Indigenous Agroforestry Manual:

The Forest Garden

Second Edition

Author: Mel Landers
English Version
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1. Introduction

The world is becoming hotter and dryer and floods and droughts are now more frequent and severe. Food production is decreasing at the same time that the population is increasing. It is urgent to make food production resistant to extreme weather events.

The purpose of this manual is to provide agricultural producers with practical actions that were developed by indigenous producers to improve soil fertility and water holding capacity and that increase production. This manual summarizes the results of 50 years of the author's experience, with the practices that allowed our ancestors to produce food, even during droughts and floods.

As a producer and as a researcher, Mel has worked in his own fields and in the fields of countless producers with whom he has shared the practices that are contained in this manual. With this manual he wants to inspire the descendants of indigenous people worldwide, to return to their original agriculture. If they apply these practices, they will be reviving the systems that enabled our ancestors to produce abundant quantities of good quality, diverse and nutritious food, even under difficult climatic conditions.

2. The Origin of Agriculture

Ten thousand years ago the people of southern Mexico transitioned from hunting and gathering to the production of agricultural crops by reproducing the natural environments where they found the plants they ate. These farmers developed foods like maize, pumpkin, beans, cocoa, tomatoes and chilies, and cotton for the fibers. They grew fruit trees like avocado and mango, and cashew nuts; also plants for dyes, medicine and many others.

The knowledge and crops spread through the Americas through migration and trade. The Maya called the areas they cultivated, "Forest Gardens;" each one, an agroforestry system that mimics the original productive ecosystem found in the forest, maintained by nature itself.

In nature there is normally no bare soil, little soil disturbance and no pure stands of anything. Nature doesn't even produce compost. It produces mulch, which is all the soil microorganisms need to provide fertility and soil moisture holding capacity for lush growth.

The Indigenous American farmers grew hundreds of varieties of crops in their fields using beneficial plant associations in raised beds that were continually covered with an organic mulch that kept the soil soft, cool and moist. The soil was not plowed and crop wastes and weeds were used as mulch; protecting from loss due to drought, excessive rain, insects and diseases. It did not harm the environment while it produced nutrient rich soils and plentiful harvests.

When the Europeans came to America they found forest gardens established on millions of hectares over the entire continent. Although this greatly impressed them, they failed to understand how the people farmed the land. So, they imposed on the land and people the destructive system they used.

The agriculture that the Europeans practiced included burning weeds and crop wastes in preparation for planting; a harmful practice which eliminates soil organic matter. Trees were also cut to clear the land, and the soil was plowed to establish mono-cultures. Soils soon began to lose energy and nutrients, and over time they became impoverished. Since the soil was left uncovered, the rain removed the most fertile layer. These eroded, hot and dry soils lost their ability to produce good harvests. This brought poverty, hunger and malnutrition to farmland in the Americas.

However, the Europeans did recognize the value of the crops developed by Indigenous Americans which they carried with them over the rest of the world. That dissemination of foods started an agricultural revolution 500 years ago.

The rescue of indigenous agriculture could start another agricultural revolution now, to provide food sovereignty and security in the face of climate change.

For thousands of years, Indigenous American farmers produced nutrient-rich soils and good crops.

Seven vital practices insure good production:

1. Crops are grown on meter wide raised beds to increase the depth of the topsoil and hold plant roots up above the water when it rains too much.

2. The soil is not disturbed and only opened for harvest of root crops. The soil in the beds is never stepped on or walked on.

3. The roots of crops and weeds are left in the ground; not pulled.

4. Channels between the beds hold all the rain in the soil, providing soil moisture during droughts.

5. Tied ridges across the channels capture rain where it falls, insuring even moisture across the field.

6. Beds are covered with a thick organic mulch, which protects the soil from rain, wind and solar heat and prevents moisture from evaporating. Mulch provides the cool, moist conditions that worms and beneficial microorganisms need. It also feeds them and provides minerals to crops.

7. A diversity of mixed crops are planted in the same area. Their odors confuse and repel many insect pests. And, when there are fewer insect pests there are also fewer diseases.

3. Changes in the surface of the soil

The essential base for the establishment of a forest garden is to change the structure of the soil. To do that, indigenous Americans created the methods that are presented below.

Raised Beds

Raised beds are rectangular structures excavated in the soil that provide a planting surface higher than the surrounding soil. These are separated by channels that capture all the rain and in which the producers walk and work. The beds are connected by ridges across the channels, which insure even distribution of rainwater throughout the field.

Mulch

Immediately after construction the beds are covered with mulch to provide a soil environment that is cool and moist for plant roots, earthworms and beneficial organisms. The decomposing organic mulch provides food for the micro-organisms and fertility for the soil. The beneficial organisms protect plants and provide them with nutrients. The mulch also prevents raindrops from splashing fungal spores onto leaves, fruit and stems. It also increases soil humidity, organic matter, fertility and microbial diversity and reduces erosion, evaporation, and risk from droughts and floods.

If organic matter such as crop wastes, straw, leaves and weeds is used to produce compost, most of the carbohydrates that soil microorganisms need are lost in the atmosphere, when oxidation converts them into gases such as carbon dioxide, methane, nitrous oxide, etc.

These are the gases that are causing the changes in the weather.

Why produce more?

Constructing the raised beds

1. Use stakes to mark where to dig ditches and where to form beds.
2. Dig the ditch, 46cm wide and 25 to 30cm deep. If it is too narrow it will not capture enough rain and it will be hard to work in it.
3. Put the soil where you will form the bed.
4. Dams (25 to 30cm) are left every 5 meters to capture rain water.
5. Form the bed between the ditches with a base of 115cm.
6. Level the top of the bed and cover it with organic matter for mulch.
7. This is repeated down the slope until all the beds are completed.

