18 inches (45cm). This is vital so you can easily water, spread compost, mulch, as well as harvest and clear after harvesting.

Smart idea!

Your paths can catch nutrients and return them to your raised garden beds! **Cover the paths** with fresh mulch, such as banana bodies or leaves, coconut husks, sawdust, bamboo leaves, fresh grass, and even old newspapers. This inhibits weed growth and the mulch helps keep moisture in the soil.

In the wet season, the mulch soaks up water and nutrients that run off the garden beds. **After about 4-6 months** you can take the decomposed mulch from the paths, pile it to aerate it, and put it on your garden beds. Then add more fresh mulch on the paths and start the cycle again.

For more information about mulch see chapter 11.

Maintaining Fertility of Garden Beds

Garden beds should not be stepped on as this compacts the soil and creates anaerobic conditions that weaken plants and encourage disease and pest attacks. Compacted soil also means that roots are impeded at the compaction layer and are forced to grow laterally, resulting in increased stress for the plant. That's why it's important to make the rows only so wide as to be able to reach the middle from either side.

The other benefit of this is that, when the soil hasn't been compacted and has instead been mulched, it doesn't have to be tilled. To keep the garden soil fertile and loose, just add organic matter in the form of mulch, with animal manure and/or compost sprinkled every 4-6 weeks over the mulch layer. This layer should protect the soil until the beds are fully covered by plants.

Photos of Unique Garden Bed Designs in SVG

Mandala Garden

Rectangular Keyhole Bed

Keyhole Bed Supported by Stones and Bamboo

Terrace Garden

Concrete Raised Beds

Garden with Different Shapes

Contour Terrace Beds Supported with Wood

Block Raised Beds

Double-Reach Beds

Chapter 9

Lasagna, or No-Dig Garden Beds

Healthy topsoil, or humus, is necessary for growing robust, disease free plants. However, topsoil takes many years to naturally accumulate through the slow decomposition of leaves, twigs, branches and other organic material. Lasagna gardening is a quick and efficient way to rapidly build the healthy soil you need for your garden through using readily available, organic materials that are often considered waste by others.

The name "**lasagna gardening**" has nothing to do with what you'll be growing in this garden. It refers to the method of building the garden, which is essentially, adding layers of organic materials that will decompose over time, creating a healthy and fertile soil filled with beneficial microorganisms. The **No-Dig method** of gardening was popularised by **Ruth Stout in her "No Work" garden book series**. The no-dig or lasagna method is based on an informed understanding of soil ecology.

The lasagna gardening method is one of the basics in the ecological gardener's tool kit. It's effective in encouraging soil life as it layers commonly accessible materials such as animal manure, cardboard, newspaper, banana bodies, leaves, straw, dried grass, seaweed, etc., together whilst also protecting the soil life from the extremes of sun, rain and wind. It's a method of eradicating weeds and building soil that requires no herbicides or tilling, both of which damage soil ecology. Lasagna bedding is **a variation on nature's way of building soil** by accumulating and breaking down organic debris whilst growing abundant crops.

How to Make a Lasagna Bed

Gathering the materials for a lasagna bed is the most time-consuming part of the job; the rest is straightforward. Fortunately, most of these items are free, local and easily available. The lasagna bed can be built **with or without a frame** surrounding it. You can do it directly on the lawn or on an existing garden bed.

Store your supplies near the chosen site *so you won't have to move them too far on the implementation day.*

Step 1

Before you make the lasagna bed, **water the site** well unless the ground is already moist from rain. The organisms that will be turning your mulch into rich earth can't work without water, and once the mulch is in place, it takes a lot of water to moisten the bottom layers. Conversely, it takes a long time for the layers to dry out—you have lots of water storage.

Step 2

Trim the land and leave the trimmings on the ground. (Beware of invasive species e.g. water grass, elephant grass, etc. These must be removed).

Step 3

Loosen the area of the bed with a fork—the soil should be loosened not turned.

Caution!
Make sure you start with a level surface. If your surface is uneven you may have runoff; resulting in soil erosion.

Step 4 **Spread a layer of animal manure**. High nitrogen manures are preferable e.g. chicken/rabbit. If using milder manure such as cattle or donkey dung then a thicker layer may be necessary.

Step 5 The next step is to **place a layer of cardboard** on the soil. Cardboard is a high carbon material, with a carbon to nitrogen ratio between 200:1 and 400:1, which is widely and freely available.

About cardboard

If possible, wet the cardboard in a drum/barrel of unchlorinated water. This hastens bacterial and fungal colonisation of the cardboard and allows roots to easily penetrate it.

Do not use glossy colored cardboard as it may contain toxic substances. The black and colored inks on standard cardboard newsprint are soy-based, nontoxic, and safe to use.

The cardboard should be layered so that the ends overlap one another, and no space is allowed for weeds to grow.

It is best to remove all plastic tape or staples from cardboard before use.

Cardboard will completely decompose adding the critical carbon element to your soil.

Step 6

The next layer is a 2-3" (5-7.5 cm) **green - nitrogen layer**. Any non-invasive green plant material can be used, e.g. banana bodies/leaves, gliricidia leaves/young branches, vetiver grass, Mexican sunflower, lawn grass, or any other form of green biomass.

Step 7

The next layer should be 3-6" (7.5-15 cm) of **carbon materials**. Here we can use dried (brown) biomass such as dry leaves, grasses and other brown (non-invasive) plant material.

*If possible, we should **water each layer** as we implement the lasagna bed.*

Step 8

Repeat the following steps:

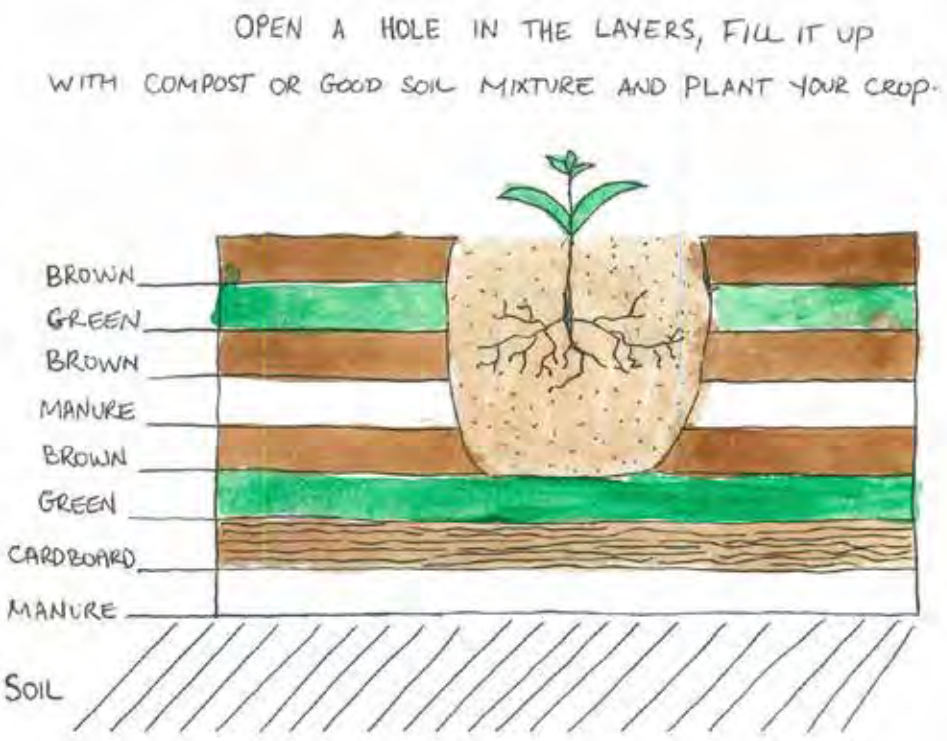
Step 4: manure
Step 7: browns
Step 6: greens
Step 7: browns

Over the next two to three months, the materials you put into the garden will decompose into nutrient-rich, healthy, well-structured soil.

We always finish with a seed-free brown carbon rich layer, as this protects the more moist, succulent green materials from heat and light, allowing the fungi, bacteria, and other soil microorganisms optimum conditions for colonisation and decomposition. For the top layer, we can also use "washed" seaweed, which has a range of beneficial nutrients.

Planting

These no-dig lasagna beds can be planted **immediately**. To do so, we create **a planting hole,** also known as a bird nest, in our lasagna bed to about 4-6" (10-15cm) deep, fill it with compost or comparable manure/soil mix, and plant. As the plants grow, their roots will reach into the rapidly decomposing layers of the lasagna garden bed to continue to access nutrients for their fulfilment.



The mulch should not be too close to the seedlings, so as to negatively affect them; 1-2" (2-5-cm) from the stem is adequate. If you made the lasagna bed over an existing bed and you didn't have enough materials to complete all lasagna layers, so that you may only have 2-4 inches of lasagna bedding, then you may punch the cardboard and plant directly into the soil of the bed.

Maintenance

To maintain the garden, simply add mulch to the top of the bed in the form of straw, grass clippings, leaves, and the periodic sprinkling of animal manure. While you will be maintaining it the same way you would care for any other garden, you will find that caring for a lasagna garden is **less work-intensive**. You can expect:

Few weeds thanks to the cardboard suppressing them from below and the mulch covering the soil from above.

Soil that is easy to work: crumbly, loose, and fluffy.

Better water retention due to the fact that compost (which is what you made by layering all of those materials) holds water better than regular garden soil, especially if your native soil is sandy or deficient in organic matter.

Less need to fertilise because you planted your garden in almost pure compost, which is very nutrient-rich.

If this is your first lasagna bed,
start small, and observe it.

No-dig/lasagna systems are best suited to gardens and smaller applications, as the amount of materials required limits the size of the area that can be covered.

Lasagna bedding is a variation on nature's way of building soil by accumulating and breaking down organic debris whilst growing abundant crops.

While you will be maintaining it the same way you would care for any other garden, you will find that caring for a lasagna garden is less work-intensive.

Chapter 10

Compost: Nature's Fertilizer

Soil is the basis of life. Ninety-five percent of the world's food is grown in the uppermost layer of soil, making topsoil one of the most important components of our food system. But thanks to conventional fossil fuel-based farming practices, nearly half of the most productive soil in the world has disappeared in the last 150 years, threatening crop yields and contributing to nutrient pollution, dead zones and erosion.

Soils play a key role in absorbing carbon and **filtering water.**

Soil degradation creates a vicious cycle in which less carbon is stored and climate change is accelerated. If we continue to degrade the soil at the rate we do now, **the world could run out of topsoil in about 60 years** according to the **UN's Food and Agriculture Organization**.

The earth under our feet is too often ignored by policymakers. but the reality is that soils are the basis of life, and we need to protect them and provide the conditions they need to thrive, or we are not sustainable and we are heading for a food supply crisis and an ecological catastrophe.

With various ecological agricultural practices such as composting, mulching, cover crops, polyculture, no-tillage, and contour farming, just to name a few, **we can rebuild topsoil within a few years**.

What Is compost?

Compost is a natural process that combines varying types of organic material into a pile subject to decomposition by soil micro organisms, primarily bacteria and fungi. The process is fueled by oxygen and adequate moisture levels.

Making **aerobic compost** is one of the best ways of introducing beneficial microorganisms to the soil. These microorganisms are responsible for establishing the ideal soil structure through binding particles of sand, silt and clay together to form aggregates.

What are its benefits?

Compost acts as an **inoculant of beneficial soil microorganisms** increasing the humus content in the soil. Compost acts as a food source, a probiotic, and a sponge for the soil underneath it, making soil more fertile and efficient whilst supporting the intricate ecosystem that maintains healthy soil. Crops fed with compost grow strong, and they are not so easily attacked by diseases and insect pests. Compost also returns nutrition to the soil that-was removed when we harvested our crops.The benefits of compost to soil quality are many:

Eliminates the need for **chemical fertilizers**.

Reduces waste and makes use of it.

Improves **plants' nutrition**.

Increases **soil moisture**.

Reduces methane emissions at landfills.

It acts like a sponge, absorbing excess water (5-20x its own weight), thereby **reducing the water's erosive effects.**

Nature needs 100 years to generate 2.5 centimetres of topsoil.

Increases the **aeration and water infiltration capacity** of clay soils.

Increases the **water content and retention capacity** of sandy soils.

Compost, like good soil, has a high carbon sequestration capacity, which helps in **mitigating Climate Change**.

Read more about soil types in Chapter 8

It is a **balanced fertilizer** releasing nutrients slowly, in sync with plants' uptake needs.

It **requires little or no expense**, except the knowledge and labour required to assemble the materials, pile them, and turn them periodically.

Compost is a **soil inoculant,** providing the soil with a concentrated injection of soil microorganisms, resulting ultimately in **increased fertility and improved soil structure.**

Understanding Compost

Understanding the **process of decomposition** that leads to compost is key if we are to produce high-quality compost for the enrichment of our soil and ultimately the vital nourishment of our bodies.

Compost can be produced both with oxygen (aerobic) and without oxygen (anaerobic). **We are more interested in the aerobic process of compost production** since the temperature of the pile is much greater when subject to more oxygen through turning of the compost pile. This higher temperature has the effect of destroying weed seeds and soil pathogens. Aerobic microorganisms—the beneficial microbes capable of building good soil structure with its attendant benefits—thrive in the oxygenated compost pile.

The composting process happens much more quickly when using the aerobic method of decomposition. Of great importance to the health and productivity of the garden is the **mass production of microorganisms** in an aerobic compost pile. These microbes will be aerobic and are the "good guys". They'll protect the plants from disease and result in healthy, abundant crops. **All disease-causing pathogens originate from anaerobic conditions**. We may consider them the "bad guys" and they are the entry points for disease in the garden.

Materials to include in the pile

The materials required to produce compost can be divided into two types:

CARBON (C) Materials:
These materials are brown in color, for instance; dried leaves, grasses, wood and other dried plant material. Carbon suitable for composting can also be found in carbon-based potential "waste" materials such as cardboard and newspapers.

