

# ORGANIC AND SUSTAINABLE GARDENING

by Paul

Pests  
Mulch  
Water  
Weeds  
Terraces  
Compost  
Moon Planting  
Pot Gardening  
Ground Covers  
No-Till Gardening  
Organic Gardening  
Companion Planting  
Grey Water Gardening



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Cover photo,  
is a picture of water coming out of a kitchen tap.  
This is the critical moment.  
What we do with it next can make all the difference to our world.

*Dedicated to all the clovers of the world.  
The smallest plants,  
tie the Earth together.  
Grow clover all over.*



Back cover,  
False pimpernel (*Lindernia crustacea*). Sour grass, (*oxalis corniculata*).  
Creeping indigo (*indigofera spicata*). Pinto peanut, (*arachis pintoii*)  
Alyce clover (*alysicarpus ovalifolius*). (*Christia obcordata*)  
Tick clover (*desmodium triflorum*). Spanish clover (*desmodium heterophyllum*)  
This is what the Earth beneath our feet could look like everywhere.

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# **CONTENTS**

i.	Introduction	1
ii.	Why Grow Organic	2
iii.	Organic AND Sustainable	3

## **PART ONE**

### **Sustainable Gardening**

1.	Garden Beds	5
2.	Planting by Moon and Seasons	6
3.	Planting - Depth and Spacing	7
4.	Planting Fruit Trees from Seed	8
5.	Pot Gardening	10
6.	Grass Mulch Pots	14
7.	Compost	15
8.	Making Compost	16
9.	Mulch	20
10.	Sheet Mulch	22
11.	Giant Mulch	23
12.	Weeds	26
13.	Ground Covers	35
14.	Companion Plants	37
15.	Green Manure	40
16.	Clovers	43
17.	Pasture cropping	48
18.	Pests and Diseases	49
19.	Crop Rotation	54
20.	Seedling Trees versus Grafted Trees	55
21.	Terraces	57
22.	Irrigation	59
23.	Keeping the House Dry	65

24.	Draining Roads	67
25.	Fire and the Land	71
26.	The Cooking Fire	74
27.	Poisons	77
28.	Hybrid Crops	80
29.	Genetically Modified Organisms	83
30.	Top Soil	89
31.	Conclusion	89

## **PART TWO**

### **The Trench Garden**

1.	Preparation	91
2.	The Site	91
3.	The Method	91
4.	Levels	92
5.	The Trench	92
6.	The Slotted Drain Pipe	93
7.	The Soil	94
8.	Collecting Water	95
9.	The Earth Tank	95
10.	The Tank Liner	96
11.	Siphon	96
12.	Watering - Flood and Drain	97
13.	Oxygen	97
14.	Automatic Syphoning	97
15.	Grey Water Gardens	98
	Photo's of Weeds and Wild Flowers	102
	Books and Web Sites	110

## **i. Introduction**

The basis for this information comes from books like, 'The One Straw Revolution' by Mr. Masanobu Fukuoka, 'Water for Every Farm - Yeomans Keyline Plan' by Mr. P. A. Yeomans and sons, and the books of 'Permaculture' by Mr. Bill Mollison and other authors. The books of Bio-dynamics by Rudolph Steiner and other authors also contain a great deal of valuable information. Also find on the Internet, 'Natural Sequence Farming' by Mr. Peter Andrews.

'One Straw' details Mr. Fukuoka's experiences in growing rice in Japan and 'Keyline' and 'NSF', primarily refer to pasture improvement for raising cattle but they have important implications for good farm and land management in general. Please refer to those books and websites for more detailed information.

Part one refers to general organic and sustainable practices that you can use together or in part in any organic garden or environment according to your needs and your available resources.

Part two is specifically about trench gardening which is a garden system that allows for efficient watering of a garden in dry areas and places with very dry seasons, and isolated areas that have limited access to water from springs, wells, streams and rivers.

Occasional rains may be caught and stored and used to irrigate the garden. There's a lot of work involved in the set up but the payoff is that it ensures a good supply of water and saves a lot of work in the future.

This system may also be adapted for use as a grey water garden system for the recycling of used domestic water as garden irrigation water.

## **ii. Why Grow Organic?**

There are many good reasons for growing organically and it doesn't matter what you grow, whether it be mangoes, petunias, roses, tomatoes or cedar trees. Organic gardening always results in stronger, healthier plants, and if you consume them, you will be healthier too, and there will be less chemicals in your environment. You will also be immediately aware of the superior quality of the organic produce that you grow and eat. Fruit, vegetables and herbs will smell and taste better.

Chemical fertilizers may contain the basic nutrients essential for plant growth but the micro-nutrients will be missing. Some are missing, even from the chemical fertilizers that claim to contain micro-nutrients. They are also present in the wrong form for natural uptake by the plants growing on them, and most just contaminate the soil, making it acidic and burning the soil and creating run off and polluting the water ways. And artificial fertilizers do not include, and even poison, the life cycles of the various bacteria and fungi in the soil that are an essential part of the feeding cycle of plants.

And why grow your plants on chemicals that are going to end up in your blood stream? And if you're growing herbs for medicinal purposes, you can be assured that the only way to get the full benefit from them is to grow them organically. Chemical cultivation will not produce plants with healthy medicinal properties.

### **iii. Organic AND Sustainable**

There is one thing to say about organic gardening and farming and that is that there is one level above organic and that is sustainable, because it is possible to be organic and not necessarily sustainable.

If only compost and mulch and no chemical fertilizers, pesticides or herbicides are applied to a garden, then it will be organic. But if the gardener continues to till the soil, then a friendly ground cover can never be established and aggressive weeds will always be a problem because the soil is full of seeds. There is an old saying, 'one years seeds, seven years weeds'. So by cultivating the ground to remove the weeds, the gardener is in fact preparing the ground for more weeds to grow. The gardener is then trapped in an endless cycle of working to remove the weeds that he plants with his work.

Digging the weeds prevents the establishment of an environment of friendly plants that protect and feed the soil by supporting an ecology of tiny animals that build soil by turning it over and mixing it with decaying plant and animal matter. It is also necessary to attract insects and animals that feed on nectar and pollen and graze on leaf matter in order to support an entire ecology of plants and creatures where no one species dominates to the detriment of others. Viruses, bacteria and fungi also play a critical part in this continual saga of life and should likewise be considered an essential part of the garden landscape.

Erosion and leaching of soluble nutrients will also be a problem in the tilled garden, especially on sloping land and in areas of high rainfall.

Digging also causes loss of moisture which is a serious problem in dry areas and dry seasons.

Non-tillage and companion plant gardening and farming is the only method that can be called sustainable. This does not exclude digging to shape the land and establish the garden and farm. However once the garden is established, there

should be no need for anymore cultivation for the removal of weeds or the inclusion of fertilizers. A union of ground covers and companion plants being cut down and mulched in is all that is necessary to make and protect healthy soil and an environment that will support herbs, vegetables and fruit trees. Any additional mulch, compost or manure that the gardener wishes to apply, may simply be scattered around randomly or placed around newly planted trees.

Organic, sustainable and natural gardening, farming and land care methods can be relied on year after year to produce quality soil, a reliable supply of quality produce and a healthy environment to live in.

## **PART ONE**

### **Sustainable Gardening**

#### **1. Garden Beds**

There are a number of ways to prepare a garden bed. If the intention is to make a sheet mulch garden then there is no need to weed or dig the garden unless you wish to terrace it first.

Beds made on sloping land should be made level first to reduce and slow down run off during rain and irrigation, allowing the soil to soak up as much water as possible and reducing erosion to a minimum. Use a spirit level or water level to level the bed.

When digging the bed, do not dig so deep that poor subsoil is mixed with the richer topsoil.

Mix in compost if you have it and cover the bed with organic matter for mulch.

Make use of any water that might flow through your land when it rains. If water flows down a footpath, drive way or road the water may be harvested and diverted into a garden with a ditch. Take the ditch to where you wish to have a garden and plant on either side of the ditch. A road can catch enough rainwater to flood a field.

The same can also be done with storm water running off the roof. A ditch coming away from the down pipe from the roof gutters, or directing water that falls from the roof can divert storm water into a level ditch which has plants growing on either side of it. Even modest rains will keep the garden watered and even dew forming on the roof overnight is enough to have a positive effect on the garden.

Never put garden beds right next to the foundations of the house and always direct excess water away from the house and into the garden.

Dig the level ditch garden a little deeper and water loving plants, like ginger for example, can be planted in it. This is automatic watering and will save a lot of work and makes efficient use of free water.

## **2. Planting by Moon and Seasons**

Get a moon planting guide and plant with the full moon and the season for maximum use of the growing period.

If you plant with the moon, generally 2 to 5 days before full moon for fruiting annuals, you will be amazed at how often you strike good weather for sprouting seeds and raising seedlings. Take note of when seasonal rains begin in your area and how that relates to the phases of the moon.

This also works well for transplanting seedlings and for planting cuttings, clones.

Generally, plant leafy greens in the week after the new moon and root crops in the week after the full moon.

Weed during barren signs of the moon.

Planting by a moon chart also helps the gardener plan ahead and manage work time productively.

Where ever you are, seasons will generally be as you expect them but keep in mind that regional differences like air and ocean currents, climate zone, altitude, geography, timing of rains and the growth habits of the crop may have an effect on when you plant in your area; so observation and discussion with experienced locals is a good idea. For example, if rice is planted at the beginning of the wet season in North Thailand, the rice will grow fast and tall but will yield little rice. The rice must be planted late which results in a small plant that is suddenly forced to flower at the end of the season. This is a kind of stress that encourages the plant to produce larger ears of rice.

### **3. Planting - Depth and Spacing**

For starting seedlings, they may be planted in small pots, 5 to 10cm - 2 to 4 inches wide and 10 to 20cm - 4 to 8 inches deep.

Depending on their size, seeds can be planted 5 to 10mm - 0.25 to 0.5 inches deep. Cover with fine soil and pat down lightly and gently water in. Scatter a very fine layer of grass clippings over this. Very fine seed can be sprinkled on top and watered in.

Plant seeds where the sun shines on them from the earliest possible moment of the day. Seedlings normally take about three days to a week to come up. Some plants like parsley and papaya can take 2 weeks to germinate.

Plant seedlings out when they are as tall as the pot is deep. With a 4 by 8 inch pot, the seeds can be planted one moon and the seedlings transplanted the next moon. To remove seedlings from pots, put your fingers around the stem and tip the pot upside down, holding the soil up with the palm of your hand. Use a stick to tap the edge of the pot upwards.

Seeds can also be planted directly into large pots or into the ground where they are to grow to adult size. However they may need more attention to begin with to ensure that they survive, as the place they are intended to grow is often very sunny and they may dry out while their roots are still very small. When planting seed directly like this, it is a good idea to plant some seeds in small pots as well, to replace any of those planted directly in the ground or in large pots that do not make it.

For spacing plants the correct distance apart, it is important to know how big the plants will grow. Space seedlings as far apart as the adult plants are wide.

Rolling seeds into clay balls as per the Fukuoka method is helpful where seed is to be scattered, especially in difficult circumstances. Unprepared seed may be broadcast but

requires a lot of seed to be successful. A coat of clay greatly increases germination rates. Seed can be scattered any time but best before the rains. The clay protects the seeds from rats, birds and sun while they wait and helps the seeds germinate when it rains.

Another method of seeding smaller gardens is to remove the top 2cm's - 1inch of soil from the garden bed and place it on a garden blanket like a piece of weed mat. Mix seed in thoroughly and spread the soil back on the garden. This achieves a very even scattering of seed and ensures that much of the seed is planted at the right depth.

Seedlings must be watered regularly, sometimes as much as 3 times a day while they are small, as they have tiny roots and can dry out quickly on a sunny day.

Plant seedlings and cuttings in the afternoon as soon as the sun is off the garden and water in. Cuttings may be planted among weeds, herbs, vegetables and companion plants to protect them from sun and wind while they grow roots, which takes up to two weeks. While working with cuttings, keep them in damp cloth or paper so they don't over heat and dry out.

#### **4. Planting Fruit Trees from Seed**

Only plant seeds taken from the best fruit. And always plant the seeds of the best fruit. Fruit tree seed should be planted immediately after being removed from the fruit. Fruit tree seed generally cannot be dried for storage like most annual herb and vegetable seed. If the seeds of most fruit trees are not growing, they are dying.

If possible, plant the seeds of fruit trees directly into the ground where they are to grow. This is because trees have deep and fast growing tap roots. When planted directly in the ground, seeds can put their roots down without interference. When planted in pots, the tap root will bend when it gets to the bottom of the pot. It may then wind around the bottom of

the pot or come out a drainage hole and anchor the pot to the ground.

If starting seedlings in pots, use the largest pots possible. Match the pots to the species planted. Trees like avocado, durian and macadamia need particularly deep pots as they have fast and deep growing tap roots.

Potted trees should be planted out as soon as they have filled the pot. That is usually when the seedling is as tall as the pot is deep. Also watch for roots appearing from the drainage holes.

When planting out either seeds or seedlings where they are to grow, it is beneficial to them to have other plants surrounding them. A small garden around them will create a micro-climate that will protect them from the elements. If it is cold, then a companion garden will keep them warm and if it is too hot or windy, then a companion garden will keep them cool and protect seedlings from drying out.

Herbs and vegetables as well as the plants mentioned in the chapters on weeds and companion plants make good companions for tree seedlings. Even weeds are better than nothing.

Once seedlings are strong and naturalized in their environment, the plants around them may be cut down and mulched in and then allowed to regrow and the process can be continued repeatedly. You will see the seedlings grow in pulses with the regrowth of the surrounding ground covers every time they are cut and mulched in.

There could be no better way of starting off fruit trees than by planting their seed directly into a healthy vegetable garden. Once the trees shade out the garden, move the vegetable patch on and start again.

As pointed out in 'One Straw', try to avoid pruning fruit trees as this interferes with the natural shape of the tree. However

it is necessary to remove dead wood, especially if it has pest or disease problems, and lower branches to allow air under them and to keep fruit off the ground. Removed branches need only be cut small enough to lie flat on the ground under the tree.

## **5. Pot Gardening**

Growing in pots can be very rewarding but basic problems with pots can include being too wet when plants are small and getting too dry when plants are big. Growing in as large a pot as possible, can moderate these problems. A large pot requires more water but the water will last longer and can grow a bigger plant.

Another problem with pots is that water poured in the top can just pour down the sides and straight out the bottom. With any pot, it is important to bowl the soil on the top of the pot, so that when the pot is watered, the water sits in the middle and soaks into the soil. Keep pots level for maximum intake of water.

Cut up some grass and weeds and place around the plant as mulch, just as with an in ground garden. Any weeds that are cut out of the pot should be mulched back in also. Mulch holds the soil in place while watering and also helps to conserve water by sheltering the soil from sun and wind. And it feeds the plants as well.

A 45L - 10 gal plastic garbage bin makes an ideal and cheap pot and can grow very large plants and even a little garden of herbs or veggies. If the climate is very dry, or the pot is protected from rain, there is no need to put any drainage holes in the pot.

By placing a piece of 55mm - 2in', agricultural slotted drain pipe, in the pot before it is filled with soil, the pot can be quickly filled with water and then drained with a siphon hose inserted in the drainage pipe. All the soil gets wet and draining the water from the pot sucks air into the soil so the roots can breathe, (roots need oxygen to breathe and leaves breathe in

carbon dioxide in the day and oxygen at night). In hydroponics this method of watering is called flood and drain irrigation.

Tie a plastic bag over both ends of the drainage pipe before you begin, so dirt does not get into it as you fill the pot with soil. Turn the pipe in a circle so it coils around inside the bottom of the pot and put a rock on the pipe to hold it down. Then turn the pipe up to the top of the pot and allow about 10cm - 4in' of the pipe to show above the top of the pot.

Fill the pot with soil, and the rock holding down the pipe can be removed as you do so. Just make sure the coil of the pipe stays flat on the bottom as you fill the pot with soil. The plastic bag on the exposed end of the pipe can be removed after but place a tin can over it to prevent dirt, rats, frogs, snakes, anything from getting down inside the pipe. Always use a good, free draining soil with plenty of humus and compost in it. If you can't make your own soil, good potting soil can be purchased from a nursery supply shop.

If the pots are raised off the ground, they can be drained by siphon hose into a tank and the water used again later. Flooding the pot is not essential every time and saved water can be returned to the pot bit by bit. If going away for long periods the pot can be half filled and left. The pipe allows water to be drawn up into the soil because it also allows air to go down into the bottom of the pot. You can also put a stick down the drainage pipe to measure how much water is in it.

In a 45L - 10gal garbage bin, a small plant can be watered in, and the pot filled with water to half way, without issue for the plant and it will just grow. Once it is big, you will be amazed at how much a plant can drink. And with this method, all the water is going into the plants and none is lost into the ground.

If high rainfall is a possibility or you cannot always be present to drain the pot then drainage holes can be put in the pot but never in the bottom of it and there are a couple of different ways of approaching this.

The simplest idea is to put a single hole, about 2 cm across, in the side of the pot (45l garbage bin), about one third of the way up from the bottom of the pot. Put some shade cloth, or some kind of screen that will not rot, over the hole inside the pot and behind the screen put something like stones or coconut fiber to hold back the soil and allow water through it. Water it from the top as you need to and if you can't get back to the pot for a while you can fill it till you see water coming out the hole in the side. It's a good idea to install the slotted drain pipe as well, running past the hole, because it's good to ventilate the bottom of the pot. And it can be watered by flood and drain if you put a plug in the hole but otherwise it won't matter as this kind of pot uses the water very efficiently.

If heavy wet seasons and drought like dry seasons are your problem then another variation on this method is to put a tank tap in the side a few centimeters above the bottom of the pot if there is room. Corrugations in the side may prevent a tap being fitted, so choose the right pot. Tank taps come in two parts and just screw together from either side of the hole and seal against the side of the tank. They can be bought from a nursery supplier or hardware store.

This tap is for draining the pot. The tap can be left closed during the dry season so that that the pot can be flooded and drained or half filled and left. Or the tap can be left open when rain is around. If a pot floods it has to be drained within a day. It takes a lot of rain to fill a pot but once the soil is wet it does not take much to fill it again. The tap can be attached to a hose to drain the water into a tank for later use.

Always make the hole very carefully or the side of the pot will split. A hole should be made with a drill or with the burning end of a stick or with a big magnifying glass. Do not breathe in the fumes. The most powerful magnifier I have seen is a plastic magnifying sheet, otherwise known as a fresnel lens, 7in's x 10in's - 18cm x 26cm in size, which can be purchased very cheaply off the Internet. They are sometimes found in newsagents and super cheap places as magnifying sheets for

vision impaired people to read with. They pack a mean punch for a magnifier in the sun.

If you put a tap in the pot, bend the drainage pipe and put it over the inner end of the tap and cover the join with some plastic to prevent soil getting in the gap.

45L - 10gal planter bags also make good pots. These can be placed on the water catchment plastic of your trench garden. If they should be watered to excess, water escaping from them will flow back into the trench garden.

With small pots, match the plant variety that you are growing to the size of the pot that you use. Put rocks (passing 1in' - 2.5cm retained on 0.5in' - 13mm) in the bottom of the pot but only around the side to cover the holes. Allow soil to reach the bottom of the pot in the middle. This can be made easier by placing a small, 2 or 3 inch wide pot filled with soil in the middle of the bottom of the pot. It is then surrounded by the stones and then the pot is filled with soil. This allows the pot to drain freely and to also soak up water more easily from the bottom up. Use the deepest water retainers you can find for the pots, 2in's - 5cm deep is good. Water in at the top to get the soil wet from top to bottom, then water from the bottom by filling the retainer and a wick effect draws the water up to the plant.

A very large plant may need to be watered 2 or 3 times a day, so if you are going away for a while, fill the pot from the top till there is water coming out the bottom and fills the retainer.

Always sit pots of all sizes on dead level ground for maximum storage of water.

Smart pots are a new idea in pots that came out of hydroponics.

The idea is very simple. The material the pot is made from is porous and allows air to pass through the walls of the pot. When the roots of the plant reach the side of the pot the roots

stop growing because they don't like the air and sunlight. The roots then branch and the same thing happens again. This stops roots growing round the pot in a circle causing root balling as would happen in an ordinary pot. Fabric pots instead encourage the plant to grow a full, healthy root system that is more successful when planted out. The material also conducts water and keeps the pot evenly damp. This technique can be applied to very large pots and even trees.

Several different materials can be used for these pots. Commercially available pots are made from a felt like synthetic material that conducts water through it. This has been used in hydroponics and is very adaptable. Pots can be hung one above the other and trickle fed with water and nutrient solution. The solution permeates the cloth and trickles down the cloth feeding all the plants. With this method, walls and buildings can be covered in plants, creating green zones. These green zones clean and cool the air helping reduce air conditioning energy costs.

Other materials may be used for pots like shade cloth and weed mat. Trees rescued from development sites may have their roots pruned and then wrapped up in shade cloth or weed mat. Trees can be left to sit in storage till needed.

These materials are all plastic which is not so great but it does not rot and can last a long time. Apparently the fabric pots are recyclable and that requires a system of recycling in place to make sure that happens.

Hemp has long lasting properties in exposed conditions. Hemp blanket pots may provide an alternative to using plastics.

## **6. Grass Mulch Pots**

When planting seeds in pots they can be given the best possible start by planting them directly into grass mulch. Grass mulch is pure food. Grass clippings may be used either fresh cut or dried out. It is easier to use if the grass is loose and has not begun to compost into a solid mass. Place the grass in a large bucket and soak in water overnight. Do not

leave any longer or it will create one of the most putrid smells you will ever encounter. Place one handful of soaked grass clippings in a pot at a time. Ram each layer of grass into the pot with the flat end of a stick. 25 cm - 10 in's inches sawn off the end of a broom handle is perfect. Pack the pot as tightly as possible with the wet grass clippings. Place seeds in the top of the pot and cover with a little more grass. Water the pots every day. Any kind of sprinkler system may be used but I find a half an hour of mist every day works well for even watering. Put the pots somewhere where they can drain into the Earth. The runoff from them can create a bad smell on cement or plastic but weed mat works well as it drains. If they drain into the soil, that spot will be greatly enriched and can later be used for a garden. This type of nursery will attract worms which will enhance the grass medium in the pot.

Tree seeds will grow well this way but a drawback is that grass clippings decay quickly and will sink into the pot. The tap root that a tree grows will then bend and wind around in the pot as it sinks. It might be a good method of starting bonsai's.

This method is best suited to plants that do not have tap roots, all herbs and vegetables basically. Corn, tomatoes, banana's and passion fruit love growing this way. Grass may be continually added to the pot as the banana sucker grows. When the pots are planted out, the roots are growing straight into a cake of pure food. Plants will just explode with growth.

With any seeds that find this medium too rich, simply use a sharp object to poke a deep hole in the grass and fill with sand and plant the seed in that.

