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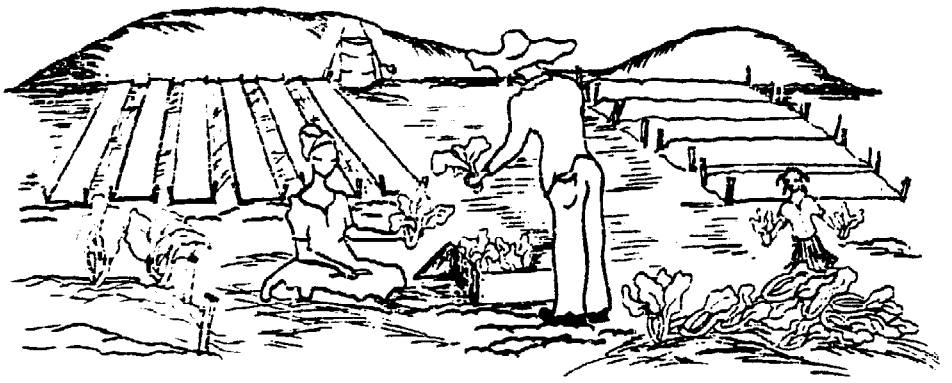
INTENSIVE VEGETABLE GARDENING FOR PROFIT AND SELF-SUFFICIENCY



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INTENSIVE VEGETABLE GARDENING

FOR PROFIT AND SELF-SUFFICIENCY

Written and Illustrated by

Deborah and James Vickery

Edited by Merlyn Kettering

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We shall always remember the warm times shared amongst the people, and especially the youth, who are concerned with the future of agriculture in Jamaica. To these persons we dedicate this book.

Deborah and James Vickery
Peace Corps Volunteers
August, 1977

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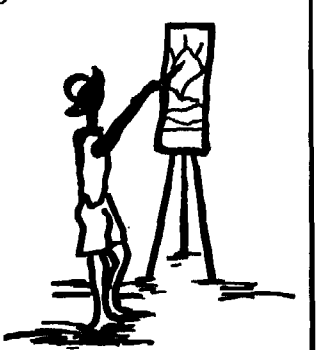

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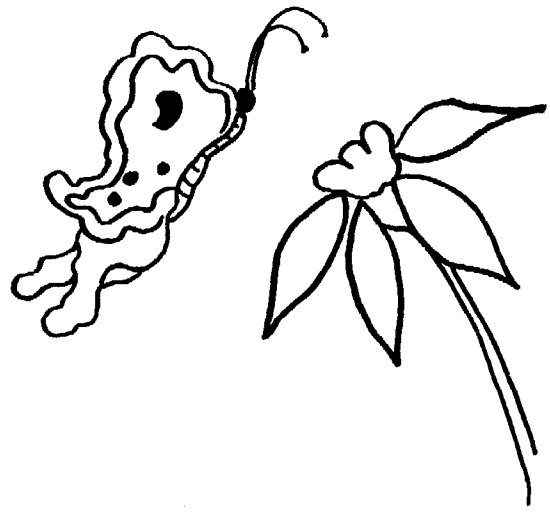

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INTRODUCTION

INTENSIVE VEGETABLE GARDENING FOR PROFIT AND SELF-SUFFICIENCY

A Manual for Small Farmers and Gardeners in Jamaica

The purpose of this manual is to demonstrate how small farmers and garden producers in Jamaica can increase their production. This will increase their income and will help Jamaica achieve the goal of self-reliance in food.

* * * * * *

The methods introduced in this manual will help the small producer be more productive. Vegetables and pulses grown with the methods in this manual can increase the profits and production of small farmers. * The methods introduced are know as Intensive Vegetable Gardening. Through the natural organic production methods, more crops can be harvested than with present conventional methods on the amount of land now available for cultivation.

Intensive vegetable gardening means that the farmer's labour, land and resources are used to achieve maximum yields in the smallest possible area. The intensive gardening method has been proven to yield an average of four times more vegetables per acre than the amount grown by producers using mechanized "modern" agricultural methods! It also uses less water. To show the high productivity of the methods, it has been demonstrated that the intensive raised bed technique can produce enough vegetables from an area of 500 square feet to feed one person for an entire year! This area can yield well over 875 pounds of vegetables per year, and even much more when different crops are grown, and when the growing season of a total year is exploited.

* Throughout this manual, the terms "farmer", "gardener", "small farmer", "market-gardener", "farmer-gardener" are used interchangeably to refer to persons who will be using intensive vegetable gardening to produce food crops on relatively limited land areas.

The term "vegetable" is used to refer to the wide variety of vegetables, pulses and tubers which are grown commonly in gardens and small farms as food crops for home use or for marketing.

The advantages of Intensive Vegetable Gardening are;

(1) Four times as much produce can be grown per acre of land planted.

(2) One half as much water is required per pound of produce.

(3) Soil fertility is maintained and improved to increase future yields.

(4) The methods are land intensive and labour intensive so that the best use is made of Jamaica's resources.

The increased production of four times normal amounts may not be achieved during the first or second season, but significant increases will definitely be achieved with the very first crops. The speed with which increased production is achieved depends solely upon the farmer's skills in improving and maintaining the fertility, texture and structure of the soil. To accomplish this, the farmer must apply organic manures, compost, soil texturizers, and chemical fertilizers in a manner that will provide balanced nutrition for productive healthy plant growth.

This manual will help the intensive gardener develop a practical and working knowledge of soil fertility. Through Intensive Vegetable Gardening, increased production on limited lands is achieved, thus increasing the profits and incomes of the small farmer.

Jamaica has been experiencing critical food shortages and is now engaged in a self-reliance program to become more self- sufficient in food production. Many small plots of land can be put to more productive use through the methods introduced in this manual. By working with intensive vegetable gardening methods we can all participate in learning and producing to Rely On Ourselves To Survive.

In short, this manual provides the knowledge, to help grow more food on less land. This increases incomes and provides for a better supply of food for the family, the nation and the world.

How To Use This Manual

The manual is divided in to a number of logical chapters. CHAPTER ONE entitled Botany, deals with the basic structure and functions of a plant. This chapter is included to give the farmer or gardener a basic understanding of plants as living things, so that the he might further develop his sense of determining and responding to the needs of crop plants.

CHAPTER TWO titled Soil and Fertility, is meant to familiarize the farmer with the basic workings of the soil and it's fertility so he can better understand the intensive soil building practices used in this manual that are so important to intensive agriculture.

The rest of the book deals with the methods and techniques of intensive vegetable production and how they can be applied to the small farm, homestead, or city garden. CHAPTER THREE, entitled Soil Management and Improvement, deals directly with the methods used to increase the soil fertility and maintain it under the conditions of continual intensive succession cropping. CHAPTER FOUR, entitled Garden Planning presents the methods for the exacting task of intensive garden planning and brings to attention the importance of this skill. CHAPTER FIVE, titled Soil Preparation, deals mainly with the techniques used for the preparation of intensive raised beds. CHAPTER SIX entitled Water, deals with methods of watering and irrigation, and the importance of water conservation. CHAPTER SEVEN, Planting, presents the methods and techniques used by farmers to plant their crops. The emphasis is on close planting techniques that increase the plant population in a given area. CHAPTER EIGHT, Cultivation For Highly Productive Gardens, is a study of intensive cultivation methods that strive to give the plants the best conditions and care, for health and production. Examples of the production and profit from intensive gardening are presented to demonstrate the advantages of these methods. Finally a set of tables is provided to help the farmer make actual plans, and get started with intensive vegetable production. These include Spacings for Intensive Method of Growing Plants in Beds, Seeds Per Ounce and Germination Rates, A List of Common Garden Vegetables With Their Companions and Antagonist, and Estimated Yields Per 1 acre of Intensely Planted Ground.

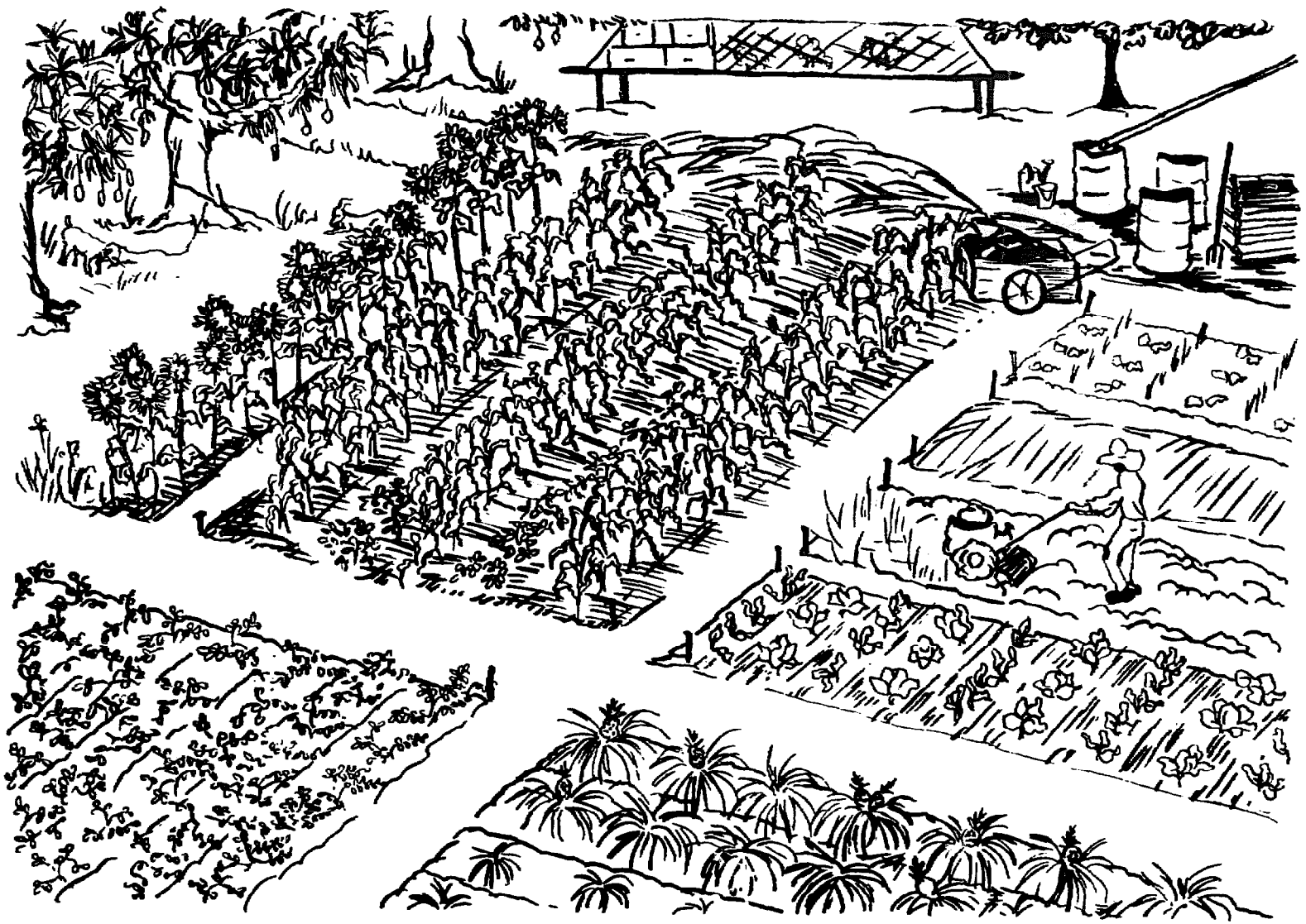


FIG. 1.0

AN INTENSIVE MARKET GARDEN

CHAPTER ONE

BOTANY

The plant is the basic unit of agriculture. No form of life can live on earth without the green plant and its ability to convert sunlight and raw materials into food for man and animals.