8. As soon as you finish a bed, immediately cover it with mulch.

9. You should watch this video before building raised beds so that you do not damage the bed walls. That would reduce the space for growing plants:

   https://youtu.be/pFGtqWrXQX0

Note: If the land is steep, dig the first bed at the highest point.

Biochar

There is no need to use inputs to increase soil fertility. With mulch, organisms fertilize the soil. But, you can use 5 pounds of biochar per meter to keep nutrients from washing out of the soil.

1. Produce biochar from maize cobs or stalks, branches or other hard-to-decompose materials. It's like making charcoal.

2. Fill a trench with the material you have.

3. Cover it with dirt, leaving a few holes for air.

4. Light a fire in the holes.

5. When the smoke becomes less dense, cover the holes with dirt.

6. Wait for the fire to burn out and for the material to cool.

7. Harvest the biochar crush it before applying to the beds.

Terraces

Terraces provide level soil for cultivation on sloping land. On gentle slopes you can use vetiver grass to retain a soil wall. But, steep slopes require rock walls to remain stable.

Vetiver Terraces

Vetiver terraces can be built on moderate slopes. The roots penetrate deep, retaining the terrace wall. Water can flow through vetiver, but soil cannot pass. If it is dry, it can be started in paper pots to develop roots before transplanting.

To construct Vetiver Terraces:

1. Dig soil from what will be the back of the terrace and pile it to the front and compact that which will be the front wall.

2. Plant the vetiver across the front wall of the terrace, leaving 10 cm between plants. The spaces between plants will close as the plants grow.

To Construct Stone Terraces

1. Construct the first terrace in the lowest part of the field. Build the next one just above it (opposite what you do with raised beds).

2. Dig a channel 20 to 25cm deep.

Slope it into the hill by about 8cm.

The wall will lean into the slope for stability.

3. The terraces width depends on the wall height.

It should not be more than four times the height.

4. Throw the soil onto the slope above.

It will be used to fill in behind the new wall.

5. The base width is a quarter of the wall height.

6. Fill in and compact soil after completing each layer.

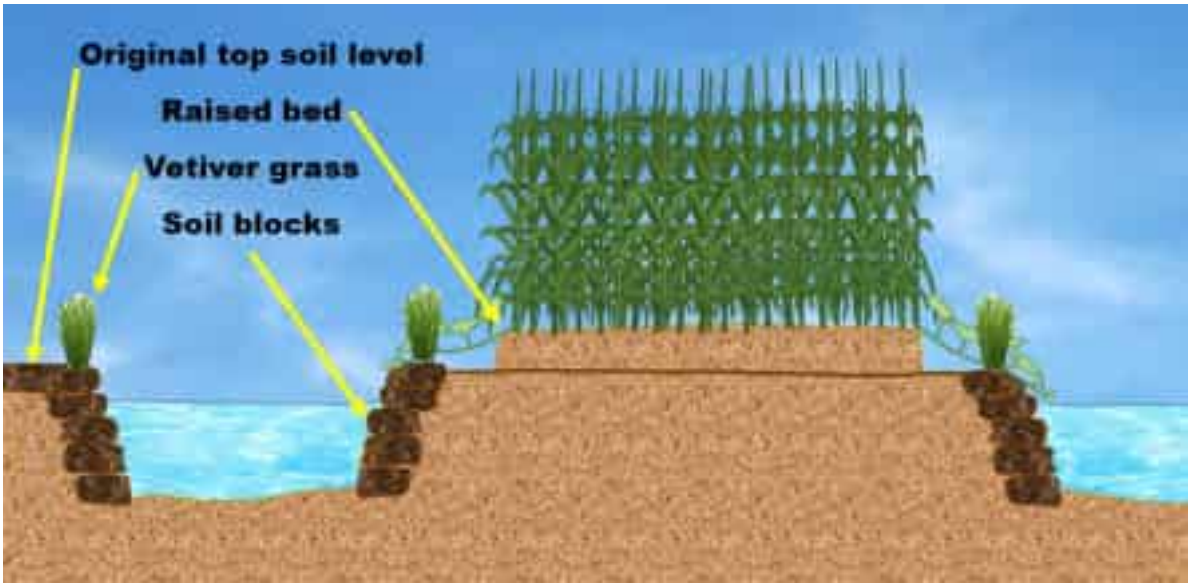
7. Use the largest rocks for the base. Use small rocks in the middle. Use longer rocks on top to hold everything together.

Platforms

Platforms are constructed in areas that are frequently flooded.

To Construct Platforms

1. Cut the surface soil into blocks of the size and shape of adobes.
2. Set stakes for platforms of 6.25 meters and canals 2.75 meters.
3. The channels will be excavated to provide soil for the platforms.
4. Pile the excavated soil onto the platform bases.
4. Stack the soil blocks around the loose soil to form the walls.
5. Leave a 75 cm walkway on each side of the platform for access.
6. Build meter wide beds on the platform from one side to the other.



4. Improving soils

Mulch will improve almost any soil within 6 to 12 months.

Under the mulch, "Mycorrhizal" fungi deposit stable organic matter.

Each added 1% organic matter holds 27,000 gallons of water per acre.

Improved soils reduce erosion and the risk from droughts or floods.

Roots grow better in the soft, fertile, cool and moist conditions.

The improved soil structure gives better drainage and gas exchange.

Beneficial micro-organisms help plants produce more food.

Improved soil overcomes farmer`s dependence on chemical inputs.

Improved soils increase production and lower production costs.

To Produce Improved Soils

Use all available Organic matter as mulch (crop waste and weeds).