## **7. Compost**

Compost and mulch are two different things and can be defined by the materials used to make them and the way they are used in the garden. Compost is decayed organic matter and is made from anything wet that will putrefy and make an oozing and smelly mass, food scraps basically, and fresh animal manure. You can even use your own manure, if you

dare. Scraps of meat and bone are also OK to use. These materials are composted to remove the heat and the ooze from them, so that they are then not so concentrated that they will burn the plants that they are meant to be fertilizing. You can even put your used tissues in the compost; the huge population of microbes in the compost will deal with any pathogens thrown into it.

Compost is mixed into the soil in new garden beds and can be sprinkled over old no-till garden beds, as once established, a garden properly planted with companion plants, need not be dug over again. Compost is also ideal for mixing into potting mix for raising seedlings.

When Fukuoka says *no compost*, which is one of the four important points he makes in his book, he is referring to the crop residue left after the harvest, rice straw in this case. Crop residue, such as straw and hay, like leaves and branches, constitute mulch and as such should not be composted but returned to the land in a whole form where possible. Some of the finer mulch may be used as layers in the compost pile to help aerate it and soak up some of the liquid ooze it produces.

As Mr. Fukuoka points out, there is no need to make compost as the natural processes in the soil, where there is a healthy environment of falling leaf litter and the animals that feed on it, are in fact a composting process which is directly available to all plants. However it is necessary to make compost in some places, not only because the end product is useful but also because there are so many people living in confined spaces. There is then too much food and organic waste, and the best way to deal with it, on site is to compost it. The reduced compost can then be removed to be used elsewhere.

## **8. Making Compost**

There are many recipes out there for making compost but don't be intimidated by this. You don't have to have all the materials that you are told are required and you can use some of the materials that we are often told to exclude, like garlic and onion skins and citrus peel. In the end, everything rots.

There are two kinds of decomposition, aerobic, with oxygen, and anaerobic, without oxygen. Anaerobic decomposition involves submerging the organic matter in water and is used to make methane. Aerobic decomposition will very slowly dry the organic matter as it decays into compost.

A compost pile will create a bit of ooze, so if the Earth has poor drainage it helps to have a layer of sand or loam on the ground to soak up any excess leakage. If there are weeds on the ground there is no need to pull them out, just flatten them down. They will rot away under the compost.

Place a sheet of woven weed mat about 2m wide and 4m long on the ground and spread a layer of mulch (chaff, grass clippings, hay, leaf litter) over one half of the sheet. This will help to soak up some of that ooze before it is lost into the ground.

On top of this layer of mulch you can place all of your food scraps and wet manures. Always spread these materials out in layers as you add them and leave them loose so the pile can breathe, never squash the compost down, this slows down the process of decomposition. Spreading the compost out in layers brings each newly added layer into maximum contact with the previous layer, which encourages decomposition and also maximizes its contact with the air, which helps the pile to breathe.

The weed mat is porous and allows moisture to leak and evaporate through it. Cover the compost pile with a 2m by 2m square sheet of plastic. The free end of the weed mat can be folded over the compost pile and the sheet of plastic as a cover. The plastic prevents the surface of the compost from drying out and the weed mat protects the plastic from the sun and other damage. The weed mat is also useful in helping to roll over the compost when digging and mixing it and moving it around. The weed mat allows the excess ooze, to ooze through it into the Earth below and also separates the compost from the ground and stops it being lost into the garden.

Worms and beetles in the garden will also be able to find their way into the compost pile and take part in the composting process. In tropical countries a large fly, called the American soldier fly, which has the appearance of a wasp, will lay its eggs in the compost. They will hatch into large hairy maggots that are beneficial to the composting process.

When adding larger and stronger materials such as paper, natural cloth, straw, weeds, large pieces of fruit like, jak fruit and pumpkin, it helps to cut them into smaller pieces. This aids the composting process and makes it easier to put the spade through it when the time comes to dig into it.

Each new layer of food scraps can be covered with a layer of mulch but this not essential. Each new layer of mulch, if you use it, can be watered a little to help it connect with the food scraps.

Use some rocks or branches around the edge to hold down the covering weed mat. If you have only limited resources then banana leaves and large palm fronds will stand in for woven weed mat and plastic.

After a couple of months the pile will be ready to turn. The easiest way to do this is simply to move it to one side and create a new pile in the same manner as described already. Move the pile by taking it away in chunks from the side, with a spade. Spread each chunk out in layers on another piece of weed mat. Building the pile in layers and taking it to the next pile in chunks and then spreading it out in layers has the effect of mixing the matter very efficiently with the minimum expense of energy. In another month or two the compost should be ready to go into the garden as fertilizer.

When ready to use, you may wish to leave the compost in the sun for a while to dry and make it easier to handle, should it still be very wet. However if compost dries out completely in hot sun it can cook and become hard and coarse and less water absorbent.

Sun can also help to remove ants that may be living in the compost. If ants are still a problem by the time the compost has dried enough to look like a rich forest soil, putting compost through a one inch - 2cm sieve, seems to convince them to leave in a hurry.

Plants like passion fruit may be planted around the compost pile to take advantage of any ooze and solids that invariably escape from it. And each time the compost pile is emptied, the next pile can be started in a new place and the old spot can then be used as a garden bed.

Throwing kitchen scraps in a chicken pen can result in unsanitary conditions for the chickens. Rather than giving the scraps directly to the chickens a compost pile could be made in a basket or small cage. The idea is that any worms or insects that crawl or fly out of the compost pile may be eaten by the chickens.

Scraps can be put in a split bamboo basket or wire cage or surrounded by a small fence that could be made from wire or bamboo or whicker.

The pile can be made like a normal compost pile by spreading food scraps out in a thin layer every time they are added to the pile. Each layer should then be covered with leaf litter, lawn clippings or chaff.

A lid may be placed over this to prevent the chickens getting directly into it and digging it up. The lid may also be made of woven bamboo and does not need to keep out rain or sun.

The chickens will spend a lot of time picking at and scratching around the compost pile. Place sticks and branches on the ground around the compost pile to stop the chickens from scratching big holes in the ground around it.

Piles of sticks and branches and leaf litter also attract and shelter insects and may be left in the chicken pen or around

the garden if the chickens roam free. Chickens love scratching around piles of mulch.

Another compost idea for feeding chickens is to leave something like a chopped up pumpkin to rot in a bucket loosely covered with a cloth. Flies will be attracted to this and will lay many eggs. In just a few days there can be lots of fly maggots in the bucket. Before they reach adult size and turn to flies they can be poured out for the chickens. The chickens love them and they are an excellent source of protein.

## **9. Mulch**

Mulch is organic matter that has not yet decayed and is made from any organic matter that is hard or dry or has a lower moisture content. Lawn clippings, leaf litter, weeds, straw, hay, sawdust, chipped bark and wood, twigs, branches, logs, palm fronds, dry sheep, goat, cow, horse and elephant manure may all be used as mulch. Even paper, cardboard and old clothes made from natural fiber's like cotton, hemp and silk can be used and work well as a first layer to hold down weeds.

When using sticks and branches as mulch, break or cut them up only enough that they are able to lie flat on the ground. This brings them into maximum contact with the ground which will speed up the process of decay.

Seeds and seedlings can be planted right up against logs to great effect. Wood makes the most soil.

Raw mulch contains both nutrients and energy. If composted in a compost pile this energy is burnt off by the micro flora in the pile. Adding it as compost to the garden then only adds nutrients without the energy that the worms and beetles need to help them dig it in. The larger, irregular shape of raw mulch also creates habitat and protection for the worms and beetles. So by mulching the garden, worms and beetles are encouraged to turn this matter into humus and dig it into the soil.

Mulch is placed on top of the soil around the plants. Well rotted kitchen compost is ideal for fertilizing your prize veggies however mulch may actually be superior. Mulch is complete, it keeps weeds down and protects the soil from the drying effects of the sun and wind. Mulch slowly releases soluble nutrients into the soil when watered, and feeds and protects worms, beetles and micro-organisms living in the soil. These tiny animals living in the soil will add their manure and do all the necessary digging for aerating the garden soil. And they will do more digging, more consistently and more delicately around the garden plants than any hoe or tractor ever could.

Mulch is spread out in thin layers to allow for maximum contact with the Earth and availability to feeding worms and beetles.

Mulch like chaff, grass clippings, hay, leaf litter and straw can be added to an established garden by throwing it in the air, so that it lands in a random pattern around the garden, as in Mr. Fukuokas 'One Straw' principle of mulching. Just shake the mulch off any plants it lands on.

A pile of lawn clippings or leaf litter may also be used as a urinal. Peeing on a pile of leaves adds nitrogen to them and aids decomposition. The leaves also help to prevent that spot from smelling bad. Just add another layer of grass or leaves after each use. The pile may be left there to decay or used in other areas. And different spots of the garden may be used in rotation to improve the soil overall.

Weeds make excellent mulch. When you don't use weeds for mulch, having to remove them is a chore. When you start cutting weeds to mulch around the papaya's and bananas and other fruit trees, you will find that there are never enough weeds to harvest.

In areas and seasons where wild fires are a problem, mulch on the ground may present a fire hazard. One course of action is to clear a fire break around the garden. The plants cleared

from the fire break area may then be used for mulch in the garden.

## **10. Sheet Mulch**

A description of sheet mulch can be found in 'An introduction to Permaculture' by Mr. Bill Mollison. Various layers of mulch are laid on the ground to make a garden bed and then one can plant potted seedlings directly into that. It does require regular watering to get it started because in the beginning the mulch does not hold the water so well. Once it gets going though, the mulch bed will save a lot of watering and needs no feeding. The mulch is the food. Sheet mulching is one of the best and fastest methods of enriching poor soil. Food and energy in the mulch is directly available to worms and beetles living in the garden instead of much of it being lost to the process of decay in a compost pile. The worms and beetles use that food and energy to dig over the soil and mulch and create the richest soil possible. The activities of the mesofauna (worms, beetles and other small soil digging creatures), fluff up the surface soil and dig deep holes and make oxygen, food and water available to roots, encouraging dynamic plant growth.

When making a sheet mulch bed it is better to cover a small area deeply, rather than spread the mulch thinly over a large area. Some people like to put some lime and organic fertilizers like chicken manure on the ground first but I have found that this is not essential. Newspaper, cardboard and natural fiber cloth may then be placed on the ground to hold down any weeds. Logs may be used to mark the borders. Next put down the largest mulch, like big sticks and branches and the stems of palm fronds, on the ground first. They need only be chopped or broken up enough that they can lie down flat on the ground. Successively place layers of smaller and smaller materials over the top of them. If it is available, a layer of chipped mulch may also be placed over this pile. Over the top, spread a layer of leaf mulch which may then be covered with a layer of lawn clippings. Make the top layers of leaf litter and lawn clippings as thick as possible, 30cm - 1 ft, of lawn clippings is good. A deep layer of leaf and grass clippings is

necessary because it is very insubstantial material and disappears very quickly. You will be amazed at how quickly the mulch will disappear. Even the sticks and branches will be gone in six months. Plant potted seedlings directly in the lawn clippings and keep damp. For some plants, make a pocket of soil in the top layer of mulch for planting seed or seedlings into.

A misting system on a timer is the best method of irrigation.

Mulch in a whole form is superior to machine chipped or shredded mulch but shredded mulch is fine as an upper layer in the sheet mulch garden. Whole mulch is better because it provides habitat for wood boring insects and various wood inhabiting bacteria and fungi. It also helps to create space and allows for more oxygen within the mulch. The mulch will rot in a more controlled manner and therefore does not lead to nitrogen starvation that mulch is so often blamed for. I have never had problems with nitrogen starvation.

Machine shredded wood chip comes into its own however with serious infestations of weeds like nut grass (*cyperus rotundus*). A 15 to 30cm - 6 to 12 inch layer of wood chip, perhaps camphor laurel or pine for this purpose for their weed suppressing properties, may be the only way of dealing with the deeply rooted corms and rhizomes of invasive weeds like this.

## **11. Giant Mulch**

Urban environments contain many trees and for all sorts of reasons huge numbers of trees are cut down every day for removal to waste sites for burial, burning or chipping. Up to one third of all materials buried in urban waste sites is waste vegetation. This is an enormous waste of vital natural resources.

By using at least some of this material to construct giant mulch garden beds, we can begin to address the problems of the enormous amounts of waste involved, scarcity of landfill sites and atmospheric pollution. Giant mulch beds can also

help to absorb the huge quantities of vegetation debris, suddenly created by catastrophic events like severe storms.

Giant mulching is the same method as sheet mulching but on a bigger scale. I have used many whole trees, (brought to me in pieces by professional tree removalists), for giant sheet mulching and made mulch beds 1 to 2 meter's deep. And there is no limit to how deep it could be.

Timber makes the most soil but the wood itself does not have much nutrition in it to begin with. There is a greater food value in the leaves, twigs and bark. As the wood decays it becomes a sponge, soaking up whatever dissolved nutrients that should drip on it. From the moment leaves fall from the trees, they release a green tea of nutrients whenever they get wet. So when a mulch bed is watered, a green tea from the top layer of leaf litter will trickle down through the mulch where some of it will be absorbed by the wood which is slowly turning into a black peat. What is not soaked up by the wood, drains into the soil to enrich it and feed plant roots.

Place the largest logs around the outside to mark the boundary of the garden bed. Then place the next size down logs and branches on the ground in the garden bed. It is possible to make a mulch bed on a solid bed of logs.

Continue building the bed as described before in the chapter on sheet mulching, breaking up branches only enough that they can be laid flat and laying down the largest materials you have first and placing gradually smaller and smaller sticks and branches over the pile in even layers. Finish by covering with a layer of leaf litter then grass clippings on top.

It's better not to use materials like thorny and spiky branches and palm fronds. Thorns last a long time and if used in the mulch bed will be the last thing left when the rest of the mulch disappears. So every time you try to plant in the mulch you will get spiked. If you can get a garden shredder then thorny branches may be chipped and used as an upper layer in a

sheet mulch garden, over which leaf litter then lawn clippings may be placed.

Banana's and papaya grow in spectacular fashion in a giant mulch bed. Papaya plants will fall over as the mulch rots away. It is best to allow them to do so and not stake them up as they will respond by putting down more roots. They will become stronger trees as they cannot fall any further. Their trunks then will bend back up to the sky and so will be shorter when they fruit (provided they get plenty of sun) and therefore easier to harvest. Papaya's are actually pulled down and tied to a peg for this reason by papaya farmers in Thailand. Just cover roots with more mulch as they become exposed.

Likewise trees that fall over in storms can also be allowed to regrow from a fallen position instead of staking them back upright and can come back stronger than the original tree. Prune off damaged branches and cover the roots with soil and, or mulch. A tree lying on the ground can regrow from numerous points along its trunk and can end up looking like many trees.

For irrigation I like to place one inch poly pipe with misting nozzles over the mulch bed. It needs to be raised as the garden grows. It is more helpful to water on a regular basis than to water for long periods of time. Running the system with a timer is a very efficient way of watering. Ten minutes at a time, three times a day is enough to create the most startling growth. Once established, the watering regime can be reduced.

I have used a digital timer that allowed for a water regime of nine times a day for two minutes every hour from nine am to five pm. If suspended in the trees, this kind of system and water regime can grow epiphytes like orchids and ferns on anything and much faster than they otherwise could.

If you don't have irrigation then you can still take advantage of a giant mulch bed as it will make the effects of rainfall last

much longer. It's always good for bananas; plant banana stumps deep in the ground and cover with a mountain of mulch. Papaya can be planted in the soil right up against logs around the pile and any trees and plants growing close to a large pile of wood are going to do much better. Even one single log lying in the garden is a very good place against which to plant papaya or anything at all. Vines like pumpkins, melons, sweet potatoes and tomatoes can be planted in the Earth all around a mulch pile and allowed to grow over it.

If there is a big pile of branches left from a clean up in the orchard, then consider planting all around it. Planting kitchen scraps that include various seeds like pumpkins, melons and tomatoes is a great way to start a vine garden. Vines love growing over a big pile of branches sticking up in the air. Their roots can reach out into the cool rich soil under the pile while the vines climb over the branches leaving their fruit hanging in the air.

And if the idea is simply to dispose of the wood, it is better to leave timber in a pile to rot away than to burn it. It will at least be making soil instead of adding to the ash and carbon already in the sky. And it will rot down much faster if it is wet, a large pile of branches can disappear in a year so why not just let sleeping logs die.

And if you have an interest in watching natural events then you will notice the many insects attracted to this organic mini-ecology and the birds and other predators that hang around and feed on them too.

## **12. Weeds**

The Earth is full of seed and you can take advantage of the plants that just come up on their own. All you need to do is remove the unwanted weeds to use as mulch and leave the helpful ones that emerge of their own accord. There is a garden in the Earth just waiting for you to look after it and you can do it just with selective weeding.

Not all weeds are plants that need to be removed, and in fact they can be your first choice of plants to use for ground covers, living mulch and green manure. That is, they can fulfill many of the tasks attributed to mulch, such as protecting the soil surface from wind, sun and rain, preventing unnecessary evaporation and erosion. This cover allows the roots of garden plants to grow closer to the soil surface and therefore have greater access to oxygen and water. This alone is reason enough to consider weeds as companion to your garden plants. However their influence goes further, by spreading their roots out through the soil, they encourage the spread of bacteria and mycorrhizal fungi that live in symbiosis with all plant roots, helping to improve the uptake of soluble nutrients in the soil. Weeds encourage worms and beetles to take up residence in the soil and also soak up excess water when there is too much. They also help pull oxygen into the soil. Roots also provide pathways for water to follow through the soil, helping to improve the availability of water to other plants. Some weeds behave as companion plants and exude organic compounds through their roots that encourage the growth of other plants and even enhance the desirable qualities of those plants.

For those weeds you wish to remove, some will need to be dug out while others can be pulled out and others still need only be cut off at ground level. Their roots will decay and feed worms and bacteria, enriching the garden soil. If weeds regrow from their roots, just cut them down again. Consider them a harvest for making mulch for your garden. Once you get to know the weeds, you will know which ones to pull out, which ones to dig out, which ones to cut, where to cut them and which ones to leave.

Aggressive weeds and large infestations can be controlled but whichever method of weed control you use it will require a consistent management campaign. In other words you have to follow through and make sure that each new generation of weeds is removed before they set seed. The number of weeds to be removed then will be reduced with each season.

Most weeds pulled, dug or cut from the garden should be mulched straight back into the garden to return their nutrient content that they have taken from the soil. If they start regrowing roots, they only need be pulled up once more and they will die.

Remove aggressive weeds before they flower and set seed.

It's easier to remove bigger older weed in the dry season when they are dying back. Weeds are most easily removed when young, get to know what they look like when they germinate. The beginning of the rainy season is the time to be looking for the new generation of problem weeds. You will possibly find some of the worst weeds growing back in big banks of seedlings. *Mimosa diplotricha* is good at doing that the first decent rain after a fire. Pull the weeds, get in a goat or goose or any grazer you can manage, chip with a hoe or mulch over while still young and easy to work with.

Allow preferred weeds and wild plants to set seed before cutting them for mulch. Collect some of their seed and spread around the garden. As broadcasting requires a lot of seed for success, if you have any less common plants on your land you wish to encourage, then maybe collect some of the seed and grow it in pots in your nursery and plant out later.

The best times to do weeding are in dry weather and during barren phases of the moon to help kill the weeds that you are removing. You may however wish to remove the weeds during a fertile sign if you wish to encourage the growth of the plants that are left behind. Weed in the mornings so the removed weeds have to face the harsh sun of the day. If you are having wet weather, perhaps the weeds can be put aside in a dry place till they are dead and can be put back in the garden as hay mulch.

There are weeds, like spiderworts (*tradescantia*), tropical chickweed (*drymaria cordata*) and singapore daisy (*sphagneticola trilobata*) that grow like succulents, holding water for a long time making them hard to kill. They are

brittle and break up making them hard to pull out and every part of them grows back easily and can quickly choke a garden.

Singapore daisy has a poor root system and can loosely grow up and over itself and other plants, and is one of the few plants that can promote soil erosion. Weeds like these should be removed altogether. When removed they may be left on a road or path in the sun to be walked on or driven over. This will quickly kill them; they can then be mulched back on the garden. This can also be done with bulbs, corms, crowns, nuts, rhizomes, runners and tubers that are always difficult to kill. Spiderworts are said to be eaten by ducks and geese.

Alternatively, tough weeds like these can be composted separately by putting them in a large plastic bag like a 45l - 10 gal planter bag. Leave somewhere in the garden where worms can get into it from the bottom. You can fill the bag and water occasionally and the weeds will quickly sink down. Keep filling the bag for a couple of months then cover the bag for a few weeks. When you empty it out you will find it is a beautiful, rich soil full of worms. Any plants still alive just put back in the bag for the next load. Depending on what sort of weeds are in it, do not spread this compost around as it may contain seed. If it has seed in it, use in singular places in the ground where it will be covered over, or in pots so seeds that emerge can be checked.

Grasses produce phenolic acids that inhibit plant growth. Cut grass however makes excellent mulch. Try to reduce the incidence of grasses by removing them, particularly the large ones and those with deep corms, crowns, rhizomes and runners, in favor of smaller broad leaved flowering plants. There are a few gentle grasses though that are welcome in the garden for ground cover and mulch. There are also of course, many grasses that are important crops like bamboo, citronella grass, lemon grass, sugar cane and thatching and weaving grasses to name a few.

If an area is infested with nut grass (*Cyperus rotundus*) or an equally invasive weed, a layer of 15 to 30cm - 6 to 12 in's of wood chip may be the only solution. If nut grass is removed manually it can be left somewhere to dry for a month to kill it and it will be good to use as mulch. With only a small amount, nut grass nuts can be dug up and crushed and then they can be used as mulch.

If it's not a huge area, weed mat may be used on nutgrass. Weed mat is porous and allows water and air through it. This convinces plants to keep growing but they can't get through the weed mat and they are starved of light which weakens and kills them. Just hold it down with rocks or branches. If any leaves should poke through the mat just lift it up and put it back. Once it has done its job the weed mat can be moved on. This process actually works quicker in the wet season. It can take a couple of months but is a lot easier and does a better job at getting all the weeds than any other method.

In larger areas that are heavily infested with weeds that are very difficult to control, the only way to control them may be to plant tall, fast growing annuals or trees that will shade them out like sun hemp, hemp and trees like *luceana*, all thickly planted. These plants have fixed flowering seasons which makes them easy to control and they like growing close together. A weed control crop is usually planted very closely to thoroughly shade out the weeds. With serious infestations successive crops may be necessary to bring problem weeds under control.

Hemp creates a lot of leaf litter ideal for worm fodder; *luceana* is a legume tree that fixes nitrogen in the soil and is an excellent fodder crop for grazing animals. Plant many trees close together, if possible on contour lines, every few meters up the slope, which is a good way to exploit the space being managed. Manual slashing or a tractor slasher may then be used in between the rows. Slash back the weeds and mulch them around the trees to help get the trees started.