The farmer must have a basic working knowledge of plant structures and their functions. This knowledge allows the farmer keener insight into the working of his crop plants. It helps him understand the problems and needs of his crops so that he can improve crop productivity.

1.1 PLANT STRUCTURE

Plants have two important parts - (1) the root system below ground, and (2) the shoot system which is above ground. The root system absorbs water with nutriments from the soil and also serves to anchor the plant. The shoot system is made up of the stem bearing leaves, branches, flowers and fruits.

1.1.1 Roots

Roots have two main functions: (a) to gather and absorb food and moisture from soil, and (b) to store and transport these nutriments to the above ground parts of the plant, or the shoot systems. The process of absorption is actually performed by the tiny root hairs. Root hairs are actually very small roots, finer than human hair, which absorb nutrients from their very close contact with soil particles. Soil particles are covered with a thin film of water in which mineral nutrients are dissolved. The transport and storage of nutrients and water takes place in the larger roots.

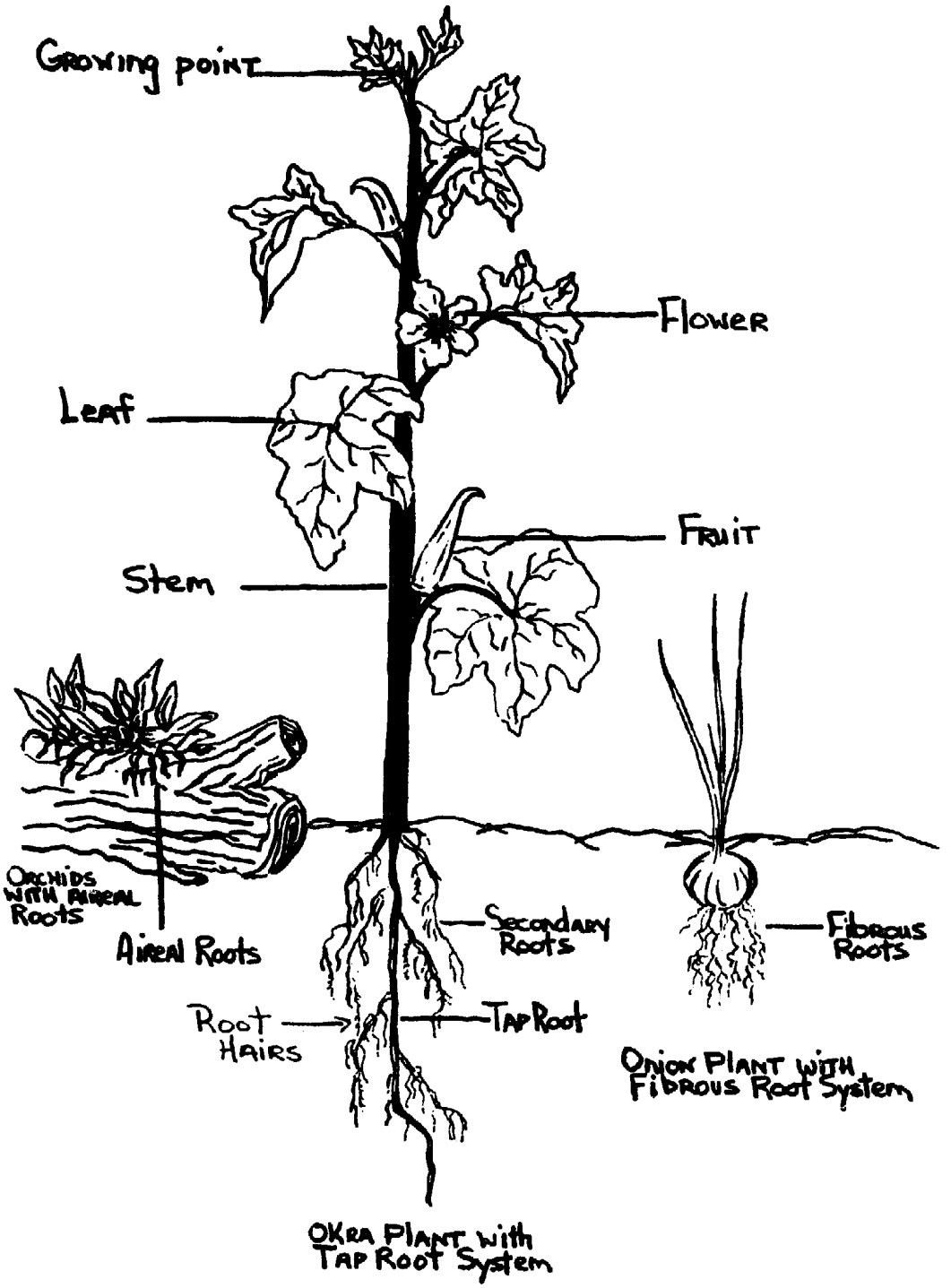


Figure 1.1 ROOTS

Roots are a very important part of the plant especially to the small farmer, because their growth and workings can be greatly influenced by man's treatment of the soil. For example, heavy clay soils and poorly drained soils present special problems for roots. Also overwatering can force all the air out of the soil and kill the roots. For the root and root hairs to live in the soil there must be air. The roots must have oxygen to breathe and grow.

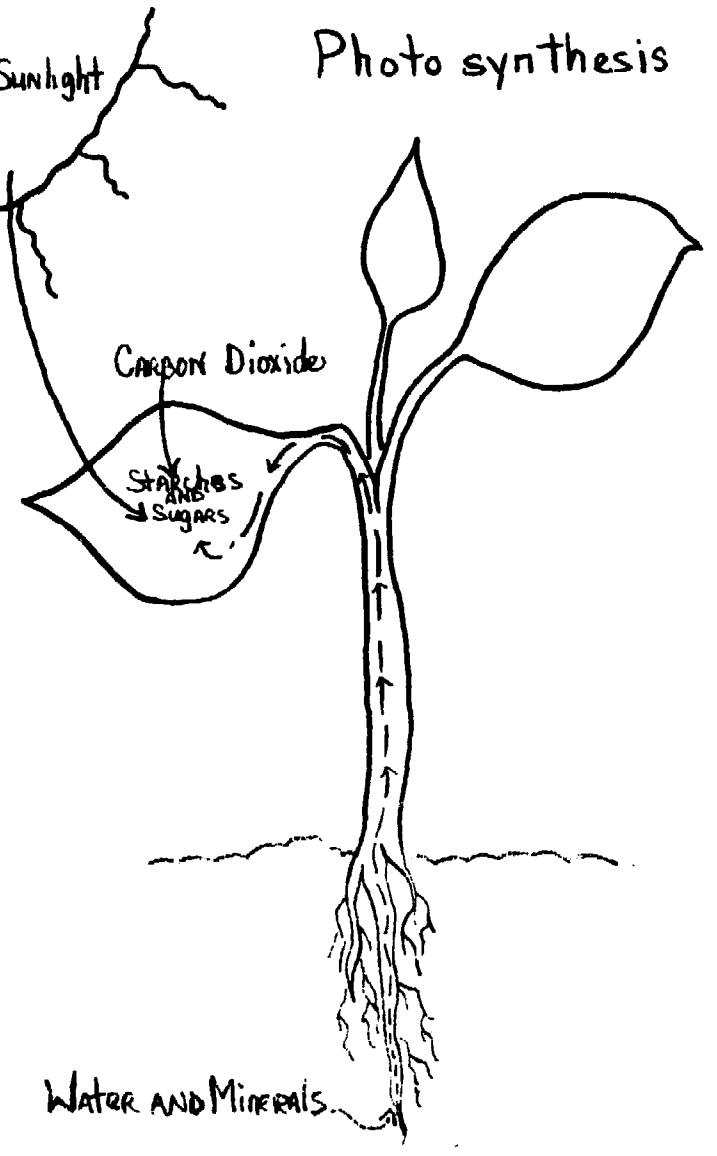


Figure 1.2 PHOTOSYNTHESIS

Roots take in nutrients for growth through root hairs. The more root hairs a plant has, the more nutrients it can take in. Many root hairs are lost when roots try to push through hard and tight soil. The basic principle of intensive vegetable gardening is to properly prepare the soil to stimulate root growth.

For root and root hairs to live in the soil there must be air. The roots must have oxygen to breathe and grow.

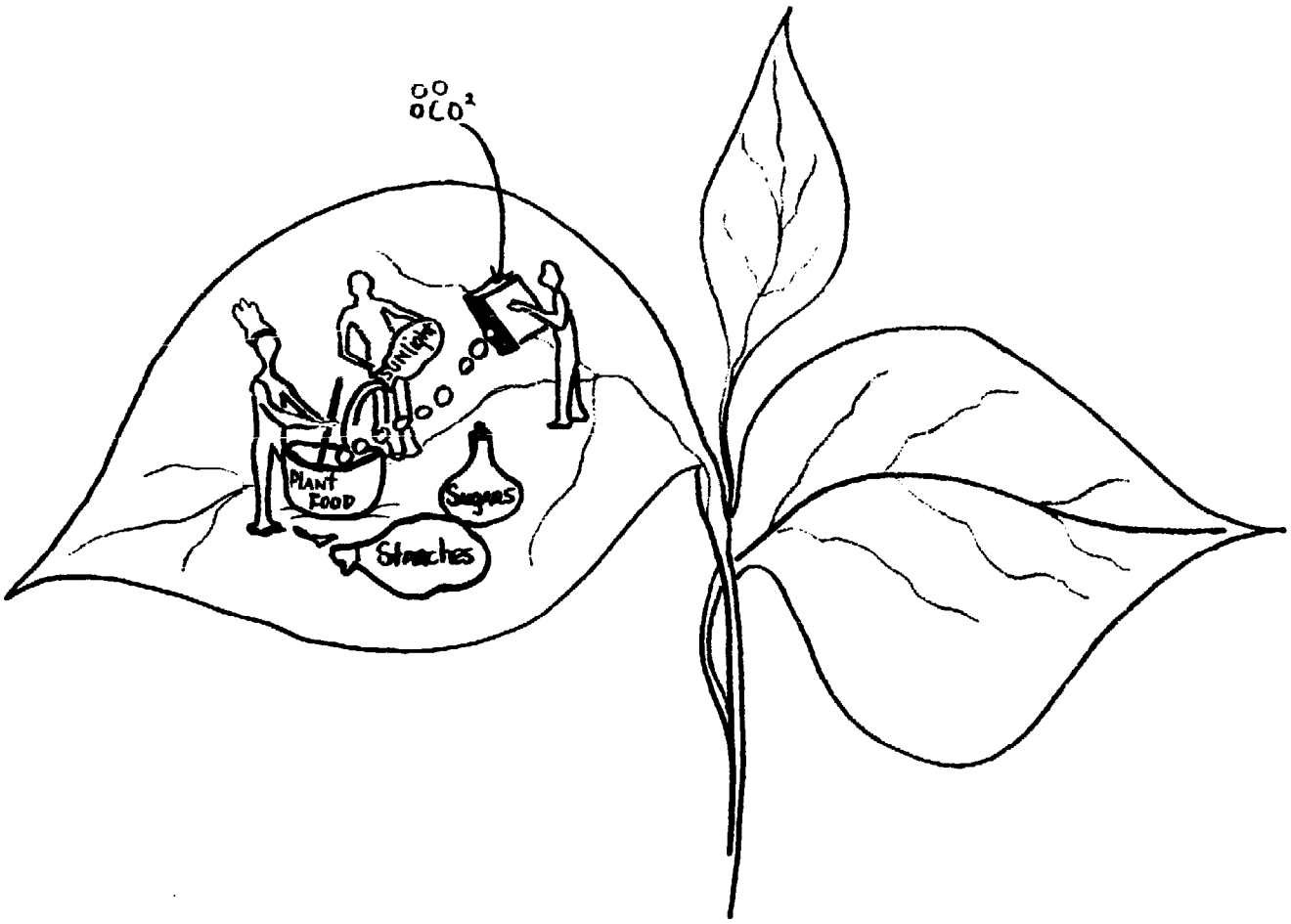
Since roots are hidden in the soil, they are often neglected. The successful small farmer must constantly strive for strong healthy, plentiful root growth, to produce stronger, healthier, and more plentiful crops.