NITROGEN (N) Materials:
These materials are referred to as green, including; green plant material (grass clipping, fresh leaves, banana bodies), animal manures, blood meal, urine, and food scraps such as raw and cooked fruits, vegetables, grains, and coffee grounds, to name a few.

In terms of what to include in a compost pile we know that *"once it has lived, it can live again."*

Good Plants for the Compost Pile

Moringa: Very high nutrient content, breaks down quickly, grows quickly, drought tolerant, can continually be cut and regrown.

Legume trees and shrubs: High nitrogen content, break down quickly, grow quickly, drought tolerant, can continually be cut and regrown.

Grass: High in nitrogen when fresh (green), good carbon for compost when dry (brown), can be regularly harvested (perennial grass).

Bamboo: Bamboo leaves contain silica. Silica makes plants stronger and helps the water to move through plants more easily, which prevents molds and fungus from growing.

Weeds: All soft-bodied weeds are potentially useful for composting, except those species that are invasive (e.g. water grass, elephant grass).

The mentioned invasive species can be used, but the pile temperature must be carefully maintained to ensure that the invasive weed species are destroyed.

Seaweed: Great source of potassium and micro-nutrients. Use dried seaweeds as fresh seaweed is mostly water, up to 97%.

If possible, salt can be washed before using, however, recent research by the Texas State University has demonstrated that salt content, when bound in the long chain carbon molecules produced through the composting process, does not adversely affect the final compost product.

Banana bodies and leaves: Contain a high quantity of potassium and hold a lot of moisture.

Palm fronds: Contain high quantities of phosphorus.

Wood shavings: High carbon content helps to absorb nitrogen from the pile and provides food for fungi, a critical component of productive soils.

Tithonia diversifolia (Mexican sunflower), cowpea, vetiver grass, etc.: Common and good compost materials, incredibly productive as biomass; useful for mulch, compost material, soil improvement.

Do not burn it, use it!

If the C:N ratio is high, meaning a high carbon content, then the pile may decompose very slowly.

Carbon:Nitrogen Ratio (C:N)

All materials suitable for composting contain a proportion of both **Carbon (C) and Nitrogen (N)** where the ideal proportion of both elements can be described as a ratio of C:N. The optimum proportion is 30 parts Carbon to 1 part Nitrogen.

High Carbon materials are those that are above 30 parts carbon, for example:

Wood Shavings*	400:1
Newspaper	250:1
Dried leaves	150:1
Dried grass	40:1

**can vary depending on the type of wood chosen*

High Nitrogen Materials are those that are below 30 parts carbon for example:

Blood meal	1:1
Urine	1:1
Fish	7:1
Rabbit manure	8:1
Chicken manure	12:1
Cow manure	16:1
Horse manure	18:1
Freshly cut grass	25:1

Freshly cut grass is close to the optimum proportion with 25 parts of carbon to 1 part of nitrogen.

The Nitrogen element is the **explosive** (heating) part of the mix, and if not suitably contained in the carbon part of the mix, then the pile may reduce significantly or possibly combust and literally burn in flames. Microorganisms, like humans, cannot eat only nitrogen (protein) they also need carbon (carbohydrates) and when this **balance** is optimum, the compost pile maintains its mass with little to no shrinkage.

The more diverse and nutrient-dense the organic materials going into the compost pile, the more fertile will be the resultant compost. Therefore, it is important to be aware of the individual benefits of the material inputs going into the compost pile and seek to add nutrient-rich sources where possible.

If the C:N ratio is low, meaning a high nitrogen content, then the pile may:

Smell putrid.

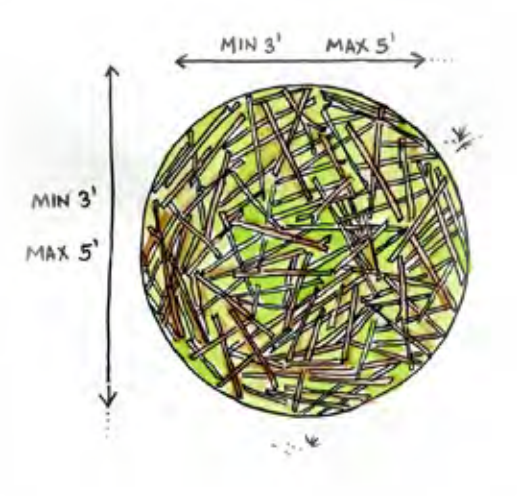
Contain maggots.

Diminish rapidly and significantly in size (by more than half).

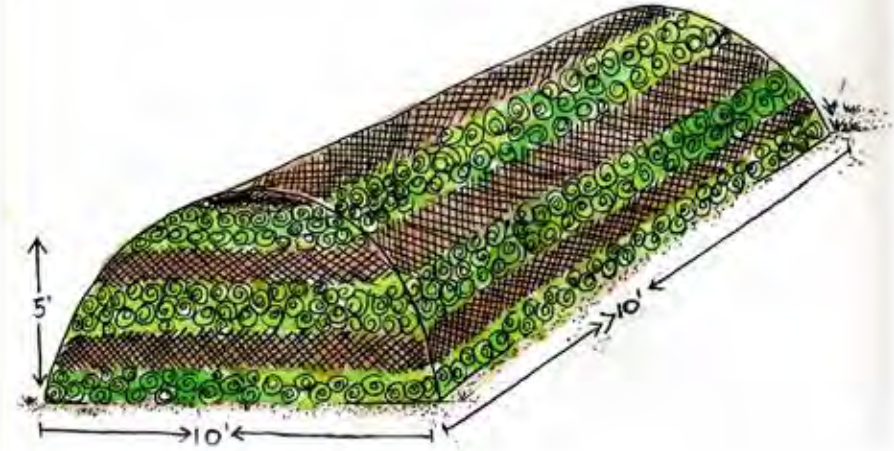
Compost Pile Size

When constructing a compost pile, there are certain maximum and minimum size limitations that can be critical in the process. The minimum size should be **no smaller than 3x3 feet cubed**. When made smaller than this, the critical mass necessary for efficient composting is not met and the piles' decomposition may be very slow and ineffective.

The **maximum recommended size for compost is 5x5 feet cubed.** When higher than 5' it may lead to compression of the pile from the weight of the materials, resulting in anaerobic conditions and stagnation of the aerobic process.



Although the ideal height of the compost pile is limited to 5', in order to produce large quantities of compost we can establish a **windrow**, see illustration:



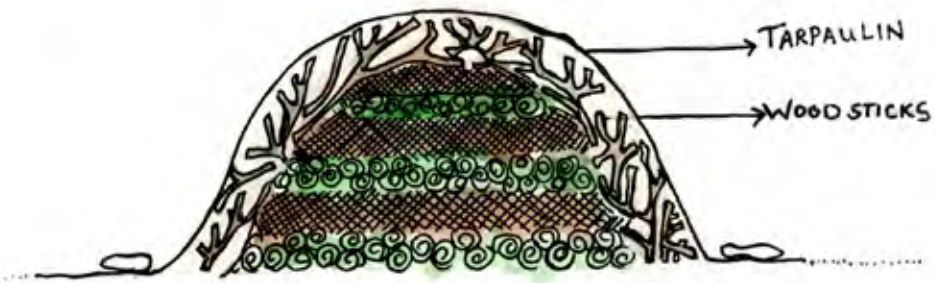
When using a windrow to make compost, the width of the base should be twice as wide as the height of the pile. For instance, if the pile is a maximum of 5' high, then the base should be 10' wide.

Compost Pile Temperature

The temperature of the compost pile should peak at between **55° Celsius (131° F) and 65° Celsius (149° F)** in order to effectively kill all pathogens and weed seeds. Should the temperature of the pile exceed 65° Celsius then a species of **thermophilic anaerobic bacteria** may proliferate and occupy the compost pile. These heat-loving bacteria are located towards the centre of the pile, where they are identifiable by their long white **mycelium-like strands**. Their presence indicates that the pile is becoming anaerobic. Measures such as adding more carbon (e.g. wood shavings) can be taken to reduce the temperature of the pile and slow the pile's diminishment.

Compost Pile Moisture Content

The moisture content of the compost pile should be in the range of **40–65% moisture**. If the moisture is higher the pile will become anaerobic. If the moisture level is too low the microorganisms will not have enough moisture to carry out the decomposition of the materials.



In order to prevent the pile from becoming waterlogged and therefore anaerobic, a **tarpaulin** or some kind of impermeable membrane can be used to cover the pile. In order that the tarpaulin doesn't hold too close to the pile surface and cause a lack of airflow, sticks with prongs can be placed against the pile and the tarpaulin hung over them so that airflow is increased.

Squeeze Test

If you want to produce compost professionally then you may want to invest in a moisture content reader. Otherwise, for small farms and backyard gardens, the squeeze test is adequate to get a sense of whether the pile needs more or less moisture.

When assessing the compost pile for adequate moisture, place your hand into the pile and take out a handful of materials, holding them in the palm of your hand.
SQUEEZE the materials:

If a small number of drops are released (1-3) then this indicates that the pile contains adequate moisture content.

If no moisture can be squeezed from the handful of materials, then the pile contains too little moisture and water will need to be added to the pile.

If many drops stream from your clenched fist, then the pile contains too much moisture and appropriate strategies for reducing moisture content will need to be employed.

Timing to Finished Compost

The speed at which you can create compost will depend to a large extent on how often the pile is **TURNED**. Regardless of the turning time of the pile, the construction can remain the same.

12-week compost

If we turn the pile once every 3-4 weeks then the pile will be complete in approximately 12 weeks.

7/8-week compost

If we turn the pile once a week then the compost is ready within 7-8 weeks.

18-day compost

If we want the compost even quicker, then we can make an 18 day "hot" compost, where we TURN the compost 4 days after making the pile, and then every other day up to day 16. Making a total of 7 TURNS within 16 days.

This "quick" method results in an aerobic compost, which is the most beneficial type of compost possible.

Step-by-Step Guide for Assembling a Compost Pile

Given its ground-changing impact, one would think the process of composting would be equally complex. Not the case! Composting is actually an easy and manageable way to produce well structured, healthy, nutrient-rich soil.

Tools needed for making the compost pile:

- Rake
- Cutlass (snips)
- Tarpaulin
- Fork/Pitched Fork (ideally)

First, we need to assemble the available organic materials to be incorporated into the compost pile.
These will consist of a pile of brown, a pile of manure, and a pile of green. Free-standing compost piles are best made not higher than 5', so they don't topple over or become too weighty and cause the pile to become anaerobic. A free-standing pile should be a maximum of 5' cubed. Typically a 4 foot cubed compost pile is ideal for ecological backyard gardens.

The smaller the materials going into the compost pile, the faster the decomposition of the materials. This is due to smaller pieces having a greater surface area than larger ones, offering microbes more area to decompose and resulting in faster decomposition. However, if they are too fine, they may compact and result in anaerobic conditions.


1/3 DRY BROWN
HIGH CARBON MATERIAL
ALL CUT UP FINE AND SHREDDED
THIS MUST HAVE A LARGE SURFACE AREA
1/3 MANURE
OLD MANURE NEEDS TO BE
POWDERED OR CHOPPED
1/3 FRESH GREEN
MATERIAL, CUT FINE

Guide for Assembling a Compost Pile (cont'd)

Once we have prepared all needed materials, and we have chosen where to construct the pile (close to a water source and close to the place where the compost will be used), we can start with assembling the pile, adding the materials in layers.

Step 1 We can start with a layer of **green materials** e.g. fresh grass cuttings or banana leaves/bodies 2-4'' (if this is added in thick layers it can become anaerobic and cause the pile to stagnate, so thin layers are preferable).

Step 2 Then add a layer of **brown material** e.g. dried grass or leaves 2-4'' .

Step 3 Then add a layer of **animal manure** e.g. cow, horse, goat manure 1-3'' (if we use higher nitrogen manure such as chicken, bat, pigeon and duck manure, 1-2'' inches will be adequate).

Step 4 **Water** the layers. Water is best applied with a watering can or a hose with a spray nozzle; the materials should be wet but not soaked.

The pile should be watered periodically as it is built to ensure it has sufficient moisture to begin an efficient decomposition process. **The pile has sufficient moisture** when the water that has soaked into the pile begins to run out at the base of the pile. When these rivulets are seen no additional water is required.

This process of green, brown, manure, and water is repeated until the desired size level of 4-5'is achieved.

When assembling a compost pile we add materials in layers:

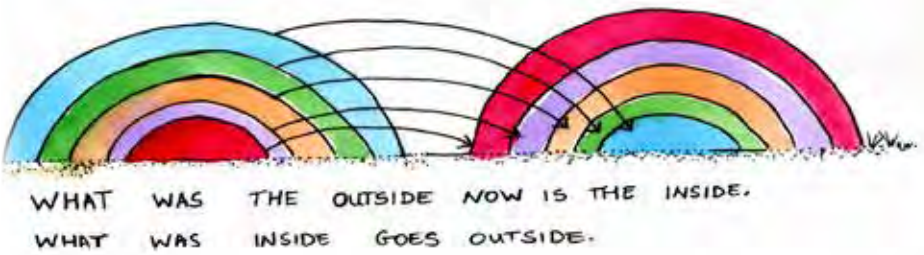
The thinner the layers the better the mixing of the materials will be when the pile is turned.

Compost Activation

Certain materials that **ACCELERATE** the composting process may be added to the centre of the pile either during assembly or after completion. These substance include stinging nettle, comfrey, fish, urine, and good quality compost.

Turning the Pile

When turning the pile it is important that the materials on the outside of the initial pile are placed at the bottom/middle of the new pile. And the materials from the inside are placed on the outside of the new pile. In this way, there is a more even breakdown of the materials over the course of the process.



Ready Compost Pile

Compost is ready when it has cooled to the ambient temperature. It takes a long time for some materials to decompose completely. Don't worry if some materials are not completely decomposed; final breakdown will take place in the soil. In the meantime, your plants will be getting lots of nourishment.