More can be grown with residual soil moisture during the dry season.

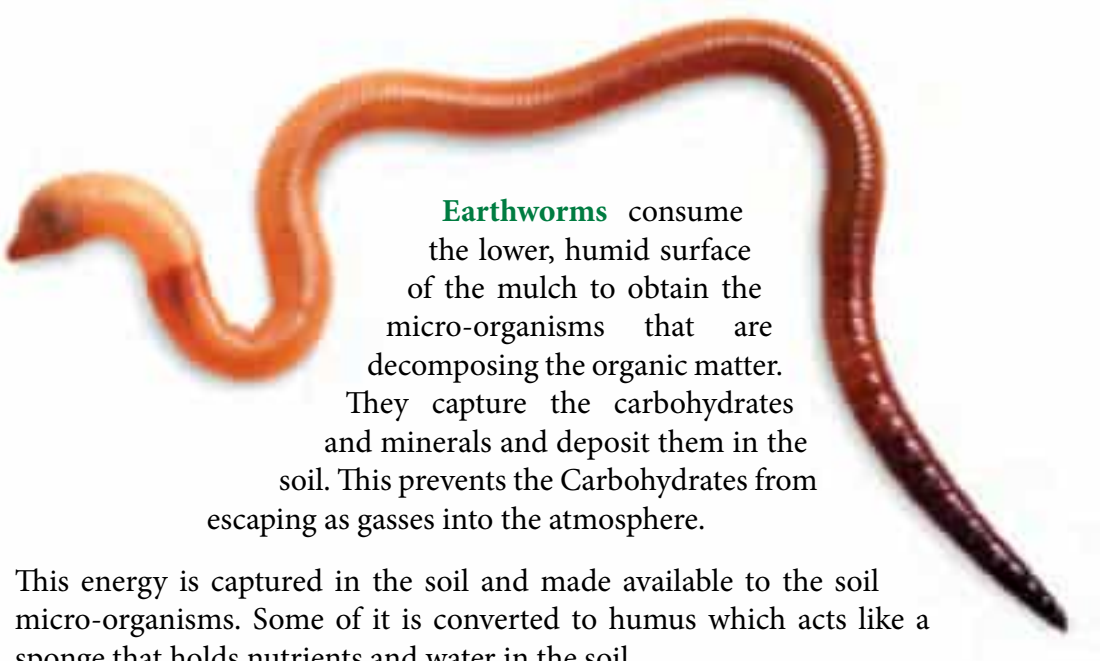
Some beds can even be devoted to the production of organic matter.

Plant lemon grass on one side of each trench for continual production.

Black Earth Soils

The richest soils in the world are from the tribes that made the black earth soils. The mulch is just one of the requirements for producing these soils. They also require biochar and humus. The charcoal is produced using hard crop wastes such as grain husks, fruit seeds and maize stalks that are burned without enough Oxygen to consume all the material. The humus is produced from feces and manure that is buried by dung beetles or worms deep in the soil, where anaerobic bacteria consume it.

This humus can be produced in an area set aside for the purpose, where dung beetles or worms can be introduced and fed; with the soil being harvested at a later date. Later this high humus soil and the powdered charcoal can be applied to the top of the beds under the mulch. Earthworms will mix it into the beds. Or, you can set aside a group of beds that you want to improve and introduce the dung beetles and manure there for three to for five years.



Earthworms consume the lower, humid surface of the mulch to obtain the micro-organisms that are decomposing the organic matter. They capture the carbohydrates and minerals and deposit them in the soil. This prevents the Carbohydrates from escaping as gasses into the atmosphere.

This energy is captured in the soil and made available to the soil micro-organisms. Some of it is converted to humus which acts like a sponge that holds nutrients and water in the soil.

Earthworms turn the soil twice a year, aerate it with their tunnels and enrich it with their feces. Earthworms can be introduced by placing them on the surface of the beds under the mulch.

Micro-organisms. There are thousands of different organisms that live in nutrient rich, cool, moist soil. Many of these are beneficial to plants because they release minerals from soil particles, kill pests and disease organisms, or directly provide nutrients and water to plants.

Mycorrhizal fungi collect nutrients and water from throughout the soil and deposit it inside the roots (in the photo to the right).

Nitrogen fixing bacteria convert atmospheric Nitrogen to a form that plants can use (in the photo below).

There are many more examples of beneficial organisms that provide health, safety and development to our plants. These organisms can be introduced to lifeless soil by applying a small amount of decomposing leaves and soil from areas that have not been plowed and have not received applications of chemicals.

5. The Forest

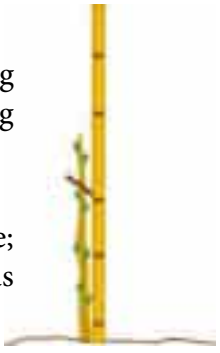
This is an agroforestry system that includes dozens of trees that:

- Create windbreaks to protect crops from strong winds.
- Produce mulch materials.
- Speed up infiltration of rainwater into the soil.
- Cool the air by increasing the humidity over the field.
- Confuse insect pests with the odors they add to the air.
- Provide food, construction materials and firewood.
- Their flowers attract pollinators.

Trees on the Beds

Each tree is kept to a size of between 2x3x4 to 3x5x5 meters (8x12x16 ft. to 12x20x20 ft.) in order to fit them on the beds and to increase their productivity. Trees protect crops by reducing the force of the wind. Their flowers attract pollinators. Their odor helps prevent insect pests from finding the plants they prefer.

Training as a fan



Each tree is trained in the shape of a fan. The main branches extend along the bed, but, side branches are pruned so that they do not hamper walking and working between beds.