1.1.2 The Shoot System

The shoot system above ground is the most obvious part of the plant. It consists of the leaves, stems, flowers, and fruits. The leaves and stems are the most common parts of the plant as they makeup almost the entire exposed portion of the plant.

1.1.3 Leaves

The importance of green leaves is easily overlooked. Besides telling us about the health and nourishment of our crop, green leaves are actually the food factory for the plant. In the green leaf, sugars and starches are made for plant growth and for storage in the roots and the fruits. This is no common task. In fact, the green leaf is the only living thing in the world that can transform the sun's light into food energy! Photosynthesis, the process by which the leaves perform this task, is very complicated and still not completely understood by the experts. (see figure 1.2)



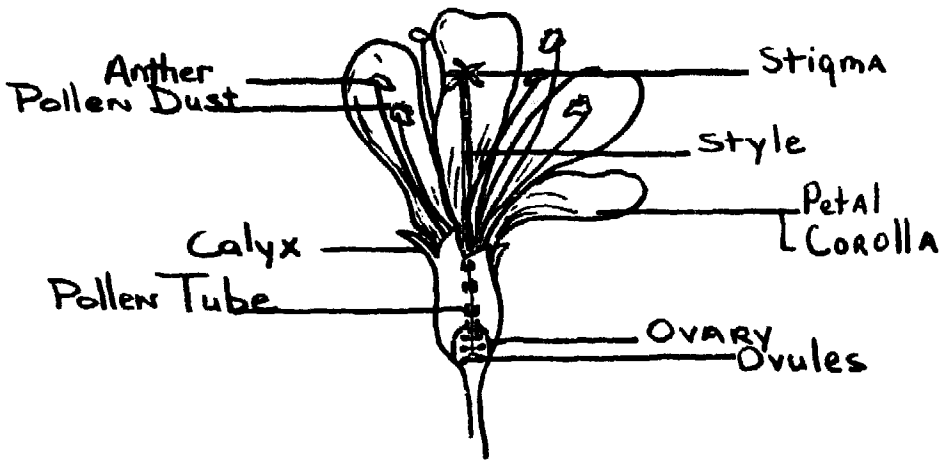
Simply speaking, to make starches and sugars the leaves take in certain elements from the air and combine them with water and nutrients brought up by the roots from the soil. Sunlight is the energy used to perform the task. This process can only take place in the green parts of the plant. When yellow or off-coloured leaves are noticed on the crop, the farmer knows that such plants are not producing food. Off coloured leaves indicate a crisis for plant growth. The farmer should strive to understand and correct the problem. (Ref. to fig. 1.2)

1.1.4 The Stem

The stem's main purpose is transportation. Stems transport nutrients and water from the roots to the leaves and transport sugar and starches from the leaves to the fruits and roots. The farmer must handle and cultivate plants very carefully so that plant stems are not injured. They should receive the same care we give our own veins. That is, life flows through them !

1.1.5 The Flower

The flower is usually the most appreciated part of the plant mainly because of its beauty and tasty fruits that often follow. The flower is very important to the plant. It produces the seed for future generations. A complete flower contains the male and female parts that unite and form the seed. The male flower part produces a yellow powder called pollen. The pollen is carried to the female egg by wind or more often by honey bees and other insects. In order to attract bees to carry pollen many flowers have bright colours and sweet smells. (see figure 1.3)



INFORMATION:

* This flower contains both male and female parts, a Bi-sexual Flower. Some flowers may be of one sex, either male or female.

Anther - The male part which releases pollen.
Stigma - The female part which catches the pollen.
Pollen dust - The fertilizing agent of the male part.
Style - The outer covering of the pollen tube.
Pollen Tube - The female part that carries the pollen towards the ovaries.
Ovary - The female part which holds the ovaries; the egg case.
Ovules - The eggs
Corolla - The petals of the flower, usually of a color
Calyx - The petals under the corolla, usually a green color.

Figure 1.3

THE PARTS OF THE FLOWER

1.1.6 The Seed

As every farmer well knows, the seed is a very important part of agriculture. The seed consists of a small plant inside and a supply of food around the tiny plant. The stored food actually makes up most of the seed. Seeds are usually encased in a pod as in red peas, or in a fruit like tomatoes.

The seed allows the farmer to plant for new crops each season. Properly dried and stored, seeds can be stored for years and when planted still produce a crop. Seeds from healthy, properly cared for plants, produce stronger plants and healthier larger crops. Proper storage can affect crop growth and yields. It is to the farmer's advantage to strive for good seed production and proper drying and storage.

By understanding and observing plant growth the small farmer is able to provide for his crops' needs. The serious farmer will become a keen observer of all aspects of nature that affect his farm. From observing and experiencing he will learn and put to use the laws of nature to produce a more fruitful land. (see figure 1.4)

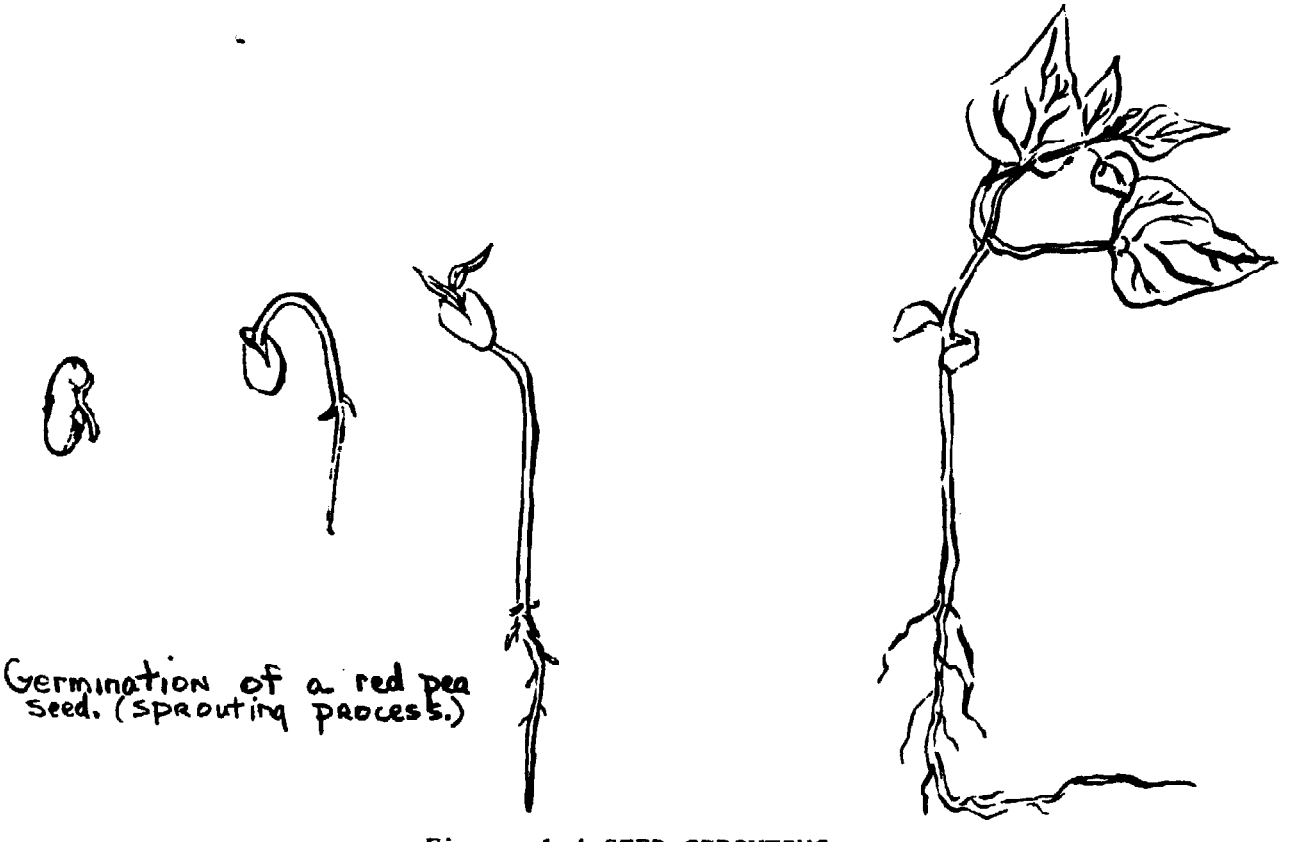
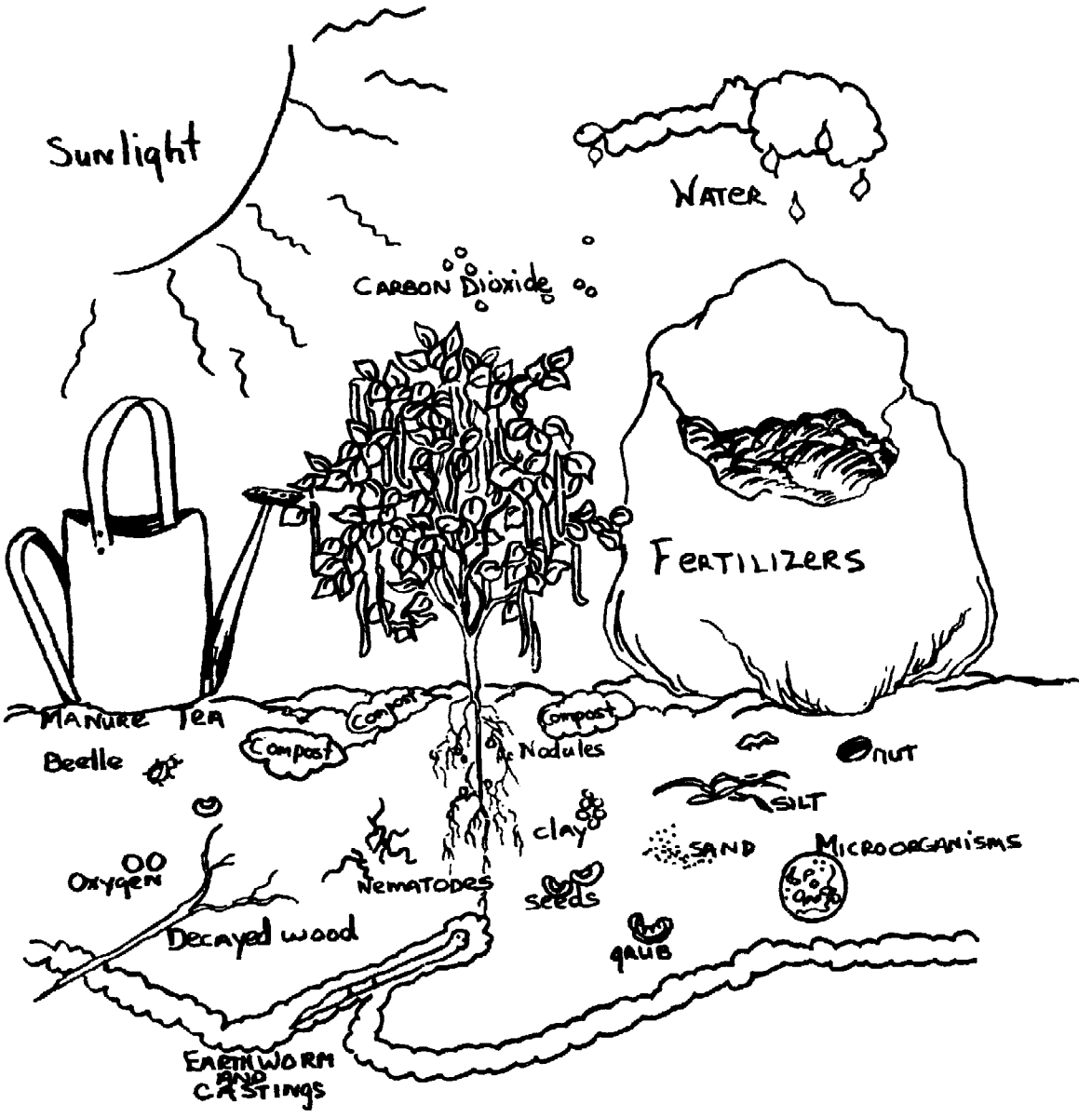