Using Compost

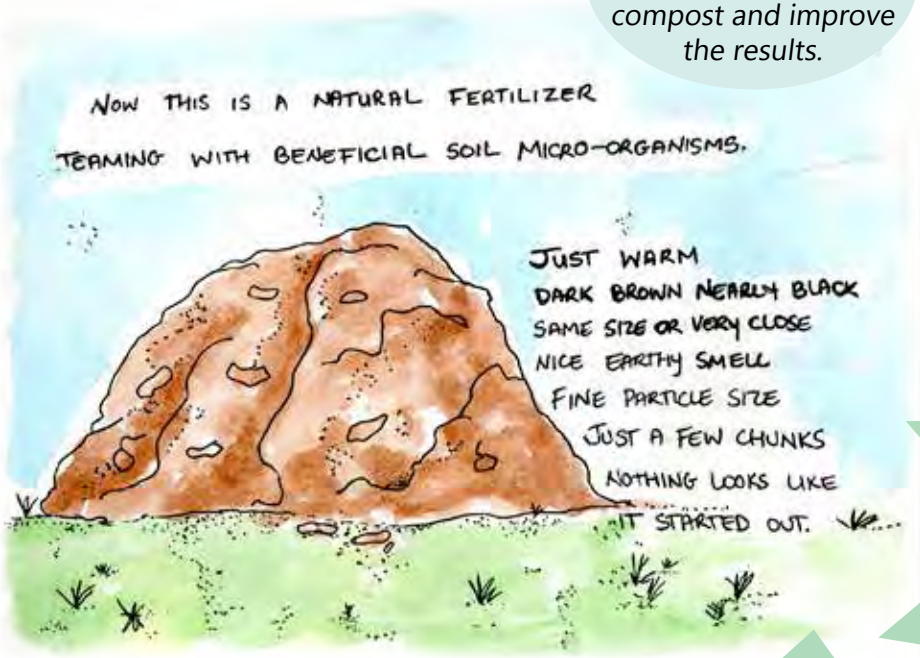
Aerobic compost should be viewed as an **inoculant** of beneficial soil microorganisms. The compost can be sprinkled over the entire garden bed(s) and covered with a mulch for protection or lightly tilled into the soil and planted to the chosen crop(s). The compost can also be added to each planting hole immediately before planting, using about two big handfuls in the planting hole for each seedling. A layer of 3 cm over a whole garden area and around fruit trees is ideal for soil health and performance.

Wise farmers return to the soil all their plant and animal wastes, instead of burning them or throwing them away.

For more efficient use of aerobic compost, **a tea can be made by bubbling the compost in a bucket or drum with an aquarium pump for 24-36 hours**. Other ingredients such as molasses may be added to further increase the proliferation of certain microbes. In this way the microbes are greatly increased in number and can be "broadcast" using a spray can.

The beneficial aerobic microbes are then able to more effectively cover the surface of the soil and plants. As they are greater in number they can out-compete the anaerobic microorganisms, thereby increasing the health and vigor of the garden or farm.

Always cover the compost with a mulch layer to protect the compost and improve the results.



Chapter 11

Mulch: Living and Non-living

Mulch is a protective layer of organic materials applied to or grown to cover the surface of the soil on your garden beds, pathways, or around trees. Mulching is a top priority for a healthy garden. Its benefits are so numerous that its hard to overstate its importance.

15 Reasons to Mulch

These are some of the reasons to use the "marvelous miracle of mulch" in your garden:

1. Adds organic matter to your soil, which helps make your garden healthier and more resistant to pests and disease plus, it saves money on pest control).

2. Provides valuable slow-release nutrients (saves money on fertilisers).

3. Helps retain moisture in the soil for longer, as it prevents evaporation by shielding the soil from the sun and reduces water runoff during rain or watering. This reduces the amount of water needed (saves money).

4. Shades delicate seedlings from too much sun (a mini-umbrella).

5. Reduces time spent watering (saves time and money). Mulch can retain up to 70% more water in the soil than non-mulched soil.

6. Is a great insulator by regulating soil temperature and keeping it cooler (reduces plant stress).

7. Provides a natural barrier to stop weeds from growing and competing with plants for nutrients by blocking the sunlight. You will find it easier to remove the few weeds that do grow (saves you time).

8. Increases biological activity in your soil by providing beneficial microorganisms and earthworms with food.

9. Improves soil conditions. Both clay and sand are made more loamy by the additional soil organic matter.

10. Stops nutrients from leaching out of the soil, especially significant during heavy rains.

11. Improves soil structure and drainage as it decomposes.

12. Improves the visual appearance of your garden.

13. Recycles "waste" materials.

14. Protects plants from mud splash during watering or rain.

15. Prevents erosion and soil compaction particularly from foot traffic on pathways and play areas.

What Is Mulch?

In ecological farming, we observe the way in which natural systems function. When we observe a forest, we can see that leaves fall, particularly from deciduous trees, along with twigs and small branches that fall from the canopy, creating **a natural layer of fallen and decomposing organic material** on the forest floor.

This is a mulch layer that over time along with the burrowing, scratching, and defecating of small animals and insects **creates compost**. In this way, the forest protects and nourishes the soil microbiology, which in turn creates soil structure capable of producing abundant plant growth. **Replicating this natural process with human endeavor** results in many benefits for the soil life in our mulched gardens.

Mulch Types

In ecological farming, there are two types of mulch: **living and non-living**. The non-living is a layer of dead organic material over the soil, and the living consists of living plants that also cover the ground.

Non-living mulch

Non-living mulch includes the use of **dried (brown) and green materials** such as; grass, straw, chopped banana bodies, seaweed, newspaper, cardboard, wood chips, and leaves. The dried mulch is preferred for the top cover of the mulch layer.

Which type of material is used will determine how quickly the mulch layer decomposes. Quick decomposition is beneficial in so far as nutrients are available more quickly for the plants (e.g. grass clippings, fresh banana leaves, fresh legume tree leaves).

Conversely, mulch materials that have a high **C:N - Carbon to Nitrogen ratio** (e.g. newspaper 250:1 or 175:1 if shredded) decompose slowly and are beneficial insofar as they keep the soil protected for longer without needing to be replaced, meaning less work/expense for the farmer/gardener.

Other high carbon options: vetiver grass, cardboard, dry tree leaves...

Plants to Avoid when Mulching

Certain plants contain **allelopathic substances,** which are plant chemicals that inhibit the growth of other plants. When mulching, care should be taken not to use mulch from allelopathic sources such as mango or cedar trees.

Avoid mulch plants that can take root from their stems, such as elephant grass and water grass.

Plant material **infected with viral and fungal diseases** should not be used, where there is a risk that the disease might spread to other plants or their roots.

Water grass takes root from its stem.

Don't use **plants that contain viable seeds** as this will encourage the spreading of them in our garden, causing issues for us in the future.

Grow Your Own Non-Living Mulch

In addition to mulching materials, we can take advantage of many other benefits that these plants can provide, such as fruits, erosion control, windbreak, animal forage, or microclimate creation.

Vetiver Grass (Chrysopogon zizanioides)

The Vetiver grass can be cut back to 10-15 cm two to three times per year. Use a nice set of hedge shears, a sharp machete, or a weed trimmer with a metal blade attachment for cutting vetiver. Use gloves as the grass can easily cut an exposed hand running along the edge. It is a valuable component of any ecological farming system, offering many beneficial functions such as:

The Vetiver's roots contain a volatile oil that is extracted and made into a perfume. Traditionally the roots are harvested, dried, and used to scent drawers storing fabric.

Vetiver grass also makes an excellent mulch, decomposing relatively slowly due to a waxy coating. The grass, when used as a final dress mulch, discourages soil-based pests such as mole crickets, which prefer to work on bare soil.

Erosion Control – Vetiver roots are thick and fibrous growing as much as 8' (2,5m) deep in 2 years. When planted close together, 4-6" (10-15cm) apart on contour, these roots bind together effectively forming an underground dam wall that constrains subterranean water flow, resulting in increasing groundwater storage.

Vetiver's leaves are shaped in way that encourages airflow when used in compost, resulting in hotter and faster composting.

It doesn't set seed quickly or often and thrives in full sun on recently disturbed sites.

Its leaves are used in the craft industry to create functional basketry and mats.

It is propagated easily by root division.

Banana Family (Musa sp.)
Species belonging to this family are a key component of successful ecological farming systems in the tropics.

The biomass from the banana family is high in potassium; it also contains high levels of moisture making it an excellent addition to the soil when applied as mulch. Earthworms are attracted to lay their eggs in the decomposing layers of chopped banana bodies, increasing the worm count and aiding the fertility of the soil.

Bananas are surface feeders, which gives them a special niche when used in developing ecological farming systems. They do not compete with the subterranean root systems of most plants and can be grown successfully on very poor soils when given a few inches of mulch or lasagna bedding. Their root systems compete with the shallow root systems of grasses for water and nutrients but do not compete with deep-rooted herbs and plants.

Due to the high water content of banana stands, they are key species in creating cooler microclimates This can be decisive when growing cool-loving vegetables.

Banana family species produce high-quality marketable fruit that can also be used as a feedstock for farm animals.

Mexican Sunflower (Tithonia diversifolia)
This wild sunflower is a woody shrub reaching up to 4 meters in height.

It is easily propagated by cuttings and loves full sun, where it produces beautiful yellow flowers throughout the dry season that support a host of pollinators.

Hack at the plant with a machete or clippers with little fear of taking too much off. It has a strong coppice response, providing a steady supply of woody mulch.

It makes a great cut and carry fodder for cattle and goats throughout the dry season.

Like sunflowers, it purportedly has the ability to accumulate phosphorus in its leaves and stems. This would be a nice addition to any mulch pile.

We can go to the forest or to our neighbors to get some of the mulch materials we need, but the best place to source them is from our backyard or farm.

— A good farmer provides much of the needs of the farm from the farm itself.

Bamboo Leaves (Bambusa vulgaris) are sustainable mulch sources that have a waxy covering and decompose slowly. They are high in silica, a mineral that aids the structural integrity of plants, making corn, for instance, more able to stand up to strong winds.

Bamboo has innumerable benefits, but for the purpose of designing ecological systems the following are important:

Bamboo culms can, along with other detritus from the bamboo clumps, be decomposed and returned to the soil. As bamboo is the world's fastest growing plant, the quantity of bamboo biomass produced is relatively large when compared to other support species, making bamboo an excellent choice for ecological farming systems.

Bamboo makes an excellent windbreak.

Bamboo stakes and culms can be used throughout the garden for staking plants, creating vining structures, and building shelters.

Coconut Palm (Cocos nucifera) and other species of the palm family are phosphorus accumulators. The roots of the palms enter into symbiotic relationships with mycelium fungi, which considerably extends the capacity of the root system to extract phosphorus from the soil biota.

This accumulated phosphorus is stored in the detritus of the palm and released as this biomass decomposes.

When we use the palm fronds in compost or as mulch, we are adding slow-release phosphorus stores to the soil.

Lemongrass (Cymbopogon citratus) is a very useful clumping grass that makes an excellent mulch source.

It is easy to grow, regenerating robustly after harvesting.

It contains volatile oils that can help to deter pests. If it is to be used in composting then caution should be taken as too much of the volatile oil may suppress microbial activity.

It is a popular culinary herb that is traditionally used as a medicine.

It can be planted along the contour to reduce erosion.

Other Non-Living Mulches

Grass Clippings

They are easily accessible in some regions of our island, especially during the rainy season when the grass grows rapidly, and the homeowners trim their lawns.

Many people throw away this valuable resource, seeing it as waste. But the grass clippings can be a fundamental part of the health and fertility of your garden soil.

Add additional layers as clippings decompose. Do not use clippings from lawns treated with herbicides.

There are some things to be careful about when we use this kind of mulch. It's not recommended to apply a layer of mulch thicker than 2-3" (5-7,5cm) Thicker layers tend to compact and rot, becoming quite slimy and smelly. Grass clippings also tend to mat down and not allow water to pass through, creating anaerobic conditions which invite plant diseases and pathogens.

Newspaper/Cardboard

Newspaper/cardboard as mulch is becoming more and more popular. Most newspapers use organic dyes, especially for their black & white sections. Shredded newspaper has been used for years to keep plant roots moist while shipping.

Layered sheets of newspaper/cardboard also have great moisture retention abilities, and they act like other organic mulches as far as suppressing weeds and controlling soil temperatures. They are also great for smothering existing grass to jump-start a new garden bed.

To use as a mulch in the garden, spread a layer of 0.5-2" (1.25 -5cm) of newspaper/cardboard around the plants. Moisten the sheets to keep them in place. On windy days it's easier to moisten the sheets before you place them down. Cover the newspaper/cardboard with a layer of organic mulch and the weed protection should last until your plants are well established and are fully covering the surface of the bed.

It is important to note that when using these high carbon mulch types, we need to add a sprinkle of high nitrogen manure to the cropping area before laying the cardboard or newspaper. Otherwise, the carbon:nitrogen ratio will be imbalanced in the short run resulting in nitrogen deficiencies in the soil.

Living Mulch

Living mulch includes living plants that have a vining or spreading growth habit. These plants are typically, but not exclusively, **leguminous or nitrogen-fixing** beans and peas. Such plants have the capacity to enter into a symbiotic relationship with particular soil microbes, giving the plant in collaboration with the microbes the capacity to convert atmospheric nitrogen, accessed through the soil, into a form of nitrogen the plant can use to provide for its needs.

However, the benefits of nitrogen fixation extend beyond the plant itself. The nitrogen accumulated in the plant is released to the soil when the plant dies or parts of it are cut and returned to the soil. In this way the soil biota benefits from the addition of atmospheric nitrogen converted to a plant available form by soil microbes.

The living mulch is of great benefit to ecological farming, as the plants chosen for the purpose have the capacity to cover and protect the soil but also to **increase the nitrogen content of the soil** beyond that which is possible from non-living mulch sources.