Once the control trees have done their job, fruit and timber trees can be planted amongst them and later the original weed control trees may be cut down and used for mulch around the economic trees or elsewhere in the garden.

Domestic animals, when not properly managed, also spread and encourage aggressive weeds. Animals will generally graze on softer, choice plants leaving behind less tasty and thorny weeds. Seeds from these weeds can also get stuck in their coats and be spread around. However, well managed, domestic animals can be used to reduce and even eliminate problem weeds. Goats will eat almost anything and even prefer to eat the worst weeds like *mimosa diplotricha*. But goats will only eat the tips and then move on. If chained or penned in one spot a goat will eat everything it can reach. Then the animal can be moved to another spot and a whole area can be mowed down. Ducks are known to eat khaki burr (*alternanthera pungens*).

All grazing animals can be managed with this method, chickens and even guinea pigs are happily raised in an animal tractor. If there are weeds that grow deep in the ground, the chickens may need to be left there for a long time, or pigs might be used to remove them. A small, strong pen that can be moved can hold a pig or two in one spot while they dig up the ground and eat all the, bulbs, corms, crowns, rhizomes, roots, runners, stems and tubers growing in that site. Move the pig tractor to the next spot and repeat the procedure. This is a very effective way of feeding the animal and keeping it happy while it does a valuable job digging, weeding and fertilizing the garden.

One nice method is to have a number pens and move the animals from one to the next then make a veggie garden in the pen they just left. Once the veggies have been picked and it's time to clean up the beds just let the animals back in and start a again.

Which weeds to remove? Simply, remove the ones that actually cause problems for you and the garden. For example,

the prickly ones, and the ones that grow at an extremely rapid rate and take over the garden, like singapore daisy, *spiderworts* (*tradescantia*) and some grass weeds, and the ones that reproduce at an equally rapid pace and also take over. Also remove weeds like spanish needles (*bidens pilosa*) and chick weed that produce seeds that stick to hair and clothing. Some weeds produce hairs that, when the plant is mature and dry, become prickly and highly irritating. Some undesirable weeds will be difficult to remove because they grow from bulbs, corms, crowns, rhizomes, runners and tubers that they put down deep in the ground. Every effort should be made to remove them properly **before** starting a garden.

Khaki burr or bindi eye (*alternanthera pungens*), and creeping sensitive weed (*mimosa diplotricha*) are two extreme examples of prickly weeds that should be removed. However both these weeds are encouraged by the use of indiscriminate cultivation, burning off and poisoning. Remove manually if possible and if they have seeds, bury them in a single place or make a layer of them and cover this with a deep layer of sheet mulch.

Also remove weeds that flower from an early age and then grow big, producing seed all the while no matter what season it is.

Where to start weeding? Answer, close to home. Start near the house and spread out from there. Also weed around plants in the garden that you like and want to encourage like any naturally occurring ground covers you have found. Mulch the weeds that you remove back in around the plants you wish to encourage.

Which weeds to use as ground covers and green manure? Plants that produce lots of foliage like soft, broad leaved annuals like thick head, (*crassocephalum crepidioides*) and puha, (*sonchus oleraceus*) also known as milk thistle or sow thistle because it was traditionally given to cow's and sow's to improve their milk quality and yield when they had calves and

piglets to feed. It's also said to give chickens darker egg yolks. Definitely a green for mothers. Puha is a nutritious salad and cooking green.

Wild amaranth (*celosia argentea*) and the *crotalaria* family are also good ground covers and companions. There are many good weeds and native plants which have large flowers and will attract nectar and pollen feeding, and therefore pollinating, insects like bee's, beetles, butterflies, hover-flies and wasps. Wasps also take grazing caterpillars to feed their young. A healthy floral ecology will feed a community of insects which will in turn attract insect predators like ladybirds, hoverflies, dragonflies, damselflies, lace wings, praying mantis, spiders, lizards, frogs, birds and bats to the garden. They will keep grazing insect numbers low and leave behind their droppings to enrich the garden soil.

Leave short lived annual weeds, and weeds that flower in a specific season because this makes them easy to control.

To encourage preferred weeds and wild plants, just leave the good weeds be when you cut or pull out, and mulch in the weeds that you would prefer not to have in the garden. This might be called replacement weeding, cultivating some weeds, by tolerating them and allowing them to replace the ones that are removed.

Good weeds for using as ground covers and green manure crops may be legumes or will have a lot of foliage. They may be soft and hairy and may also be aromatic. Some weeds may even be oily and resinous to the touch, such plants make good mulch but may be distasteful and even toxic to livestock. And they can really stink so you'll only want to keep the ones that smell nice. When cut down, the plant part cut back will die and mulch in easily. The roots left in the ground may die or regrow for harvest for mulch.

Some good weeds will have little foliage, this is an advantage as they will be able to grow next to your vegetables without casting a shadow over them, and the garden will then have

the benefit of the presence of their flowers and binding roots in the soil.

There are many native plants that people do not grow because they grow wild and they do not see other people growing them. They consider these plants weeds even though they may not grow in vast numbers. Native plants are ideal green manure and living mulch as they are adapted to your local conditions and attract local pollinating insects. They will also live in harmony with your garden plants.

If collecting native plants for your garden here are some points you might consider. Do they grow fast? Do they have attractive flowers or foliage? Do they have a single season for flowering and producing seed? This will make them easier to control. Do they have seeds you can collect and scatter in your garden? Only take a portion of the seeds you find on the plant so that it may reproduce successfully.

Don't dig up wild growing plants to transplant into your garden as they usually have very deep tap roots and it will be very difficult to get the whole plant without killing it. Take a few seeds when you see them on the plant or perhaps a cutting if the plant can grow that way.

You will not know the habits of some plants till you grow them, so you'll have to watch them through their life cycle till they set seed and die. It may not be till they are completely dead dry that those fluffy hairs become prickly and irritating or the seeds turn out to be sticky or prickly.

In a healthy garden with good soil and plenty of water, the only thing your chosen living mulch weeds will compete for is the sun. When these welcome weeds begin to over shadow your garden plants it is time to cut them down and mulch them in or just bend or squash them down to the ground or just mulch over them while also removing or mulching over any unwanted plants. The same can be done when it's time to make space to plant something new in the garden.

By removing undesirable weeds and allowing the desirable weeds to grow, you can create a ground cover of plants that will shade out and discourage aggressive weeds from germinating in the garden. Weed management then becomes much simpler.

Prostrate weeds are particularly useful and can fill an important niche. There are many low growing plants that can make a fine lawn and can also act as companion plants and living mulch amongst vegetables and crops and lawn grass.

The *desmodium* family, also known as trefoils, offer a number of excellent prostrate, leguminous ground covers. Tick clover (*desmodium triflorum*), Spanish clover (*d. heterophyllum*) and also alyce clover (*alysocarpus*) are legumes that improve lawn and pasture for livestock and should work well as living mulch in no-till crops in the tropics.

Sour grass or yellow wood sorrel (*oxalis corniculata*) is edible and can come up naturally in any garden.

By encouraging plants like these we can end up with low maintenance ground covers, living mulch and lawns that are practical, attractive and comfortable to live and work with.

And if the earth is too full of weeds for you to manage, you might use it for another purpose like building on or with. Mix with subsoil and use it to raise the land to build on, or build with by making mud bricks.

### **13. Ground Covers**

The terms companion plants, cover crops, green manure, ground cover, living mulch and smother crops basically all mean much the same thing. To make new top soil and prevent it from being blown or washed away it is essential to have plants of all kinds, covering all the Earth, at all times. Ground covers offer many benefits; they shade the ground from sun and wind, which helps to keep the Earth cool and damp, and an interlocking mat of roots protects soil from erosion during high rainfall and irrigation.

Ground covers prevent weeds from being a problem by reducing the available space where weeds could take up residence. A land without any plants is an open invitation for the first seed that comes along to settle down and make the most of it. And it could be something prickly or poisonous so take advantage of open space and introduce friendly and potentially useful ground covers that will inhibit the growth of uninvited plants.

Ground covers may provide fodder for livestock. The plant matter provided by ground covers also feeds worms, beetles, fungi and bacteria. Ground cover plants also provide shelter and habitat for beetles, worms and lizards which gives them a chance against predators like cats, dogs and chickens.

A collection of wild plants spread throughout the garden will support a diverse ecology that prevents population explosions of potentially problem plants and animals.

Small animals, like beetle and cicada nymphs, are important to have in the soil because they dig deep holes that allow air and water to penetrate deep down. Worms also drag leaf litter and organic matter deep into the Earth and eat it. Their carbon rich waste is loaded with bacteria inoculating the soil with microbes essential to plant root growth.

Roots can penetrate deep and break open hard Earth allowing pathways for water to seep along.

Roots are grazed by the life in the soil and contribute to the soils organic content.

Roots die and decay and add their carbon to the Earth and make food and space for worms, beetles and microbes to live in and for water to follow.

It is essential to keep a ground cover, from small annuals to shrubs and trees that helps to open up the soils and allows rains to soak in and fill the water table which feed springs, creeks and rivers. This slows down the movement of water

through the environment by filtering it through the Earth. Flowing water is cleaner and if topsoil is not washed into the waterways every time it rains, then creeks and rivers can be prevented from silting up. Rivers today are full of silt and sediment that has resulted from modern deforestation, forest fires, tillage farming, road building, mining and urban development. Because rivers have no deep pools in them anymore, when the high rainfalls come, they are no longer able to cope with the extra water so the water spreads out causing flooding in the lower regions of the catchment area.

The point to all this information is that it is absolutely essential to good land and water management to keep the Earth covered with plants.

#### **14. Companion Plants**

Any plants which can be controlled and do not grow aggressively and swallow your garden may be used to protect soil and moisture and add nitrogen and organic matter, however there are a few plants that can do a little more for the garden.

All plants exude chemicals into the soil and the air; some will have an effect on some of the plants nearby. Some can suppress other plants and cause them to decline in health. Some can be good for the surrounding plants and encourage good growth in them. Legumes can be good at this, they're adding nitrogen to begin with and they can also produce chemicals that suppress weeds while helping your herbs and veggies. This is called allelopathy. Many herbs and vegetables are known to do this for each other and can be planted together to take advantage of this. This kind of gardening is known as companion planting or intercropping.

Different crops are grown in a single garden at once for the benefit of having multiple harvests from the garden. This extra diversity turns the garden into a complex maze of plants that insect pests have to work a bit harder to find a meal in, reducing losses.

Plants in such a garden are matched by their growth habits, how fast they grow and their final size and the size and shape of their root systems. They can be different sizes if the shorter plants don't mind some shade like corn, beans and squash.

The properties of most vegetables as companions are already known and can be determined with a companion planting guide. An intercropped garden may be built around a main crop which is surrounded by supporting companion plants as this table demonstrates. You can add even more plants to this by consulting a more detailed companion chart.

**Main Plant      Companion Plants**

Tomatoes	-onions, parsley, or cucumbers
Squash	-corn or marigold
Strawberries	-spinach, lettuce, or bush beans
Beans	-pumpkins
Potatoes	-horseradish or cabbage
Asparagus	-parsley or basil
Onion Family	-carrots or lettuce
Carrots	-radishes or tomatoes
Eggplant	-beans or peppers
Pumpkins	-beans, peas
Garlic	-lettuce, cucumbers, or peas

Yarrow (*achillea millefolium*) and stinging nettle (*urtica dioica*) are two good companion plants because they produce organic compounds that improve the oil contents and medicinal properties of the herbs that they grow with. Yarrow can improve the oil content of peppermint and when grown in dairy pasture can improve the cream content and milk yield of the cattle.

Stinging nettle is a hard plant to work with for obvious reasons. You may wish to harvest some and mulch it around your garden plants. Use gloves and be careful. Dry nettle leaves do not sting. You might also clear an area of stinging nettle for the purpose of planting your garden there. Stinging nettle is an excellent soil conditioner and the Earth under an old nettle patch should be a very good place to make a

garden. A boundary of nettle will also discourage inquisitive animals. You might also make a tea of nettle and spray it on your plants as a foliar fertilizer, or pour it on the garden. The same can be done with yarrow but yarrow plants are much easier to manage and can be planted direct into the garden. Yarrow can also be used to make a lawn. Just mow or walk on and it will grow in a prostrate form.

There are many plants that can be used as companions, look at companion planting guides. Alfalfa and white clover are good plants that fix nitrogen into the soil. Plant thickhead seed (*crassocephallum crepidioides*), when planting vegetable seed, so that they come up together. Seedlings in pots will grow faster when accompanied by thickhead.

Companion plants and weeds can also behave as decoy plants, that is, some insects will prefer to feed on them rather than attacking the vegetables.

Flowering weeds and companion plants also attract bees and other pollinating insects to the garden.

Aromatic herbs like lemon basil and lemon grass also make good companions and may lend their flavors to other herbs.

Comfrey is also a good companion plant and is known as a compost activator.

Some plants are anti-companions. Rue, fennel and gotu kola are anti-companions to some plants. Gotu kola is fine growing around the bananas and taro.

All you need to do to manage companion plants is bend them over and away from your vegetables and clip them down when they start getting too big. Mulch in the clippings which means scatter them under the plants left behind.

Perhaps the best way of growing a garden of herbs and vegetables would be in a large, diverse and chaotic garden mixed with wild plants and ornamentals.

When plants in the garden mature and die, there is no need to remove them. For example dead marigolds or basil plants may be simply broken down or squashed down flat. They may be mulched over or new seedlings may simply be planted among them or seed dropped by the old plants may be allowed to grow up through the old plants remains.

There is plenty of information about companion planting on the Internet. But in the end it is not necessary to know specifically which plants are companions for which plants. Plants just like company.

### **15. Green Manure**

When plants are grown specifically for the purpose of making as much bio-mass as possible for use as mulch, it is known as a green manure crop. Legumes are often used as green manure for their ability to fix nitrogen in the soil. Some plants add nitrogen by producing large amounts of nitrogen rich leaf litter. Good green manure plants will have lots of foliage and short life spans, one season generally and all flowering at the same time. Many plants can be used as green manure crops. Herb and vegetable seed such as alfalfa, basil, beans, corn, perilla, peas, hemp, sunflowers, sun hemp, wheat and also wild plants, especially legumes like the *crotalaria* family, and many others can be used.

Seed like those for cooking and sprouting, can be purchased cheaply from health food shops and the like. Gather as much seed as possible and scatter everywhere in the garden. You may use Fukuoka's method of making seed balls by rolling seeds into clay balls. You can see him doing this on YouTube. Clay around the seeds protects them from rats, birds and sun and also helps plant the seeds in the Earth while they wait for rain.

To take advantage of its nitrogen fixing abilities, a green manure legume crop is harvested when it begins to flower. This is when the plant has the most stored energy and nitrogen in its roots and it's about to spend it on its flower and

seed production. Slashing will release that stored carbon and nitrogen into the Earth.

Green manure crops may consist of many different kinds of plants used for different places and for different reasons. For example:- Alfalfa, sends roots deep to bring nutrients to the surface. Buckwheat (*fagopyrum esculentum*), is a rapidly growing green manure in temperate regions, tyfon is a brassica known for a strong tap root that breaks up heavy soils. Velvet bean (*mucuna pruriens*), common in the southern US during the early part of the 20th century, before being replaced by soybeans, is popular today in most tropical countries, especially in central America where it is the main green manure used in slash and mulch farming practices. Ferns of the genus azolla have been used as a green manure in Southeast Asia.

Alsike clover (*trifolium hybridum*), crimson clover (*trifolium incarnatum*), fava beans, fenugreek, hemp (*cannabis sativa*), lupins, mustard, oats (*avena sativa*), rapeseed (*brassica napus*), soybeans (*glycine max*), sudan grass (*sorghum vulgare var. sudanense*), sunflowers, sunn hemp (*crotalaria juncea*), tick beans, wheat, white sweetclover (*melilotus alba*), winter field beans, winter tares (*vetches*) such as hairy vetch (*vicia villosa*), winter rye (*secale cereale*) may all be used as green manure crops.

Heliconia's and ginger's can produce a harvest of flowers and edible roots and shoots as well as a lot of mulch. There are many big leaf ornamentals in the tropics like heliconia's that like water and produce a lot of soft leaf and stem matter ideal for mulch. Just make sure to choose clumping varieties over running types. Clumpers allow you more control of their growth habits. Runners can get away and come up anywhere becoming a nuisance. The same is true of bamboo.

Different kinds of green manure crops may be used in different climates and seasons for particular purposes such as-

**a. Summer green manure crop**

A summer green manure crop occupies the land for a portion of the summer growing season. These warm-season cover crops can be used to fill a niche in crop rotations, to improve the conditions of poor soils, or to prepare land for a perennial crop. Legumes such as alfalfa, cowpeas, soybeans, sweet clover, sesbania, guar, crotalaria, or velvet beans may be grown as summer green manure crops to add nitrogen along with organic matter. Non-legumes such as sorghum-sudan grass, millet, forage sorghum, or buckwheat are grown to provide biomass, smother weeds, and improve the soil.

**b. Winter cover crop**

A winter cover crop is planted in late summer or fall to provide soil cover during the winter. Often a legume is chosen for the added benefit of nitrogen fixation. In northern U.S. states, the plant selected needs to possess enough cold tolerance to survive hard winters. Hairy vetch and rye are among the few plants that meet this need.

Many more winter cover crops are adapted to the southern U.S. These cool-season legumes include clovers, vetches, medics, and field peas. They are sometimes planted in a mix with winter cereal grains such as oats, rye, or wheat. Winter cover crops such as oats or rye have long been used as green manures. Winter cover crops can be established by aerial seeding into maturing cash crops in the fall, as well as by drilling or broadcasting seed immediately following harvest.

**c. Catch crop**

A catch crop is a cover crop established after harvesting the main crop and is used primarily to reduce nutrient leaching from the soil profile. For example, planting cereal rye following corn harvest helps to scavenge residual nitrogen, reducing the possibility of groundwater contamination. In this instance, the rye catch crop also functions as a winter cover crop. Short-term cover crops that fill a niche within a crop rotation are also commonly known as catch crops.

#### **d. Forage crop**

Short rotation forage crops function both as cover crops when they occupy land for pasturage or haying, and as green manures when they are eventually cut for a no-till mulch. Examples include legume sods of alfalfa, sweet clover, trefoil, red clover, and white clover, as well as grass-legume sods like fescue-clover pastures. For maximum soil-improving benefits, the forage should not be grazed or cut for hay during its last growth period, to allow time for biomass to accumulate prior to slashing.

#### **e. Living mulch**

Living mulch is a cover crop that is inter-planted with an annual or perennial crop. Living mulches suppress weeds, reduce soil erosion, enhance soil fertility, and improve water infiltration. Examples of living mulches in annual cropping systems include over-seeding hairy vetch into corn, no-till planting of vegetables into sub-clover, annual rye grass broadcast into vegetables and sweet clover in small grains. This is the heart of "One Straw", Fukuoka grew rice and clover together. Living mulches in perennial cropping systems are also grasses or legumes planted in the alleyways between rows in orchards, vineyards, christmas trees, berries, windbreaks, and field nursery trees to control erosion and provide traction for farm vehicles.

### **16. Clovers**

*Desmodium* - tick clover. Wet tropics. World wide.

400 species.

*Alysicarpus* - Alyce clover. Wet tropics. Africa, Asia, Aus.

30 species.

*Indigofera* - indigo. Tropics, temperate. World wide.

700 species.

*Crotalaria* - rattlepod. Tropics, temperate. World wide.

600 species.

*Mimosa* - Tropics, temperate. America, Asia, Aus. 400 species.

*Medicago* - medic, burr clover, alfalfa, lucerne. Sub-tropics, temperate - Mediterranean, Africa, America's, Aus. 80 species.

*Lotononis* - yellow clover. Sub-tropics, temperate. Africa, Aus.  
40 species.

*Melilotus* - sweet clover. Temperate, Europe, Asia, America's.  
20 species.

*Lupinus* - lupin. Temperate. Southern Europe, Northern Africa,  
America. 200 species.

*Vicia* - vetch. Temperate. North hemisphere. 140 species.

*Astragalus* - milk vetch. Temperate. Northern hemisphere.  
3000 species.

*Lotus* - yellow clover. Temperate. Europe, America.  
150 species.

*Trifolium* - common clover, white clover, red clover, sub-  
clover. Temperate. World wide. 300 species.

Clovers are also known as trefoil's which simply means three leaves and usually small. While the *trifolium* family is what you might call true clover, there are many other plants that fit that description and that is reflected in their common names. Other families listed here can have any number of leaves, usually in odd numbers but also in evens, 1, 2, 3, 4, 5, 7, 9 or more. Many of these plants could be called clovers by virtue of giving the same general benefits of staying low while fixing nitrogen and providing high protein fodder and protecting top soil from erosion.

These families of plants are very widespread and diverse, containing many species and will undoubtedly be found outside these regions and climate zones. They have travelled around the world either as opportunistic weeds or were deliberately introduced as pasture fodder for livestock. *Crotalaria* were introduced in some places as a green manure for improving pasture but proved unpalatable to livestock. It is moderately toxic to them but they avoid it if they have plenty to eat. *Crotalaria* are of greatest benefit in the orchard. Chipilin, longbeak rattlebox (*c. longirostrata*) is one edible *crotalaria* traditionally eaten in Central America and is non-toxic to livestock. Trefoil rattlepod (*c. medicagenia*) is a prostrate *crotalaria* that is safe for livestock.

All these families of plants are legumes, fixing nitrogen from the air. They contain species of all shapes and sizes but there are a lot of short and spreading plants represented here. These plants are usually very tasty to grazing animals and they respond by staying low. Being short is a defense against grazing. They are trying to keep out of the way of the animals that would eat them. This makes them very versatile. They are easy to manage and can fit into any garden and farm design; some make good lawns and many fit between veggies, herbs, trees and crops so they are made for pasture cropping. They are the carpet that adds the finishing touch; they cover every last space so that no Earth need be exposed. Clovers also produce many flowers and are a very productive source of nectar for honey bees, except the sub-clovers which are tops for grazers but low in nectar yield.

The mimosa family is very tasty as well but many plants in this family respond to grazers by growing thorns or spines. This layer of protection allows them to grow upright and take their chances with the cattle and goats. Even the prostrate sensitive weed (*m. pudica*) is very prickly. It's much less prickly when growing in the shade.

There are many families of legumes so keep an eye out for anything that looks useful, these are some of the more widespread families of prostrate or low growing legumes you are likely to come across, depending on where you are and they give you an idea of what to look for. If you can, check google images for pictures of them.

Most of these families are predominantly prostrate or low growing but have a few erect species as well.

Some of these families are predominantly erect (*crotalaria*, *indigofera*, *lupines*, *mimosa*) but they have a few prostrate species. Some can be bushy little plants that respond to grazing or mowing by growing very flat.