To begin training, bury a stake beside the tree when it is one year of age; loosely tying it to the stake with heavy sting. That stake will serve as support to the main stem.

Cut the stem diagonally at about 45 to 60 cm (18 to 24 in.) above the ground, just above two buds that point toward the ends of the bed. Allow all branches to grow for 6 months.

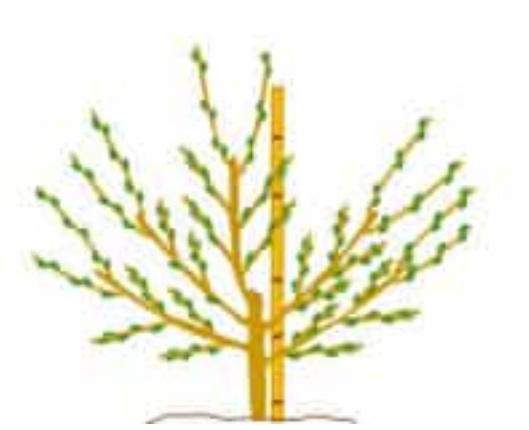
At 6 months choose the branches to be trained. The upper most branch will be the central branch and four other branches will provide the rest of the structure. Cut off all others.

In the second year each branch is cut to 60 cm, (24 in.) just beyond a pair of buds. Keep two new branches from each of the original five in order to form the fan shape.

Cut the ends of the secondary branches when they have grown 60 to 90cm. (24 to 36 In.)

Allow branches to form off of the primary and secondary branches.

Cut them when they have grown out to the full width of the tree.



6. Establishing the System

Raised beds prevent crops from being killed by waterlogging during heavy rains. But, when there is a drought, they capture 100% of the rain. The ridges that tie the beds together force the rain to infiltrate where it lands. So, there is even distribution of soil moisture across the entire field.

Plant other crops immediately after harvesting a section. Thus, the beds are kept producing all the time.

If possible, have the next crop already growing in the nursery.

Always rotate the beds. Do not plant the same crop family in the same bed two cropping cycles in a row.

Plant Marigold a meter apart on both side walls of each bed to control the nematodes that cause damage to plant roots.

If you plant lemon grass in the canal along one side of each bed, you can grow a continual supply of mulch.

- Make changes on the ground during the dry season so that it is ready when the rains start.
- Determine what foods the family wants to eat and design the five meter sections to fit them in.
- Make a map of the beds so you know where everything will be planted.
- Think about what medicinal plants, fiber plants, bamboo, etc. Should be included in the system.
- Decide what fruit trees will be planted as windbreaks.
- It is easier to work as a group. Five families can work one day on each families land during five days.
- Cover the bed immediately after building it with organic matter to protect it from rain, wind and Sun.
- Save all organic matter that is cut from any area to use as mulch and grow more in unused beds.
- Infect new beds with micro-organisms with a bit of soil from where organic matter is decomposing.
- If there are no earthworms, they can be introduced under the mulch.
- Pre-Germinate seeds and plant in paper pots or directly in the ground according to the type of seed.
- Sow the raised beds with a diverse mixture of crops.

7. Other indigenous practices

Companion planting

The odor of some plants confuses or repels insect pests. Some plants give shade or support and they utilize different nutrients at different levels of the soil. These are called companion plants.

Some examples of companion plants include:

Plant marigold on both sides of the beds to kill root knot nematodes and to repel various pests.

Plant cabbage with carrots to repel cabbage moth. The cabbage also repels the carrot root fly.

Plant dill with cabbage and tomato. It attracts the wasps that parasitize many larvae.

Basil repels some tomato and pepper pests.

Nasturtium or rosemary repels Mexican bean beetles.

Nasturtium also helps repel cucumber beetles.

Oregano, Cilantro and other herbs repel many pests.

Colorful flowers attract many kinds of pollinators.

Plant radish around peppers, spinach and other plants that are attacked by leaf miners. Leaf miners prefer radish and it does not affect their production.

The Three Sisters

The Three Sisters method is a type of companion planting that consist in the planting of maize, beans and squash (or melons) in the same area.

To plant the three sisters:

Plant the maize in two rows. (on each side of the bed) with two seeds in each hole, spaced 50cm (12 in.) apart.

When the maize is 30cm (20 in.) high, plant three bean seeds around the base of the plants.

When the maize is 60cm (40 in.) high, plant a squash or melon plant at each end of the maize and train them toward each other and into the channel on each side.

Do not use large leaved pumpkins or squash.

The maize supports the beans, the beans provide Nitrogen and the squash shades to the soil.

This practice also works well with sorghum or sun flower.

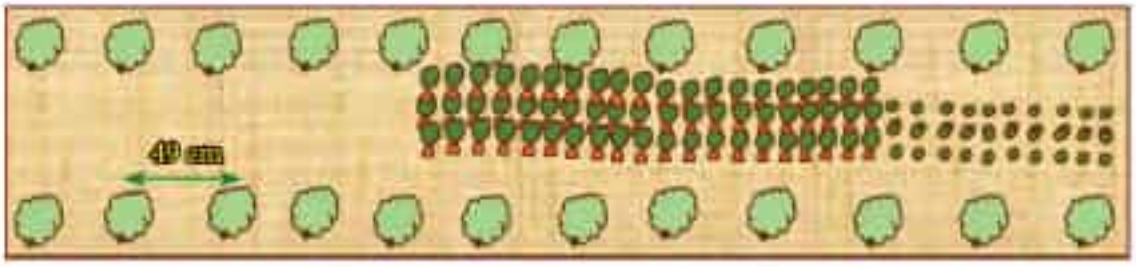
Following, are some other useful examples of crop combinations:

Plant combinations

Cabbage and Carrot

Sow two seeds of cabbage in paper pots, 0.5cm deep. Transplant 25cm apart.