Figure 1.4 SEED SPROUTING



The Nature of Agriculture

Figure 2.0

CHAPTER TWO

THE SOIL AND FERTILITY

This section of the manual presents information needed to build and maintain soil fertility. The professional market gardener or farmer needs to understand his soil, and be able to properly access or estimate the physical properties and fertility of his soil. Good soil fertility is the foundation for producing increased yields through intensive market gardening.

Soil fertility is the life blood of the world's agriculture. Where the soil's fertility has been depleted entire civilizations have crumbled. It is truly the duty of the farmer to preserve the fertility of his soil: without it he and his nation cannot produce and survive!

To learn how to manage his soil's fertility the farmer must first understand how nature has produced and maintained the soil's fertility for hundreds of years.

2.1 THE FERTILITY CYCLE OF SOIL

Understanding comes through observation. Nature's fertility cycle can best be observed in the deep forest where the earth is covered with thick layers of dead and decaying leaves, plants, bark, insects and molds. Leaves, branches, animals, insects and soil microbes are constantly growing, dying and collecting on the floor of the forest. This mulch of leaves, stems and debris is put down layer upon layer as the seasons pass and builds up very thick in some places. As moisture collects in this mulch, conditions become right for soil microbes and mold grows, this causes the mulch to rot and decay. Slowly, coarse leaves and stems are changed into mineral nutrients by the rotting and decaying action of the soil microbes. In this way, the forest naturally produces its own fertility and continually replenishes it.

The lesson to the small farmer is nature's law of return to the fertility cycle of the soil.

To maintain and build soil fertility, the farmer must return decayed organic matter to the soil.

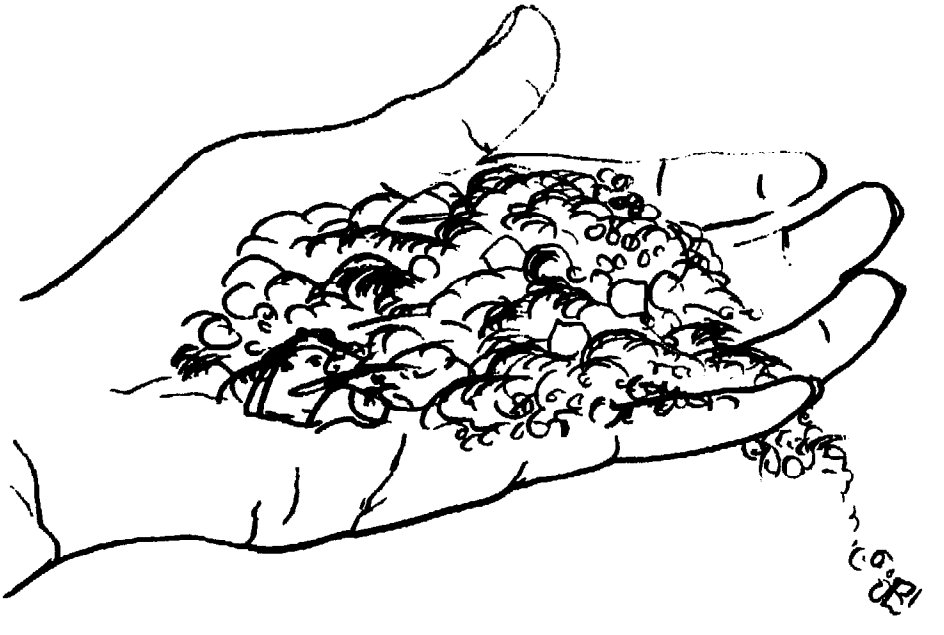
The soil's fertility can be thought of as a bank. If the farmer keeps drawing crops from the bank without returns, both he and the bank will soon go broke. But if he is always returning and building a savings of fertility, he will reap bountiful crops with interest for years to come.

2.2 A DICTIONARY FOR SOIL STUDY

The following list of terms and their meanings should be thoroughly understood by the professional market-gardener. These terms will help the small farmer to better understand and estimate the fertility and state of his soil.

2.2.1 Soil: Soil is the loose top layer of the earths surface that supports the growth of plants. Soil consists of mainly four parts: minerals, organic matter, water, and air.

2.2.2 Texture: Soil texture refers to the portions of different size particles that a soil has in it. These particles vary greatly in size. There are stones, gravel, sand, silt, and clay particles. Many particles may be too small to be seen except with a microscope.



2.2.3 Structure: Soil structure refers to the grouping together of the particles in a soil into larger pieces or granules. Good granulation or crumb structure of the heavier soils is essential to good growth and yield. Sandy soil shows very little granulation, as the sand particles do not stick together. Understanding soil structure is important in soil preparation. For example working with soils that are made up of mostly clay, when wet can destroy the good structure.

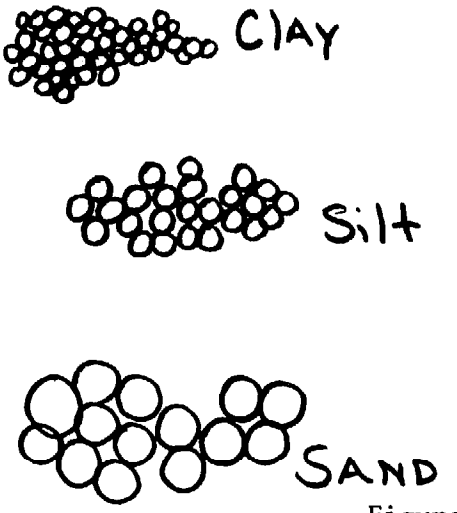


Figure 2.1
SOIL STRUCTURE

Plowing, cultivation, draining, liming and manuring the land all affect the soil structure. For example strong acid and strong alkaline soils tend to run together when wet and lose their structure. Good structure is most often found in soils that are near neutral in their reaction.

Adding organic matter to the soil is the main method by which a farmer can improve the structure and granulation of his soil. Organic matter not only binds soil particles together, but also lightens and expands the soil, making it porous and increases its ability to absorb and hold water, like a sponge. This effect is called "sponge structure". It is very desirable and beneficial to all soils. Healthy plant roots also help greatly in improving the structure of soil.

2.2.4 Porosity: Soil porosity (also called pore space) is related to soil texture. The pore space of a soil is that portion of the soil occupied by air and water. The amount of pore space a soil has is determined by the structure and granulation of the soil particles. In sandy soil the pore spaces are large, in clay soils the pore spaces are more numerous and smaller. Good soils have 40 to 60 percent of their bulk

taken up by pore space. Pore space may be filled with either water or air.

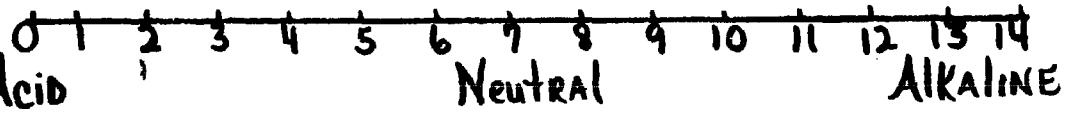
In very sandy soil the pore spaces are large. The result is that water goes through the soil very fast and is lost to the plant. These soils dry very quickly. On the other hand a very clay soil may hold too much water. This causes the roots to rot. Also water cannot penetrate the surface quickly. This causes much water to be wasted running off and leads to a loss of soil through erosion.

Porosity is greatly benefited by organic matter, manures and compost. These materials make the soil porous, like a sponge. Soil is then able to take in larger amounts of water and air quickly and hold them.

2.2.5 Water: Soil water occurs in three forms; hygrosopic, capillary, and gravitational. The hygroscopic soil water is chemically bound to soil elements and cannot be taken up by the plant. Gravitational water is that which normally drains out of the pore spaces after rain. If drainage is too good the capillary water runs short faster and plants suffer from drought.

It is the capillary water upon which plants depend for their supply of moisture. The ability of the soil to hold and store water is of great importance to the gardener and his crops. Organic matter and good structure increase this supply of available water in the soil.

2.2.6 Soil pH: The term pH is the method of expressing the amount of soil acidity or alkalinity. This is commonly known as the "sourness" or "sweetness" of the soil. There is a pH scale which measures from 0 to 14. The 0 end of the scale is the acid end, and the 14 end of the scale is the alkaline end. A pH soil testing of 7 will be exactly neutral, that is the soil is neither acid



or alkaline. A soil testing of a number greater than 7, say 8.5 would be an alkaline soil. A soil testing less than 7, say 6.0 would be an acid soil. Usually most common vegetables, field crops, fruits and flowers grow best on soils that have a pH of 6.5 to 7.0, in other words, a soil that is slightly acid to neutral.

Soil pH is important to the gardner because certain plants' food cannot be taken up by the plant if the soil is either too acid or too alkaline. In areas with much rain, soils will usually be acid. Acid soils can be corrected by adding and mixing ground limestone to the soil. This raises the pH of the soil.

After the farmer has determined his soil type, he can then determine the amount of limestone to apply to his land. The information in chart 2.1 will help the farmer figure his limestone needs. To use the chart the farmer would first locate his soil type in the column on the left hand side of the chart, then read across to the column in which his soil's pH is located. Assuming the soil type is muck and the pH level is 5 the farmer would see that he needs 3 and one third tons of limestone to adjust the pH for one acre of his soil. (See 2.3.1)

CHART : 2.1

Tons of Ground Limestone per acre needed to raise pH

Soils of Warm Temperate
And Tropical Regions

	from pH 3.5 to 4.5	4.5 to 5.5	5.5 to 6.5
Sandy and loamy sand	0.3	0.3	0.4
Sandy loam	...	.5	.7
Loam	...	.8	1.0
Silt loam	...	1.2	1.4
Clay loam	...	1.5	2.0
Muck	2.5	3.3	3.8

2.3 SOIL TESTING

A professional market/gardener benefits from knowing as much about his soil as possible. He should know what general type of soil it is, what plants will grow best on it, and how to fertilize it. By testing the soil, the farmer can learn what plant nutrients are present in his soil and which ones are scarce or missing. The first test the farmer should make is a pH test. As mentioned before,this will tell him if his soil is too acid or alkaline. In soils that are too acid or alkaline, certain plant nutrients will not be available to the plant, causing the plant to starve for those nutrients.