If you are collecting wild seeds for your garden, look in environments like the one you wish to introduce plants to. Is

the soil sandy or clay? Is the aspect shady or sunny? Wet or dry? Matching plants to your needs gives them a better chance of success.

Legumes are able to grow in poor soils as they can provide their own nitrogen. They will often be found in recently cleared land where soils have been removed or disturbed and poor base soils have been exposed. Look at where the Earth has been scraped from the side of the road and you will find them. These plants are mostly annuals or biennials and are quite tough and not all have characteristics you will want in your garden or farm. Apart from thorns, one of the major irritations some of these plants have adopted is to have hairy pods that become very sticky when they ripen and dry. When a person or animal walks by and touches them, hundreds of seed pods can get attached to fur, hair and clothing. This can be degrading to an animal's health and a nuisance generally, not good for wool producing sheep.

These sorts of plants can be spread by people and animals very quickly and this may be considered an advantage for fodder or erosion control but choosing plants that spread slowly and are best spread by hand sowing gives the farmer more control over where plants grow. It is also more considerate to the neighbors.

So while there are many species in these families that are in the good weed category, there are a few that are in the bad weed list, and they can be closely related and hard to tell apart, except for how the pod is designed. So it is important to get to know how a plant behaves before introducing it on a large scale or condemning it as a nuisance. *Desmodium* is one such family that has innocuous smooth seed pods on some plants, yet hairy, sticky pods on very similar related species.

Tick clover, a *desmodium*, is one of the flattest and most common legumes in the wet tropics. It is slow to get going and a bit sensitive to excessive traffic but very attractive as a lawn and fits well with many other plants.

Many of these plants produce chemicals which can affect the growth of surrounding plants; they can suppress the growth of some weeds and may also encourage the growth of herbs and vegetables. They can also discourage some insects. This is called allelopathy. These abilities can also serve to make some of these plants an invasive pest in the wrong place as they can smother the local flora which is a consideration if you wish to encourage native plants. You may wish to do some background research on your local plants and on plants you might be thinking of introducing.

Sometimes the short comings of plants are over looked as in the case of the medics, burr clovers (*medicago*). They bare their seeds in a prickly coiled pod that is very irritating, however it is a high quality fodder and very tough and is grown in tough Mediterranean regions where there is little else for sheep to eat. Not all the medics produce a burr, alfalfa or Lucerne is one; commercially available spineless burr medic (*medicago polymorpha var. brevispina*) is another.

Over grazing on a single legume, like Lucerne may lead to bloat, a healthy pasture will contain many different species of grasses, legumes and other herbs avoiding this problem. Alysicarpus does not cause bloat.

If you are looking for low growing legumes you will find something growing near you all ready and it's possibly a member of one of these families but there are many more. If you want to grow your own ground covers and green manures it is good practice to introduce new helpful plants but it is also a good idea to take a close look at your local environment and see what you have already got. It makes it easier on you and local plants are less likely to create an imbalance and it helps to protect your local diversity because bio-diversity really is enormous and everyone has a different version of something in their back yard and you are its keeper.



## **17. Pasture Cropping**

Pasture cropping is when the seed of a crop is sown directly into pasture without the use of tillage plowing. The grasses and weeds present are not mowed or plowed in. Rather than competing with the crop, the grasses protect the soil from sun and wind. This unplowed and protected soil will have a higher moisture content and the life cycles of the worms, beetles, bacteria and fungi are not disrupted. All leaf litter and organic matter dropped by the pasture grasses and the crop will be quickly cycled back into the soil by the living things within it maintaining a high humus content and therefore high carbon content.

Being unbroken and tightly held by a diverse mat of roots, the soil is far less prone to erosion by rain and irrigation runoff water. This will have a huge impact on the health of streams and rivers as they will not fill up with top soil so reducing the severity of flooding.

Weeds are also less of a problem as fast sprouting and growing plants are not advantaged by the cultivation of all other plants.

The farmer also has a lot less work to do as he no-longer has to prepare the ground in advance. And the field can be returned to forage pasture immediately it is harvested.

All around, pasture cropping greatly reduces the farmer's expenses and labor requirements and increases the productive use and the returns on that land.

Pasture cropping may be assisted by introducing low growing ground cover plants, such as legumes like clovers, to fix nitrogen and increase plant diversity in the field. Clovers also improve protein uptake by livestock.

If the farmer also takes time to plant the crop in contoured lines as in Keyline pattern plowing (a detailed description can be found in 'Water for every farm' and other books of 'Keyline' by P.A. Yeomans) the water and humus absorbing properties

of the land will be further enhanced. The farmer pegs out the contour line and then follows that line on the slope above with either chisel plow or seed planter for two or three widths of the tractor and then marks out the contour line again and then repeats the process. This is done because the angle of the slope varies from the valley to the ridge. If following the keyline above the slope, (above parallel contour plowing) the blade on the upslope side of the plow will drop as it travels from the valley to the ridge. This will then encourage water to gently drift from the valley, the wettest shape in the land, to the ridge, the driest shape in the land.

Water that runs into the chisel furrows can sit there and soak into the ground. The furrows also allow oxygen into the soil and organic matter that falls in can sit there. The furrow and the leaf litter in it provide habitat and food for bacteria, fungi, beetles and worms, which work to convert leaf litter into humus and dig it into the soil. Seed that falls into these furrows will have a better chance of germination.

More than a billion hectares of land is plowed for crop farming and pasture cropping will prove to have a more significant impact on the environment than any other single change we could make to our approach to land management.

## **18. Pests and Diseases**

In a diverse organic garden, pests and diseases are not an issue. Just like weeds, pests and diseases are caused by clearing, monoculture, tillage, poisons, fire and neglect and are carried around the world by our high speed transportation system.

A diversity of herbs, vegetables, companion plants and ground covers will attract and support a healthy population of nectar and pollen feeding and grazing insects and other animals in which no one species is able to dominate and be a problem.

The most important factor in supporting a healthy insect and animal population that will assist the garden is the presence of flowers. The floral ecology attracts and supports pollinating

insects and animals like bees, beetles, butterflies, flies, wasps, birds and even tiny bats and other small mammals, which will assist the garden in bearing fruit and will in also attract predators like lady birds, hoverflies, centipedes, praying mantis, lace wings, damselflies, dragonflies, spiders, wasps, lizards, frogs, birds, bats and more. All these creatures will feed, excrete, die and decay in the garden, becoming a part of the endless cycle of life and death and carbon and the creation of the topsoil that keeps it all going.

Sweet alyssum, calendula, chives, cosmos, dandelion, dill, feverfew, marigold, wild mustard, statice and yarrow are good flowers for attracting lady birds, which in turn eat aphids. It also attracts nectar feeding wasps that remove caterpillars from the garden to feed their young. Yarrow also repels some insects that graze on herbs and vegetables.

Introducing ladybirds to a garden infested with aphids can be too late as the lady birds can take a week to find the aphids. It is better to always have a small population of aphids present to encourage lady birds to live permanently in the garden. This would make it difficult for aphids to expand rapidly in numbers. Sow thistle (*sonchus oleraceus*) is a host for aphids and so is a decoy plant. It attracts the aphids away from the crop and as a result, attracts aphid predators like the lady birds.

Mulch like leaf litter, twigs and branches will also feed the kinds of wood boring insects, beetles and worms that feed on dead plant matter. These insect and animals too will attract predators like centipedes, frogs, lizards and birds to the garden.

Birds can be invited into the garden with bird blocks, seed, honey water, fruit hung in trees, bird baths and posts for birds to sit on.

Shaped like a walking stick with a handle but upside down, a bird post for a small bird to perch on, placed in the veggie

patch, will also help to add bird droppings to a garden bed while the bird is watching for insects to pick off the veggies.

Mirrors can also attract birds but they can drive some birds crazy when they are trying to defend their territory.

Nectar bearing flowers and seed bearing plants like sunflowers, millet and other grains and grasses will also attract birds.

Fruit bearing bushes like chilies are much loved by some birds, like chickens.

Nesting boxes can bring birds, bats and gliding possums to gardens and farms. The right box for each species you wish to attract is placed at the right height in a tree or on a post. A metal guard is nailed around the base to stop cats, rats, snakes and other predators getting to the nest. A family of owls eats eight to twelve rats a night.

Mosquito's are a difficult problem as it seems there is no one predator that predominantly feeds on adult mosquitoes or their larval stage, the wriggler. The best approach with mosquito's is an all round healthy environment that fosters every kind of insect and animal that feed on them and in one case a plant. Bladderworts (*utricularia*) are small carnivorous plants that live in water. The bladder refers to the small green sacks on the plant that have an amazing ability to suck in their prey when small hairs on the plant are triggered by the small creature as it swims past.

Nymphs of dragonflies and damselflies prey on wigglers while the adult's feed on the adult mosquitoes. Salamanders and newts prey on wigglers but are not found in Australia. There are also carnivorous tadpoles but only a couple of uncommon ones in Australia. Small fish are good wriggler predators. Look for local fish to stock ponds with for mosquito control, exotic fish can cause problems. Dragonflies will find the garden if an undisturbed environment is left for them. Dragonflies

especially like rice paddies. An organic rice paddy will have a great cloud of dragonflies flying over it in summer.

There is even a giant mosquito (*Toxorhynchites*) that preys on mosquito wrigglers during its larval stage and only feeds on fruit as an adult.

In very wet areas mosquitoes can breed on the ground, it may be necessary to dig drainage ditches that drain excess seasonal water into ponds or dams that can be stocked with wriggler predators. This is called OWMM (Open Water Marsh Management).

Keeping water moving also prevents mosquitoes from laying their eggs. Water features like fountains, waterfalls and aerators can discourage mosquitoes from laying their eggs.

Adult mosquitoes are also eaten by some small birds like swallows and swifts as well as small bats and lizards.

You can also help reduce the mosquito population by removing any rubbish like empty containers and plastic debris that can hold water, turn unused containers upside down. Empty water out of old tires and cover, fill with dirt or remove them to prevent them filling up again. Wells and disused septic tanks can be very bad breeding grounds for mosquitoes and should be either covered properly or filled in. Hollow trees can hold water and breed mosquitoes.

If your new seedlings disappear, it's probably grasshoppers. Just sprinkle some clean fire ash or commercially available ground rock powder on the survivors and the grasshoppers won't touch them. It's like eating a salad full of sand. The dust may reduce the plants ability to absorb sunlight however this is preferable to grasshopper destruction. Once the plants are a little bigger they shouldn't need any more help from ash or rock dust which are also a wholesome addition to the organic garden and easily washed off the veggies. Even dust off the road can be used this way however the ash and rock dust are sure to be bacteria free.

Caterpillars are also discouraged by ash and rock dust. But some things like broccoli and cabbage may have caterpillars eating right through them where the ash or rock dust may not get to them. A culture of bacteria called *Bacillus thuringiensis* (BT) may be the answer; it is commercially available as a powder, called Dipel in Australia and Thuricide in the USA. (This is the same BT whose genes have been spliced into corn and other crops. That's when BT is not so good).

BT is mixed with water and sprayed on the plants. It is caterpillar specific and has zero toxicity to other creatures and is suitable for organic gardens. The first indication that you may have a problem coming is when you see little white or pale yellow butterflies hanging around. Or you may first see tiny caterpillars and half eaten leaves on the plants. Or you may first see their droppings, little round balls, on leaves. BT should be applied as soon as you notice any trace of caterpillar activity.

There are a number of species specific organic recipes for dealing with some pests. These usually involve some active ingredient like garlic, onion, tobacco, aloe or oil, being mixed with soap and water. The purpose of the soap is to dissolve the active ingredient and help the mixture stick on the plant. Fukuoka sprayed with machine oil for scale in the citrus orchard. Alcohol, hydrogen peroxide, lemon juice, vinegar and wood vinegar can also be useful. A solution of 20% milk to water can be sprayed on pumpkins and other plants to control powdery mildew. Some helpful sites with recipes are listed in the back of the book.

Integrated Pest Management (IPM) is a consultancy group that recommends reducing pesticide use and encourage the use of predatory insects to manage insect pests. They recommend attracting predatory species of insects to a crop by planting islands of their host plants around the borders of the crop. By surrounding a crop with native plants aimed at hosting predatory insects and attracting predatory birds, reliance on pesticides can be greatly reduced by farmers

normally dependant on them. Reduced pesticide use also allows predatory species to feed more safely on insect pests.

Native bees make excellent pollinators and attract insect eating birds. Native bees are usually solitary or live in small groups in holes in wood left by other insects. They can be encouraged to live in the garden with untreated wooden posts and wood hanging from trees that has lots of holes drilled in it 2 to 3 mm in diameter and 5cm deep. Planting native flowers, like *crotalaria*'s is always a good way to invite bees to the garden. A bank of *crotalaria trichotoma* brings hundreds of different bees to the garden.

Honey bee's keep elephants away. They don't like to get bee's in their noses.

Just as for plants; bacteria, fungi, viruses and all microbes are best kept under control by encouraging diversity. The use of mulch and compost and a diversity of plants and the leaf litter that rains down from them will support a diverse ecology of micro-organisms in which no one species can multiply unchecked and cause harm in the garden. A diverse and balanced environment like this is clean and healthy and a joy to behold.

So if there is a problem with fruit-fly in the banana patch, then mulch them and plant all manner of flowering herbs, wild flowers and ornamentals amongst them.

## **19. Crop Rotation**

When planting beds with singular crops, pests and diseases specific to the different vegetables may build up in the soil over successive seasons. Crop rotation can reduce the chance of pests and diseases in your veggie patch. Crop rotation is effective because diseases and pests specific to certain plants, cannot establish in the soil due to the constant movement of different crops from bed to bed.

Different vegetables prefer different soil conditions; which means that when rotating the vegetables, the soil needs to be

treated to suit the new crop. Onions like alkaline soil, whereas tomatoes like it acidic. So when planting onions in a bed that was previously occupied by tomatoes, the soil needs to be limed.

The following season the old onion bed will be used for legumes (peas and beans) because they like sweet soil too. The legumes fill the soil with nitrogen, so they can be followed by leaf veggies like cabbages, cauliflower, broccoli, lettuces and silver beet.

Root crops like carrots, parsnips and beetroot can be planted next and don't need much compost.

Following that the bed can be planted with tender veg like sweet corn, pumpkin, cucumber and zucchini. By this time the soil will have started to turn acidic again, which is good for tomatoes and capsicums.

Spread some lime and plant with onions again.

## **20. Seedling Trees V Grafted Trees**

There are advantages and disadvantages in planting fruit trees either from seed or from grafted stock.

Seedling trees can take longer to bear fruit than grafted trees. However they generally will only take a year or two longer than a grafted tree.

It is also possible that a seedling tree may not bear true to its parent. This is most likely with hybridized F1 varieties bred for commercial purposes. A selected seedling variety will bear true to type and may also bear as soon as grafted varieties. The florigan mango is noted for being an excellent seedling tree that is capable of producing superior seedling offspring. It is also wind and rain resistant when flowering.

Seedling trees are superior in the respect that they are undamaged. A grafted tree is a wounded tree right from the start. The wound made by the graft will contain bacteria that

may one day become a handicap for the tree. In poor conditions, and/or, high winds, the tree may break off at the graft.

A grafted tree is in fact not a tree but a branch. As such it will not grow as large as a seedling tree. This has advantages for the commercial grower. A shorter grafted, bushier tree will bear its fruit closer to the ground and will be easier to harvest.

Seedling trees will all be genetically unique, offering the grower diversity and the opportunity to discover new and superior trees.

Genetically diverse tree crops offer pests and diseases the challenge of having to adapt to each new potential host tree.

Grafted trees are genetically identical and in effect clones of the parent tree. By grafting from superior trees the grower can be sure of having higher yielding trees bearing superior fruit. However being clones, when pests and diseases threaten grafted trees, the entire crop is vulnerable to attack. This is more of a problem when there are hundreds of identical trees in an orchard. Individual grafted trees in back yards are not going to cause the same problems with feeding armies of pests.

Seedling and grafted trees both offer the grower advantages and disadvantages. A compromise might offer the best of both worlds. Perhaps plant a majority of seedling trees and a few grafted trees. The grafted trees offer an earlier crop and an assured quality of product. The seedling trees offer strong growth and potential new varieties.

A seedling tree that is weaker and bears a poor quality fruit may be removed entirely. A seedling tree that is strong but bears a poor fruit may be cut back and grafted onto with a superior variety, obtained either from one of the grafted trees or from one of the superior seedling trees. The process is a long one but the end result can be a diverse crop of superior fruit trees.

## **21. Terraces**

Not only does the nutrient cycle play an important part in the natural fertility of the land, even the shape of the land itself can have an influence on the life cycles that occur in the soil. Terracing is a powerful and often overlooked technique.

If sloping land is left bare, the next rains will just run off the land and wash the exposed top soil away. In contrast, terraced land will prevent top soil erosion and retain soils and humus. Terraces help save water in dry climates and save topsoil in wet climates.

In his books of Keyline, Mr P.A. Yeomans shows us that it is not essential to build flat contoured banks to benefit from the level line. It is possible to exploit the level with swales, ditches and contour chisel plowing that invests water, oxygen and organic matter in the ground, building up the top soil and filling the lands water table. Contour ditches also slow down water and spread it out as it flows through the landscape.

Where ever possible, prevent excess water from flowing downhill. The best place to store water is in the ground on which the rain has fallen, take any excess water sideways for storage in micro-dams or direct it to spread out on ridges which are the drier areas of the landscape. A Keyline dam is built high in the landscape. The higher and smaller dams may not be used, their purpose is simply to hold water and let it soak into the ground. This helps wells, creeks and streams lower down the slope last longer through the year.

Larger dams intended for use are built with a lock pipe installed under the front wall, allowing the dam to be drained with a one to two foot diameter gate valve. This means that a Keyline dam can be emptied in the event of parasite problems. Silt filling the dam is also not an issue as it passes through the pipe. The lock pipe can be opened up for fast flood flow irrigation or it can gravity feed water to any kind of irrigation system. A lock pipe dam is ideal for running hydraulic ram pumps, turbines, water wheels and micro-hydro power for the home.

Keyline and terracing might be considered as plumbing the land, it is in effect, adding the water works to the landscape and gives the farmer control over movement of the water flowing through the landscape and harnesses the most freely available energy source there is, gravity.

Practiced over a wide area, Keyline would have the effect of moderating the flow of runoff water and erosion caused by heavy rain and reducing the impact of any associated flooding. Using ground covers further strengthens the integrity of keylined land.

For building a terrace, mark out a level line on the ground using a sight level or a water level described in the chapter on levels. Dig on the uphill side of this line to keep the floor of the terrace level. Leave a lip on the edge to hold water on the terrace. When rain occurs, watch how the water sits and flows on the terrace and make any needed adjustments by shifting Earth.

Terraces may be built in different styles. They can take the form of a deep narrow trench with a large front wall, or a wide flat bed with a lip to hold water on the bed, or a deep and wide trench with a wide front wall. If the terraces are intended to fill and over flow then drainage will have to be taken into account. Direct the water to spill over the terrace at its lowest angle of the slope which is on the centre of the ridge.

If you lack time and energy, simple terraces can be made by placing rocks, sticks, branches, logs, bamboo, anything across the slope on the level line. Soil drifting down the slope will back up behind them and create small natural terraces. The same effect can be achieved by planting seeds, trees, bamboo, comfrey, lemon grass, vetiver (*chrysopogon zizanioides*) and any desired plants close together on a level line across the slope.

## **22. Irrigation**

There are many kinds of irrigation from the most ancient, like ditch irrigation to the most modern, like drip irrigation, an over head misting system or hydroponics. Each method has an appropriate place and purpose depending on your needs and the local circumstances and the resources available to you. And to make best use of these methods it is important to garden and farm with sustainable, no-dig gardening methods. The use of mulch, ground covers and contours will help reduce evaporation and erosion, conserving water and topsoil.

The first aim of good irrigation is to try and spread the water as evenly as possible.

Then next point to observe is to give the plants only as much water as they need to grow productively and no more than that. This saves water and reduces salt build up problems. Over watering can also reduce crop quality.

Irrigation is usually stopped a week or more before harvest. This gives the harvest time to dry a little. Fruits, greens and seed crops will have a lower moisture content and will be easier to harvest. Produce will also have better flavor and nutrient content and will be less prone to bacterial and fungal problems giving the harvest longer storage and shelf life.

### **a. Ditch irrigation**

Ditch irrigation is the oldest and least conservative method.

Once only possible where there were springs, streams and rivers that could be drained by digging channels to take the water to the crop; today irrigation ditches can be fed by pump or siphon.

OK where you have a lot of water to use and limited resources.

Does not require expensive inputs like pumps and irrigation pipe but is labor intensive in the development and maintenance stages.

Important to observe levels and slopes.

It is best to flood the ditches and water the crop as quickly as possible to reduce losing water that soaks into the earth.

Can result in salt problems on marginal land and with poor management.

Requires regular maintenance as leaf litter, tree roots, weeds and erosion will fill the ditches and channels and clog them. A collective of people, called the Soobah, from different villages can be seen cleaning the irrigation channels once a month in Bali.

Community co-operation is important to make large scale ditch irrigation work effectively. Rural communities were some times organized almost entirely around the organization of the water supply.

Ditch irrigation is also the simplest way to deal with waste grey water. Ditches may be dug to take waste water into the garden. Grey water in the drains can be unsightly and can make the ground stale. Covering the drains and adjacent gardens with leaf litter helps keep them clean by filtering water and harboring worms that turn over soil and consume any products of the grey water. Leaf mulch also helps keep the weeds down but leaves will block the free flow of water through the drainage ditches in the garden.

Place slotted drain pipe in the ditch and then mulch over that with leaf litter. This allows the water to quickly spread along the drain pipe in the ditch and into the garden. The water coming out of the house does not drain down the pipe but is poured on the leaf litter and soaks through the slots in the drain pipe like a filter.

If the house is raised above the garden the grey water can drain out of the house from a pipe right on to a pile of leaves before it soaks into the slotted drain pipe underneath.

If the ground is porous, water entering the ditch may just soak in before it goes far but usually waste water floods the garden when we take the plug out of the kitchen sink or the bath or drain the washing machine. So it will go a long way along the ditch before it soaks in. This sort of garden can grow a lot of mint and kang kong, it can also grow a lot of weeds too so immediately remove any weeds you see. Plenty of leaf litter should keep down most weeds. Mulch is consumed very quickly by a wet garden. You may need to lift the pipe out and clean the ditch occasionally as it may attract tree roots.

### **b. Covered ditch irrigation**

Build irrigation channels just as for ditch irrigation but agi-pipe with 100 holes per meter is placed in the ditch and then the ditch is back filled with Earth.

The pipe is flooded with water which quickly soaks into the ground through the many holes in it.

Loss of water by evaporation is reduced.

Maintenance is also reduced; a covered ditch will not clog with leaves, weeds and Earth.

Creates a wide spread of water which does not encourage root balling in orchard trees.