Plant carrot seeds in small grooves after opening a channel in the mulch. Cover them with a little soil. When the leaves are about 10cm in height remove extras to leave only the best plant every 8cm. Plant a quarter of carrots every two weeks.



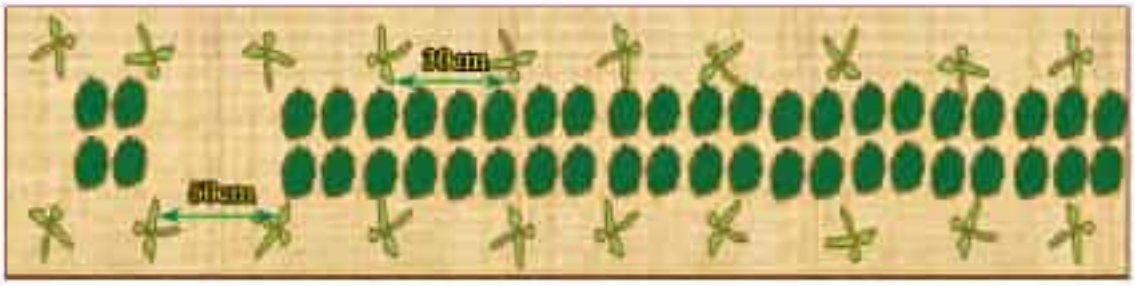
The smell of cabbage repels the fly that damages carrot roots.

The smell of carrot repels the white moth that affects cabbage.

Maize and Bush Beans

Plant 2 seeds of maize 2cm deep every 50cm in 2 rows, one on each side of the bed. Harvest when the ears are dry.

Sow 2 bean seeds 0.5cm deep every 30cm in 2 rows in the center of the bed. When you harvest the beans leave the bean roots in the soil to provide Nitrogen to the next crop.



Tomato, Peppers, Chili and Basil

Grow them where they can receive light shade for best production.

Plant 2 seeds of tomato, chilies or peppers 0.5cm deep in paper pots.

To plant Basil just mix with the surface soil and keep moist.

Transplant peppers before they have 8 true leaves.

Transplant these in groups of four, with 50cm between plants.

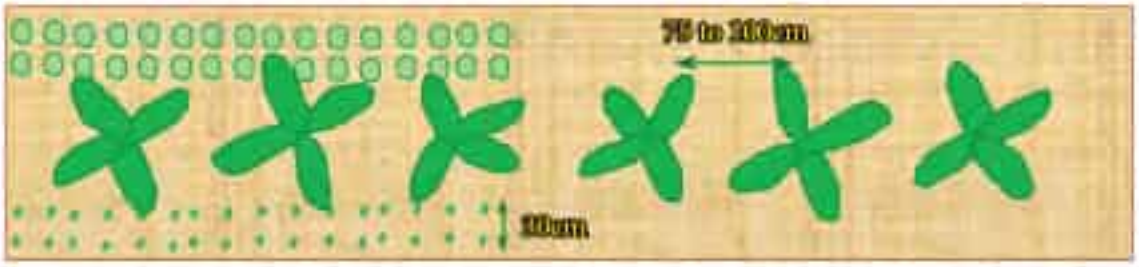
Put Basil in the center of each group of peppers, chilies or tomatoes.

Banana or Plantain and Spinach

Plant banana suckers in the center of the bed about 80 to 90cm apart.

Start spinach in paper pots sowing 2 seeds 0.5 cm deep, three weeks before transplanting. Transplant 30cm apart in two rows 30cm apart.

For home use, harvest large leaves first and let small leaves grow. For the market, cut the stem to 7.5cm above the ground and let it grow back for a second harvest. Plant more spinach every 3 or 4 weeks for a continuous of leaf harvest.



Moringa

Plant two seeds in each hole in four rows spaced 20cm between rows and between plants. Reduce to only one plant per hole.

Another option is to plant woody cuttings: they set roots well and develop fast.

To have a continuous harvest it is recommended to plant a line of 4 plants every 2 days.

When the tree reaches two meters, it is cut off to 20cm.

They regrow and each group is harvested every 45 days.

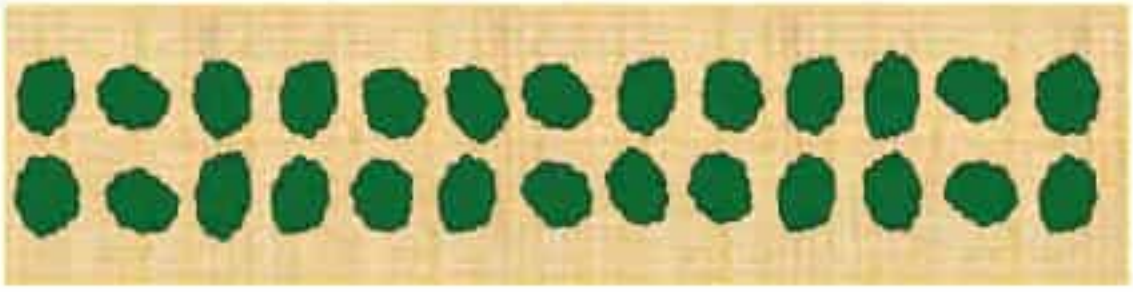
Use the fresh leaves in soups, eggs or salads. Or, left to dry, they are crushed (or ground) to a powder and stored for eating little by little.

Potatoes

Plant whole potatoes the size of large chicken eggs. They are spaced 40cm between them in two rows spaced 50 cm apart.