Mulch, whether living or non-living, is an integral part of ecological farming and needs to be supplied from the farm itself rather than being brought in as an input from outside.

The farm needs to be designed in such a way as to make the provision **of these materials easy and efficient.**

The species chosen to use as a living mulch will depend on the climate. In SVG the climate is the dry/wet tropics.

Cowpeas (Vigna unguiculata)
are an excellent living mulch as they grow for around 6 months and are well suited to the dry season but can be grown year-round. They produce an edible pea that can be used at 3 stages: as a green bean, shelled for green peas, or shelled for dry peas.

Macuna pruriens
is one of the best plants for rapidly building fertile soil. It has been used successfully in Central and South America for the last 40 years. It was used historically on the plantations in SVG prior to the "Green Revolution" as a living mulch and soil builder. Known as 'Bengal'; locally, it is light and moisture sensitive, performing best when planted from April to August and cycled back to the soil between September and November.

Jack Bean (Canavalia ensiformis) is a more erect shrub-like bean species that is very hardy and drought tolerant. It can be used as a green manure cover crop to rehabilitate degraded drought-prone landscapes.

Pigeon Pea (Cajanus cajan) is a shrub-like legume that can be used as a living mulch, except that it is not covering the ground itself; but when closely planted 4–5 feet apart, it can completely shade the ground while providing the benefits of a nitrogen-fixing plant.

Perennial Peanut (Arachis glabrata) is another living mulch that fixes its own nitrogen and can be used in the tropics as a soil-enriching ground cover in much the same way that clover is used in more temperate latitudes. The perennial peanut, as the name suggests, is "permanent" and doesn't have to be replaced annually, as the other examples given

How to Apply Mulch: General Guidelines for Mulching

- Do not apply mulch directly in contact with plants. Leave an inch (2,5cm) or so of space next to plants to help prevent diseases and let the roots have access to more air.

- If there are no plants on the bed, cover the entire surface with mulch and make holes in it to plant the seedlings. These holes are called birds' nests.

- Make the layer of mulch a minimum of 8" (20 cm).

- Try to have the top layer of the mulch covered with dry grass. The greener and faster decomposing plant material should be below the hardy mulch, which will stay longer protecting the soil.

Mulch Maintenance

The mulch itself is very easy to maintain, but it's still a good idea to check it from time to time. If it starts to smell, turn your mulch to allow air to circulate so it will decompose aerobically, leading to fewer potential diseases. It should be noted that if mulch material is incorporated/mixed into the soil, its effect is very different than if it is placed on the top of the soil.

When incorporated, the materials require more nitrogen to fuel a faster decomposition process and therefore can deprive the soil of nitrogen in the short term. This results in insufficient availability of nitrogen for plant growth.

Mulched Gardens

Tips for the Mulching

Technique for removing seeds from grass, hay, and leaves: Put any sort of seed threats in the chicken yard before using it for mulch. The birds will eat all the seeds, scratch it up, and add a little nitrogen to the mixture. It feeds them, then feeds the garden that will supply more fodder for the chickens.

Chapter 12

Trees

Adding trees to the ecological garden has many benefits for the garden as well as for the environment and can contribute substantially to mitigating the effects of climate change.

Fruit trees provide improved nutrition for the family, and fruits can be sold fresh or processed. Trees, even fruit trees, are much more than mangoes and oranges, and it is through **the recognition of the many varied roles of trees** that we can appreciate and place them correctly in our system:

Trees **supply foods** in the form of fruits, nuts, edible leaves, and pods.

Trees supply **gum**, **resin**, **flowers**, and valuable **medicines**.

Trees can be used for **fences**, and they provide **shade**.

Trees supply **compost** and **mulch** materials.

Growing trees also has many other benefits for our environment:

Trees supply **timber** and **firewood**.

Trees supply **fodder** for animals.

Trees invest approximately **40% of all the energy** they produce through photosynthesis into exudates to feed the Soil Food Web, which in turn stores much of this carbon in the soil, further mitigating the effects of climate change.

Trees are not easily killed by drought because they have tap roots that can **draw water from deep within the soil**.

Trees **absorb CO2** from the air and bind it in the plant material, contributing to mitigating climate change.

Trees can grow on hills and rocky places that are not suitable for growing anything else.

Trees help to **retain moisture** in the soil by providing channels for rainwater.

Trees moderate the temperature, creating a **good microclimate**.

Trees can **protect** fields and houses from wind and flooding.

All trees are part of creating **humidity** and **ambiance**.

Trees can stop **soil erosion** and **improve** the soil.

The Many Roles of a Tree

1. Produce oxygen and store carbon

Land-based ecosystems major in trees, as they are the **most developed form of plant life**, having evolved adaptations to extremely varied environments over millennia.

Trees are intimately connected to our own existence. They provide numerous benefits to humans and other life forms. First of all, we inhale oxygen and exhale carbon dioxide, whilst trees perform the exact opposite function; they exhale the oxygen that we breathe while absorbing the carbon dioxide that we exhale and **convert it through photosynthesis to carbon**, which is a critical element for life on earth.

2. Permanent solution for stability

Trees are **perennial**, which is another way of saying they are "permanent". This permanence means they are critical for protecting and nourishing the soil, the basis of life. Trees' extensive root systems hold the soil together, assisting in preventing soil erosion. The crown of the tree is important in intercepting the rainfall, thus protecting the soil from compaction and erosion. **The tree is patterned in a way that directs the rainfall down its trunk to its root system**, which is typically bedded in organic detritus from the tree.

Plants living for three or more years are known as "perennials". Unlike annuals, they don't need to be replanted yearly.

This organic bedding can **absorb large quantities of water** (1 cm of water absorbed for every 3 cm of humus), which then enters the groundwaters and feeds streams and eventually rivers. In fact, this process is what **allows streams to run even during periods of drought**.

3. Temperature moderator

Trees have the amazing ability to moderate temperatures. For instance, during hot conditions, trees pump considerable water into the atmosphere. This **process of evapotranspiration** has a cooling effect on the surrounding environment. When we stand in the shade of a tree on a hot day, we benefit not just from the shade of the tree, but also from the cooling effect created by the evapotranspiration.

An average-sized birch tree can evapo-transpire 3000 to 4000 liters of water per day!

Conversely, at night when it is typically cooler, **trees condense the water vapor in the air on their leaves**. This can be an extremely beneficial phenomenon in rain-stressed areas where **leaf drip** can account for 80 plus percent of the precipitation. Another aspect of this condensation is that as the water vapor condenses, heat is released during the process, actually warming the surrounding environment.

4. Nutrient accumulators

Trees have very deep tap roots that pump water and also nutrients **from the deeper soil layers and convert them to biomass** like branches, leaves, fruits, and other organic matter, which when dropped under the trees, provides the **soil biome** (soil microorganisms) with food that is in turn processed to provide the tree with nutrients in a plant available form.

Certain trees, like nitrogen-fixing legumes, are grown within our ecological systems primarily to feed other trees and plants.

5. Life supporting system

Trees provide food, not just for humans, but for many animals, insects, and birds, all of which contribute to the growth and benefit of the tree in one way or another. More and more farmers and scientists have come to understand that nature works with systems where plants, animals, and insects over a long period have built up a co-existence, a **symbiosis**—they all live and benefit from each other's company. When these systems are destabilized, we end up in situations where the soil is destroyed, or some animals or insects come to dominate, and in this way become a pest for other plants or animals in the system.

The more we can derive our food from tree crops instead of annual plants (e.g. rice, corn, soy), the more we can stabilise our ecosystems and our food supply lines.

Trees are one of nature's most ingenious answers to many of our problems. A landscape without trees becomes very hostile for people and animals.

6. Our most powerful weapon for mitigating climate change

We're in the midst of a **climate emergency** that is threatening the life on our planet as we know it. According to scientists, climate change is happening at a faster rate than ever. Our polar ice caps are melting leading to rising sea levels, the weather patterns are becoming more and more unpredictable, hurricanes are getting more frequent and more severe, the ocean is getting more acidic, and our forests are burning.

According to experts, **we're on track for a temperature increase of between 3°C and 4°C by 2100**. And these are only global average temperatures. At the poles and over land (where people live), the increase may be higher, possibly even double.

In order to not let this happen, **we need to stop emitting greenhouse gases (GHG)**. There are two ways people can change this trend:

1) Reabsorbing carbon dioxide from the atmosphere.

2) Reducing carbon dioxide (and other greenhouse gas) emissions.

Trees can help us do both. Trees are the ultimate carbon capture and storage machines. Like great carbon sinks, woods and forests absorb atmospheric carbon and lock it up for centuries through the process of photosynthesis. Forests help to regulate and stabilise our climate by **absorbing Carbon Dioxide (CO_2)**. The more forests we lose, the smaller the amount of carbon that can be stored, by trees, in the soil

and by the trees themselves, and therefore the greater the impact of the unabsorbed carbon dioxide that stays in the atmosphere and contributes to planetary warming.

Deforestation, or the felling of trees, accounts for about 20% of global warming.

A **tree that grows for 15 years can store 1.8 tons of CO2** as organic matter in its stem and roots. If the tree is burned, the CO2 stored in it is released into the atmosphere. If the tree is allowed to rot, the greater part of its carbon content is restored into the soil. Trees are one of nature's most ingenious answers to many of our problems. A landscape without trees becomes very hostile for people and animals.

So remember to build into your designs and landscapes the beings of trees. We have such a diverse collection of trees from all around the world available to us that fulfilling needs in any given climate should be possible. Remember the life ethic, however, and **if the life of a tree is to be taken, use it wisely, use it efficiently and use it with thanks**.

The stored sunlight, the strength to resist wind, the ability to build soil, the willingness to give habitat to others including humans, are all qualities to be thankful for. In conclusion, a new economy around trees rather than annual crops must sprout so that the end of the industrial age's dependence on annual crop monocultures is defeated. Evolution is near and trees can be a huge inspiration for a permanent culture as they so well embody it. Reforestation is going to be a crucial part of repairing the planet. Then, **why do we not think that it is vitally important to plant as many trees as possible?**

Chapter 13

How to Plant a Tree

In the previous chapter, we discovered just what a force trees are in an ecosystem. They are life enhancing instruments within our gardens, trees are home to animals and insects, they stabilise soils, protect homes, and create microclimates. Trees are magnificent and critical elements in ecological systems.

1. Where to plant

Different trees have different sizes.

Fruit trees can grow big, typically up to 33' (10m) high and 23' (7m) wide in their branches and roots, however in our tropical climate it is possible to grow much larger species, with some mango trees exceeding 70' in height. **Try to plant them in a place where they can grow to their full size,** or be prepared to prune them when needed.

***Do not plant too close to the house**, as the roots can damage its foundations. Particularly if the house has no roof gutters, the water runoff from the roof will attract the roots to the house.*

A place with the right amount of sunlight.

The tree may survive in a place with less sunlight but it may not be as productive. To get the most from your tree, **give it the sunlight it has evolved to expect** for best results. Most fruiting trees do best in full sun but some can thrive in less, so research the tree you're considering and determine its optimum sunlight requirements.

A place where the shade from the tree will be an asset rather than a burden.

You have to consider **the future canopy** of your tree and the shade it will cast. Will the tree one day shade out another growing area that will lessen the production of that area?

2. Tree species

In selecting the appropriate species for your location the following factors should be considered:

Read more about soil types in Chapter 8.

Which **product** do you want from the tree: fruit, nut, flower, timber, or something else?

How much **sunlight** will be available for the tree?

Are the trees **deciduous** or **evergreen**?

How much **space** do you have?

What **type of soil** do you have?

Can you grow crops under them, or will the leaves block out too much light?

Are the trees **easy to harvest** from?

If the tree is going to be planted on the prevailing wind side, is it **wind resistant**?

If the tree is going to be planted on the seaside, is it **salt-resistant**?

Any other **specifics** of your land and **wishes** that should be considered?

Which tree crops grow best in your area?

3. When to plant a tree

In the wet/dry tropics the optimum time to plant a tree is at the **start of the rainy season**, which typically starts in June. However, depending on your location in SVG and the corresponding average yearly rainfall for that area, you can potentially plant a tree at any time of year once the correct planting strategies are followed.

After you procure the tree, make sure to keep its roots moist until the planting time comes.

4. Spacing

Spacing between the trees if you have more than one:

- Plant trees like guava, cherry, sugar apple, soursop, plums, citrus, and guinep **20' (6m)** away from each other.
- Plant plum rose, wax apple, avocados and nut trees **33' (10m)** away from each other.

Preparing to Plant a Tree

Step 1: Gather Materials

Prepare all needed materials before planting.

- Compost, if you have available
- Water for the planting
- Tools for digging and shaping the land as well as transport of materials
- Mulch material; green and brown (cut and gather beforehand).
- Animal manure
- Guild plants
- Tree protection
- Woody material
- Labour

Step 2: Determine Placement

Locate the centre of the hole and create at least a 4′ (1,2 m) diameter clear space around. If you desire larger guilds, you will want to have an 8′ (2,5 m) diameter on your tree ring. Why this big? Because the more space we occupy with functionally beneficial plant species, the less invasive weed species we will have to contend with and the more diversity and its associated benefits will be available for the tree, ourselves and other life forms.

The initial effort required to set up a guild is minimal when compared to the advantages that the guild offers.

Read more about guilds in Chapter 12.

Step 3: Dig the Hole

Dig a hole two to three times as large as the root base of the tree. We will use the example of a hole of 2′ (60 cm squared and 3′ deep. Dig a square hole of 2′ by 2′ by 3′ (60 by 60 by 90 cm).

When we plant in a round hole it's very likely that the roots of our tree will spread first in a circular shape; this can cause root binding, disease and possible instability in the future. This is especially true if the soil in which you are going to plant the tree is compacted or with a high clay content. Square holes enable the roots to spread via the corners, helping them to anchor better in the native soil, making them more stable. Their greater root spread allows potentially more root-microbe interactions and thus greater fertility for the tree.