A good method for using grey water as it is underground and any unclean water containing bacteria is not exposed. But the water should pass through a biological filter like a compost worm farm or at least a pile of leaves first to remove any suspended solids that would clog the pipe.

Underground disposal of grey water is required by law in some countries making this an acceptable method of grey water use.

Great for contoured gardens and orchards.

More efficient than ditch irrigation and I have heard that it is 30% more efficient than drip irrigation.

### **c. Drip irrigation**

Drip irrigation is a very efficient method of irrigation.

Used in areas where water is in short supply.

Used for all kinds of crops and landscaping.

Costs of installation of pipes and dripper nozzles can be high, especially for large areas.

Concentration of water at drippers can result in root balling for tree crops.

### **d. Sprinklers**

There are many kinds of sprinklers for covering large and small spaces with either high or low pressure water. Do some research before deciding on which sprinklers are best for your needs. Sprinkler parts can be expensive.

### **e. Flood irrigation**

Long term flooding mainly used for rice and taro and a few other aquatic crops.

Short term flooding can be adapted to different crops and situations.

Fukuoka would flood his rice fields for one week then drain them rather than keeping the fields flooded. Because he grew his rice through a living mulch of clover, evaporation was greatly reduced. His fields might only need flooding a few times throughout the growing season.

### **f. Fast flood flow irrigation**

A Keyline dam is used in combination with Keyline pattern chisel plowing on sloping land. A large amount of water is quickly released and the contoured pattern made by the chisel plow spreads the water over the land to quickly soak in.

Useful in the production of pasture and crops, particularly by the pasture cropping method.

Allows for the flood irrigation of sloping land.

High cost of installation but lowest cost in use and maintenance.

Dependant on rainfall to fill Keyline dams.

Can be used in seasonal creeks streams and gullies.

### **g. Flood and drain**

A large pot (with no drainage holes) is flooded with water, once the pot is soaked it can then be drained. Read chapter on pots for more detailed info.

Flood and drain can also be done by placing one or more pots (with drainage holes) in a container that is flooded then drained.

Flooding ensures that the soil or rooting medium is thoroughly soaked and draining it ensures that the medium is then filled with air so the roots can breathe.

The water that is drained out may be stored in a tank or dam for re-use at a later time.

If artificial inputs are used, chemical salts can build up in reclaimed water.

Organic inputs can make smelly water but it will not be dangerous to plant health, in fact the garden will like it.

Usually used in pots and hydroponic systems.

Good for herbs, vegetables and annuals.

This method can also be applied to the rice paddy which may be flooded for a short time then drained. This is how Fukuoka irrigated his rice fields.

If the drained water can be captured for re-use then this becomes a very efficient method of irrigation.

#### **h. Mist irrigation**

Usually used in small areas for intensive applications such as nurseries where you want to give young plants the best start.

Almost lab conditions can be produced where plants can be easily propagated by cuttings, clones.

A misting system can produce a very humid tropical environment. Epiphytes do best with mist. Orchids can grow onto trees more quickly with regular mist.

Misting in exposed areas is inefficient due to high evaporation of water so is usually done in protected environments.

Control mist irrigation with a timer. Two minutes every hour, nine times a day from nine am to five pm is a very efficient regime that produces amazing results.

The soil does not need to be saturated it only needs a constant breath of humidity in it and roots will happily grow right through it.

And with a digital timer you can try any watering schedule to suit your needs. The important thing is to observe soil moisture and plant health and adjust the system accordingly.

#### **i. Time controlled irrigation**

Most plants do not need large volumes of water; in fact too much water can reduce the quality of the crop by making fruit and greens watery.

Over watering can also cause issues with bacteria and fungus, resulting in disease and rot.

Salt build up is another possible side effect of over watering. However a regular water supply is crucial to achieve uninterrupted and productive growth.

A timer controlled irrigation system will ensure plants get water when they need it without getting anymore than they need. A carefully observed watering regime not only saves water, it optimizes crop quality as well.

It is necessary to monitor the system as the weather changes and to ensure the irrigation system is working and properly maintained.

### **23. Keeping the House Dry**

The house is made of organic and inorganic materials which will last longer if they are kept as dry as possible. The presence of water can cause serious problems for the health of both the house and the people who live in it. If the timbers in the house contain any moisture in them, they become more attractive to wood eating termites, wood borers and molds. The walls may be eaten away by insects, while molds rot the wood, producing spores which fill the air affecting the health of the residents of the house.

In this light water can be seen as pollution and even dangerous to your home and your health, so it is very important to get all water away from the house as quickly as possible. This then presents the gardener with an opportunity to make use of this otherwise waste water in the garden. Here are some hints to help keep your house drier and your garden wetter.

There are a number of different sources of water that can enter the house; rain from above, water flowing down hill, around and under the house, and moisture rising up out of the Earth.

When building, site the house on the highest land, or raise the land in a mound shape if you have to and compact it, so that any water coming from or near the house does not soak in

and flows away from the house and into the garden. Put drainage trenches on the slope above the house to divert water away from the house and into the garden.

Build as large a roof as possible, especially if there is no gutter on the roof, to keep splashing water away from the house. It is important to prevent water from running under the house or sitting in puddles around it, so for roofs that do not have gutters on them, gutters should be dug into the ground, especially on the uphill side of the house. This will take the rain water from the roof away from the house and into the garden.

Water should never be allowed to flow under the house. Water under the house can rot wooden stumps and cause house stumps to move. Wooden stumps can float up in wet Earth and sink back down when it dries out. And metal and concrete stumps can just sink. Concrete slabs can also break up when water gets under them causing clay to expand or leeching Earth out from under them. Water can also encourage roots to grow under the concrete causing it to crack. Any movement in the Earth and foundations can cause structural damage to the house which can result in damage to the roof and cause it to leak. Wet Earth under the house also causes rising damp and mold in the house which can directly affect your health. Trees and gardens should not be planted right next to the house.

The plumbing is another source of water in the home that could cause damage to the house if not properly managed. It is important to fix leaky taps and pipes. Outdoor garden taps should never be fitted to the exterior of the house. Taps should be fixed to a strong post at least 2 to 3 meters from the house, preferably sited over a ditch garden to take advantage of any lost water.

The shower, kitchen, laundry and toilet should be situated to one side of the house rather than on the slope above the house. The water is then diverted sideways away from the house and into the garden.

Any place where water is used in the house like the bathroom, kitchen, laundry and toilet should be well ventilated so that they can dry quickly after use and cleaning and when spillages occur.

When building; concrete floors can be made to slope slightly in the direction that you would like water to flow. This will make it easier to clean when cleaning and after accidental flooding. In the bathroom, a floor slightly sloping toward the drain will help to keep the shower and toilet area well drained and dry and easier to clean.

Concrete steps and paths around the house should slope away from the house so that rainwater drains off them quickly. One third of a degree is enough to shed water and will not be noticed. This is a drop of about 1cm per meter or an eighth of an inch per foot.

#### **24. Draining Roads**

Drainage is important for both dirt and paved roads. They will last much longer if water is kept off and away from them. Roads for cars and rail on hillsides should be considered as terraces as they will concentrate water. But as building constructions taking a heavy working load they must be considered as the opposite of a farming terrace and must be properly drained. Poor drainage of hillside roads will cause water to seep into the Earth under the road making it heavy with water and weakening it. This is how hillside roads and railways are undermined by landslides in heavy wet weather. A hillside road that erodes away or slips in a storm can be very expensive and sometimes even impossible to fix.

Pushing Earth off the edge to make level land on sloping land leaves a lot of loose soil that will be washed away in the next rain. This earth really should be compacted to make the embankment safer and reduce erosion and pollution and sedimentation of creeks and streams; which would in turn, help reduce flooding downstream during periods of high rainfall.

Dirt roads are everywhere and new ones are being made every day. Most dirt roads are found in rural communities, on farms and in forests. New forest roads are often made to assist logging so they are usually made for limited use and will likely never be maintained. This results in erosion over a wide area and will fill up creeks and streams below the road with mud. This is the first of a series of obstacles placed in the path of the water; farms, factory's, mines, roads and urban development cross the waters path all the way to the sea causing it to tear up soil and deposit it in the water drainage system. The mud will keep flowing all the way to the sea resulting in fish kills and smothering aquatic life the whole way.

The mud also fills the deep pools in the river system reducing its water carrying capacity. This prevents proper drainage during times of high rainfall when that drainage is most needed, resulting in flooding.

Dirt roads are more susceptible to erosion because they are exposed to rainfall and the physical action of the traffic that travels on them. On flat land where water does not flow along the road, puddles may form that will need to be drained. The most damage is done to a road when puddles are allowed to remain on a road and traffic continues to use it. It really pays to dig a ditch or two to drain it before the damage gets out of hand.

Drivers who use dirt roads can also do a lot to minimize erosion of either wet or dry roads simply by driving slowly and using lower gears and not accelerating quickly.

A big problem for dirt roads is that they are often made by a dozer pushing aside soft top soil to expose the harder subsoil. This dead subsoil only becomes more compact and wears away as traffic drives over it. The Earth beside the road however is alive and therefore continues to rise because of the actions of plants and small animals living in it. This leaves a gully for water to follow. So on sloping land any water that falls on the road will follow it to the bottom of its journey

causing erosion to the whole road. To counter this it helps to drain the road by putting speed bumps across it.

It's easier to divert a trickle than a huge rush of water and within a short distance a trickle can become a torrent, so place the first speed bump at the highest convenient point on the road.

More bumps are placed below this as needed, usually every couple of meters. The distance between the drainage bumps will depend on how steep the slope is and the amount of water that gathers on the road and how fast it travels down the road. So it helps to observe the road during wet weather to get an idea of the amount of water you are dealing with. You will also be able to see where to drain the water from the road and where to drain it to.

In steep places there may be no where to drain water to, so you just have to divert what you can above those points as high on the slope as possible and then again immediately after. If a large amount of water is arriving at this lower point then the drainage ditch beside the road will have to be larger to take the large volume of water, maybe even a full size swale will be needed or even a small dam.

A water diverting bump usually need only be one or two inches high depending on how much water is involved. A large volume of water will require a bigger drainage bump. The bigger the bump is, the longer it will last but it will have a greater effect on the traffic driving over it so it doubles as a speed bump. As roads cover a large area of land and are impervious to water, it is sometimes a huge volume of water coming down the road, even in places that look like deserts most of the year. When there is a very large amount of water it probably won't be necessary to have a speed bump across the road. A ditch placed beside the road may be all that's needed to get water away from it and then it might only take a portion of that water. If the water is fast moving the ditch will need to be positioned at an acute angle to the flow of

water so that it catches the water and uses its own energy to divert it away from the road.

If the drainage channel is short, water may pour out the end and cause erosion there. A contour ditch should be made as long as possible for water to soak into the Earth and fill the water table. Excess water that overflows from it will spread out over the land below it and can benefit crops, orchards, gardens or forests.

A speed bump meant for draining roads will not usually be positioned at right angles across the road. Place the bump on an angle to the road slightly graduated down to the lower side of the road.

The water diversion bump is made with wet clay. It is best to apply the wet clay to a solid surface. If there is any vegetation growing on the road between or beside the wheel tracks, use a spade to carefully scrape the weeds and any soft Earth off the road.

Try not to dig into the road as the compact Earth is very strong material and an asset to the road. Just scrape enough off the road surface so that water does not form puddles on the wheel tracks.

When you have a clear area, wet it first so that the mud that you apply will stick to it (mud house building technique). The mud can be applied just like making pottery. That is, as the mud dries out you can work it by slapping it and stomping on it to the shape required. This will make it strong.

Once the water is taken off the road it is best not to let it sit beside the road as this can seep under the road and end up causing it damage.

A ditch that catches the water coming off the road should be positioned at a similar angle as the water bump on the road. If this ditch needs to flow acutely downhill at the beginning it can be turned a couple of meters away from the road to follow

the contour line into the forest, orchards, fields and gardens that you would like to water.

By digging contour ditches, and using the Earth removed to make embankments below the ditch, you can make a series of small stepped paddy fields that fill with water whenever there is heavy rain.

## **25. Fire and the Land**

The burning off of rubbish, waste vegetation, crop residues, weeds, pasture, under storey vegetation and forest fires in rural areas creates serious air borne pollution which is both offensive and dangerous to our health. This airborne pollution is a big part of the carbon pollution responsible for climate change.

Fire is the final act of annihilation, it destroys the leaf litter and humus in the soil and sterilizes it of its micro-flora and fauna and the complex organic chemistry that all these living things have worked for generations to create. Without this chemistry in the soil the Earth would be no different to the Moon or Mars where life cannot exist.

Wildfires can destroy 10 metric tonnes of timber and leaf litter or more on every hectare of land, releasing into the air large amounts of carbon and other pollutants which, unburned, would have been part of the soil cycle. The loss of ground covers, leaf litter and fallen twigs and branches leaves the Earth open to erosion and leaching when it rains. This loss of water controlling organic matter will also intensify the dry season resulting in drought and will contribute to flooding downstream when the wet season returns.

Contrary to popular belief only 5% of fire ash is water soluble and available to plants and will mostly be washed away with the first rains.

Most fire hardened species do not need fire to germinate their seeds, they merely survive it, quickly taking the place of their

fire sensitive neighbors and creating an aggressive weed like regrowth.

With an annually repeated fire regime these effects add up to change an environment from marginal rain forest or wet schlerophyl to one of dry schlerophyl and eventually not even that.

Fire regrowth is also adapted to dry conditions and is more easily combustible, making it highly vulnerable to fire in following seasons. Such trees also transpire less and have a more limited effect on the climate, meaning that rain will be less likely, especially in marginal environments.

Fire impacts heavily on the presence of soft, broad leafed plants that are an essential part of the ecology. These plants help to suppress more aggressive weeds that make gardens hard to manage. Fire removes the soft, broad leafed plants and favours the fast growing weeds that often have burrs, spikes, thorns and prickly hairs that will quickly take over fire damaged land. These weeds act as a defense mechanism. They protect the land while it regenerates but they have the effect of making it very hard for humans to interact with the land.

In severely fire damaged areas, the vegetation may take a long time to return, and without a supply of fresh leaf litter provided by a normal ground cover, the Earth quickly becomes compacted and lifeless.

Slash and burn farming is an age old practice that has worked for a long time because till now there has been so few people and so much land. When the land was depleted by this practice, the farmer was able to move on and start again, leaving the land to lie fallow till it recovers when the farmer returns after having depleted the next piece of land. Today the situation is reversed, with less land for more people. If the farmer wants to maintain the fertility of his land he would be better off exchanging slash and burn for slash and mulch and other sustainable farming techniques.

People who believe that a fire regime is appropriate land management, should be prepared to explain and justify their beliefs and practices, to those peoples of small island nations, who are about to lose their entire countries, because of sea levels rising as a result of climate change. They should also be prepared to open their countries and their homes to these same peoples, when their countries finally do disappear and they become greenhouse refugees. It's just one small world we live on and we're all responsible for it.

Apart from plastics, chemically treated timber and other modern products, anything that can burn, can be used for mulch no matter how big a piece of timber it is.

Plastic and toxic materials should never be burnt, and should be recycled or removed to an appropriate waste site, perhaps for storage for later use.

If seasonal wild fires are a problem, there are steps that can be taken to reduce the risks, other than burning off.

Make a fire break by cutting and clearing ground cover and leaf litter to reduce the fuel load on the ground. This material can be used as mulch on the garden and around trees.

Terracing and Keyline also act to slow down the spread of fire by placing a physical barrier across the path that fire is most likely to move most rapidly, which is uphill. With terraces and level ditches and mounds across the slope, the speed and force of a fire can be reduced. Keyline farms rarely burn and may be seen to be green while neighboring farms are burnt out.

If there is no alternative to burning off the fuel load on the ground, there are ways of reducing the impact of a fire regime on the Earth.

If possible, clear fire breaks around areas to be burnt and burn small patches rather than large areas.

Burn off the fuel load in the cooler months before the hot dry season to help reduce the intensity of the fire.

Fires should be lit in the evenings when it is cooler and moisture rising from the ground begins to settle on ground cover plants for the same reason.

Set the fire at the edge of the fire break towards which the wind is blowing so that the fire is forced to creep into the wind.

When burning off sloping land, start the fire at the top of the slope so that it creeps slowly downhill rather than racing uphill.

But please, try as hard as possible to avoid the use of fire in the management of the land. As fires are mostly lit by people, it will only be through education and community co-operation that the regular occurrence and effects of fire in the landscape can be reduced.

## **26. The Cooking Fire**

The cooking fire is an essential part of many homes around the world but it also produces smoke which is unpleasant and toxic to those nearby. There are ways of reducing the irritations and dangers of the smoke of the house hold cooking fire.

Only make fire out of need, combustible materials are costly and can often have a number of different possible uses, such as building material or as mulch. And smoke is a toxic substance that is also responsible for climate change so the less smoke the better.

When making a fire, be mindful of the smoke and the wind direction, is there someone downwind of you who will be breathing in your smoke?

Never burn plastics, glossy paper or any modern products of any kind on the domestic fire place as they produce very toxic

gases. These things also poison the ash and will mean it cannot be used in the garden.

Never put any food scraps in the fire place. They produce thick smoke and burn poorly and dampen the fire. Food scraps are an important resource, either as food for farm animals or compost for the garden.

Enclose the fire in a stove or oven. By holding in the heat, the amount of fuel required is greatly reduced, reducing the economic and environmental cost of the fire place.

Put a chimney on the fireplace, so that the smoke can be vented from the house, reducing pollution in the home.

If cooking over open fire, pots and pans can be kept clean by smearing the exterior with a thin layer of mud before putting them on the fire, the soot will wash off easily.

Only burn old wood that is dried and cured, not rotten. Rotten wood burns poorly and releases large amounts of mold and bacteria spores into the air, which is unhealthy for people sitting around a fire. Hard old silver wood is the fire wood getters prize.

Bark the timber before burning it. Bark is the living part of the tree and therefore contains resins and nutrients that when burnt become toxic gases and airborne particles. Bark should be returned to the garden for mulch, or some other useful purpose found for it.

Green harvested trees are the easiest to bark. When cut down turn the axe over and hit the tree with the back of the axe, particularly with the top corner of it. Fresh, green bark is brittle and more easily smashed and removed. If you have a lot of trees to bark and, or very hard bark to work with, then you might use a jackhammer with a wide foot attachment instead of a digging spike. Some saplings and poles can be stripped with a tool that looks like a giant paint stripper.

Logs should be raised off the ground to dry and cure them. Place two logs on the ground on which to rest the other logs cut down. This is true for both fire wood and building timber. Wood for building should also be barked as the bark feeds and harbors wood boring insects and microbes which quickly damage the log. It is best to put a roof over it as well so building wood can dry and cure slowly in the shade to prevent it from splitting. A roof also keeps the rain off and reduces mold and insect damage to both building and fire wood.

Firewood should be completely dried and allowed to sit and cure for some months before it is burnt. Curing helps to reduce the organic compounds in the wood and allows it to burn with the greatest efficiency. It will be easier to light and will burn at the highest temperature possible, reducing the wood to its simplest elemental form and making the smoke given off by the fire as harmless as possible. These are old principles, practiced in many countries around the world, especially in cold climates, where timber would be cut in the spring and summer and stacked for use in the winter.

Tree species which grow faster; are easier to harvest, and produce wood which burns more easily, are preferred for cropping for firewood. For tropical regions, acacia mangium is a fast growing tree with many uses. It produces a lot of leaf litter, and left on the ground, the uncured wood rots quickly making it an excellent green manure tree. Stored raised off the ground, it will cure and makes excellent firewood or working timber. The young saplings are strong and springy and are used for spears, bows, farm tools, musical instruments and building.

Ash and charcoal from the fire place should not just be thrown away into the garden, they are useful and in large amounts they are toxic and will sterilize the soil. Sift the ash and store it separate from the charcoal. If there is nowhere to store it, just make one pile of charcoal and one pile of ash somewhere so that it is not spread out too much and so you can find it and use it when you need to. Cover the ash if possible to stop the rain from leaching it.

Charcoal can go back in the fire or be used in filters or for drawing and other purposes. Ash also has many uses; it makes a good abrasive for cleaning. Ash can be dusted over plants or mixed into solution and sprayed over them for the control of some pests. Grasshoppers can be discouraged from eating the greens this way, and the ash is easily washed off the vegetables before consuming them. Even dust off the road can be used this way however the ash and rock dust are assured of being bacteria free.

As a fertilizer, ash should be used sparingly in the garden and spread out evenly at a rate of 1kg, about a large bucket, to every 30 square meters.

Never use ash for cleaning or fertilizing the garden that has had plastic or any other artificial rubbish or treated or painted wood burnt in it. The smoke and ash from burning artificial rubbish contains many chemicals like dioxin which are some of the most poisonous chemicals known.

## **27. Poisons**

The use of synthetic pesticides, herbicides and fungicides, all have much the same impact on the environment as the continual use of cultivation and fire but worse. The initial damage done to the soil and the local environment may be obvious as the loss of the tiny plants and animals; bacteria, fungi, worms and beetles, that live in and make topsoil. This will result in the soil becoming compacted and water resistant, and only the toughest weeds that have grown resistant to poisons will grow there.

And on top of that, the toxic artificial residues of these poisons can remain in the environment long after the local ecology has appeared to recover, and can affect the genetic viability of future generations. Residual poisons in the soil do result in mutations in farm animals and children generations after they were last used. The use of agent-orange and its ongoing effects on the people of Vietnam and its neighbors is a tragic indicator of the dangers of poisons in the environment.

Aggressive weeds sprayed with poisons will die, however their seeds will germinate and take advantage of the cleared land once occupied by a diversity of plants. Natural selection will favor weeds resistant to poison which will quickly become a problem on poison managed land.

Remarkably it turns out that all you have to do to eliminate poison resistant weeds is to stop spraying. In order for a plant or animal to become resistant it must acquire some new gene. When it does that it loses a gene that once gave it an advantage over the other competing plants or animals that were eliminated by the poison.

With the poison gone that poison resistant species loses its advantage and its competitors and predators will return.

Huge areas of land the world over are soaked with agricultural chemicals resulting in damage to soil fertility, biodiversity and the health of the local people.

Scientists claim to be developing plants and bacteria designed to degrade synthetic chemicals. But it seems that they will be genetically modified and that is not a good thing either. And such technology will probably be used as an excuse to keep spraying chemicals.

Phyto-remediation is not perfect but it is the best method of poison removal we have so far and it is a technology available to everyone. The principle is simply to grow plant bio-mass to absorb, reduce and disperse chemical residues.

Residual pollutants in the soil are taken up by plant roots and processed by different plants in different ways.

Some plants take the chemicals inside their cells and change them through oxidation. Other plants transpire very dilute amounts of the toxins in a gaseous form through their leaves, so the gases blow away in the air.

Some plants show a greater resistance to, and superior uptake of some chemicals. Follow the links listed to find plants recommended for phyto-remediation. It is interesting to note that some of them are some of the worst weeds to plague farmers and the reason why farmers were spraying in the first place.