The beds are covered with a thick layer of mulch (40cm) before planting. Place the potatoes on the mulch and then cover with another 40cm of mulch.

After 3 or 4 months check in the mulch for large potatoes, but, leave the others until the plants begin to die.



Squash and Pumpkin

Plant Zucchini in groups of four, 75cm apart in 2 rows. Plant herbs in the center of each 4 Zucchini plants.

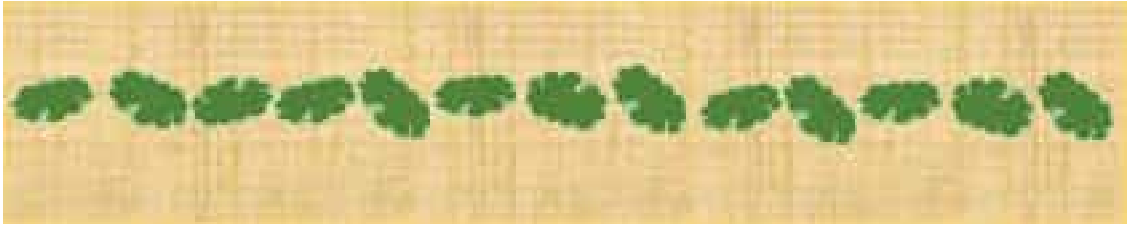
Plant winter squash or pumpkin every meter in the center of the bed. These plants can grow over the beds and in the channels.

Sweet Potato

Plant cuttings every meter, (15cm long) directly into the center of the bed or plant them in paper pots to root them before planting. Lift the vines weekly to prevent them from forming small roots, which would rob nutrients from the harvestable roots.

Watermelon

Plant 2 seeds in each paper pot and leave only one. Transplant to the center of the raised beds. Space watermelons 40cm apart. Space other melons a meter apart. Watermelons are ready to harvest when the tendrils on each side of the stem turn brown. Other melons should separate from the stem when lifted, when mature.



8. Seeds: Our Livelihood

Living seeds contain the embryo of a new plant and the nutrients it needs to thrive in moist soil. If you purchase imported seeds, you are planting varieties that are designed to produce in a variety of conditions. But, they are not designed to produce abundant crops in the conditions that you encounter in your community and on your farm.

Local seeds are the legacy left to us by our ancestors. Farmers have improved our seeds from generation to generation at the family level and at the community level, adapting them to the areas where they live. The use of these seeds helps guarantee a harvest because they are adapted to local conditions.

Seeds you save provide you with food sovereignty. You have ownership of these varieties. This is important, because without food sovereignty, there is no food security.

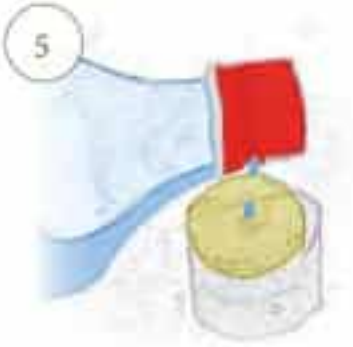
The seeds you harvest are adapted to the unique environment of your farm. To obtain good seed, first select the best plants: the strongest, most pest and diseases resistant, drought and flood resistant, the most productive, with the best flavor, color and size. Select for whatever traits are the most important to you.

Dry seeds like maize, beans and peppers are the easiest to process: just dry them completely in the shade and store in plastic bottles.

Wet seeds like the tomato and the cucumber need to ferment: they are left with pulp in a bowl with water for 3 to 5 days in a warm shaded place and stirred each day. When white mold forms on the surface and the pulp is dissolved they are rinsed until clean. They are then left to dry in the shade and then stored in plastic bottles.

Planting in Paper pots

1. Cut newspaper into 7.5 by 27cm strips. Roll the strip onto a tube, dowel or jar that is about 4cm in diameter; Leaving 2.5cm of paper protruding beyond the edge.
2. Fold the protruding paper to make the bottom of the pot.
3. Press the bottom so that it maintains its shape and slide it off.
4. Fill the pot with soil.
5. Drip water from a bottle to wet the soil.
6. Make a hole in the center to the correct depth.
7. Plant the seeds and cover them with soil.
8. Place pots in the nursery and keep them moist until the plants are ready to be transplanted.



You can watch our paper pot video at https://www.youtube.com/watch?v=qVkczchu3xw&t=25s

Pre-germination of Seeds

Pre-germination of seeds insures the vitality of every seed that is planted. To pre-germinate, the seeds are put in a jar of water for 8 to 12 hours. Remove the water and leave the jar covered with a cloth. The seeds are rinsed 3 or 4 times a day, until they germinate.

The germinated seeds can be transplanted directly in the field just as you would plant the dry seed, only taking care not to damage the roots. Or, plant them in paper pots for later transplanting. Be sure to protect the pots from rain.

Visual Selection

To select the best plants and thus achieve the best seeds for the next cycle, the first thing you have to do is decide the criteria for choosing plants.

It is best to select seeds from plants that:

- Grow and develop quickly
- Have strong stems
- Are resistant to the insect pests
- Are resistant to major diseases
- Are resistant to drought
- Have no less than two ears (for maize)
- Have large ears (for maize)
- Bloom at the same time;
- Mature early and all at the same time;
- Any other feature that interests the producer.

The process for maize is similar for other crops as well. It is begun by putting stakes next to all the plants which germinate rapidly. (As in the photo below, but not in a mono-culture). Thereafter, daily walks through the plot are made to observe the development of the plants; removing stakes of each plant that does not comply with the Criteria: those that have weak stems; the most affected by insects and diseases, drought or floods; having only one ear, or that have small ears, etc.