Step 4: Fork the Base

Lightly fork the base and sides of the hole to ensure the soil isn't compacted. When planting on steeper slopes, a box terrace can be created from bamboo, logs or stones and filled with organic materials. This ensures that the tree sapling has a fertile and protected start on sloping lands.

5. Planting

Step 1 Add the layers of organic materials and soil mix to the hole.

On the bottom put a layer of woody materials, press on the wood until it becomes a layer of 12" (30cm). Next is our 4" (10cm) green layer. You can use any green biomass such as banana bodies that are rich in potassium and moisture. Make sure there are no spaces between the layers.

Add 2" (5cm) of dry animal manure. This is our nitrogen layer. Cover with a 2" (5cm) layer of soil. Add brown material around 4" (10cm). You can use dry tree leaves, grass or palm leaves (accumulated phosphorus).

Repeat a 4" green layer. Use gliricidia or other nitrogen fixing plant material for added nitrogen. If the tree sapling is not immediately available for planting, follow instructions given in the "useful tip" below

The rest of the hole should be filled with a mixture of soil and dry animal manure/compost, and rise above the surface of the soil by 4-6", when the tree or 2' banana body is in the hole.

The size of the layers will vary depending on the materials and the size of the hole you make.

Useful Tip: If we are filling an excavation for planting a tree sapling as described above, but the sapling is yet to be obtained, we can cut a banana trunk 2' (60 cm) long and approximately 8-10' in diameter. Before we fill the planting hole completely, we can place the banana trunk upright in the centre of the hole and draw the final layer of soil mix or compost around the trunk. The area can then be lasagna bedded and planted to guild species. When the tree sapling is available and ready to be planted, the banana trunk can be withdrawn from its position, leaving behind a perfect space to slip the tree sapling into seamlessly. This method has proven very effective in the field.

Step 2 **Thoroughly soak the root ball in water before planting.** Standing it in a bucket is good for this.

Step 3 **Preparing The Root Ball.** First, you will want to loosen the soil around the roots, use water if necessary to get the roots loose so they hang.

Step 4 **Placing the Tree.** Place the root ball in the hole so that the point where the roots meet the trunk is 4-6"(10-15cm) above the soil surface, this affords some leeway as the organic materials in the hole decompose, the level of the pile will diminish. This can result in the tree being in a sunken pit, a reasonable strategy for drylands, but not a good one in high rainfall areas.

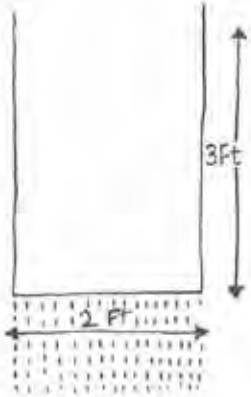
Step 5 **Fill the remaining hole with soil mix/compost** and lightly press down the soil to establish the tree firmly in place.

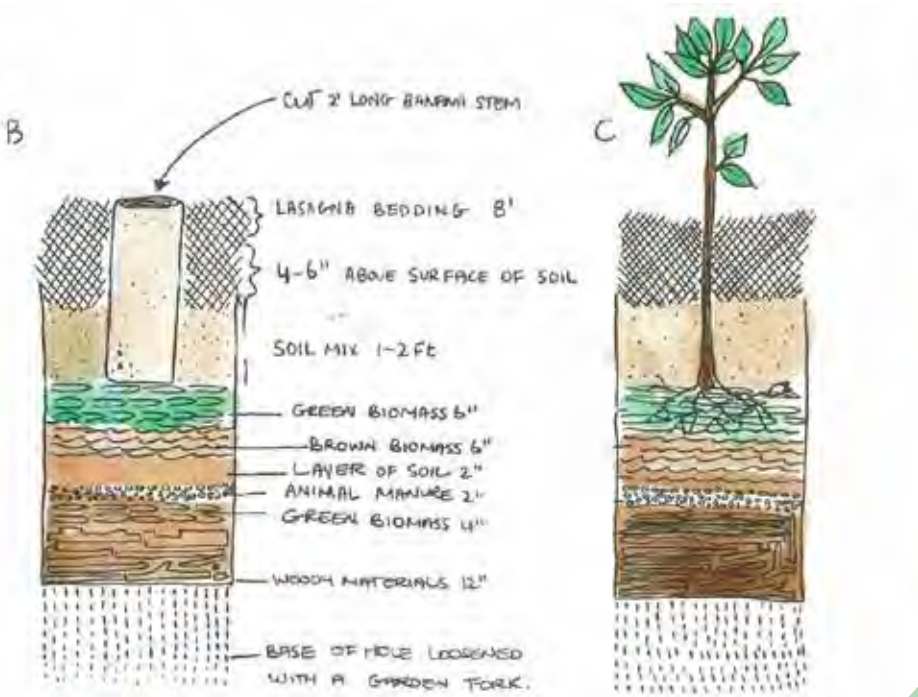
If there is danger of wind damage, support the tree with one or two poles on either side and tie them in place, or create a temporary windbreak e.g. used tyres stacked and filled with organic materials and planted to the windward side of the tree sapling.

Step 6 **Water the soil well.** Be diligent the first few days, making sure the tree gets enough water. Water deep! This means watering heavily enough so that the water saturates at least the top 12" (30 cm) of soil.

Step 7 **Cover the soil around the tree with 3-6' squared feet (1-2m squared) of the lasagna layer.** If you don't have enough materials, make sure that you cover the soil with a thick layer of mulch. The size of the diameter depends on the space and on how many plants you want to position around the central tree.

Don't pile mulch up around the tree trunk. Leave a 3-6" (7.5-15 cm) space between the trunk and the mulch. If the mulch touches the trunk of the tree there is a greater chance of disease pathogens affecting the tree.





Step 9 Plant the support species (the guild) around the tree.

Permaculture Guilds

In permaculture a guild typically refers to a group of plants/trees that work together to help ensure their health and productivity. A guild will normally have a tree at the centre and the associated plants around it. The plants around the central tree may offer many beneficial functions in relation to the main tree and to each other.

Important functions required for a successful guild, include:

Plants that attract insects, both for pollination and for pest predation (e.g. the umbelliferae family—dill, fennel, etc.)

Plants that have the capacity to fix nitrogen should account for 30% of the guild (e.g. peas, beans, peanuts, leucaena, etc.)

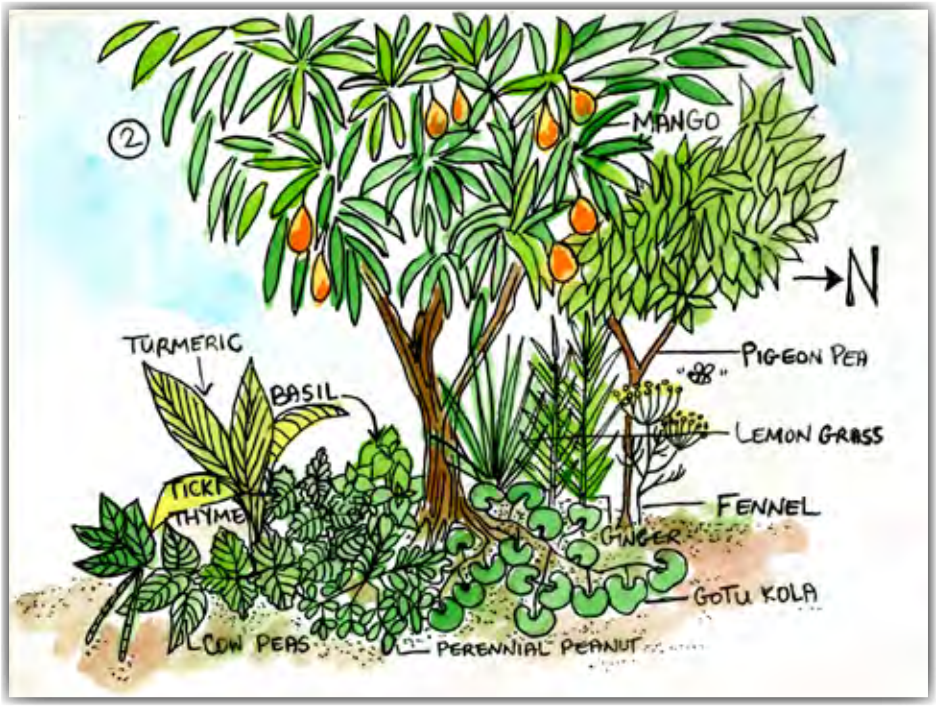
Plants capable of suppressing weeds (e.g. a ground cover—cowpeas, tiki thyme, gota kola, etc.)

Plants capable of accumulating nutrients usually have deep roots (e.g. comfrey, amaranth, Mexican sunflower, etc.)

Piles of stone are a useful addition to guilds, offering habitat for beneficial insects, as well as performing a mulching function in the guild.

Plants that can supply mulch (e.g. lemongrass, vetiver grass, dwarf banana, etc.)

Plants that have a perennial root system (e.g. turmeric, ginger, garlic, chives, etc.). These plants typically dry down in the dry season, but the root remains, holding the space until the rains return and new shoots emerge.



Using these plants in a guild results in:

- Reduced root competition
- Water conservation
- Nitrogen fixation
- Improved soil tilth and fertility
- Diversified food yield
- Habitat creation
- Increased pollination and pest predation

Barbados cherry tree guild

Considerations When Designing a Guild

Guilds should reflect the needs of the tree (e.g. citrus trees are heavy feeders therefore need a majority of nitrogen fixing plants supporting them).

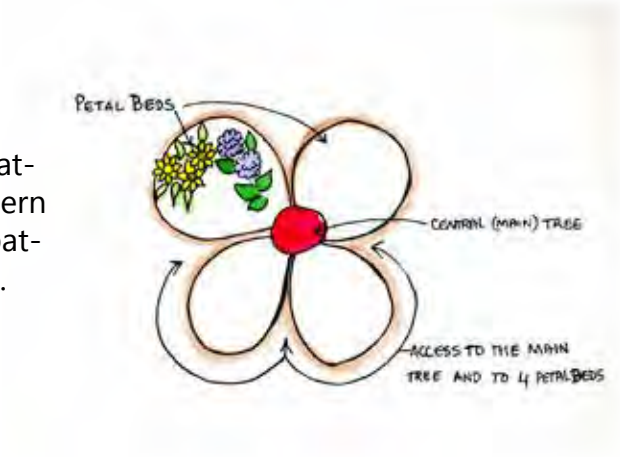
Guilds should be **self-managing**, once established they should need very little input. There would be a need to harvest any available yield, as well as chop and drop the mulching and nitrogen-fixing species.

The **orientation** of the guild plants to the central tree and to the sun can be very important. Taller species, such as bananas and Mexican sunflower, should be oriented to the north of the main tree so as to minimise the amount of shade cast onto it. Some trees, such as coffee and cacao, need over 50% shade in their first few years (understory trees) and therefore may require taller species on the southern side to provide shade in those early years.

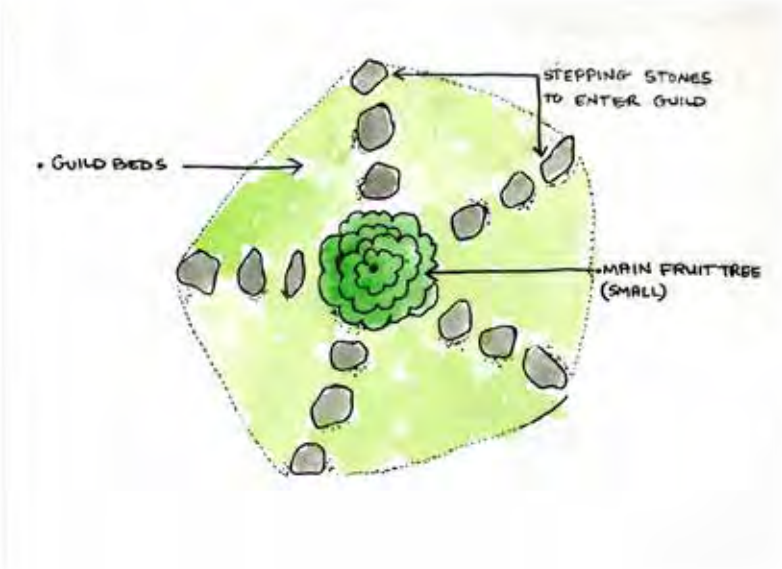
Access to the Tree Guild

Appropriate access to the guild is important and can be achieved in a few ways:

We can design the guild by applying pattern. A suitable pattern is the flower petal pattern illustrated here.



Another option for accessing guilds is to use stepping stones in the pattern of a star, as illustrated below.



Size of Tree Guild

When planting a tree sapling, the size of the guilds should be a minimum of 3 feet squared. As the tree grows, the guild can be expanded so that the spread of the crown of the tree is at least matched by the size of the guild See illustration on the next page.

The guild is established on a lasagna no-dig bed. For more information on how to construct a lasagna no-dig bed, please see Chapter 9.

Chapter 14

Banana and Papaya Circles

In St. Vincent we like to keep our yards tidy. Although it is common to get rid of the abundant organic material by simply burning it, there is an alternative solution, which not only helps you recycle the waste, but also results in food production: Banana and Papaya Circles. In this chapter you will learn how to create such a circle, what its benefits are, and how you can maintain it in the long run.

The banana/papaya circle uses a **pattern** to create added function. The pattern is a circle, which has several advantages:

1. **EFFECTIVE:** Bananas and papayas are gross feeders and they thrive on the nutrients they capture from the decaying organic material in the circular pit.

2. **SIMPLE:** You will save effort by having only one place to mulch, feed and water your plants.

3. **COMPACT:** Is your garden small? The circles will help you fit more plants in a smaller area.

It should be noted that in terms of fruit/nut bearing perennial species, **this circular pattern design works for bananas, papayas, pineapples, and coconuts**. Most fruit/nut trees have branches, unlike those mentioned above, resulting in criss-crossed tangled branches when grown in pit circles.