While there are particular plants of importance for dealing with certain chemicals, and especially if they are present in high concentrations, growing huge volumes of organic matter of any kind will help to significantly speed up the process of soil remediation.

A number of species of fallow crops, quickly growing large amounts of foliage and deep, densely matted root systems will more readily deal with toxic residues.

Just to stop spraying is a good start but adding as much organic matter as possible and getting it as deep as possible in the ground will do the most to help.

This kind of cropping will attract leaf and root grazing insects and beetles and other creatures that will consume plant matter and turn it over in the soil. The aim is to destroy toxins by burning them off with the fire of living chemistry.

Obviously this process comes at a cost to the plants used in the process and any fauna that enters the system. There will be mutations and cancers occurring amongst those things living in a phyto-remediation ecology that has a high content of synthetic residues. So over time you may notice a few mutants in the garden. I once lived on an old disused tobacco farm, (tobacco farms are notoriously toxic). I saw a number of freaks like emaciated toads with no eyes and flies with no wings.

In terms of which plants you might grow, anything that grows fast and produces large amounts of foliage and densely matted roots. All the green manure and ground cover crops should be of benefit. Sun hemp and hemp are tall fast growing

plants producing large amounts of foliage and fiber and deep, matted roots.

Rainfall is also helpful as it can leach the soil. This is the one time when leaching would actually be useful but the down side of this is that the contaminants just end up somewhere else, generally in waterways, so the fish can end up accumulating toxins.

Potatoes are said to absorb metals in soil and water hyacinths are good for removing metals and some chemicals from water. Water hyacinths are an excellent feedstock for generating methane.

Synthetic poisons are highly persistent but I have heard reports that people who have tried organic methods of soil remediation have found toxin levels significantly reduced after a few years.

I think soil testing is important if poison levels are a concern to you. If possible get soil tested before purchasing land. Organizations that provide organic certification can offer soil testing services.

## **28. Hybrid Crops**

Hybrid plants have a bad reputation in some circles because of the way they have been exploited by the commercial seed companies that profit from them, however hybrids are not necessarily a bad thing. Hybrids do occur in nature, and they are in fact one of the mechanisms of evolution.

When done on a small scale and then followed through for several generations and stabilized, a new variety can help to fill a niche or replace a variety that has been lost to us. The problems with hybrids arise when patented and unstabilized F1 varieties are released on a large scale onto an unsuspecting world.

Not all varieties can be crossed to create a desirable new variety, often the results are poor in quality, so it takes a lot

of work to find two compatible varieties that will result in a new high quality variety. When two varieties are crossed together with a desirable result, the resulting hybrid will display what is called hybrid vigor. This means that the offspring, known as an F1 or first filial, will display stronger growth and yield patterns than either of the parent varieties. Because this is the first generation and all the offspring share equal amounts of DNA from both parents, they will be uniform in growth and yield. This is an important selling point for commercially produced seed. The problem arises in the second generation, known as the F2 stage. Now the genes of the plants start to get mixed up and they will show little uniformity in growth patterns and yield. This means that gardeners and farmers cannot save their own seeds for next year's crop and have to keep returning to the seed company for next season's seeds.

However, should the gardener feel inclined, it is possible to take a hybrid F1 variety and stabilize it, thereby creating a new seedling variety. This is done by applying discriminating selection, that is, choose the best offspring that arise in each generation and continue to propagate each successive generation from the best plants only. Remove and use for mulch all inferior plants and make sure they do not reproduce. It is usual to start with only a few good plants in the first generation and work with up to 50 plants per generation after that in order to find one or more plants that will display desirable qualities. The new hybrid strain should be quite stable after four generations and could be considered a new variety by the seventh generation.

Of course this is all an enormous amount of work and this is what the seed companies profit from as it means that gardeners and farmers are very unlikely to go through this process and will be more inclined to go back to the seed company to purchase their next seasons seeds.

However, there is little need for hybrids because there are already hundreds, even thousands of different varieties to choose from. For example the wheat plant alone had some

seventy thousand different strains just a century ago. This degree of diversity exists because these crops were looked after by so many different people, in so many valleys for so long. Every people had their own variety and sadly many of them are now lost to the age of industrial farming practices. But there is still a lot out there in need of looking after. This vast bank of agricultural heritage represents the history of human endeavor, our role in nature and our future. All these varieties have different needs and will give different returns; that is what bio-diversity means, there is something out there for everyone, everywhere, it's all a matter of getting connected and finding out what you need to suite your circumstances and then looking after what you have chosen. When there is that much diversity in the world it takes everyone working together to protect it and you can help by having a garden and keeping the treasures of our ancestors alive.

Discriminating selection should also be applied to stable varieties to ensure they maintain their desirable qualities and gradually improve with successive generations. This might be thought of as natural genetic engineering.

One example of organic and stable hybrid varieties, are the three rice strains called happy hills rice that were developed by Mr. Masanobu Fukuoka. He grew and stabilised them over some three decades. They are stable and hardy varieties and suitable for growing in a number of different environments and have some of the highest yields of any strains of rice.

Sadly in researching this chapter I have learnt that Mr. Fukuoka retired from farming in his later years and lost his three strains of happy hills rice. He did however distribute them to various interested people around the world and if anyone out there has any idea where they might be found, please let me know via my web site. Larry Korn, who co-wrote the English translation of 'The One Straw Revolution', is also looking for them too.

## **29. Genetically Modified Organisms**

Heralded as our salvation by those who profit from them, genetically modified plants and animals are easily one of the greatest threats facing us today.

Plants and animals that have been genetically modified have already shown themselves to be vulnerable to environmental influences like pests and diseases and fluctuations in the weather. They have also proven to be toxic to animals that are fed on them. Experimental rats preferred to starve rather than to eat GM tomatoes and had to be force fed. Lab animals and farm animals around the world including rats, rabbits, chickens, sheep, pigs, cattle, water buffalo and horses fed on genetically modified corn, canola, potato, soya, tomatoes and other crops, in lab tests and in the field, have become sterile and many died prematurely. They show damage to stomach, liver, reproduction and immune systems and also show signs of DNA breakdown. Reproductive dysfunction has also been shown to pass on down the food chain and humans will end up with the same conditions as the plants and animals that they consume, and these problems can be passed on to their children as well. It may turn out that the declining fertility rates in the western world, so far attributed to endocrine disrupting synthetic pollutants and poor modern diets may also be attributed to the rise in the use of GM foods.

Crops like GM soya beans and BT 176 maize (maize with added bacillus thuringiensis genes, this is when BT is bad) have been modified to produce toxins that are meant to poison caterpillars and other pests. These toxins are one reason for the sterility and deaths of the animals that ate them. Bacteria and viruses naturally swap genes with other living things. When these foods are eaten, their GM DNA can be absorbed by the digestive bacteria in the gut. These bacteria have been found to lock into the intestinal walls of rats fed on GMO's (genetically modified organisms). The animals own intestinal flora then start producing these toxins and so their own gut begins to poison them. These poisons, thought to be bio-degradable have been shown to survive in the gut of cattle fed with them and they even continue to

survive once excreted and then bind with clay in the soil where they then continue to affect the environment.

New genes are added to plants by the use of a gene gun and are literally fired into the plants leaves. This damages both the genes of the plants and the genes being added with unpredictable results. For example, added pesticide genes change in character and are no longer species specific and poison beneficial insects and other animals further along the food chain as well as the targeted pest insects.

And you don't even have to eat these genes to be affected by them. Whole villages of people in the Philippines became sick, when the new crops of BT Maize that surrounded them, began to produce pollen.

Also as a result of this process, new proteins, never before seen in nature, have been found to occur spontaneously in genetically modified species as a by-product of the GM process. Proclaimed harmless by the company that produced it, a GM variety of maize with a new randomly produced artificial protein (Cry3Bb1), first caused reduced milk yield in dairy cattle and then the sterility and deaths of the cattle and pigs it was fed to.

In the past only certain crops could be sprayed with herbicides as some crops would be killed off by the poisons along with the weeds. Round-up ready soya beans and other crops genetically modified to be resistant to herbicides can have poisons poured on them and still grow, meaning that they will be far from organic when they arrive at the dinner table. And now that the new crops are resistant to the weed killers, poisons are being used on more crops and more land than ever before, and some farmers are using their poisons carelessly. So with more weeds over greater areas being subject to more chemical herbicides, the forces of natural selection have stepped up a gear. The majority of non-resistant weeds have disappeared leaving behind only super resistant weeds, which without competition from the weeds now exterminated by herbicides, have experienced a

population explosion, presenting farmers with enormous weed problems and forcing them to apply ever more herbicides. The result is higher costs for the farmer, a toxin laden environment, and a serious health issue for consumers.

Not only that but the poison resistant genes in the new GM crops have already been found to transfer, via pollen and viruses, into the weeds that the farmer is spraying for. Now the weeds have become totally resistant to herbicides and farmers find themselves pouring massive quantities of poisons on their crops with little or no effect on these new weeds.

Like herbicide resistant genes, if anti-biotic and vaccine genes, already introduced into some crops, were to transfer into bacteria and viruses, we could see a whole new world of super resistant diseases, not to mention the natural selection effect on these diseases of being permanently exposed to these bio-drugs in our diet.

Pollen contamination of non-GM crops by nearby GM crops has also been shown to be a serious problem. Non-GM farmers are given no assistance and are even told to move their crops, at their own expense.

The danger to organic growers, whose crops have been contaminated by pollen from GM crops, is that they lose their market as GM produce cannot be sold as organic. This has severely affected the Hawaiian papaya industry. Thailand has also had similar problems with GM papaya.

Pollen contamination of non-GM crops like grain and pulse crops by GM crops also means that the food seed that they yield will then be as toxic as the GM crops are.

Non-GM farmers found to have GM crop contamination caused by escaping pollen can and have been sued by the companies that have patents on those genes.

Worse still, some companies have gone as far as inserting genes into plant varieties, and then patenting the entire plant

DNA, and then suing farmers for owning plants that contain natural genes that also appear in the patented plants to which the companies have added modified genes. If the courts were mad enough to support these legal actions, it would result in the lawfully required extinction of non-GM plant species.

In future, some companies intend to introduce 'terminator genes', which means that the collected seed from a crop will be non-viable and cannot be used to grow the next season's crop. The intention is to prevent farmers from saving seeds or distributing seeds to other farmers in order to protect the company's intellectual property rights. This means that farmers always have to return to the company for seed for next year's crops.

It is claimed that the terminator gene will prevent the contamination of surrounding crops and wild plants, however the terminator process is a complicated one, and it is possible that these terminator genes CAN spread via pollen, which would result in MOSTLY unviable seed production in related species of surrounding non-GM crops and wild plants. However under certain circumstances the resulting seeds can be viable, with the terminator genes remaining dormant inside them in the form of recessive genes, to emerge in future generations in the form of lethal genetic diseases, potentially killing off large percentages of future crops and wild plants. Viral transfer of DNA could also result in the contamination and genetic degradation of unrelated species. There is also the possibility that these genes could transfer into the animals and humans consuming them, meaning that they too could suffer similar genetic degradation and the diseases that would result from this.

F1 hybrid seeds were already terminator type varieties of plants that were introduced long ago to prevent farmers from saving seeds as the next generation would produce variable results and a poor yield. Now farmers in India and elsewhere have reason to believe that terminator genes have already been introduced by stealth as many crops are producing little viable seed. In India, pea pods with decreased numbers of

peas inside the pods and in Ecuador, potatoes with no eyes to grow the next season's crop. Was this the introduction of terminator genes by stealth or did successive generations of GM crops reveal the genetic weakness of genetically modified organisms?

In India many farmers have committed suicide because they cannot repay money borrowed to pay for very expensive GM seed which reliably fails to produce a worthwhile harvest. One reason GM crops fail is because GM crops are fertilizer dependant and chemical fed plants require more water to take up the water soluble chemical nutrients, and there just is no extra water for these crops in most of India's agricultural areas.

Introduced GM crops have other implications as well. When the UN entered East Timor, one of the UN aid projects was the introduction of a new GM rice variety. The claim was that this would increase crop yields. In the first place East Timor already had its own rice varieties that did not have any problems with harvest or yield, being comparable with other varieties around the world.

When the introduced GM variety was harvested and taken in for storage it was mixed in with the rest of the local harvest. The new GM variety matures two weeks later and 30 cm taller than the local variety. When this grain was replanted the following season, the new crop was a mix of the two varieties. The crop had to be harvested when one grain was ripe and the other either immature or over ripe. Either way, half the crop was lost. This crop failure made East Timor dependant on imported rice.

If new crops are going to be introduced to help people, there must first be studies done of the existing traditional agricultural crops and customs to determine if there is a real need for them and how best to introduce them. There also needs to be a sound education campaign and management plan to go with those new crops. There also needs to be a guarantee by those introducing new crops and techniques that

they will absorb the cost of crop failure. And traditional heritage crops must be protected from extinction.

With large sectors of the agricultural community taking on both hybrid and GM varieties, old, safe and proven varieties of farm crops disappear and are lost to future generations.

Genetic modification interferes with the course of evolution which is nature's own ongoing experiment in genetic engineering. Nature has its own checks and balances and has ways of dealing with the mutations that do occur naturally.

GM both poisons us and makes us dependant on unnatural and ecologically vulnerable species that could all disappear in a moment when nature produces an ecological solution to this unnatural monster. GM is totally unnecessary and a serious mistake. We already have all the plant and animal varieties we need and all we have to do to make the most of them is to practice organic, sustainable and natural methods of gardening, farming and land care.

Avoid and resist 'Genetic Modification' in all its forms.

"The fact is, it is virtually impossible to even conceive of a testing procedure to assess the health effects of genetically engineered foods when introduced into the food chain, nor is there any valid nutritional or public interest reason for their introduction."

Richard Lacey: Professor of Food Safety, Leeds University.

### **30. Topsoil**

Top soil has been created by the effect of plant and animal life working in unison, eating, growing, excreting, dying and decaying and turning over the Earth. Top soil is made up of the mineral elements of the base soil and rock having been broken down by the chemical and physical actions of plants and animals and then combined with a complex carbon chemistry that plants have made from carbon dioxide and other gases extracted from the air. This decaying plant and

animal matter in the top soil, known as humus, represents a huge mass of carbon storage. The loss of the Earth's topsoil's therefore has an enormous impact on climate change. Eroded topsoil's that end up in rivers and the sea, decompose much more rapidly than they otherwise would, releasing their carbon to the atmosphere. Degraded environments take a long time to recover, meaning that there is then less potential for carbon storage, doubling the impact of topsoil loss on the climate change.

To have any meaningful impact on the effects of greenhouse gas emissions, we must reverse the trend of the destruction of the Earth's topsoil's and restore healthy environments to where they have been lost. Anyone who is in a position to grow a garden has at their disposal the means to help reverse the effects of the increasing amounts of carbon gases in our atmosphere. So if you care, and if you can, please grow a garden, and do it by sustainable methods. All you need to know is already written down for you in a few good books like the ones mentioned here.

### **31. Conclusion**

While some still debate the effects of CO<sub>2</sub> in the atmosphere, climate change seems to be upon us already and erratic weather appears to be the result. And whatever its causes, CO<sub>2</sub> emissions should not be focused on to the exclusion of all else. Increased CO<sub>2</sub> in the atmosphere is not the only variable capable of influencing weather patterns. Climate change has many causes. Loss of forest cover, top soils and ground water results in higher ground temperatures, lower atmospheric humidity, and decreased populations of ground cover generated airborne bacteria, essential for seeding clouds and triggering rain. Quite simply, chop down the trees and you chop down the rain. And in this simple equation we find the solution. Plant trees and bring back the rain.

Pollution in many forms is still being dumped on the land and poured into the skies, the rivers and the seas. Ground water and wetlands are being drained, clean water is becoming scarce, forests are still being cut down, plant and animal

diversity is being lost, the Earth's rich soils are eroding into the oceans, farm lands are disappearing and the only things growing are cities and deserts.

All too quickly the efforts of the last four billion years of life on Earth are being undone by the misdirected actions of the Earth's ignorant inhabitants. The current era of climate change has resulted from our own poor land management practices and it is in the problem that we find the solution. For if, with all our misdirected effort, we can make such a measurable negative impact on our environment, then surely a concerted effort to manage our land and resources responsibly should have a collectively positive effect on our environment and climate. And it is with sustainable and natural land management practices that we have the power to positively influence our world.

So if we are to see any positive change in the way that we interact with the Earth, it will be necessary that all people become aware of the natural cycles of life, and that we incorporate that practical knowledge of nature and the garden into our every day habits.

Until that day comes, it will only be a few individuals who are aware of nature's cycles and how to take part in them harmoniously, who will be responsible for helping to guide the rest of us in the right direction to create what we all could share today, paradise on Earth. Fortunately there are already many people who have such knowledge and live by their principles. May I encourage you also to go into the garden and Guard Eden.

Happy gardening



## **PART TWO**

### **The Trench Garden**

#### **1. Preparation**

If you have not made a garden before, any method of garden preparation will take a lot more work than you expect. Some people just want to jump in and plant. It is far better to get all your preparation done first. This way you are not still trying to build the garden while you are looking after plants, which is a lot of work in itself. This increases your chance of success after you plant. The easiest way for you to get started may be with some pots. Look to the chapters on pot culture.

For making a large garden, it is best to start preparation work a long way ahead of your planting time by at least one season. Use the dry season to prepare for planting for the wet season. There is no point trying to grow a garden during the dry season until next year when you should end the wet season with a full tank. You will only break your back trying to keep your garden alive in that first dry season. It's also easier to get the digging done without the hassle of heavy rain and mud.

#### **2. The Site**

This garden can be made in remote places and can be dug on a slope and near the top of a ridge to get the full benefit of the sun. Slope in the site is very helpful for collecting rain water and draining the garden by siphon into an Earth tank. Hill slopes and ridge tops are most likely to be solid clay or full of rock, as that is what holds them together, so digging here is going to be difficult but rock and clay are excellent materials for building terraces and tanks.

#### **3. The Method**

The trench garden is basically an outdoor version of flood and drain hydroponics. A level trench is made across a slope and lined with plastic to save water from draining into the Earth. A drainage pipe full of holes is placed on the plastic at the bottom of the trench garden. This plastic lined trench is filled

with soil. A plastic sheet is placed on the ground on the slope above the trench. Any rain that falls will drain from the sheet into the garden. A siphon hose can be used to drain excess water from the drainage pipe in the garden. The excess water is drained into an 'Earth Tank' dug below the garden. Water can be bucketed or pumped from the tank back into the garden. This method makes it possible to grow in dry locations by taking advantage of intermittent and seasonal rains and mountain mist.

#### **4. Levels**

A 1.2m - 4ft carpenters level is a very handy tool. A fiberglass level is relatively cheap, strong, light and easy to carry. However they can be a little tedious to use when marking out a long line on the ground. For longer distances, a sight level can be used or a water level can be made with a 15m - 50ft piece of clear vinyl pipe, filled with water. Ensure that there are no bubbles in the pipe. Two black plastic taps, one at each end, can be turned off and will hold the water in the pipe when you are moving the water level around. The ends of the pipe are taped on to 2, 185cm - 6ft staff's, with measurements marked on them in centimeters or inches. Two of the above mentioned fiberglass levels will stand in well for this job, they often have measurements marked on them. 120cm wooden T-squares also work well for this job and are cheap.

The staff's are held upright, either by tripods, made from branches with forks left on the end, or by two people, which is much easier. The two people read off the measurements indicated by the water level against the measuring sticks to each other. When the measurements are the same, you have found the level. This device can also be used to accurately measure the rise and fall of the land.

#### **5. The Trench**

Use a level to mark out a level line on the ground and dig a trench below the line 19m - 62 ft long, 40cm - 16 in's deep, 50cm - 20 in's wide at the bottom and 100cm - 40 in's wide at ground level. It is important that the bottom of the trench is

as close to level as possible for maximum efficiency. At both ends of the trench, dig a V shaped sump 15cm - 6 inches below the base of the trench. Of course this trench can be any length. I have made them 5m - 16ft long but the longer it is, the more efficient it becomes. When you water one plant, you water the whole garden.

Earth dug from the trench is placed in front of the trench and packed down to create the front wall and help make the trench deeper. The front wall should be level with the back of the trench, which is on the up slope side of the trench. The front wall should also be kept flat and level to make a path that can be walked on. To pack the soil tighter, it helps to sieve the soil through a 20mm - 1 inch sieve. Pack the Earth down tightly with your hands and even stomp down with your boots. Some moisture in the Earth will help it compact more tightly but don't make it muddy.

The Earth and rock may be kept piled up on 'woven weed mat' until it is to be used. 'Weed Mat' is very strong and comes in fifty meter rolls, six feet wide and can be purchased by the meter. Cover loose Earth with plastic in case it rains before you have time to use it. Line the completed trench with a single piece of concreters plastic, no holes or joins. If you are using a number of pieces of plastic together, then a number of overlapping layers will seal together well.

## **6. The Slotted Drain Pipe**

Place 20m - 66 ft, of 55mm - 2 in', agricultural drain pipe in the trench. This pipe is the magic ingredient that makes the gn work. Normally a garden that is lined with plastic will become water logged and starved of air, suffocating the soil and plants. The pipe allows you to drain water easily, and introduces fresh air, right down to the lower layers of soil. Tie plastic bags on either end of the pipe before you begin, to prevent soil getting down the pipe while you work.

Place rocks on the drain pipe at either end to force the pipe to bend down into the bottom of the sumps. Then fill in the trench with the best soil you can get.

You can now dig out the rocks holding down the pipe. Both ends of the drain pipe should be exposed by about 10cm to 15cm - 4 to 6 in's. Cover the ends with old cans to prevent the pipe being eaten by rats and to prevent soil, rats, frogs getting down the pipe. The pipe has hundreds of slot shaped holes cut into each meter. Because they are slots, they cannot block up and air and water can always drain through the pipe. A stick can be inserted in the pipe to check for the presence and depth of water in the garden.

If you do not have access to plastic, the trench can be lined with clay to seal it. If you also do not have access to slotted drain pipe, then tiles, bricks or rocks can be used to create a space in the bottom of the trench for water to flow along the garden. If you do this, then one side of the base of the trench should be left free so that the soil can still reach the bottom of the trench, so that the soil can soak up water. Where the sump goes, you can put a small well from which to drain the water.

## **7. The Soil**

You may be lucky enough to have good topsoil nearby but don't be fooled, even good looking forest soil can be quite poor. Perhaps take a sample to a nursery suppliers to test first. If there is absolutely no usable soil in the vicinity, you may need to purchase five or six cubic meters of free draining top soil. This is also a good opportunity to mix your choice of fertilizer through the soil as it goes in the trench, as you can easily mix it right through from the bottom to the top. This also avoids possible damage to the plastic liner that can occur by using a spade to turn the soil over once it is in the trench. I prefer to use my own kitchen compost for this job. There is nothing better, except for mulch over the ground, which should be used as well as compost. I like to sieve the garden soil through a 10mm - half inch sieve. This breaks up all clods and clay and helps mix the soil thoroughly. Use larger sieves, roughly 50cm - 20in' across, for all garden work.