The only plants from which you will harvest seed will be those that still have stakes at the time of harvest. These should be the first harvested (for maize it is preferable to harvest cobs of not less than 200 plants). The rest of the harvest will be for family consumption and for the market.

The visual selection is a good strategy for saving seed to ensure productivity and adaptation to local conditions. The family will own their own varieties, thus ensuring food sovereignty and security.

Seed Storage

It is important to manage and conserve seeds produced on the farm to keep them in good condition for the next harvest.

The most practical and effective way to store seeds is in tightly closed plastic bottles; to protect them from air, moisture and insects. For the best insect protection, put neem leaves in the bottles before closing them, and then place them in a cool shaded location.

9. Control of Pests and Diseases

The first priority for the control of diseases and pests, is to grow healthy plants with healthy immune systems. Insuring adequate soil moisture, providing a cool moist root zone and maintaining diversity are all important to a healthy immune system. The control of pests also helps to control diseases. Most diseases are transmitted by insects when they feed.

For that reason, it is advisable to:

- Improve the soil, capture all of the rain and provide nutrients for microorganisms through the application of mulch.
- Keep the ground covered with mulch to avoid rain from splashing fungal spores from the soil onto the plants.
- Diversify crops to confuse and repel insect pests.
- Do not work with plants when they are wet, to prevent the transmission of diseases from one plant to another.
- Do not let smokers into the field. They are contaminated with a virus that kills tomatoes, peppers and chilies.
- Allow chickens and ducks to eat insects in the field.
- Build small wooden or or covered cardboard boxes covered with plastic and hang them in trees so that wasps build their nests in them. The wasps lay their eggs in the larvae of insect pests.
- It is important to keep field tools clean to prevent the transmission of diseases from one plant to another; especially if those tools have been used on infected plants.

Control of some Principal Pests

Aphids

Garlic and onions repel aphids. Zinia flowers attract hummingbirds, which feed on aphids and other soft-bodied insects.

Armyworm

Sprinkle wood ashes and chili powder into the intersection of the leaf and stalk. 2 Kg ashes to 3 tablespoons of chili powder.

Asparagus Beetle

Chickens and ducks eat these beetles; They can also be controlled using neem and by hand picking.

Cabbage Root Worm

They live in the soil, so, they are controlled by rotating crops so that there are no plants of the cabbage family growing in the same section for three years.

Inch Worm

Inch worms can be controlled by wasp larvae. They are repelled by dill, carrot and Mint that are inter-planted with cabbage, mustard, collard, broccoli and cauliflower.

Carrot Root Fly

Carrot root fly is repelled by plants of the cabbage family and by onions.

Potato Beetle

Chickens and ducks eat them. They can be controlled with neem or by manual harvesting.

Maize Earworm

They are controlled by applying mineral oil to the silks when they form.

Cucumber Beetle

Repel them with onion and neem. Control with sticky yellow traps, ducks or by manual harvesting.

Cutworm

Set out well established plants and, place a ring of plastic or kraft paper around the stem.

Flea Beetle

They can be controlled by spraying water with liquid soap or neem spray.

Grasshopper

Grasshoppers are easily controlled by the chickens and ducks.

Red Spider Mite

Control them by spraying an infusion of neem leaves.

Japanese Beetle

Ducks and chickens eat the beetles and the larvae.

Bean Beetles

Control them with chickens or ducks, with an infusion of neem or by hand picking.

Nematodes

They are controlled by planting marigold every meter on both sides of the beds.

Onion Fly

Onion fly larvae are controlled by crop rotation because they go into the soil to pupate.

Snails and slugs

They are controlled with beer left in bottle tops on the ground. They enter and drown. Or let them accumulate under banana stem sections and sprinkle with salt.

Vine borers

Locate the bug and remove it by cutting open the stem. Then, cover the stem with soil.

Stink Bugs

Hand pick adult beetles, destroy their green eggs on the underside of leaves and plant marigold and sun flower to attract the predators that eat them.

Tomato Horned Worm

The tomato horned worm is controlled by manual collection.

White Fly

White fly is repelled by Basil. Control it by spraying an infusion of neem seed oil or neem leaves.

Control of some Major Diseases

Anthracnose

To control anthracnose, rotate crops and remove infected plants. Do not touch healthy plants with infected hands, tools or clothing.

Blight

Mulch and crop rotation help control blight. Spray plants with a gallon of water with 2 Tablespoons of baking soda and neem. Do not touch healthy plants with infected hands, tools or clothing.

Rust

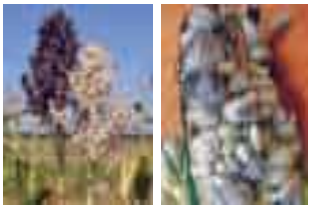
Mulch and crop rotation help control blight. Spray plants with a gallon of water with 2 Tablespoons of baking soda and neem. Do not touch healthy plants with infected hands, tools or clothing.

Damping Off

This disease can be controlled in the nursery by using high organic matter soil from the beds to start the plants, by controlling humidity and by ensuring a good flow of air.

Smut

Smut disease is controlled by burning infected ears before they open.



Mold

Mulch and crop rotation help control blight. Spray plants with a gallon of water with 2 Tablespoons of baking soda and neem.

Viruses

Viruses are controlled by controlling sucking insects and by burning infected plant material.

Citrus Greening

It is necessary to control sucking beetles and to burn infected plant material. The application of a gallon of water with 2 Tablespoons of baking soda to plants may prevent its spread.