Creating a Banana/Papaya Circle

Step 1: Locating Banana / Papaya Circle

Your first task is to choose an area where you want your banana/papaya circle. Typically, the circles are located on flat land with slopes of twelve degrees or less.

Once you have found an optimal location, **mark out two circles**: the inside one with a diameter of 2m (6.5ft) and another larger one 45-60cm (18-24 inches) wider.

The inside circle shows you where to dig, and the larger one guides you where to place the soil you have dug up.

Step 2: Digging the Pit

Using your 6.5 ft (2m) circle, **dig out a basin-shaped hole** to a depth of 3.3 ft (1m). Pile the soil around the outside edge of the **circle in the shape of a donut**. You can place some organic material around the edges before placing the soil on top of it. This circular bed is where you are going to plant most of your plants.

At this point, you can make an opening at ground level for rainwater run-off to enter the circle, as well as thinking about where it wants to overflow once it arrives in the banana circle. Ensure that the **water is coming in at the top of the slope** and the overflow is at the bottom.

In tropical climates, this pattern is most effective due to the rapid decomposition of organic material occurring during the wet season.

Step 3: Filling the Pit

The next step is to **fill the circular pit with organic matter**. The coarser sticks, branches and other organic materials that take longer to decompose should be at the bottom of the pile (e.g. palm fronds).

On top of this should be other lighter decomposable materials (e.g. small branches, leaves, grass cuttings, etc.). Decomposition can be quickened by adding animal manure to the pile. This is particularly important if cardboard is used to line the pit.

Read more about Carbon: Nitrogen ratio in Chapter 10.

The circular pit should be **filled to the point of overflowing**, that is, pile as much as possible without affecting the plantings. Once the organic material decomposes the mound will shrink significantly, hence the importance of piling it high initially.

Step 4: Planting

When planting the banana circle, dig **4 equidistant holes 18 inches deep** for the banana suckers.

For papayas the holes should be dug **according to the size of your transplants**.

The earth mound surrounding the circular pit can be protected with **a living mulch of sweet potato vines**. This helps reduce root competition with grasses and weeds that will invade any newly disturbed space. This planting method allows for one productive crop of sweet potatoes while the bananas grow to maturity. After harvesting, the vines could remain to provide vine material for future planting in the garden. Other possible plantings include:

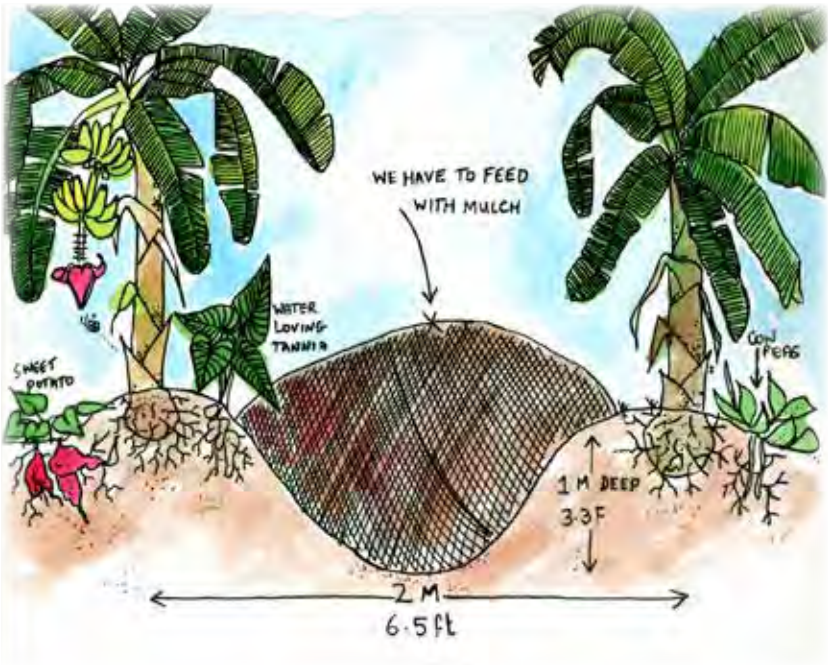
Shade tolerating plants such as **Ginger** and **Turmeric**.

Tanias (Taro). They can be placed on the inside edge of the circular pit approximately 3-4 feet apart.

Deep rooted legumes (e.g. **Cowpeas**)

Cassava

Deep rooted herbs (e.g. **Basil**)



If a **papaya circle** is implemented then more dry tolerant plants can be used (e.g. cassava), in which case, depending on circumstances, both the cassava and the papaya could be **mulched with stones** instead of organic materials. Pineapples could be used as an understory in the papaya circle.

Stones' primary function is to improve drainage, which both papaya and cassava require; they also act as a mulch covering the soil.

Step 5: Mulch and Water

Heavily mulch your newly planted garden. **All soil should be covered** to minimise evaporation and to make sure new plants settle in well with minimum transplanting shock. When conditions are dry, water everything well.

More about mulch in chapter 11.

Maintenance

Cut off dead or yellow banana leaves and chop and drop any spent plants and throw them into the centre of the circle.

Add moisture to the centre of the pit during the dry season if necessary.

Keep adding organic matter to the centre of the pile.

Plant productive ground cover plants. Keep the soil mulched.

Banana/papaya circles can be a great help in creating abundant, regenerative systems to solve some of the problems of soil degradation, waste disposal and water management in the tropics.

Benefits/ Functions of Circular Pits

Alternative Deposition Site for Organic Materials:

As ecological farming is against the burning of organic materials (a common practice in our region), circular pits offer the perfect location for deposit of these resources, which tend to be coarser materials (e.g. tree prunings and other chunkier biomass). Finer materials (e.g. leaves, grass clippings, etc.) are more likely to go to a garden compost pile or added directly as mulch on garden beds.

Efficient Provision of Moisture and Fertility:

The bananas/papayas are planted around a circular pit, acting as a central compost, mulch and moisture provider for them. In this way, we may concentrate the growth of 4 roots of bananas within a small space whilst providing them with moisture and fertility.

Banana circle covered with sweet potatoes and water loving taro plants on the inside of the pit.

Providing Compost for the Garden:

The circular pit can be emptied every 6-10 months depending on the time of year and the predominant materials in the pile. During the dry season, decomposition is slow, so we tend to empty our circular pit/compost towards the end of the rainy season, approximately 1-2 months before the dry season. The more coarse, un-decomposed materials can be returned to the pit, whilst the remainder can be sifted for use as a seedling growing medium or returned unsifted to the garden beds.

Kitchen Scraps:

You can throw in all of your organic waste (except meat!) as well as cardboard and paper.

Water Retention:

The circle stores more water in the soil and in the compost material, extending the wet season and fully utilizing any dry season rains. Water Cycling: you can direct your excess surface water (rainwater or in some cases grey water from your house) into the circle.

Food Production:

Bananas, papayas, pineapples, deep rooted herbs, and root vegetables such as sweet potatoes and tanias.

Biomass Production:

For mulch, composting or re-planting.

Chapter 15

Seed Saving and Propagation

Seed Sovereignty is Food Sovereignty. Seeds are the first link in the food chain and the repository of life's future evolution. As such, it is our inherent duty and responsibility to protect them and to pass them on to future generations. The growing of seed and the free exchange of seed among farmers has been the basis for maintaining biodiversity and ensuring food sovereignty.

Today, we are witnessing a **SEED EMERGENCY** at a global level. The disappearance of our biodiversity and of our seed sovereignty is creating a major crisis for agriculture and food sovereignty globally.

The current industrial food system based on monocultures, widespread use of agrochemicals, commercial/patented seeds, and genetically modified seeds are major contributors to the **disappearance of 75% of plant genetic diversity** in the last century. The prices of seeds continue to increase as the companies that produce them become fewer and fewer.

If we can save our own seeds and develop **strains that are adapted to the particular environment in which we live**, we have a degree of independence from the industrialised food system, as well as increasing biodiversity in our area.

We need many skills to manage both the farm and the homestead. Of those skills, seed saving and seed propagation are two of the most important.

Why Save Seeds?

Genetic Survival

One of the most important reasons to save seed is to ensure the **continuation of certain genetic traits** that characterise a particular variety. During the 1900s we experienced a startling drop in the number of open-pollinated varieties, because gardeners stopped saving and trading their own seeds. When we rely on commercial seed companies, any seeds that sell slowly simply get dropped from production and disappear.

Adaptability to changing environmental conditions

The loss of varieties translates into lower genetic variability in our food plants. **Lower variability means lower adaptability to stresses such as disease or climate change**. Each time a seed variety is lost, we lose another chance to feed ourselves in a world of changing climate and shrinking resources. For instance, if we plant an open-pollinated variety of sweet pepper and the plants have to endure a harsh drought, if out of 100 plants there are 2-3 that withstand noticeably better than the rest, then we will save the seeds from these plants because this indicates that this seed will be more adapted to drought conditions than the others.

Food Sovereignty

It is the right of people to have access to healthy and culturally-appropriate food produced through ecologically sound and sustainable methods. **To not depend on imported food is true independence**. In the words of **the great African leader, Thomas Sankara**: "Who feeds you controls you". To take responsibility for our food supply lines requires us to be free from the dependence on imported hybrid or GMO seeds.

Create New Varieties Adapted to Your Conditions

Simply save seeds from all the plants that do well in your own garden each year, and your seed collection will begin to adapt to your local conditions and gardening habits. Using a few basic rules and some common sense, you can help this process along—and save plants specially adapted to your own gardening conditions and culinary tastes.

Cheap and Easy

With some simple directions, anyone could save seeds, and apart from the time required, there is relatively no cost involved.

Satisfying

Watching your seeds grow and mature from flower to seed lets you connect deeply with Nature's cycles and seasons. Knowing how to produce the seeds that you will use to plant your garden each year creates feelings of self-reliance and empowerment.

Seed Exchange and Community Resilience

Establishing a seed exchange in your community is a great service to provide. It ensures that saving seeds is entrusted to as many people as are interested. The more people planting a variety, the more chances are that variety will survive.

Improve Plant Quality

There is a relationship between quantity and quality. Commerce has bred seeds for quantity lbs/acre. Research shows that in doing this, nutrition has decreased, indicating that quality is sacrificed when we seek quantity. Therefore, in planting lower-yielding open-pollinated varieties high in nutrients and taste, we are aware that we are giving up higher yields for other beneficial factors. Of course, we want high yields but not at the expense of nutrition. We want to find the balance.

Seed Saving

When saving your own seeds there are a number of factors that need consideration:

The plant from which we select seed should be robust and disease-free. Healthy, strong plants produce seeds and seedlings that are larger, more viable, and more vigorous than seeds produced from plants that have suffered stress, whether this is drought, nutrient deficiency, or some other stress factors.

What traits/characteristics should you select? For example, when you save corn seeds, you might select **the largest "ears" of corn** so that you can have larger "ears" in your next crop. You may select the corn seed based on the **fastest maturing and bearing plants**. This will give you a reduced growing time with the resultant quicker yield. Alternatively, you may select the seed from the corn plants that **perform best during the stressful periods of drought**. Focusing on these genetic characteristics allows adaptation to dryer conditions. **The seed density** on the corn cob may also be a factor we can focus on when selecting seeds to save.

Advice: Start small. Learn how to save seeds from one plant and then move to another!

*Ideally, seeds saved from a **large plant population** and from more than one plant offer the greatest genetic potential. Select seeds from many plants to ensure a strong, healthy and diverse seed stock for the future.*

Harvesting and Cleaning Seeds

Seed harvesting and cleaning techniques fall into two main categories according to whether the fruits and seeds are dry or wet when mature.

Dry Seeds include beans, okra, peppers, basil, lettuce, pak choi, and members of the onion and carrot families.

Cleaning dry seeds usually involves simply drying and crumbling the pods or husks, then screening the seeds to separate them from the chaff.

Wet Seeds are found in plants such as tomatoes, eggplants and many squashes.

Cleaning wet seeds requires washing to clean the seeds and to separate them from the surrounding pulp. The seeds can be placed in a strainer and washed under water until clean. They can be dried on paper or other similar material. They often stick together in clumps and require separating.

Storing Seeds

After the seeds are dry they need to be stored well. When storing saved seeds it is best to keep them in a **dry, cool location** that does not receive sunlight. Store them in conditions that do not cause them to sprout. In the tropics, seeds keep the longest when stored in an **air-tight, dry container in the fridge**. Stored in this way, seeds can be viable for 2 or more years.

Keep Your Seed Stock Strong!

It is good to refresh your seed stock every few years. To do this you need to cross your existing seed stock with seed stock from somewhere else. This helps keep your seed stock healthy and productivity high.

Setting seed

When setting seeds to be grown organically, we need a soil medium that is **free draining**, while retaining moisture and providing the necessary nutrients for optimal growth. **The preferred option of medium is compost**. Properly made compost that has attained the necessary levels of heat (approx. 55-65 degrees Celsius) will be free of all weeds seeds, and pathogens, as they are destroyed by the heat.

Note:
Depending on the consistency of the finished compost product it might be necessary to add some sand or Rabacca to facilitate adequate drainage.

More about compost in chapter 10.

If no compost is available we can make a soil mix from available resources. This includes but is not limited to:

Animal manure or any dry manure. Chicken and pig manure can be used if it is well cured (dried) for at least 3-6 months.

Bay sand contains many important trace nutrients. It can also be added to the soil mix to improve water drainage.

Soil. When selecting soil to add to your soil mix we are interested in dark, humus-rich soils. These types of soils can typically be found under large trees.

Ash(wood) contains high levels of potassium whilst also increasing the pH in the soil mix. This can be important if the mix is too acidic.

*Avoid taking soil from beneath trees that are known to have **allopathic properties,** e.g. mango and local cedar.*

When collecting soil from beneath a tree, first scrape away decomposing organic matter such as leaves and twigs, then scrape the remaining dark soil into a container. Any indent left in the ground can be filled with organic materials.