## **8. Collecting Water**

On the slope above the trench, lay a large sheet of concrete's plastic. It is usually 4m - 12ft wide, folded in half on a roll, and can be purchased by the meter. Lay the lower edge of this sheet over the plastic liner that emerges on the upper level of the trench garden and dig it down a little under the soil. Any rainfall will flow off the catch sheet and into the garden. 1cm - 0.4in's of rain will add up to 10L - 2.2gal of water per one square meter - one square yard. Excess water can be siphoned from the garden and stored in a tank below the garden.

If rainfall becomes excessive then the plastic sheet may be removed or the lower edge of the catchment plastic may be tucked under the edge of the plastic liner of the trench. The water will then flow under the trench sealer and soak into the ground.

Cloud mist can be caught with this method if gardening in the mountains. Day light may evaporate the mist before it has a chance to flow down the plastic but at night droplets of water will accumulate and flow into the garden. I found that an 8m x 4m piece of plastic could collect more than one hundred litres a night. The tank slowly filled up and kept the garden going through the whole dry season, purely on cloud mist.

## **9. The Earth Tank**

On the slope below the garden trench, dig a rectangular hole, 1m - 3.3 ft deep, 2m - 6.6 ft wide and 3m - 10 ft long. Sieve the Earth through a 10mm - 0.5 inch sieve and loosely pile up the rock around the hole and incorporate the rock removed from the trench. Use a level to ensure that the rock is level all the way around the top edge of the tank.

The fines (dirt passing the sieve) can be mixed with water into a mud and thrown into the rock wall and smoothed down by hand. When dry, this will be very strong and stable.

## **10. The Tank Liner**

At each corner of the tank, place a star picket fence post and stretch fencing wire between them, level with, or just below and outside, the top edge of the tank. Concrete plastic will not be strong enough to line the tank, as it will not stand up to daily use, as one often needs to get in the tank while it is still dry. A large tarpaulin 9m x 9m - 30 x 30 feet, folded in half is ideal. Then use at least 30 strong fold back clips to clip the tarp to the wires.

## **11. Siphon**

If possible, make the top level of the tank lower than the bottom of the sumps in the garden trench. This way, all excess water can be siphoned from the garden into the tank. Sediment, mainly caused by worms, will creep through the pipe and collect in the sumps. This sediment will block a 1/2 in' hose preventing it from siphoning. 3/4 in' poly-pipe is best. Install an elbow in the pipe where it emerges from the drain pipe, so it can easily turn down to the tank at ground level.

Unlike a 1/2 inch pipe, a 3/4 in' pipe is impossible to start with lung power. A very handy device is a '12 volt Submersible, Conga in-line pump' which can be found on the net and at good nursery suppliers. A small 12 volt battery can easily be carried to your garden and can be recharged with a solar cell.

Pump some water from the tank into the garden and when you no longer hear any bubbles, stop and remove the pump and the siphon will start immediately. Allow the first of the back flow to drain into a 20L - 5gal bucket to catch the sediment, which is mostly worm castings and sometimes worms as well. The water will run clear before the bucket is full, you can then let the pipe drain into the tank. Pour the bucket of dark water back on the garden.

## **12. Watering - Flood and Drain**

When the garden needs water, you can bucket water out of the tank, be careful to avoid damage to the tarp. Make life easy and use your 'Submersible, Conga in-line pump' to water the garden. Pour the water on the garden, not down the slotted drain pipe.

Just as with flood and drain hydroponics, you can completely fill the garden with water and drain it by siphon back into the tank as described already. You will hear bubbles clicking in the soil as the garden drains. Flood and drain ensures that every cubic centimetre of soil in the garden is wet and therefore available to root growth. If you are using totally organic fertiliser, the water in the tank will get smelly but you will not have to worry about a buildup of salts in the water being recycled.

## **13. Oxygen**

By removing water from the garden this way, air is being sucked down into the soil and the drain pipe itself will hold a column of air under the garden, which will make oxygen available to the roots. Roots need oxygen because they are white and do not photosynthesize. This is why flood and drain and D.W.C. deep water culture hydroponic systems, work so well. Plants just love growing this way. They produce deep, thickly matted roots.

## **14. Automatic Siphoning**

A 3/4 inch pipe removes the water very quickly and the soil will remain very damp. This remainder will slowly drain to the bottom, filling the sumps. With the sediment removed from the sumps by the larger siphon, a 1/2 inch clear vinyl hose can then be used to drain the rest. You can use the hose of the 'Water level' for this purpose.

An interesting phenomenon of automatic siphoning can be exploited by simply bending the pipe down the slope, 30cm - 12in's below the ground level of the garden, where it emerges from the drain pipe. Then turn the pipe back up to the level of the front wall and follow the path to where it then flows down

to the tank. Get the siphon effect going and ensure that the lower end is submerged in the tank. Once the water drains from the sump, an air bubble will enter the hose causing the flow to slow right down and even to stop. Surprisingly the pipe will remain full of water as long as the lower end of the pipe remains submerged in the tank. When rain starts filling the garden again, pressure from the raised water level in the garden will overcome the blockage caused by the bubble and the siphon will resume flowing again.

The flow will be slower because of the presence of the bubble restricting the flow of water. However, even at this slow pace, the garden will still be fully drained by the time you get back. And the siphon will maintain itself, should rain continue spasmodically. This is very useful during wet weather when you have to leave the garden unattended for some time.

### **15. Grey Water Gardens**

A house with plumbing has clean water running into it and grey water running out of it. This waste water may be unfit for drinking or cleaning but that is no reason to throw it away. It is perfect for use in the garden and when it is looked at in this light the house with plumbing and waste water running out of it becomes a spring and the possibilities for a garden become apparent.

There are a number of different kinds of grey water garden. There is a filter system which filters the water in biologically active tanks. The water can then be pumped from there onto the garden. This method can also be used to generate methane gas for use as a lighting and cooking fuel.

Then there is the biological grey water garden which imitates natural wetlands by passing the water through steps that contain different aquatic plants and animals that filter the water.

And there is the soak trench which takes the grey water, after it has passed through a compost filter, into underground perforated drainage pipes where the water can be used by

plants. It is also possible to use these methods together in series.

This chapter will detail the soak trench garden.

Grey water, especially raw kitchen waste water, should not be poured on the ground or through Earth or sand to filter it.

It must pass through an organic mulch or compost filter made of leaf litter, chaff, lawn clippings and kitchen compost. It is also essential to have worms in this system.

This filter traps larger matter as well as smaller suspended solids. These solids when poured on the ground will clog it up very rapidly causing water to pool on the surface rather than soak in.

The mulch lets water pass through it while it grabs the food scraps. The worms eat this matter and aerate the pile and reduce it to a liquid waste that drains into the trench and into the garden. Worms love water so long as they have drainage.

This kind of worm farm, automatically watered and fed by your daily activities, would be the premier worm farm in any organic garden. And the soak trench is the simplest way to deliver that nutrient rich water to the garden.

The trench garden described already can be adapted to use for grey water recycling and irrigation in your home garden. If you do this, the water from your house must not go straight down the pipe. It must first be filtered of solids that would otherwise clog the drainage pipe. Where you wish to place the compost filter, make the trench much wider. The trench is lined with plastic. Place the 55mm - 2inch, agricultural slotted drain pipe in the bottom of the trench. Put a plastic bag or can over the end to stop solids from entering the pipe. Place a large 1 to 2 inch, 3 to 5 cm metal screen over the pipe supported on four bricks. Place a layer of lawn clippings or leaf litter on the screen.

The daily kitchen compost can also go on this screen. Always spread out all new compost in a layer as it's added. The water that drains from your home can then be drained into the middle of this and it will be filtered by the mulch and compost. Worms are an essential ingredient in this and may be found in your garden and put in the compost pile. If you think it necessary, you may be able to purchase composting worms to get the system going. There are three main varieties of non-migrating, composting worms; red wigglers, Indian blues or tiger worms (*eisenia fetida*).

A well constructed grey water garden with a worm farm composting filter may even be used to recycle black water from the toilet.

Place a weather proof cover over this, a sheet of plastic covered with U.V. resistant woven weed mat will do fine.

Back fill the rest of the trench with the soil that was removed from the trench. If the Earth removed from the trench is poor you can fill the trench with better soil and use the dirt removed from it as a path on the lower side of the trench, should it be on sloping ground. You now have your own composting, grey water, worm farm and irrigation system.

You can take the trench in any direction you wish on flat ground, so long as the base always stays level. To achieve this, place a permanent mark somewhere, like a wall or a stump, at a measured distance above the base of the trench so that you can easily find the level again as you continue working, and if you should desire to extend the trench in future.

If the trench is built short to start with, then the end of the trench can be left open so excess water can drain into the Earth until you are able to extend trench.

Unfortunately tree roots may clog the pipes. Keep the plastic liner up to the soil surface to prevent tree roots entering the trench.

The trench garden should be well planted so that the garden draws up as much water as possible.

You can end up with quite a large garden from this method. You'd be surprised how much water comes out of your house. The average western household uses 1100 litres a day and a little goes along way. You can make as much as 20m - 60ft of trench garden for every person in the house.

The trench should be longer than necessary so it can handle occasional large volumes of water coming in. The trench may be used to fill ponds that contain fish to eat mosquito larvae, or to fill tanks so that water may be siphoned or pumped out and used for above ground irrigation.

This form of garden bed should be mulched over to encourage the presence of worms and beetles in the garden. They dig burrows and create an exchange of oxygen and gases in the soil that prevents the soil becoming too damp and stagnant. Even a grey water trench may need some watering as the surface may dry out.

Trees and plants with tap roots should not be planted in this garden as tap roots will not be able to grow down and may puncture the lining. Otherwise you can plant many kinds of plants such as water loving plants like bananas, gingers, lilies, reeds, taro and also plants that like to be watered from underneath, rather than above, like melons, pumpkins, squash, tomatoes, zucchini and whatever else you can think of.

The simplest version of this would be to have the grey water drain out the bathroom or kitchen right into a small paddy field filled with leaf litter and worms and water loving plants. Like a normal rice paddy it is surrounded by a bank to hold water and leaf litter. Earth should be built up under the house to keep out water. This garden is put on the lower side of the house so water is more inclined to seep away from the house. Rainwater from the roof may also be drained into this garden.





Above, showy rattlepod or rattlebox (*crotalaria spectabilis*). Native to Australia, related species found throughout the Asian region and tropics. Legume, fixes nitrogen in the soil. Grows up to one metre tall. Attracts and feeds the black leopard butterfly and the black and white crow butterfly and acts as host to their caterpillars. Also attracts native bee's which are superior orchard pollinators.



Left, sunn hemp, (*c. juncea*). Right, curara pea, (*c.trichotoma*). Also known as rattlepods, the crotalaria family make excellent green manure, ground cover and companion plants. They are ideal plants for slash and mulch agriculture in the organic orchard. Cut for mulch when they begin to flower for maximum release of nitrogen from the roots into the soil. Allow some plants to set seed and collect them for spreading around the garden and anywhere extra ground cover is needed. If nitrogen release is not so important allow them to set seed, they will support a rich ecology of pollinating insects and other animals beneficial to the garden and the environment.



Above left, puha (*sonchus oleraceus*) a herb for breast feeding mums. Above right, thickhead (*crassocephallum crepidoides*) has a positive influence on seedlings growing around it and can be considered a good green manure and companion plant. Edible in small amounts.



Low growing legumes can be found in almost every environment. Left, hare's foot or rabbits tail (*uraria lagopoides*) North Thailand. Right, *Lotononis bainsii* in a lawn on the Gold Coast, Australia.



Left, yellow wood sorrel or sour grass, (*oxalis corniculata*), lemon flavor and medicinal properties. Use in salads, teas and soups. Right, false pimpernel, (*lindernia crustacea*), medicinal properties. Free ground covers found in tropical lawns around the world.



Left, alyce clover (*alysocarpus ovalifolius*), prostrate legume, ground cover and living mulch. Many varieties found around the tropics. Right, (*christia obcordata*) a small flat legume in North Thailand.



Left, tick clover, (*desmodium triflorum*). Right, Spanish clover, (*desmodium heterophyllum*); prostrate ground covers and legumes, ideal green manure and living mulch for crops and pasture. Found right round the tropical world. Wild plants like these come up for free and can make a beautiful patchwork lawn needing little care. These trefoils produce high amounts of antixenotic allomones which repel many insect pests and allelopathic compounds which kill weeds.



Left, recognize legumes by their flowers. Many will have the classic pea flower. Right some have the puff ball flower of the mimosa family, (*m. pudica*) sensitive weed, prickly, edible tips high in iron.



Above, legumes have many forms. Left, the single leaf of sunn hemp. Right, the classic trifoliate leaf of this rattle pod. This plant also has extra leaves on its stem, making more bio-mass for mulch.



Above, flowers bring pollinating insects to the garden and plants afford shelter for predators.



Above, wild plants, add foliage, flowers and mulch and attract local insects to the garden. Clustered blumea (*blumea glomerata*) has thin, soft, purple foliage that looks like a purple mist in a mass bed.



Left, easy to grow, a common amaranthus has an extra large flowering mass that adds color and bio-mass to the garden. Right, payang payang, (*desmodium pulchellum*) has an extra abundance of foliage bio-mass and has many uses in Chinese herbal medicine.



Left, cinderella weed, (*synedrella nodiflora*), right, billy goat weed or blue top, (*ageratum conyzoides*). Common weeds that grow fast in the wet season and produce masses of seed in all seasons from a small size but still not the worst of weeds; can be used to control other weeds and make mulch if you have nothing else.



Above, Spanish needles, (*bidens alba*), produces many barbed seeds and right, the sticky seed pods of tropical chickweed (*drymaria cordata*); nuisance weeds that get stuck in clothing, hair and fur.



Left, a plastic lined trench delivers grey water to the garden. The drain pipe is buried inside it already. Right, the slotted drain pipe delivers water and oxygen to the plants roots.



Creeping sensitive weed (*mimosa diplotricha* aka *m. invisa* )



A savage legume that responds aggressively to clearing, cultivation, fire and poison. Used as a green manure in some places. Plants like this are attempting to protect the land from further damage and do build soil but make hands on management of the land very difficult. Use gloves to remove this plant and put it in a pile and mulch over it.



The dead plants burn in the dry season and the surviving seeds grow from the ash when the next rains come. Young seedlings are easier to control than adult plants, watch for them to appear in banks after the first rains of the wet season; pull out, mulch over or chip with a hoe as soon as they appear. Goats will control it as it is an excellent goat food and is in fact preferred by goats over almost all other plants. The seed leaves of the young sprouts are very sweet.



**Grumichama cherry (*Eugenia brasiliensis*)**

Before enlightenment,  
chop wood, carry water.  
After enlightenment,  
plant trees, eat fruit.



***Myrciaria jaboticaba***

NB. I've done a lot of web surfing to identify and name the plants pictured in this book and website and it has become clear in researching botanical names that there is some confusion out there. Some plants appear to have different names depending where you find the reference, is it *crotalaria spectabilis* or *c. retusa* or something else? And the spelling can vary, is it *uraria lagopodioides* or *u. lagopoides*? Or are they really two different species?

Unrelated species can appear very similar but some plants do have more than one scientific name. And the common names of plants can be even more confusing, some plants are known by many different names and some names can apply to many different plants; there are at least four different flame trees and there are numerous plants known as tick trefoils.

*All links listed here can be clicked on at this website*  
**organicandsustainablegardening.yolasite.com**

**Recommended Books that can be purchased on the Internet**

- 'The One Straw Revolution', by Mr. Masanobu Fukuoka. 1978
- 'The Natural Way Of Farming', by Mr. Masanobu Fukuoka. 1985
- 'The Road Back To Nature', by Mr. Masanobu Fukuoka. 1987
- 'Water for Every Farm - Yeomans Keyline Plan' by Mr. P. A. Yeomans.  
Can only be purchased from Mr. Ken Yeomans at this address,  
[www.keyline.com.au/](http://www.keyline.com.au/) a true must have.
- 'Permaculture: A Designers' Manual' by Mr. Bill Mollison.
- 'Introduction to Permaculture' by Mr. Bill Mollison.
- 'How to Have a Green Thumb Without an Aching Back' by Ruth Stout.
- 'Gardening Without Work' by Ruth Stout.
- 'Esther Deans Gardening Book: Growing Without Digging' by Esther Deans, (1977)  
Harper and Row.
- 'Leaves of Life'. by Esther Deans, (1994). Harper Collins Publishers.  
ISBN 0-7322-7099-5
- 'No-Dig Gardening' by Esther Deans, (1994). ABC Books. ISBN 0-7333-0941-0.
- Cornucopia II: A Source Book of Edible Plants  
[amazon.com/Cornucopia-II-Source-Edible-Plants/dp/0962808725](http://amazon.com/Cornucopia-II-Source-Edible-Plants/dp/0962808725)
- 'Edible Forest Gardens'. [edibleforestgardens.com/](http://edibleforestgardens.com/)
- 'LikLik Buk', village technologies.
- 'Permaculture Timor Lorosa'e' by Lachlan McKenzie and Ego Lemos.

skinnyfishmusic.com.au/site/store/item/a-permaculture-guidebook-from-east-timor

Find on-line or at your library. If your library does not have a copy of these books, they can order it from another library for you. If a book is not in the national library collection then the library will purchase it for you. When you are finished with it, that book will then be on the shelf for others to share.

### **Free E-Books**

'Organic and Sustainable Gardening' by Paul at

scribd.com/doc/91931891/Organic-and-Sustainable-Gardening

'The One Straw Revolution' by Masanobu Fukuoka.

'From the Forest to the Sea. A Story of Fallen Trees'. U.S. Department of Agriculture.

The above three books can be downloaded at

organicandsustainablegardening.yolasite.com/

'The One Straw Revolution' can also be found at this address

idcoa.cloverpad.org/resources/Documents/One\_Straw\_Farming\_Fukuoka.pdf

'The City Forest. The Keyline Plan For The Human Environment

Revolution' by Mr. P.A Yeomans can be found at these address'-

soilandhealth.org/01aglibrary/010127yeomansIII/010127toc.html

free-book.58search.com/relatedTag/ebook-Plan-2530.html

Free scan of 'From the Forest to the Sea. A story of Fallen Trees', by the U.S.D.A.

treesearch.fs.fed.us/pubs/3073

fs.fed.us/pnw/pubs/gtr229

'Permaculture Timor Lorosa'e' by Lachlan McKenzie and Ego Lemos, written in Tetum, (East Timorese).

scribd.com/doc/6618867/Per-Ma-Culture

''The Formation of Vegetable Mould, Through the Action of Worms, With Observations on Their Habits' by Charles Darwin, LI.D., F.R.S.

gutenberg.org/ebooks/2355charles-darwin.classic-

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online.org.uk/EditorialIntroductions/Freeman\_VegetableMouldandWorms.htm

### **Web Sites**

Keyline [www.keyline.com.au/](http://www.keyline.com.au/)

Keyline plow [www.yeomansplow.com.au/](http://www.yeomansplow.com.au/)

Larry Korn [www.onestrawrevolution.net](http://www.onestrawrevolution.net)

Permaculture [permaculture.com.au/online/](http://permaculture.com.au/online/)

[permaculture.org.au/](http://permaculture.org.au/)

permaculturedesign.us/home  
Sustainable community and industrial design  
mcdonough.com/  
Masanobu Fukuoka can be seen making seed balls and detailed info  
sites.google.com/site/onseedballs/How  
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**Prince Charles. environmentalist and grey water gardener**

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[www.huffingtonpost.com/2010/11/19/harmony-prince-charles-of-wales\\_n\\_784183.html](http://www.huffingtonpost.com/2010/11/19/harmony-prince-charles-of-wales_n_784183.html)

### **Kings and Water**

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### **Story of Lenigrad Seed Scientists, Pavlovsk**

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[vaviblog.com/lets-get-some-things-straight-about-pavlovsk/](http://vaviblog.com/lets-get-some-things-straight-about-pavlovsk/)

### **Fruit Tree Map**

This is a map of fruit trees, untended or leaning over fences, in Melbourne. This is a great idea that should spread around the world.  
[feralfruitmelbourne.wordpress.com/](http://feralfruitmelbourne.wordpress.com/)

### **Cuban Organic Revolution**

[bss.sfsu.edu/raquelrp/pub/2000\\_aug\\_pub.html](http://bss.sfsu.edu/raquelrp/pub/2000_aug_pub.html)  
[cubaagriculture.com/agriculture-today.htm](http://cubaagriculture.com/agriculture-today.htm)  
[sustainablecities.dk/en/city-projects/cases/havana-feeding-the-city-on-urban-agriculture](http://sustainablecities.dk/en/city-projects/cases/havana-feeding-the-city-on-urban-agriculture)

### **Slow Food Cities**

[slowmovement.com/slow\\_cities.php](http://slowmovement.com/slow_cities.php)  
[slowfoodusa.org/index.php/local\\_chapters/](http://slowfoodusa.org/index.php/local_chapters/)

**Hope in a Changing Climate** - documentary about the use of ground covers and terraces in repairing land degraded by farming, reducing erosion on the Yangtze River.

[thewaterchannel.tv/index.php?Itemid=53&option=com\\_hwdvideoshare&task=viewvideo&video\\_id=510](http://thewaterchannel.tv/index.php?Itemid=53&option=com_hwdvideoshare&task=viewvideo&video_id=510)  
[whatifwechange.org/blog/?p=582](http://whatifwechange.org/blog/?p=582)

**Animated maps of the Earth** - showing changes through seasons over the last ten years. Includes effects of CO<sub>2</sub>, cloud cover, fire, snow, etc.