2.3.1 The Soil Test Kit

For a soil test, the farmer may either request the local extension officer to test his soil or a small test kit can be purchased for less than ten dollars. The soil test kit comes under various brand names in different sizes and prices. The smallest, cheapest test kits can test pH and nitrogen, phosphorous, and potash the three fertilizer elements. Larger test kits are more expensive but can test pH as well as for the eight major plant nutrients, and some of the minor plant nutrients.

A kit usually contains test tubes, colour charts, and reagents, which are chemicals that react with the plant nutrient being tested for. The presence or amount of the plant nutrient is determined by comparing the colour with the colour charts. The test is made by putting a small portion of the collected sample in a test tube. Then a reagent or two is added to the test tube and a comparison is made between the colour of the mixture in the test tube with the colour charts.

SOIL COLLECTING JARS

Figure 2.2

2.3.2 Collecting the Soil Sample

This is the first step in making a soil test of any kind. Collecting the soil sample is a most important and critical part of soil testing. Because the nutrients in the soil may vary greatly in different parts of the garden or field, samples must be collected from different locations in the garden or field. It is a good idea to number your samples and record their locations on a garden map to avoid mix-ups or confusion. Each sample can be tested alone.

Also the samples can be mixed together and tested.

To collect a sample, cut a thin slice of soil about 6 inches deep, and 1 - 2 inches wide. This will give you a good test of topsoil layer which is usually 4" - 6" deep. Always be careful not to gather samples where fertilizer bags have been thrown or spilled as this will cause the test to be inaccurate.

It is wise to gather samples where you notice special problems such as stunted plants.

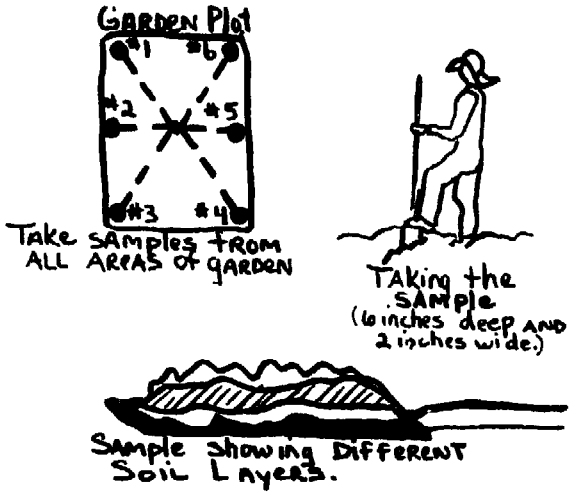


Figure 2.3

2.3.3 Testing Soil Texture

The farmer can tell much about a soil texture by just feeling the soil. Usually it is helpful to wet the samples before feeling them. By rubbing a damp soil sample between thumbs and fingers a farmer can get a good idea of how much sand, silt and clay are in the soil. Clay will feel sticky and can be roiled very thin, sand feels gritty, and silt has very smooth, floury or powder feel.

Figure 2.4 The "Feel" Method

An accurate method of determining the texture of soil is by mechanical analysis, using the settling jar method. This method is very simple and requires no special materials.

SETTLING JAR METHOD

In this method, simple sedimentation is employed with a minimum of equipment.

1. You will need a quart jar (clean, clear, smooth glass) a millimeter ruler, soil sample and calgon water softner.
2. Prepare an 8% calgon solution. This is done by adding six tablespoons of Calgon Water Softner to one quart of water and shake well.
3. To obtain a soil sample, scrape away the top few inches of debris from any area of ground. Dig a core of dirt from the first six inches and run the soil through a 1/8" mesh sifter. This is your soil sample.
4. Place one-half cup of your soil sample in the quart jar. Add five tablespoons of the 8% Calgon solution. Add 3½ cups of water. Close the jar and shake for five minutes.
5. Place the jar on a level place and let stand for forty seconds. Measure the depth of the settled soil with a ruler. It is important to measure in millimeters because it is more precise, and saves you the job of mathematical conversion when it comes time to work on the percentages. This first layer to be measured is the sand layer.
6. At the end of thirty minutes, measure the depth of the settled soil again, subtract the depth of your sand layer from this second measurement in order to obtain the depth of the silt layer.
7. The measurements you have made may be converted into percentage figures by substituting your values for the ones in the formulas below:

$$\% \text{ Sand} = \frac{\text{depth of sand layer}}{\text{total depth of sand}} \times 100$$

$$\% \text{ Silt} = \frac{\text{depth of silt layer}}{\text{total depth of soil}} \times 100$$

$$\% \text{ Clay} = 100\% - (\% \text{ sand} + \% \text{ silt})$$

The fertility of the soil as we have stated before is of utmost importance to the farmer as well as to the plant. This section reviews the minerals, and nutrients that the soil must supply to the plant for balanced growth and development.

2.4 ELEMENTS REQUIRED FOR PLANT GROWTH

There are thirteen elements that the soil must supply to the plant for healthy growth. Six of these elements are used in greater amounts by the plant, so they are called the major nutrients. The remaining nine elements are only needed in small quantities so they are called the minor nutrients. All these elements must be present for healthy plant growth. Nitrogen, Phosphorous, and potassium are usually considered the most important major nutrients. These are the three nutrients present in bagged fertilizer.

CHART 2.2 MAJOR & MINOR NUTRIENTS

MAJOR NUTRIENTS	MINOR NUTRIENTS	
Nitrogen - N	Manganese	Molybdenum
Phosphorous- P	Boron	Chlorine
Potassium - K	Zinc	
Sulfur	Aluminum	
Calcium	Silicon	
Magnesium	Copper	
	Iron	

2.4.1 Nitrogen

Nitrogen is one of the most important elements in the soil. When there is too much or too little nitrogen in the soil, productivity declines. There must be a continual renewal of nitrogen in the soil,because this nutrient is essential for plant growth and is always being removed from the soil by crops, rains and other natural processes

Nitrogen is directly responsible for leaf and stem growth of plants. When nitrogen is available in the right amounts the plants grow strong and mature quickly. With the right amount of nitrogen, plants have a rich, green colour. When the plants are starving for nitrogen, their green colour becomes pale,or even yellow in severe cases.

Too much can cause as much harm as too little nitrogen. An excess of nitrogen usually occurs when concentrated chemical forms of nitrogen fertilizers are used. Although these types of fertilizers cause the plant to make fast, lush, watery growth, the plants are usually more susceptible to disease and insects. This type of unbalanced growth results when the excess nitrogen displaces other nutrients which the plants need.

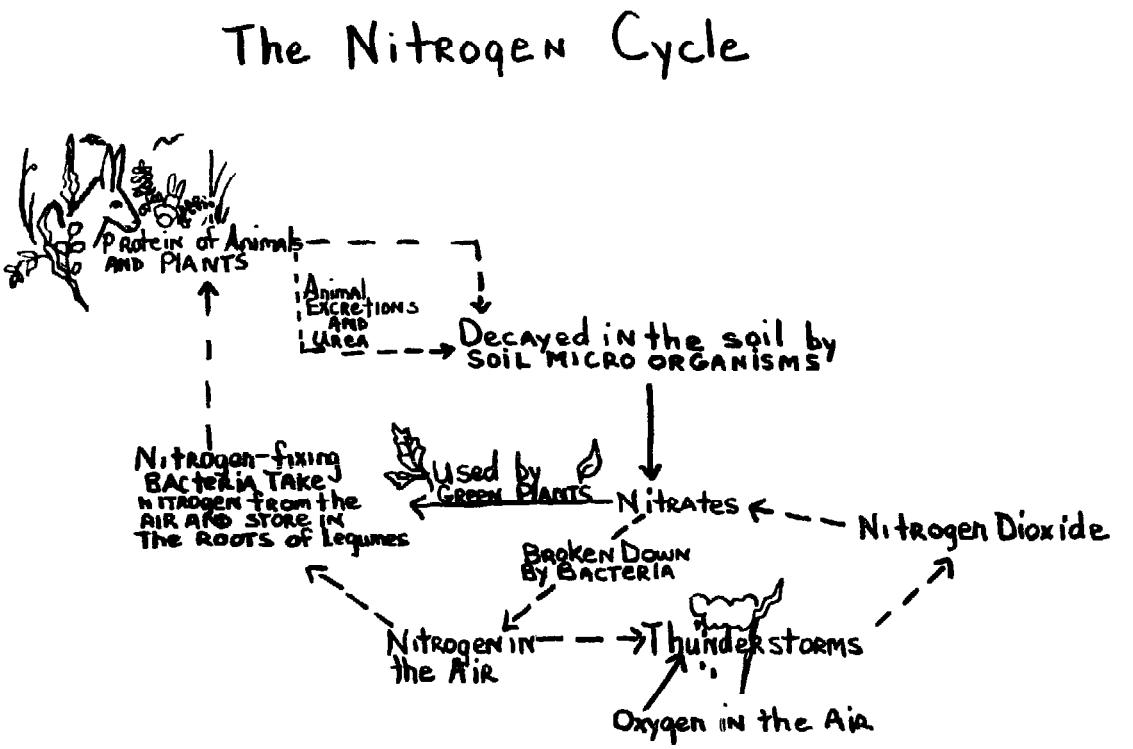


Figure 2.5 THE NITROGEN CYCLE

Forms of nitrogen fertilizers such as animal manures, peanut shells, etc., feed nitrogen to the plants slowly over a longer period of time. This provides a more balanced and resistant plant growth. Nitrogen in organic matter is released by the action of soil microbes. (Small bacteria and molds which cannot be seen without a microscope). Soil microbes cause organic matter to decay and nitrogen is released in a form that can be taken in by plant roots.

Chart 2.3 is a list of organic materials and their nitrogen values. The farmer should use this chart as a guide when searching for nitrogen rich values for composting or fertilizing.

CHART 2.3

Nitrogen Content of Organic Materials

Materials	% Nitrogen		% Nitrogen
Bone black bone meal	1.5	Fresh crabs	4.6
Raw bone meal	3.3 to 4.1	Dried ground crabs	10
Steamed bone meal	1.6 to 2.5	Dried shrimp heads	7.8
Cottonseed meal	7.0	Lobster wastes	2.9
Corn fodder	.49	Mussels	1
Oats, Green fodder	.49	Shrimp waste	2.9
Corn silage	.42	Dried ground fish	8
Gluten meal	6.4	Acid fish scrap	4.0 to 6.5
Wheat bran	2.3	Oyster shells	.36
Wheat middlings	2.7	Milk	.5
Wheat meal	9 to 11	Wool wastes	3.5 to 6.0
Bone tankage	3 to 10	Beet wastes	.4
Cattle manure, fresh	.29	Brewery wastes	1.0
Cattle manure, urine	.58	Castor pomace	4.0 to 6.6
Hen manure, fresh	1.63	Cattail reeds	2.0
Dog manure	2.0	Cocoa shell dust	1.0
Horse manure, solid fresh	.44	Cocoa wastes	2.7
Horse manure, fresh urine	1.55	Grape pomise	1.0
Human excretment, solid	1.00	Green cowpeas	.4
Human urine	.60	Nutshells	2.5
Night soil	.80	Peanut shells	3.6
Sheep manure, solid fresh	.55	Peanut shell ashes	.8

cont'd

Materials	% nitrogen		% nitrogen
Sheep, fresh urine	1.95	Potato skins	.6
Stable manure,mixed	.50	Sugar waste	2.0
Swine manure, solid, fresh	.60	Tea grounds	4.1
Swine fresh urine	.43	Coffee waste	2.0
Sewage sludge	1.7 to 2.26	Tobacco stems	2.5 to 3.7
Bat manure	6-10	Corn stalks	.75
Eggshells	1.0	Alfalfa	.24
Dried blood	10 to 14	Cowpea hay	3.0
Feathers	15.3	Pea hay	1.5 to 2.5
Dried jellyfish	4.6	Soybean	1.5 to 3.0

2.4.2 Phosphorous

The second of the three major elements, phosphorous, is essential for healthy growth, strong roots, fruit development, and greater resistance to diseases. When virgin lands are first brought under cultivation, there is fast decay of the organic matter and humus.