Preparing the Soil Mix

To prepare the soil mix, add the ingredients described above to a bucket or other suitable container and mix them together.

The estimated percentage of each soil mixture ingredient:

Dry manure – 40%
Soil – 40%
Bay sand – 10%
Ash – 10%

The percentages here are a rough guide and can be adjusted according to the variant qualities of the materials used. For instance, if the mix is too clammy and may prevent free drainage then more sand can be added to the mix.

Once the materials are well mixed, they can be **sifted through an appropriate size mesh**. This will ensure that the soil has a light and fluffy consistency that results in a soil mix less likely to have a fungus that may cause the seed to rot. When prepared in this way, the mix allows water and air to easily enter and pass through the soil, resulting in healthier seedlings. Once the mix is ready you can use it in a seed tray or on a seed table.

Important Considerations When Setting Seeds

Do not plant the seed too deep – The general rule is that we should not plant the seed more than 3 times its diameter in depth.

Watering – Seeds should be watered during the daytime rather than at night. This reduces the risk of fungus attacking and rotting the seeds. Care should be taken to not overwater, as this can also contribute to disease.

The seed table or nursery being used should be in a sunny location – If the location is too shady the plants become weak and spindly as they stretch to try to get any available sunlight, in which case the plants are described as being etiolated. Conversely, a sunny location may need some protection, in which case the nursery shade cloth can be used to ensure the ideal amount of sunlight necessary for optimal plant growth.

Transplanting

Seedlings should not stay in seed trays too long, as they become root-bound and stressed. The time to transplant the seedlings will depend on the particular seed being set. But a general rule for many vegetables is to plant them out when they are approximately **1.5-3" (4-8cm) tall**.

Before transplanting it is good to **"harden off"** the seedlings. This is done by moving them from their protected seed table or nursery to a location in full sun and leave them for a few hours a day, so they can start to get accustomed to more harsh climatic conditions. This will cause the plants to grow more slowly, but they will grow stronger and be better prepared for life in the garden. Ideally, this can be done for **3-5 days, for 3-4 hours of direct sunlight each day**.

Three weeks after germinating, the seedlings are ready for transplanting. Water the seedlings before removing them from their pot/container. A small stick can be used to carefully lift the seedlings while keeping as much soil around the roots as possible. Be sure to lift the seedlings by the leaves, not the stem. If the stem is injured, the seedling will suffer more than if a leaf is damaged. Open a hole in the garden bed and carefully place the seedling. The hole can be covered with soil and lightly pressed down by hand.

Make sure that you are giving a good start to your young plants!

Try to **transplant on cloudy days, or late in the afternoon** when the sun is not very hot. You can shade your transplanted seedlings for a few days with plant umbrellas such as 2' (60cm) sections of gliricidia branches stuck into the soil next to the transplant. When placed correctly, these cuttings will act as umbrellas protecting the transplants. This is very good practice and will help the seedlings to recover more quickly from the shock of transplanting.

Understanding Seeds Vocabulary

If you buy your seeds, you need to know what you are buying—which seeds are organic, which are chemically treated and from which you can or cannot save seeds for the next season. Here are some of the most common seed terms used in the market:

F1 - Hybrid Plants

These seeds are produced by companies through careful pollination of two different plant varieties. Normally, this highly selective plant breeding is done to bring together two traits in each of the chosen varieties so that the resulting seed has both of the traits.

Positives:

- Productive (hybrid vigour/ 25% greater yield)
- Uniform appearances
- Disease resistant

Negatives:

- Seeds may not be adapted to the local conditions and may suffer difficulties as a result.
- Reduced natural diversity of plants, as seed companies only choose certain varieties (e.g. those with a long shelf life).
- Seeds do not reproduce true to the parent plant, therefore the results from the next crop using hybrid seeds is unknown.
- Cannot save seeds from the plants for next season.
- Seeds lose their natural capacity to adapt to their environment.

Avoid F1 hybrids for seed saving and for creating local seed stock. They can give good results in terms of productivity and disease resistance but create a dependency on imported seeds and incur high recurring costs for the farmer/ gardener.

Note: Hybrid seeds can and do occur naturally.

Open-pollinated seed varieties

When these varieties are properly isolated from other varieties in the same plant species, they will produce seeds that are genetically true to type. When varieties of the same species are allowed to cross-pollinate, the result is a hybrid.

Positives:

- Can select "best" seeds (e.g. largest, early bearing, withstand drought, etc.).
- Inexpensive, we can save seeds ourselves.
- Better flavour, textures, etc. than created hybrids.
- Can save seeds and use them again next year.
- Better adapted to your local climate.

Negatives:

- Lower yield (than hybrids).
- Not as resistant to some particular diseases as hybrid varieties.

Note: Heirloom seeds are stabilised, open-pollinated seeds from the 1930s or earlier.

Genetically **Modified (GM)** Seeds

We strongly recommend NOT using GM seeds. The seeds are modified genetically in a laboratory. GM seeds break all natural laws, as new seeds have genetics from not only other plant families but from animals too!

Positives:

They can produce good yields in the short term and provide high disease resistance.

Negatives:

They are expensive to grow. GM seeds do not grow well using organic farming techniques. The seeds are sold in a package with chemical fertilisers, pesticides and herbicides, and farmers need to use these to obtain good yields.

You have to buy the seeds every year. If you save their seeds and use them, the company can take you to court for using their property.

Mostly they only grow once, and any new seeds that come from them will never grow.

Unknown long term effects on human and environmental health.

Seeds Treated with Chemicals

(Coloured powder). Treated seeds have been coated with some type of chemical fungicide, pesticide or preservative. This is to prevent them from being eaten by pests, fungus or bacteria in the soil and also improve the length of the shelf life of seeds.

Positives:

May produce more pest and disease resistant seedlings: Coated seeds may have improved germination rates due to the protection the seeds get from pests and diseases due to their inorganic coating.

Negatives:

Treated seeds, when consumed in large quantities, are harmful to mammals and fish, so it is important that you dispose of any unused seeds correctly.

The chemical seed coating may contaminate water supplies and harm insects and pollinators of the plant.

May damage soil microorganisms affecting the fertility of the soil.

With some simple directions, anyone could save seeds, and apart from the time required, there is relatively no cost involved.

If we can save our own seeds and develop strains that are adapted to the particular environment in which we live, we have a degree of independence from the industrialised food system, as well as increasing biodiversity in our area.

Chapter 16

Maintaining a Nutrient-Rich, Ecologically Friendly Garden Bed

Starting to build a new garden isn't difficult. The hard part is to sustain the health of our soil in the long run. The more we can do to keep the soil healthy, the more productive the garden will be and the higher the quality of the crops produced.

To ensure the fertility of the garden beds we have to protect the soil structure, by **feeding the soil with nutrients from locally derived organic sources** and increasing the diversity and numbers of microbes and other organisms that live in the soil. For more fertile soil, we need to increase organic matter and mineral availability, and whenever possible, we should avoid tilling the soil and thus leave its structure undisturbed.

It's important to understand that if we want healthy strong plants, we should make sure we have healthy soil. The chemical fertilisers, fungicides, herbicides, and pesticides have short-term benefits, but **over time these products destroy the life of the soil,** which is responsible for maintaining long term soil structure.

Soil life is complex, consisting of bacteria, fungi, nematodes, protozoa, and micro-arthropods.

As the life of the soil diminishes, **the structure of the soil collapses** resulting in compacted soil, which has no space for water and air to pass through. This compaction leads to **anaerobic conditions** resulting in disease, nutrient deficiencies and greater and greater dependency on chemical biocides to maintain production and thus profitability. To be able to create healthy nutrient rich food for our family we have to understand how to grow our plants without the use of synthetic biocides.

More about anaerobic and aerobic conditions in chapter 10.

Life in the Soil

It's often said that organic material in soil consists of "the living, the recently dead, and the very dead". This is a helpful way to understand the processes that shape soil and make it fertile.

The living portion of soil is made up of plant roots and the innumerable microbes and other living organisms that improve soil structure. They break down organic and inorganic materials into soluble forms that can be taken up by the roots of plants.

The recently dead components include deceased soil organisms, green plant material and microbe "poop"/ manures. They decompose readily, and release nutrients quickly.

The very dead portion is humus, the final residue of organic matter breakdown that's important for soil structure, fertility and disease suppression.

For fertile soil, all three forms of organic matter should be present at all times. Following these principles, let's give an example of the way in which we maintain an ecologically friendly garden bed.

Maintaining and Preparing an Existing Plant Bed for New Plantings

Use permanent beds and paths

A key strategy for protecting soil structure is to grow in suitable and efficiently-sized permanent beds and **restrict foot traffic to the pathways**, thus avoiding compaction in the growing areas.

Remove all weeds and unwanted plants from the soil

Unwanted plants and weeds can be cut so their roots remain in the soil where they can decompose and further enrich the soil. Desired perennials, herbs and flowers may remain.

Do not burn weeds or crops when clearing land for the next crop! *Burning wastes a lot more nutrients than it creates. In tropical climates, most of the nutrients (80+%) are stored in plants and these are lost with every burning event.*

***If you want to add some ash**, use ash created during the burning of charcoal or that left after the roasting of breadfruits. Spread this ash over the garden beds. Weeds and old crops are excellent for compost material, animal food or mulch, and all the nutrients are recycled with these methods. Also, burning kills the beneficial microorganisms that improve your soil.*

Loosen the bed with a work

There are various benefits of tilling the soil for aeration, but the benefits of tilling are outweighed by the negative effects. Turning the soil exposes...

many **dormant weed seeds** to the elements (air, sun, water), in effect encouraging new weeds to propagate. Weeds are adapted to and favour disturbed soils.

soil microbes to harsh and inhospitable conditions that deplete this critical life component responsible for soil fertility in ecological systems.

the **carbon element** in the soil to the air resulting in the oxidation of the carbon into carbon dioxide, a greenhouse gas and the leading cause of climate change. This is a problem for the atmosphere, but it also reduces the carbon content of the soil thereby reducing productivity.

On the other hand, **loosening** (but not turning) the soil in the garden bed with a fork helps to maintain the structure of the soil by not disturbing or killing the microorganisms present. This prevents soil erosion and increases the water retention capacity of the soil, resulting in reduced work for the gardener, healthier soils and therefore healthier plants.

Add animal manure for nitrogen, phosphorus and potassium

All livestock manures can be valuable additions to the soil; however, care must be taken as some fresh animal manures (e.g. poultry) can be **too high in nitrogen**, and may literally burn plants, damaging and often killing them.

It is best to compost chicken manure, otherwise it should be left for approximately three months or until sufficiently dry.
Pig manure is also a concern as it may harbour pathogens, heavy metals and dangerous bacteria. It needs to be composted, preferably in a hot, aerobic compost that will destroy the dangerous elements.

All manures are anaerobic and will benefit from the aerobic composting process.

We recommend that the chosen manure be **sprinkled over the entire bed**, typically on top of the permanent mulch cover, every 4-6 weeks. In this way the anaerobic manure is being added
to an aerobic environment rich in the necessary microbes for releasing and cycling the nutrients present in the manure.

Wet the soil

Water is the basis of all life processes and as such, as organic materials are placed on the garden beds, sufficient moisture levels should be maintained for best results, by watering each layer of organic material as it is added to the bed.

Water-Saving Techniques

It is important to water **early in the morning or late in the afternoon.** Early morning is better because watering in the late afternoon and at night can promote diseases associated with detrimental fungal colonisation.

Watering plants on bare soil in the middle of a hot day can damage or kill them. This results as the water entering the soil is heated by it, to the point where this now relatively hot water negatively affects the plants roots. Another problem associated with watering in this way is that a significant amount of the water added to the soil is evaporated and therefore lost to the atmosphere.

When the garden bed is **well mulched**, however, watering in the middle of a hot day will not have the same effect as watering on bare soil. This is because the mulch keeps the soil cool, so water entering it is not heated up and no detrimental effects to the plants can be observed. Also, little to no moisture is evaporated as it is likewise protected from the effects of harsh sunlight.

In tropical climates the sun is most intense between nine in the morning and three in the afternoon. During this time it is not uncommon to see plants with wilted leaves, which indicates that the plants are under stress; therefore they are not photosynthesising and consequently not growing during these times. When there is **sufficient mulch** on the garden beds, moisture levels are maintained and plants continue to function and grow even at the hottest times of the day.

Windbreaks around the garden help to prevent what is known as the **clothes line effect**, a situation where strong winds dry out both the soil and the plants leaves, increasing stress and reducing productivity of the plants. Windbreaks can be used to reduce the amount of water required in the garden. This is most important for young seedlings and saplings.

Garden borders help a lot to maintain moisture levels in the soil. Use rocks, bamboo, wood, etc.

Utilising these watering tips can help conserve our valuable water resources.

Cover the bed with cardboard (optional)

The cardboard will act as a ground cover and keep the weeds from popping up. Cardboard is very rich in carbon, as it is made of wood. Over time, it will completely decompose and add organic matter to your soil! It's advisable to soak the cardboard or paper in unchlorinated water. In this way decompositions will be accelerated and the soil will stay moist for a longer period of time.

Mulch-Mulch-Mulch

One of the most important steps that should be done during the year is **mulching**. Mulch is a way to keep the soil covered by using organic materials (e.g. grass clippings, leaves, woodchip, banana bodies, vetiver grass, coconut husk). Cover the soil with a thick layer of organic material, approximately 8-12" (20-30 cm) deep. The mulch retains soil moisture and protects against temperature extremes. Microbes, earthworms and other forms of soil life can decompose the mulch, and slowly incorporate their residues into the topsoil.

See Chapter 11 about Mulch.

Planting

Open the mulch like a bird nest and add one to two handfuls of compost or quality soil mix and plant directly into the bird nest. Plant as densely as possible in the garden beds. Dense plantings help to shade the ground, which benefits both soil life and plants by conserving moisture and moderating temperature extremes.

Plant diversity sponsors plant fertility, as each diverse plant species attracts particular microorganisms and therefore, the more diverse the plantings, the greater the diversity of soil life and the greater the potential fertility associated with that life.