How to Make a Good Spray to use against Pests

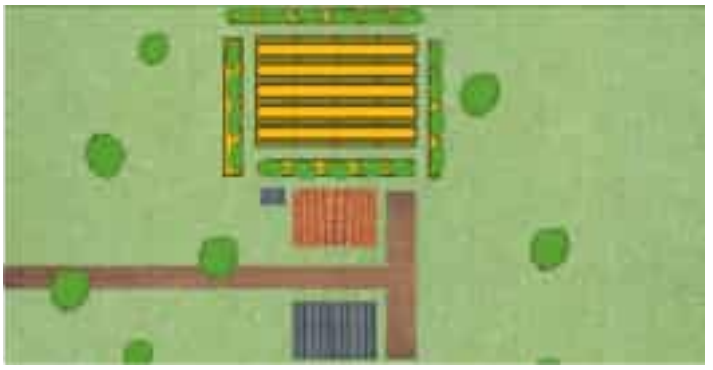
To make a good infusion against pests the ideal is to use a mixture of chili, neem, garlic, marigold, castor bean, tobacco and lemongrass.

If some of the ingredients are not available, a part of them can be used. The infusion is prepared by boiling the ingredients in water. Mix one part of the infusion with two parts water and spray all surfaces; both over and under leaves.

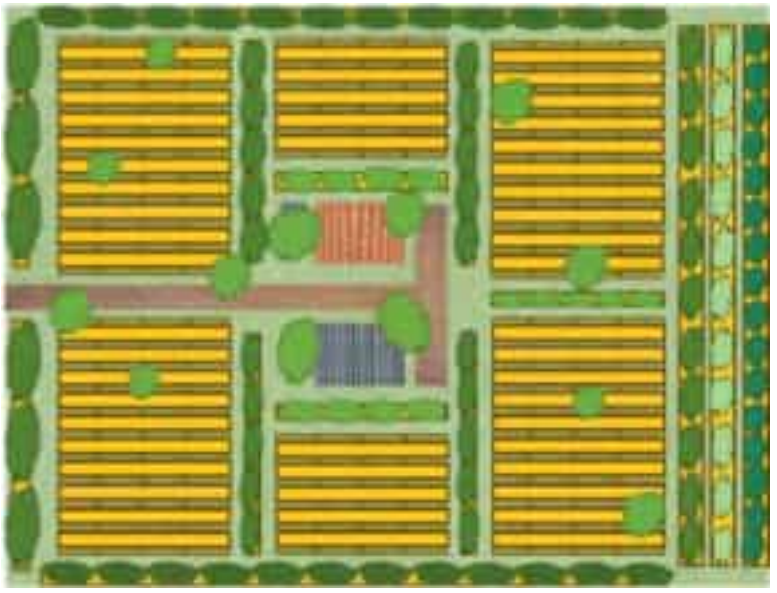
This is done late in the afternoon or in the evening so that you do not harm bees. Prevent the infusion from penetrating the mulch, since it could harm beneficial organisms.

10. Starting and growing the system

- It is best to start small in order to get accustomed to growing so many different crops together.
- A trial of 10 x 10 meters to 10 x 20 meters in size is best (150 to 300 square meters with 6-12 ten meter long beds).
- It is important to plant trees at the beginning (20 to 30 of them).
- One or two beds can then be built each day over a couple months to arrive at fifty raised beds (about three Tareas).



- This is good for a small family; using 40 to 60 hours a week to grow the family`s food and more to produce income.
- This size system has about a hundred fruit and nut trees.
- These will provide food, firewood and mulching materials.
- If possible, the beds should surround the house to provide as much security against theft as possible.



11. Ultimate recommendations

- Always plant on raised beds.
- Leave small dams or dikes in the channels between beds to prevent erosion and to catch all the rainwater that falls.
- Never walk on the raised beds.
- If you want to have production in the dry season, water the beds at least once a week to keep them moist.
- Except for harvesting, never open the ground after building beds, tillage kills organisms that contribute to the plants.
- Beds should never have empty areas, even in the dry season.
- Do not use all the seeds: always save enough seed for replanting if losses occur in the first plants. The extras are a guarantee of food security.
- Pre-germinate seeds. This reduces the risk of lost production and uses less seed.
- Diversify the plot as much as possible, with fruit trees, medicinal plants, herbs, shrubs, vegetables, roots, tubers and any plant you need or want.
- Do not burn organic matter or make compost: Weeds and crop residues are the real wealth of the farm.
- This system will produce good harvests in both wet and dry years. But, if it is not applied in an integral manner, it will not be sustainable. It is vitally important that you not try to mix this system with other agricultural methods unless you have proven that it works.

12. Final Comments

Most food is produced by small farmers: they are the ones who are feeding a growing population.

The main challenges facing food production today are extreme weather events: drought and floods. Indigenous systems were developed and used over thousands of years of evolving climatic conditions. It was continually adapted to produce food during extreme conditions.

This form of Agriculture makes food production resistant to climate extremes, increases productivity, produces healthy food and accomplishes this in a sustainable, and environmentally friendly manner.

In the event of flooding, the beds hold roots up in well oxygenated soil. During droughts, the beds retain moisture, which allows the plants and trees to absorb the little water that falls as rain. This also contributes to the continual recharge of waterways.

Finally, we want to say that it is our desire that the information shared in this manual is useful for the production of abundant food in all weather conditions, by the people who are affected the most by the erratic weather that has been caused by the quickly deteriorating climate system on the earth. We have hope that this information will enable them to survive and thrive in these difficult times.

Annex 1. Forest Garden Map

Always begin each season with a map showing where to plant each crop.

Show the beds, trellises and perennials when you draw the map.

Do not plant similar groups of crops in adjacent five meter sections of bed.

Plant something from the bean family with maize, sorghum or other grain.

Make new maps as the season progresses and you replace harvested crops.

Date maps and save them as a record of what was planted in each bed.