Decay produces acids that make locked up phosphorous in the soil available to plants. As the humus decreases so do acids. Phosphorous then becomes locked up and the plants starve for phosphorous. Here again the farmer/gardener realizes the importance of returning organic matter to the soil. In chart 2.4 the farmer can see that many locally available materials can supply phosphorous to his crops. This chart will help the farmer locate those materials that have the highest phosphorous value for composting and fertilizing.

CHART 2.4

Organic Sources of Phosphorous

Materials	%Phosphoric acid		% Phosphoric acid
Bone meal, raw	22-25	Cow manure, fresh	0.25
Steamed bone meal	30	dried	1.0

Cont'd

Materials	% Phosphoric acid	Materials	% Phosphoric acid
Bone black, bone meal	30	Wood ashes	1-2
Shrimp waste, dried	10	Peapod ashes	3
Dried ground fish	7	Banana trash ashes	2.3-3.3
Lobster refuse	3.5	Citrus waste, orange skins, ashed	3
Bat manure	10	Dried blood	1 to 5
Tankage	2	Hoof and horn meal	2
Woolwastes	2-4	Cotton seed meal	2-3
Raw sugar wastes (filter press)	8	Cocoa wastes	1.5
Castor pomace	1 to 2		
Poultry manure, fresh	1 - 1.5	Goat and sheep manures fresh	0.6
Poultry manure, dried	1.5-2.0	dried	1.0-1.9
Hog manure, fresh	.45	Horse manure, fresh	.35
		dried	1.0

2.4.3 Potassium

The third of the major plant nutrients is potassium, also known as potash. It is essential for the development of strong plants. Potash can do more than any other mineral to counteract excesses of nitrogen. High nitrogen causes plants to lose their resistance to disease, but a good supply of potash increases their resistance. Plants starving for potash do not resist heat. They are not disease resistant. Signs of weak stems may indicate a need for potassium.

Chart 2.5 is a list of natural organic sources of potash. the farmer can make good use of this chart to find materials that will return potassium to his soil.

CHART 2.5

Natural Sources of Potash

Materials	% Potash	Materials	% Potash
Wood ashes	10	Cow manure fresh	1

Cont'd

Materials	% Potash		% Potash
Molasses waste	3.0 to 4.0	Cow manure dried	1.5
Tobacco stems	4.5 to 7.0	urine	0.5
Garbage	2.3 to 4.3	Horse manure,fresh	.3
Water lily stems	3.4	dried	1.6
Cocoa shell residue	2.6	urine	1.5
Dried potato vines	1.6	Urine	.8
Vegetable waste	1.4	Goat & sheep manure fresh	.3
Castor Pomace	1.0 to 2.0	dried	3.0
Beef wastes	.7 to 4.1	urine	2.3
Wool waste	1.0 to 3.5	Chicken manure, fresh	.6 to 1.0
Alfalfa hay	2.1	dried	1.2
Cowpea hay	2.3	Banana trash,ashed	41.0 to 50.0
Soybean hay	1.2 to 2.3	Peapods,ashed	27
Weeds	0.7	Hog manure fresh	.5
Potato tubers	2.5		

CHART 2.6

PERCENTAGE COMPOSITION OF VARIOUS MATERIALS

(Nitrogen, Phosphorous and Potash)

MATERIALS	NITROGEN	PHOSPHOROUS	POTASH
Banana Skins (ash)		3.25	41.76
Banana stalk (ash)		2.34	49.40
Bat Guano	1-12	2.5-16	
Brewers grains (wet)	.90	.50	.05
Castor Bean Pomace	5-6	2-2.5	1.0-1.2
Cattail reed and stems of water lily	2.02	.81	3.43
Cocoa shell dust	1.04	1.49	2.71
Coffee grounds	2.08	.32	.28
Coffee grounds (dried)	1.99	.36	.67
Corn cobs (ground, charred)			2.01

Cont'd

MATERIALS	NITROGEN	PHOSPHOROUS	POTASH
Corn cobs (ash)			50.00
Common crab	1.95	3.60	.20
Cow peas (green forage)	.45	.12	.45
Cow peas (seed)	3.10	1.00	1.20
Cucumber Skins(ash)		11.28	27.20
Dried jellyfish	4.6		
Duck manure (fresh)	1.12	1.44	.49
Egg shells,burned		.43	.29
Eggshells	1.19	.38	.14
Feathers	15.30		
Field beans (seed)	4.00	1.20	1.30
Field bean (shells)	1.70	.30	.35
Fire pit ashes			4.96
Fish scrap (fresh)	2-7.5	1.5-6	
Fresh water mud	1.37	.26	.22
Garbage, rubbish	3.4-3.7	.1-3.7	2.25-4.25
Hair	12.-16.		
Hoof meal and Horn dust	10-15	1.5-2	
Leather, ground	10-12		
Lobster refuse	4.3	3.50	
Lobster shells	4.60	3.52	
Molasses residue in manufacture of alcohol	.70		5.32
Orange skins (ash)		2.90	27.00
Peanut shells	.80	.15	.50
Pigeon Manure (fresh)	4.19	2.24	1.41
Pumpkin seeds	.87	.50	.45
Residue from raw sugar	1.14	8.33	
Salt marsh hay	1.10	.25	.75
Tea grounds	4.15	.62	.40
Tobacco leaves	4.00	.50	6.00
Tobacco stalks	3.70	.65	4.50
Waste from rabbits	7.00	1.7-3.1	.60

2.4.4 Other Minerals

The remaining essential nutrients are very important to plant growth. In fact plants will not grow healthy if only one nutrient is missing. Usually farmers depend on the soil to supply these minerals. By applying compost, organic matter and chemical fertilizers to the soil, the farmer can be assured of supplying his plants with all their mineral needs.

2.5 SOIL MICROBES AND THE SOIL WORKSHOP

Soil microbes are very tiny living plants and animals that cannot be seen by the naked eye. They are best seen under a microscope. Without these soil microbes, agriculture could not exist.

We can imagine that the soil is a workshop for soil microbes. Within a soil there are many different kinds and groups of microbes, each performing a special job in the soil's workshop. The operations of all types of soil microbes are necessary to the support of healthy plant life. The work of soil microbes is the basis of agricultural productivity. Soil microbes work in many ways. Some break down complex organic matter into foods that plants can use. Microbes which bring about the decay of organic matter are most familiar. For example, when plants or animals die their dead bodies, by the work of microbes, fall apart and give back to the soil and air most of the elements taken from these sources for life. These elements are then used as food for other forms of life. This is known as the life cycle. Life is supported in a continuous cycle:-

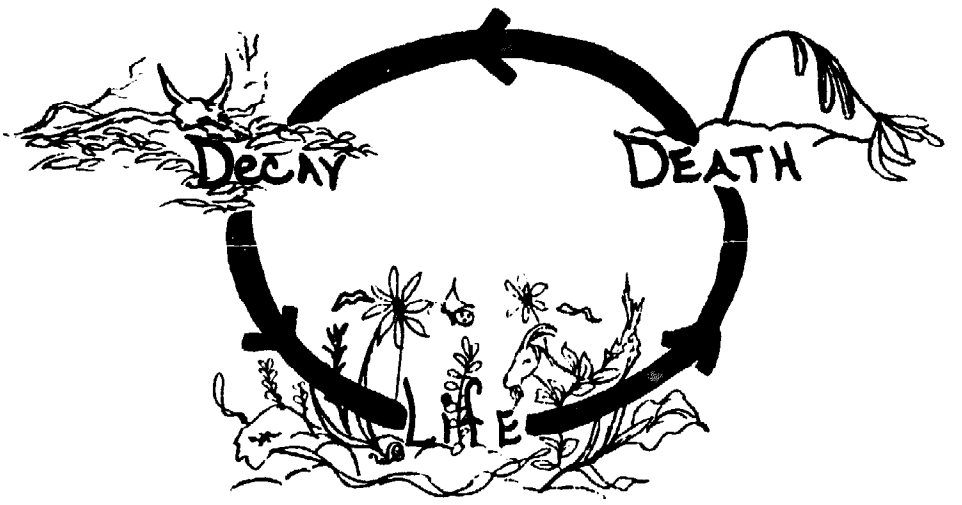


Figure 2.6 THE LIFE CYCLE

Other very helpful soil microbes capture nitrogen from the air and change it into food for plants. Some microbes, called nitrobactia, change certain nitrogen materials of the soil into forms easily used by plants. Other microbes lock up and store nitrogen surpluses, and then release them slowly as needed by the plants. There are even microbes (predaceous fungi) which attack and eat nematodes (very small worms that eat plant roots). These microbes are only found in soils with humus. Health producing vitamins and disease fighting antibiotics are produced by microbes and plants in a healthy soil.

The skilled gardener can learn to judge if his soil's microbes are healthy or not. One way to do this is by the smell of the soil. A healthy soil microbe population will give the soil a very satisfying smell that cannot be found in badly eroded or depleted soils. If earthworms are abundant in soil, one is assured that the soil microbes are also present and healthy. More experienced farmers can detect their presence by the spongy feel of a good soil.

Soil microbes multiply at a fast rate whenever the right kinds of foods are made available to them. Practically all of the beneficial, helpful soil microbes feed on organic matter in one form or other. By building up the organic matter and humus of the soil and applying mineral fertilizers, the farmer and nature join hands to produce abundant healthy food. The more skill the farmer developes in handling his organic materials the more service he will get from his soil microbes.