Extra Nutrients for the Soil

Wood ash (potassium), coffee grounds (nitrogen), biochar, detritus from palm species (phosphorus), organic liquid fertiliser, eggshells (calcium), and seaweed (micro-nutrients) are some of the ingredients that can help to make the soil richer by providing specific and important nutrients.

Pest and Disease Control

Pest and disease control in the garden is not just about removing the pest problem. **Problems are a sign that the system is not in balance**, and rebalancing the system is the best solution. To control pests in a sustainable way involves using many different techniques, such as improving soil quality, encouraging pest predators, good garden management, and using baits and traps.

For example, using compost does not only improve your soil and increase production, It also helps plants to be more resistant to pest and disease attacks. It adds beneficial soil microorganisms, both prey and predators, that reduce the amount of problem microorganisms in your soil.

*If pesticides or fungicides are still needed, **natural recipes from local plants** should be used, not chemical pesticides or fungicides as they damage the soil biota.*

Planting Method and Planting Time

Transplanting Ideas

A week before transplanting the seedlings, they should be exposed to increased sunlight, allowing them to start adapting to the relatively harsher environment of the garden into which they will be planted. This technique is called "hardening" the seedlings. It reduces stress and leaf burn from the sun, when they are planted.

Be very careful when handling plant roots. Do not expose the roots to harsh sunlight; be careful not to damage the roots when transplanting; hold the plant by the leaves not the stem. Plant seedlings in the late afternoon to avoid the hot sun during the middle of the day stressing the transplants.

During the hottest times of the year, **shade seedlings with plant umbrellas** (e.g. gliricidia branches) for two to three days after transplanting to reduce stress from intense sunlight.

Succession Plantings

Ecological gardening encourages the planting of diverse plant families that mature at different times. This allows the ecological garden beds to be kept in continual production; as one crop is harvested another replaces it. In this way the garden beds are never bare of plants, but in **continual production**, which is particularly beneficial in limited spaces, such as are encountered in backyard gardening.

Plants are alive and react to damage or mistreatment in the same way as humans! Any **damage slows plant growth and reduces the final harvest.**

Plant the slower growing vegetables the same distance apart as usual, so when they are fully grown they fill the garden bed. Plant the fast growing vegetables in the spaces in between slower growing species.

If planted at the same time, lettuce and fast growing greens will need harvesting first, before the other vegetables have matured. The long-term vegetables will then grow to their full size and start producing their crops.

Lettuces, radishes, and green-leaf vegetables grow fast and produce their crops in one to two months.

Always water before and after planting seedlings in the ground.

Be careful to minimise root disturbance of the long-term crop when harvesting the short-term crop.

Eggplants, chilies, cabbages, tomatoes, beans, and other vegetables can take three months or more to produce their crops.

Crop Rotation

Crop rotation helps to balance the amount of nutrients taken from a garden bed. Different plants take different amounts of nutrients. Crop rotation is also very important to reduce pest and disease problems, particularly fungal diseases in the soil that attack plant roots.

Never grow the same vegetable in the same bed twice in a row. For example, all beans are from the Legume family. Tomatoes, eggplants, peppers, potatoes, and chilies can all be considered as one type of vegetable as they are all from the same family of plants, Solanaceae. Similarly, cabbages, broccoli, cauliflowers, mustard, radish, and kale are all from the Brassicaceae family of plants.

It is good to give each garden bed **a rest for a few months**, once every two years to help it regain its stock of nutrients. During this time, add lots of compost and mulch, and plant a green manure crop as a living mulch.

Companion Planting

Growing different crops together will reduce the incidence of pest problems, as it takes longer for the pests to locate the crops they like. Some plants benefit from having other plants grow near them. For example, basil improves the flavour and health of tomato plants. Beyond this, it is a great repellent of insects—such as mites and aphids—and it deters diseases from the bean and cabbage families. Basil plants will not stop all aphids, but it discourages them and reduces their numbers.

Planting flowers and herbs in garden beds attracts insects that increase the pollination rate of vegetables. Insects that feed on pest insects also increase in number and help to reduce pest problems.

For more information on Crop Rotation and Companion Planting see RVA's booklet ***"Make Your Home Garden Flourish"*** *richmondvale.org/en/publications/rva-publications*

Following these steps you can be sure your soil will be continually improving, and your plants will be healthier and stronger.

Chapter 17

Model Gardens and Designs

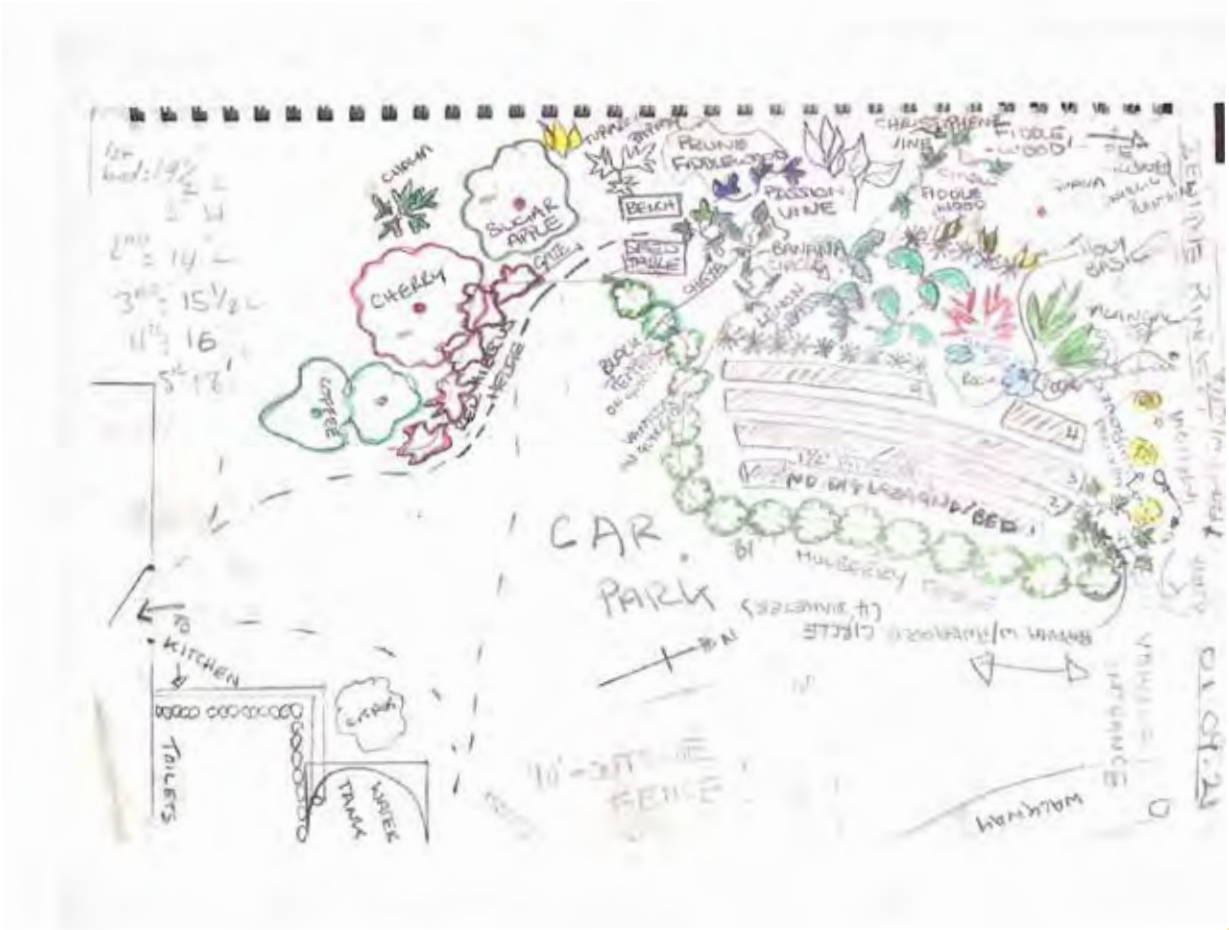
Terrace Beds in Sharpes, Chatoe


STEF MALONEY
08/09/21
MAIN ROAD
LEMON GRASS
PLANTAIN/ BANANA
MEXICAN SUNFLOWER
GLYRICIDIA
30'
R.B
H.B
RAISED BED
R.B
PERMANENT RAISED BEDS
H.1
R.B
R.B
APPLE
GOATS PEN
30'
AVOCADO
GATE
AT 12-1PM SHADED
SEED TABLE
GATE
MEXICAN SUNFLOWER
LEMON GRASS
SOIL:
SAND - 85%
SILT - 13%
CLAY - 2%
HOUSE
FRONT OF HOUSE
WATER TANK EITHER SIDE


BANANA
BACK WALL
MEXICAN SUNFLOWER
MS
MS
MS
CHAYA
WATER TANK
SUGAR APPLE
POMEGRANATE
PIGEON PEA
VETIVER
PAPAYA
HOUSE
SEED TABLE
AVOCADO
SOUR SOP
COCONUT
MAIN ROAD
RAISED BED
LEMON GRASS
FENCE
STAIRS
BREADFRUIT
TANYA
CHEESE
RAISED BED
N
SOIL:
SILT - 35%
SAND - 64%
CLAY - 1%
ENTRANCE
JANELLE 2021


VERGEL BRONNE
SUNLIGHT: 6-8 HRS
SOIL:
SAND - 80%.
SILT - 17%.
CLAY - 3%.
HIBISCUS
LEMON GRASS
S
N
MANGO
* NEED TO PRUNE SOME LIMBS


15.02.21
NORTH
VINING CROP
BEANS/CUCUMBER/PASSION FRUIT
MARIGOLD
FENCE
MEXICAN SUNFLOWER
PIGEON PEA
RAISED NO DIG BED (RNDB)
BANANA CIRCLE PIT
Bush BEANS
TRELLIS CROP
ALOE
CUCUMBER
(RNDB)
SMALL BANANA
CORN
SQUASH
BEANS
3½' SEED TWIG
LEMON GRASS
(RNDB)
BUILDING
PAVEMENT
1½'
PATHWAY
TOMATO
BASIL
26'
20'
DILL
(RNDB)
SPINACH TREE
LETTUCE
CHIVE
CABBAGE
DWARF GOLDEN APPLE
CUCUMBER
MARIGOLD
(R·N·D·B)
DILL
STEPS
PIGEON PEA
LEMON GRASS
31'


CURRAN
SUGAR APPLE
CHERRY
COFFEE
BENCH
PASSION VINE
BANANA
CHIVES
BASIL
CAR
PARK
KITCHEN
TOILETS
WATER TANK
MULBERRY
N

Chapter 18

Epilogue

Many people reject ecological (organic) farming methods because they do not understand the extremely complex relationship between plants and the rest of nature. They also are not fully aware of the environmental and human health consequences of using chemical products on the land. This whole misunderstanding has been deliberately created by monopoly chemical seed and fertilizer companies whose interest is to forget the old knowledge of self-sustaining agriculture and make us dependent on their costly, addictive products.

It is time to break this endless chain of poisoning our families and communities for the benefit of multinational corporations. The first step for this is to arm ourselves with the right **knowledge**.

For those of you who are already farmers and use chemical fertilizers, fungicides and pesticides, it will be more difficult to adopt these ecological techniques. This is because "thanks" to the miracle chemicals, we find quick solutions to our problems. It is easier to farm with chemicals: we don't need too much knowledge, we don't need to weed, we don't need to protect from pests, and we don't need to care about what's happening in the soil. But the question is for how long and at what cost can we continue to do so?

Some of you may say, "We've been trying organic methods for a while, but they don't work, and this gives us confidence that it's only possible with chemicals." This result is also normal. After cutting down most of the trees, farming off the contour, planting monocultures, poisoning the soil, and destroying its structure, it is not possible to maintain a healthy ecological farm immediately. Chemical farming creates an addiction that is not easy to get out of.

Our farmers depend on their produce for money, so we encourage you to start small with a few beds, and as the understanding of this way of food production arises, then expand to larger areas.

To have a system that is self-regulating, with crops that can withstand pest attacks on their own, with predators that can help us regulate the number of unwanted insects, with soil rich in numerous available organisms and minerals, with a microclimate that supports good temperature and humidity in the property, we need a bit of time.

We need to be patient and dedicated.

We need to accept nature as our teacher and observe and learn from the land.

We need to nourish the soil and encourage the life in it.

We need to protect the property from the strong winds by planting trees.

We need to make sure we take maximum advantage of the water passing through our property by harvesting it with tanks, ponds, swales, and beds on contours, and keep the water from evaporating by covering the soil with mulches and plants.

We need to have a polyculture with a mix of plants from different families that take different minerals from the soil, that have different root systems, and that have different purposes.

We need to make our own fertilizers and use mostly native, chemical-free, and non-GMO seeds.

We need to stop looking at the farm as something that is just a money-making machine and start seeing it as a pharmacy that improves our lives and the life of nature on which we depend for our existence.

We should see it as a bank in which we invest the future of the Earth and our children. It will take time, probably several years for this system to be set up. But once the rules of nature start working, you'll have less work, more productive crops, healthier plants, and a variety of tastier crops for your home diet. Compare this with the opposite, where chemical agriculture over time needs more chemicals, more water, and more work, with weaker plants and tasteless, nutrient-poor products. The choice is ours. And the time to make it is now.

Ecological farming is not just about growing food, it is about raising conscious people who understand the magnificent importance and power of our nature. These people can protect the planet and fight for future generations.

So let us fight not with bullets and destruction, but with compost, seeds, and love for the creation.

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Richmond Vale Academy Guide to Ecological Gardening in St. Vincent & the Grenadines

We have created this book to help people across the Caribbean learn how to become more food and water secure in a time of climate crisis.

This book is how to achieve that with a learning-by-doing approach.

This book is the first of its kind in St. Vincent and the Grenadines and will benefit hundreds of small farmers.

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