[earthobservatory.nasa.gov/GlobalMaps/](http://earthobservatory.nasa.gov/GlobalMaps/)  
[earthobservatory.nasa.gov/NaturalHazards/view.php?id=37343](http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=37343)

### **Southeast Asia on Fire**

[eoimages.gsfc.nasa.gov/images/globalmaps/data/mov/MOD14A1\\_M\\_FIRE.mov](http://eoimages.gsfc.nasa.gov/images/globalmaps/data/mov/MOD14A1_M_FIRE.mov)

Brown cloud 'causing health problems in India'

[aljazeera.com/news/asia/2012/02/201221264643936626.html](http://aljazeera.com/news/asia/2012/02/201221264643936626.html)

### **Crop Rotation**

[cropsreview.com/crop-rotation.html](http://cropsreview.com/crop-rotation.html)

[resources.cas.psu.edu/ipm/POP/croprotat.pdf](http://resources.cas.psu.edu/ipm/POP/croprotat.pdf)

[ag.ndsu.edu/pubs/plantsci/crops/eb48-1.htm](http://ag.ndsu.edu/pubs/plantsci/crops/eb48-1.htm)

[allotment.org.uk/vegetable/crop-rotation/index.php](http://allotment.org.uk/vegetable/crop-rotation/index.php)

[abc.net.au/gardening/vegieguide/crop\\_rotation.htm](http://abc.net.au/gardening/vegieguide/crop_rotation.htm)

[britannica.com/EBchecked/topic/143973/crop-rotation](http://britannica.com/EBchecked/topic/143973/crop-rotation)

[oisat.org/control\\_methods/cultural\\_practices/crop\\_rotation.html](http://oisat.org/control_methods/cultural_practices/crop_rotation.html)

[gardenorganic.org.uk/schools\\_organic\\_network/leaflets/CropRotation.pdf](http://gardenorganic.org.uk/schools_organic_network/leaflets/CropRotation.pdf)

### **Pasture Cropping**

[nokillcropping.com/](http://nokillcropping.com/)

[winona.net.au/farming.html](http://winona.net.au/farming.html)

[carbongrazing.com.au/default.asp](http://carbongrazing.com.au/default.asp)

[abc.net.au/landline/content/2012/s3511972.htm](http://abc.net.au/landline/content/2012/s3511972.htm)

[futurefarmonline.com.au/farm-research/pasture-cropping](http://futurefarmonline.com.au/farm-research/pasture-cropping)

[milkwood.net/2010/12/07/why-pasture-cropping-is-such-a-big-deal/](http://milkwood.net/2010/12/07/why-pasture-cropping-is-such-a-big-deal/)

[permaculture.org.au/2011/01/26/why-pasture-cropping-is-such-a-big-deal/](http://permaculture.org.au/2011/01/26/why-pasture-cropping-is-such-a-big-deal/)

[soilhealthknowledge.com.au/index.php?option=com\\_content&view=article&id=54&Itemid=108](http://soilhealthknowledge.com.au/index.php?option=com_content&view=article&id=54&Itemid=108)

[dpi.nsw.gov.au/agriculture/field/pastures-and-rangelands/management/pasture-cropping](http://dpi.nsw.gov.au/agriculture/field/pastures-and-rangelands/management/pasture-cropping)

### **Stubble Star**

The StubbleStar is technically a new seed furrow opener, a no till sowing device which enables crop growers to sow seeds directly through stubble (and into the soil) thereby eliminating the need to remove or burn the stubble. Seed furrow openers create a well-defined groove in the soil where the seed and fertiliser can be placed at the proper depth.

[abc.net.au/tv/newinventors/txt/s1452027.htm](http://abc.net.au/tv/newinventors/txt/s1452027.htm)

[grdc.com.au/director/events/groundcover.cfm?item\\_id=publication-issue59&article\\_id=482BC0D6E64506386D0787176520EF83](http://grdc.com.au/director/events/groundcover.cfm?item_id=publication-issue59&article_id=482BC0D6E64506386D0787176520EF83)

### **Moon Planting Charts**

[ourgardengang.tripod.com/moonplanting.htm](http://ourgardengang.tripod.com/moonplanting.htm)

[geocities.com/athens/troy/2214/lunar.htm](http://geocities.com/athens/troy/2214/lunar.htm)

[astrologie-info.com/mocal.cgi?language=eng&sidtrop=sid](http://astrologie-info.com/mocal.cgi?language=eng&sidtrop=sid)

[aracariaguides.com/new/Products/Moon\\_Planting\\_Chart.html](http://aracariaguides.com/new/Products/Moon_Planting_Chart.html)

For Australia and southern hemisphere

[organicsaustraliaonline.com.au/prod3475.htm](http://organicsaustraliaonline.com.au/prod3475.htm)

### **Organic Seeds**

[rareseeds.com/](http://rareseeds.com/)

[seedsavers.org/](http://seedsavers.org/)

[seedalliance.org/](http://seedalliance.org/)

[organicseed.com/](http://organicseed.com/)

[groworganic.com/](http://groworganic.com/)

[victoryseeds.com/](http://victoryseeds.com/)

[heirloomseeds.com/](http://heirloomseeds.com/)

[edenseeds.com.au/](http://edenseeds.com.au/)

[seedsofchange.com/](http://seedsofchange.com/)

[saltspringseeds.com/](http://saltspringseeds.com/)

[amishlandseeds.com/](http://amishlandseeds.com/)

[greenpeople.org/seeds.htm](http://greenpeople.org/seeds.htm)

[highmowingseeds.com/](http://highmowingseeds.com/)

[greenpatchseeds.com.au/](http://greenpatchseeds.com.au/)

[grannysheirloomseeds.com/](http://grannysheirloomseeds.com/)

[organiccatalog.com/catalog/](http://organiccatalog.com/catalog/)

[attra.ncat.org/attra-pub/organic\\_seed/](http://attra.ncat.org/attra-pub/organic_seed/)

### **Ground Covers**

[tropicalforages.info/](http://tropicalforages.info/)

[kerryg.hubpages.com/hub/Clover-Lawns](http://kerryg.hubpages.com/hub/Clover-Lawns)

[uvm.edu/vtvegandberry/factsheets/covercrops.html](http://uvm.edu/vtvegandberry/factsheets/covercrops.html)

[tropicalforages.info/key/Forages/Media/Html/index.htm](http://tropicalforages.info/key/Forages/Media/Html/index.htm)

rirdc.gov.au/programs/established-rural-industries/pollination/clover.cfm  
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tropicalgrasslands.asn.au/  
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### **Comparison Charts Tropical Crops**

echocommunity.org/resource/resmgr/a\_to\_z/azcompch.htm

### **Tropical Herbs**

naturia.per.sg/buloh/plants/candlesticks.htm  
yorubareligion.org/\_con/\_rubric/detail.php?nr=158&rubric=healing&P  
HPSESSID=6pe467oifdfgj404vv69jma22

### **Medicinal Plants Nepal**

mtnforum.org/sites/default/files/pub/6190.pdf

### **Tropical Weed Identification**

Plants of Hawaii [hear.org/](http://hear.org/)  
and [hear.org/starr/plants/images/species/](http://hear.org/starr/plants/images/species/)  
The Plant Observatory [natureloveyou.sg/](http://natureloveyou.sg/)  
Flowers of India [flowersofindia.net/](http://flowersofindia.net/)  
India Nature Watch [indianaturewatch.net/](http://indianaturewatch.net/)  
Plants of Africa [plantzafrica.com/](http://plantzafrica.com/)  
Weeds of Australia [weeds.org.au/](http://weeds.org.au/)  
Western Australian flora [florabase.calm.wa.gov.au/](http://florabase.calm.wa.gov.au/)  
Plants of the US [calphotos.berkeley.edu/](http://calphotos.berkeley.edu/)

### **Companion Planting Charts**

ghorganics.com/page2.html  
en.wikipedia.org/wiki/List\_of\_companion\_plants  
ourherbgarden.com/companion-planting.php  
gardensablaze.com/Companions/CompanionYield.htm  
howtogardenadvice.com/garden\_info/companion\_gardening.htm

### **Flowers for Insects**

englishplants.co.uk/ladybird.html  
dianeseeds.com/flowers/beneficial-insects.html

### **Lady Birds**

latimes.com/news/nationworld/nation/la-na-ladybugs-20120424,0,7977197,full.story

### **Push Pull Insect Control**

en.wikipedia.org/wiki/Push-pull\_technology

### **Dung Beetles**

csiro.au/solutions/DungBeetles.html  
corangamite.landcarevic.net.au/southern-otway/events/dung-beetles-workshop-with-dung-beetle-expert-john-feehan

### **Bee Deaths**

alternet.org/story/154039/have\_bees\_become\_canaries\_in\_the\_coal\_mine\_why\_massive\_bee\_dieoffs\_may\_be\_a\_warning\_about\_our\_own\_health/comments/

### **Cloud Catchers and Fog Farmers**

oas.org/DSD/publications/Unit/oea59e/ch12.htm  
sustainablefootprint.org/en/cms/gebruikers scherm.asp?itemId=446  
newswatch.nationalgeographic.com/2010/03/16/water\_harvested\_from\_clouds\_in\_south\_africa/

### **Water Gardens**

letsgogreen.com/greywater-recycling.html  
hydroponics.net/items/details/multiflow.asp  
hydroponiconline.com/faq/hydroponic+nutrient.html  
deepgreenpermaculture.com/diy-instructions/building-a-small-water-garden/  
hydroponics.com.au/free-articles/issue-82-ipm-practices-for-outdoor-growers

### **Hydraulic Ram Pumps**

bamford.com.au/rampump/  
lejpt.academicdirect.org/A11/059\_070.htm  
sangam.org/2010/01/Hydraulic\_Civilisation.php?uid=3805  
ncollier.com/rampumps.pdf  
hydromissions.com/ramsetup.pdf

### **Hay Bail Urinals**

guardian.co.uk/artanddesign/architecture-design-blog/2013/apr/26/uritonnoir-straw-bale-urinal-festivals

## **Worm Farm Composting Toilets**

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wormfarm.com.au/domestic.php  
abc.net.au/gardening/stories/s793561.htm  
scarecrowsgarden.blogspot.com/2007/09/grey-water-worms.html  
forums.gardenweb.com/forums/load/verm/msg0820161424496.html  
poormanguides.blogspot.com/2009/06/update-on-worm-farm-composter\_10.html

## **Worm Farming**

thewormfarm.net/  
wormfactory.tripod.com/  
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wormbincomposting.com/  
redwormcomposting.com/  
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cleanup.org.au/PDF/au/cua\_wormfarming\_fact\_sheet.pdf?gclid=CM6f-saytnK0CFUF66wod3EuznQ  
Notes and collected web links

## **Organic Cleaning Recipes**

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eartheasy.com/live\_nontoxic\_solutions.htm  
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back-to-basics-cleaning.com/Natural-cleaning-reference-guide.html  
greenliving.about.com/od/greenathome/tp/natural-cleaners-cleaning-tips.htm  
len7288.hubpages.com/hub/Natural-Cleaning-Agents-for-Your-Home-Cleaning

## **Bird Boxes**

**US.** Birds, building and placing boxes  
birdsforever.com/birdhouses.html  
extension.oregonstate.edu/catalog/pdf/ec/ec1556.pdf

**UK** funkybirdbox.co.uk/  
garden-birds.co.uk/information/nestbox.htm  
fendigital.co.uk/html/national\_nest\_box\_week.html  
Bird box with video camera UK

britishbirdfood.co.uk/shop/nest-boxes/camera-nest-box

**Australia**, Boxes for birds, bats and possums.

latrobe.edu.au/wildlife/nursery/nestboxes

sustainablebluemountains.net.au/localiving/more/files/Nestboxes.pdf

### **Home Drainage**

ext.nodak.edu/extnews/newsrelease/2005/062305/11draina.htm

### **Organic Pesticide Recipes**

gardenersnet.com/spray.htm

appropedia.org/Organic\_pesticide\_recipes

weekendgardener.net/how-to/snails-slugs.htm

cbc.ca/news/background/pesticides/recipes.html

ezinearticles.com/?Homemade-Pesticide-Recipes&id=308404

faq.gardenweb.com/faq/lists/organic/2002081329023823.html

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greenhousewife.com/green-household-recipes-organic-pesticides.php

associatedcontent.com/article/955925/recipesfororganicpesticidesand.html

dpi.nsw.gov.au/\_\_data/assets/pdf\_file/0018/111744/organic-news-vol-1-issue-4.pdf

Search this site for Mosquito Control

wbrccouncil.org/

### **Soil Remediation - Removing Chemicals**

clu-in.org/download/citizens/citphyto.pdf

mobot.org/jwccross/phytoremediation/

ecotox.org.au/aje/archives/vol4p37.pdf

arabidopsis.info/students/dom/mainpage.html

cpeo.org/techtree/ttdescript/phytrem.htm

ars.usda.gov/is/ar/archive/jun00/soil0600.htm

archive.deccanherald.com/Deccanherald/apr42005/95755200543.asp

hazeltreefarm.com/2011/01/grokking-gaia-reclaiming-poisoned-land.html

m2.com/m2/web/story.php/200158FB12BC6919D8EA80256A42004A900C

### **Agent Orange. Vietnam's Forgotten War Victims**

aljazeera.com/focus/2010/2010/07/201072302826665260.html

### **Children of Agent Orange**

aljazeera.com/programmes/peopleandpower/2011/09/2011928111920665336.html

### **Eco-toilets Haiti**

[aljazeera.com/programmes/earthrise/2012/03/20123308540952903.html](http://aljazeera.com/programmes/earthrise/2012/03/20123308540952903.html)

### **Methane Digester**

[fogenergycorp.com/fog.php](http://fogenergycorp.com/fog.php)  
[biorealis.com/digester/construction.html](http://biorealis.com/digester/construction.html)  
[youtube.com/watch?v=I5e\\_2W71jMM](http://youtube.com/watch?v=I5e_2W71jMM)  
[youtube.com/watch?v=OVclKRemXDs](http://youtube.com/watch?v=OVclKRemXDs)  
[biogas-energy.com/site/BiogasEnergy.pdf](http://biogas-energy.com/site/BiogasEnergy.pdf)  
[adelaide.edu.au/biogas/resources/skproj.pdf](http://adelaide.edu.au/biogas/resources/skproj.pdf)  
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[habmigern2003.info/biogas/Baron-digester/Baron-digester.htm](http://habmigern2003.info/biogas/Baron-digester/Baron-digester.htm)  
[small-farm-permaculture-and-sustainable-living.com/methane\\_generator.html](http://small-farm-permaculture-and-sustainable-living.com/methane_generator.html)  
[ds.dial.pipex.com/town/terrace/ae198/digesters%20gold%20series%20plan.html](http://ds.dial.pipex.com/town/terrace/ae198/digesters%20gold%20series%20plan.html)

### **Fuel Efficient and Smokeless Stoves**

[praktidesign.com/](http://praktidesign.com/)  
[who.int/indoorair/interventions/kampala41.pdf](http://who.int/indoorair/interventions/kampala41.pdf)  
[web.mit.edu/adnane/www/adnan/portfolio/idd/stove.html](http://web.mit.edu/adnane/www/adnan/portfolio/idd/stove.html)  
[sustainableharvest.org/news-articles/articles/newsletter-articles/origin-and-benefits-of-the-damak-wood-conserving-stove](http://sustainableharvest.org/news-articles/articles/newsletter-articles/origin-and-benefits-of-the-damak-wood-conserving-stove)  
[exodus.co.uk/assets/pdf/PLAN\\_Smokeless\\_Stoves\\_Oct09.pdf](http://exodus.co.uk/assets/pdf/PLAN_Smokeless_Stoves_Oct09.pdf)

### **Micro-Hydro**

[palangthai.blogspot.com/](http://palangthai.blogspot.com/)  
[gvepinternational.org/en](http://gvepinternational.org/en)  
[micro-hydro-power.com/](http://micro-hydro-power.com/)  
[smallhydropower.com/manual3.htm](http://smallhydropower.com/manual3.htm)  
[balwois.com/balwois/administration/full\\_paper/ffp-903.pdf](http://balwois.com/balwois/administration/full_paper/ffp-903.pdf)  
[en.howtopedia.org/wiki/How\\_to\\_Plan\\_a\\_Micro\\_Hydro-power\\_Plant](http://en.howtopedia.org/wiki/How_to_Plan_a_Micro_Hydro-power_Plant)

### **Fresnel Lenses**

[pmmalens.com/](http://pmmalens.com/)  
[fresnel-lens.com/](http://fresnel-lens.com/)  
[3dlens.com/shop/](http://3dlens.com/shop/)  
[greenpowerscience.com/](http://greenpowerscience.com/)

### **Mud Brick and Earth Building**

[kleiwerks.org/aboutus\\_thailand.php](http://kleiwerks.org/aboutus_thailand.php)  
[ruffordsmallgrants.org/rsg/projects/jon\\_jandai](http://ruffordsmallgrants.org/rsg/projects/jon_jandai)  
[pcthailand.wetpaint.com/page/jon+jandai+adobe+farm](http://pcthailand.wetpaint.com/page/jon+jandai+adobe+farm)

## **GMO Danger**

seedsofdeception.com

i-sis.org.uk/GM\_aids\_virus.php

primalseeds.org/news160600.htm

shareguide.com/SmithJeffrey.html

home.intekom.com/tm\_info/rw91231.htm

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saynotogmos.org/scientific\_studies.htm

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gene.ch/genet/2003/Dec/msg00152.html

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en.wikipedia.org/wiki/Genetic\_use\_restriction\_technology

organicconsumers.org/Monsanto/spillbeans0605.cfm

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waronyou.com/topics/50-harmful-effects-of-genetically-modified-gm-foods/

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foodmarketexchange.com/datacenter/product/organic/details/dc\_pi\_organic\_08.php

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greenpeace.org.uk/media/press-releases/greenpeace-urges-ministers-to-reject-bt-11-gm-maize

theecologist.org/blogs\_and\_comments/commentators/other\_comments/269728/kept\_in\_the\_dark.html

pej.org/html/modules.php?op=modload&name=News&file=article&sid=6169&mode=thread&order=0&thold=0

dailymail.co.uk/news/worldnews/article-1082559/The-GM-genocide-Thousands-Indian-farmers-committing-suicide-using-genetically-modified-crops.html

books.google.com/books?id=mlVh3ysN4ZwC&pg=PA66&lpg=PA66&dq=terminator+genes+spread+to+other+plants&source=bl&ots=3M3EunyW6S&sig=qAm-nNnIZ39LVcs9dxCUgJa\_arE&hl=en&ei=O6CLSpezKZjw7AOJ5eWdDw&sa=X&oi=book\_result&ct=result&resnum=5#v=onepage&q=terminator%20genes%20spread%20to%20other%20plants&f=false

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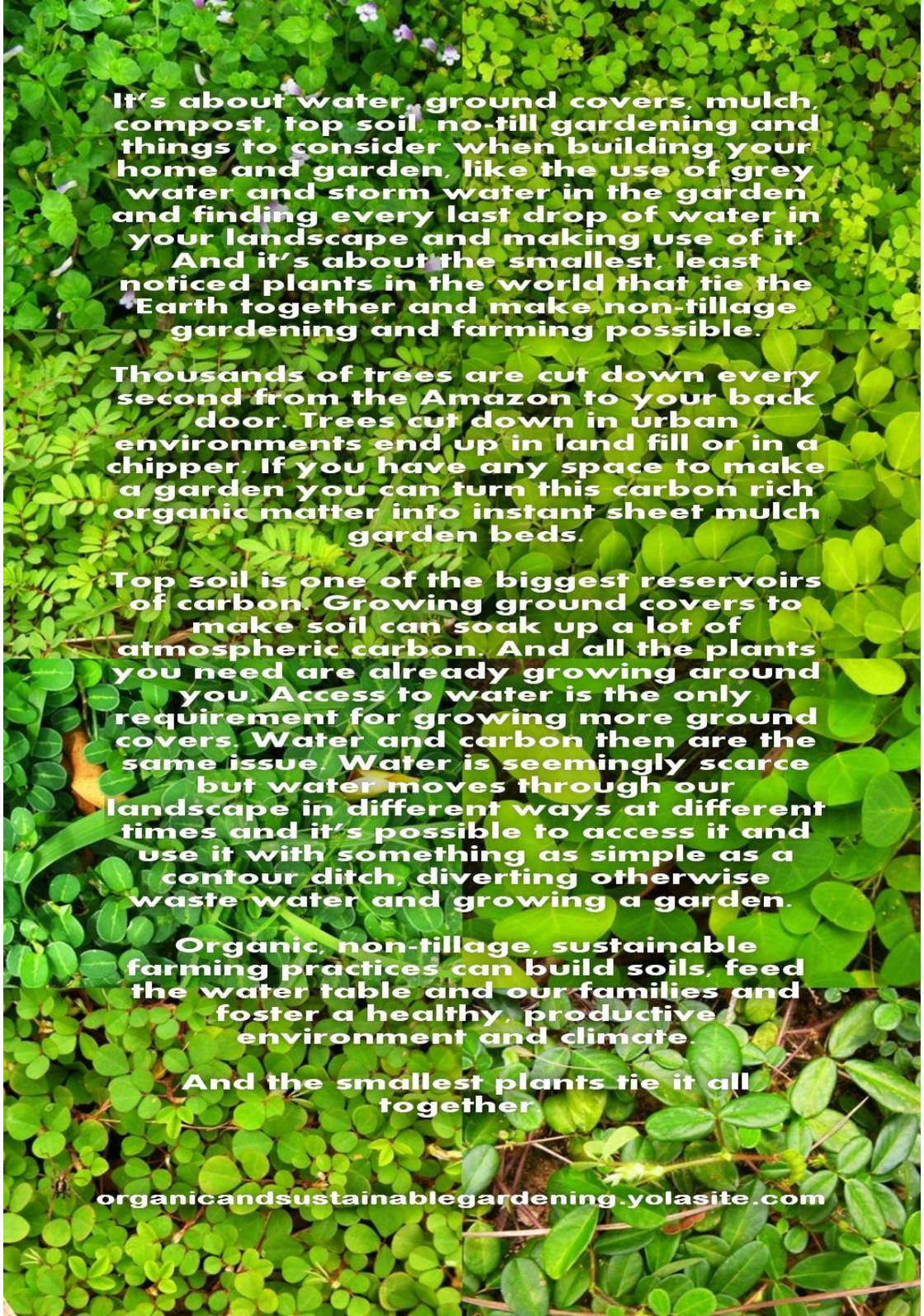
**organicandsustainablegardening.yolasite.com**



***"As the King is the water,  
I shall be the forest.  
The forest devotes its loyalty to the water"***  
***HM Queen Sirikit of Thailand***  
***December 20, 1982***







**It's about water, ground covers, mulch, compost, top soil, no-till gardening and things to consider when building your home and garden, like the use of grey water and storm water in the garden and finding every last drop of water in your landscape and making use of it.**

**And it's about the smallest, least noticed plants in the world that tie the Earth together and make non-tillage gardening and farming possible.**

**Thousands of trees are cut down every second from the Amazon to your back door. Trees cut down in urban environments end up in land fill or in a chipper. If you have any space to make a garden you can turn this carbon rich organic matter into instant sheet mulch garden beds.**

**Top soil is one of the biggest reservoirs of carbon. Growing ground covers to make soil can soak up a lot of atmospheric carbon. And all the plants you need are already growing around you. Access to water is the only requirement for growing more ground covers. Water and carbon then are the same issue. Water is seemingly scarce but water moves through our landscape in different ways at different times and it's possible to access it and use it with something as simple as a contour ditch, diverting otherwise waste water and growing a garden.**

**Organic, non-tillage, sustainable farming practices can build soils, feed the water table and our families and foster a healthy, productive environment and climate.**

**And the smallest plants tie it all together.**

**[organicandsustainablegardening.yolasite.com](http://organicandsustainablegardening.yolasite.com)**