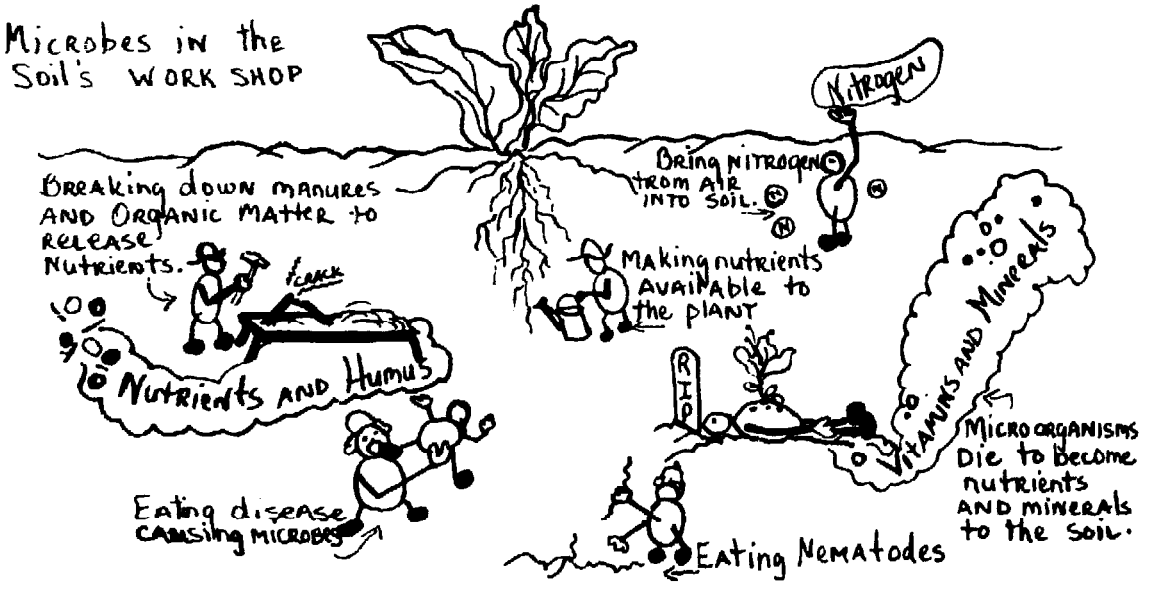
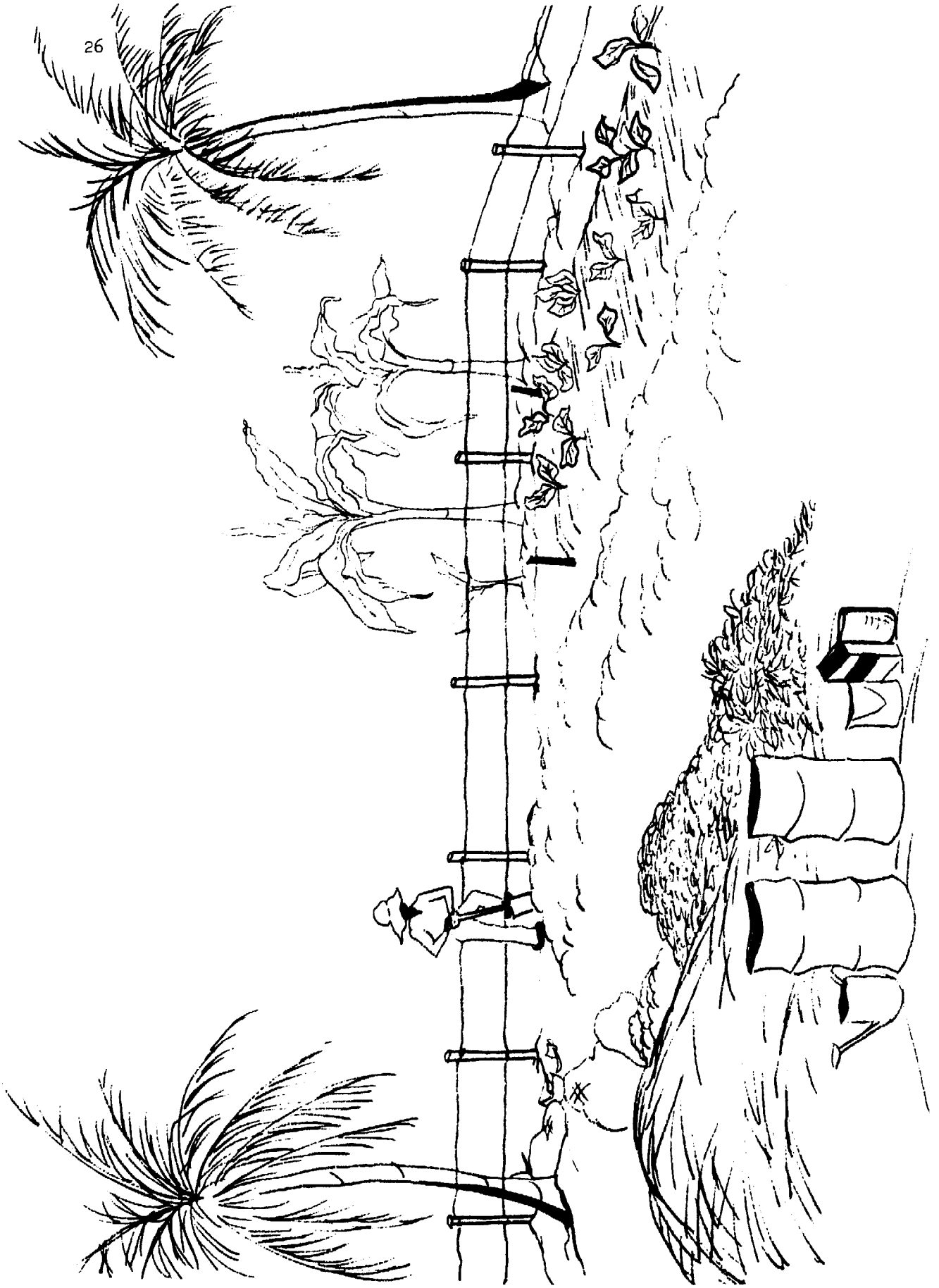


Figure 2.7 THE SOIL'S WORKSHOP



CHAPTER THREE

SOIL MANAGEMENT AND IMPROVEMENT

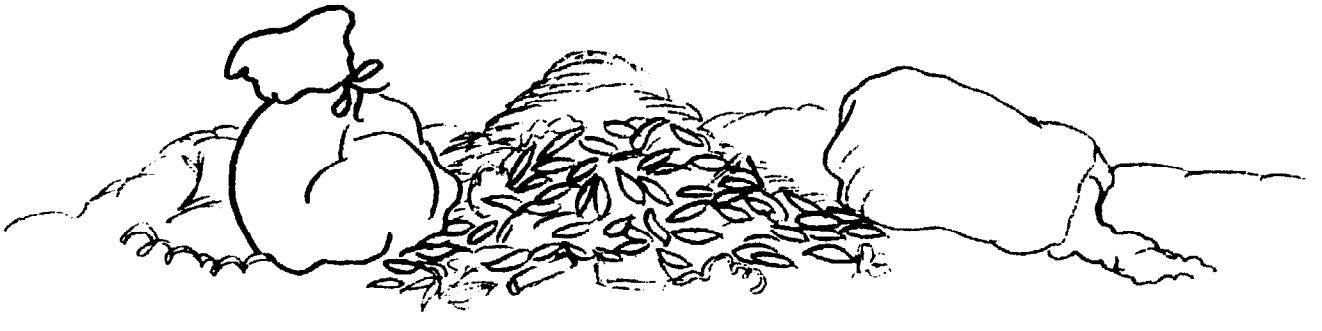
A soil management and improvement programme is essential to every farm if the farm is to remain a viable food producing unit for the decades to come.

When the farmer takes steps to maintain and improve his soil's fertility he is truly building a heritage for himself his family and his country.

3.1 ORGANIC MATTER IN SOIL MANAGEMENT

In developing a soil management program the farmer must first assess his soils' fertility and general condition (e.g, structure, texture, pH,erosion). Then the farmer should decide which crops can be grown, and are best suited to his farm's climate, slope and soil conditions. The farmer should then search out and locate all locally available materials that can be used for fertilizers, mulches, and general soil building. Examples of these materials are: animal manures (such as chicken, horse, cow, rabbit, pig, donkey, goat and bat), wood ashes, banana trash, sawdust, filter press mud, bamboo leaf trash, grass,garbage scraps, and any other organic waste materials.(see charts 2.3, 2.4, 2.5) The farmer should also locate and know the price of all commercial bag fertilizers that are available. All these materials are the food for the soil and crops.

One of the important aspects of soil fertility and structure in the tropics is the soil organic matter. With the increased heat and moisture in the tropics, soil organic matter is used up very quickly. Organic matter is the term used when speaking of any plant or animal matter. Useful organic matter would include all animal manures, all plant materials and organic waste materials such as cannery wastes, sawdust, citrus peels, etc. All these materials and many more can be very useful to the farmer in building and maintaining his soil's fertility.



Organic matter is life for the soil, the storehouse of the soil's nutrients. When properly handled and applied to the land, organic matter improves the texture and structure of the soil. It increases the soil's ability to hold water, stimulates beneficial soil organisms, suppresses disease organisms, and provides and makes available nutrients to the plants.

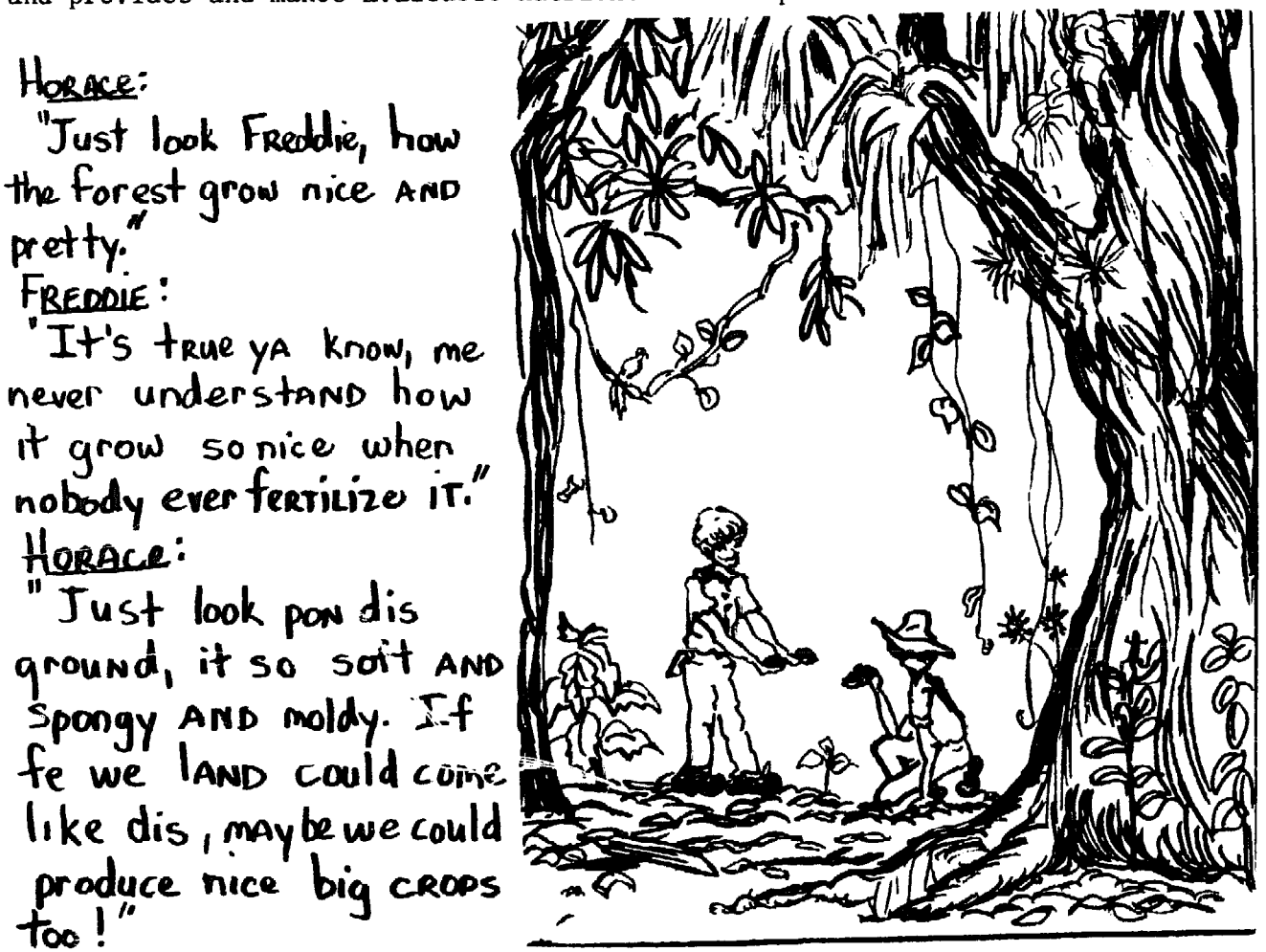


Figure 3.) OBSERVING THE FOREST FLOOR

It is often noticed when forest land is newly cleared and cultivated, very good crops are produced for the first few years with little or no fertilizers. Then, as the land grows "older" , more and more fertilizers are needed to produce an adequate crop. This happens because the natural fertility of the land, which is in the form of organic matter and humus, is depleted, but not replaced. By observing and applying natures fertility cycle, the farmer can maintain his soil fertility and produce bountiful yields. Observing the forest which grows very well without any fertilizers, one might ask, "How is it so?" In the forest, the roots of the trees and plants gather nutrient from shallow and deep in the soil and sends them to

the leaves of the trees or plants. When the leaves and branches die and fall to the ground, they decay and rot, releasing nutrients to the soil to be used again by the plants. This is the natural life cycle.

The lesson is that anything that will rot and decay is potential and necessary plant food. Certain materials which rot and decompose quickly, such as animal manure, release their nutrients to the soil quickly, they are especially useful to the farmer. But anything that will rot, from corn cobs to newspapers, will improve the fertility of the soil. The key point is that organic matter must be decomposed before the nutrients are released for use by the plants.

A farmer's fertilizer program must provide all the nutrients needed for plant growth in a balanced form. In the beginning, as previously mentioned, a soil test is very beneficial and helpful. Many of the nutrients will already be in the soil. The farmer does not have to actually add all the nutrients, but he must be sure that they are available to his crop. This can usually be done by correcting the soil pH, and by replenishing the soil organic matter.

3.2 ORGANIC FERTILIZERS

In this manual we have divided fertilizers into three groups, organic fertilizers, chemical fertilizers and composts.

In previous pages it was learned that organic matter is any plant or animal material. Organic fertilizers are those types of organic matter that are best suited for the fertilization of crops. Actually, anything that will decay will provide nutrients for plants, but those materials that decay quickly and release their nutrients are most commonly used.

It is generally recognized that the most important fertilizer elements for plant growth are nitrogen, phosphorous and potassium. When using organic fertilizers, many of the other essential elements are present also but, the best basis for determining the quality of animal manures and other organic fertilizers is the amount of nitrogen, phosphorous, and potassium present in them.

3.2.1 Animal Manures

Animal manures are the most commonly used organic fertilizers. Many break down very quickly, which makes them even more valuable as fertilizers for crops. When properly collected, stored, and used,animal manures can return much fertliity to the land.

With most animals, such as goats or cows and donkeys, about half the manure is dropped in fields or uncultivated land and therefore lost for most practical purposes. The real potential is where many animals are confined to a small area for a period of time. Rabbits, chickens, goat pens, pig pens, horse stables and dairies provide manure which builds up and can be easily collected.

To be valuable to soil, manure needs to be "protected". When manure is allowed to build up in an area and is exposed to rain and sun much of the plant nutrients are lost. In fact if it is allowed to stand in small scattered piles in an open yard exposed to rain and sun, it will lose more than half of its fertilizer value. This loss occurs mainly in the form of leaching, which is caused by rain water dissolving precious nutrients and washing them away. When manure is allowed to dry out, nitrogen in the manure becomes a vapor and is lost in the air. Whenever the smell of ammonia is noticed around a manure pile or stable, this is a sure sign that nitrogen is escaping to the air. Such an odor is an undenible symptom of wasted plant nutrition.

An important part of animal waste is the urine or liquids which are richer in plant nutrients than the solids. Whenever possible, efforts should be made to conserve the urine. This is usually done by providing some sort of bedding in the pen or cage that will absorb and hold the liquid. Materials commonly used for this purpose are sawdust, wood shavings, straw, cut grass, or bagasse.

Stored manure should be placed in a watertight pit or container. For the market gardener we would suggest 55 gallon drums (with covers) for the storage of both manures and chemical fertlizers. If manures must be stored in the open they should be heaped in a pile on a level place with a clay base to prevent the loss of nutrient rich juices. The pile should also be covered

with a layer of soil if it is to sit for a long period. The soil cover serves to conserve moisture in the heap and also prevents gases from escaping.

The best method of dealing with large quantities of manures is to compost them. This will be discussed in the section on composting. If the manure cannot be composted it should be spread and worked into land quickly to conserve as much of the nutrients as possible. Spreading manure and leaving it on the surface of the soil is very wasteful. On hilly or sloping land, rain will wash most of the nutrients away. It is wise for the small farmer to hoe or fork the manure into the soil. If a power hand tractor is available, it can be used very effectively. Any method may be used, but the important thing is to get the manure into the soil. The chart on page 32 shows which manures are highest in fertilizer value. Animal manures also add valuable trace nutrients and organic matter to the soil which improve the soil's texture, fertility, and structure. This promotes general plant growth.

To make the best use of manures and other organic fertilizers, the farmer should try to combine the manures and other materials to obtain a completely balanced fertilizer. This will produce healthy, balanced plant growth, and greater resistence to disease and insects. When a fertilizer or manure very high in nitrogen is used alone or in an unbalanced mixture the plants will suffer. For example, if too much readily available nitrogen is in the soil the plants will show signs of burning, or if there is much nitrogen and not enough of the other nutrients, fast, but weak leaf growth will occur. This type of growth is very watery and is very susceptible to insect and disease attack. When the plant does not have balanced nutrients it developes more sugar and starches, and less protein. Since insects prefer sugars and starches, the plants are attacked more often when such unbalanced growth occurs. A balanced program of manure application helps avoid unhealthy plants.

CHICKEN MANURE - Looking at the chart on page 32 , we can see that hen manure is high in nitrogen. For this reason it is called "hot" manure, and some farmers are afraid to use it. But chicken manure is one of the best organic fertilizers in Jamaica and is also the easiest to find. This manure is usually mixed with some type of bedding material, such as saw dust or bagasse, and is usually well rotted. When handling large amounts of the manure the nose and mouth should be covered with a handkerchief or dust mask.

Chart 3.1
N P K VALUE OF VARIOUS MATERIALS

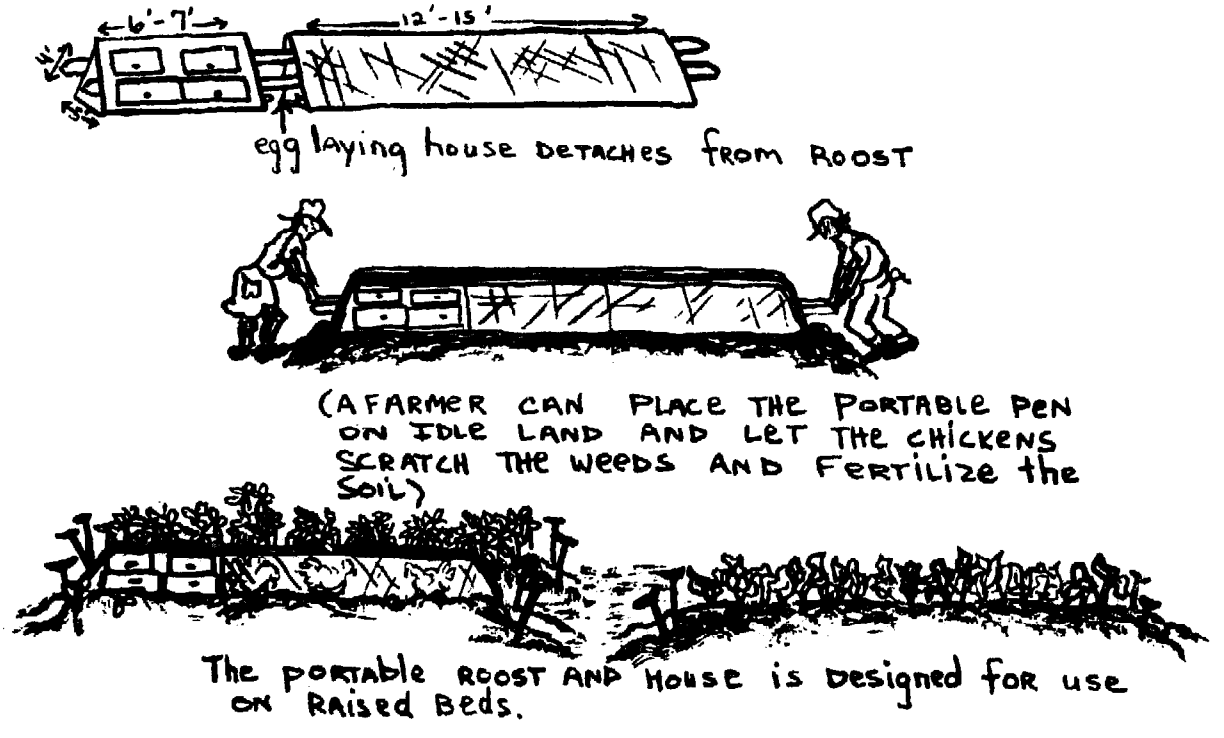
PERCENTAGES OF NITROGEN, PHOSPHATE, AND POTASH IN DIFFERENT MANURES

MANURES	% NITROGEN	% PHOSPHATE	% POTASH
Rabbit	2.4	1.4	.6
Hen	1.1	.8	.5
Sheep	.7	.3	.1
Steer	.7	.3	.4
Horse	.7	.3	.6
Duck	.6	1.4	.5
Cow	.6	.2	.5
Pig	.5	.3	.5
Bat Manure	1-12.	2.5-16.	

ANNUAL EXCREMENT PER 1,000 lbs. LIVE WEIGHT

ANIMAL	TOTAL EXCREMENTS POUNDS	SOLID POUNDS	LIQUID POUNDS
Horse	18,000	14,400	3,300
Cow	27,000	19,000	3,000
Pig	30,500	18,300	12,200
Sheep	12,000	8,300	4,200
Hen	8,500		

Figure 3.1 PORTABLE CHICKEN ROOST AND EGG LAYING HOUSE



The dust, when inhaled, can cause sinus and throat infections.

Chicken manure is usually used at the rate of two tons per acre for intensive market gardners using raised beds, 15 to 20 pounds of chicken manure per 100 square feet of bed should be applied. Chicken manure is low in phosphorous and potassium, so it should be used with other organic or chemical fertilizers that supply those two nutrients. An example combination would be 10 pounds of chicken manure plus 8 pounds filter press mud, and 5 pounds fresh wood ash. Filter press, the waste material from sugar factories, is very high in phosphorous. Wood ash supplies potash. This or similar mixtures form a balanced fertilizer. Chicken manure alone can be used on leaf crops such as callaloo, chinese cabbage and swiss chard, but when used alone for fruit crops such as tomatoes, peppers, and garden egg, the plants produce more leaves and less fruit. When using raw or fresh chicken manure, one part ground limestone to six parts chicken manure should be mixed to help conserve nitrogen and mellow the manure.

A portable chicken roost (see figure 3.1) can be very helpful to the intensive market gardener. The roost can be made from fairly cheap materials such as wood or bamboo, and is covered with chicken (mesh) wire. The floor is also covered with mesh wire. The portable roost is made just the right width (5 feet) to fit a raised bed. The roost is placed on the bed as soon as the crop is reaped off. The chickens eat the remaining weeds, insects and crop waste and fertilize the soil with their manure. The roosts can house from 10 to 15 layers or 40 to 50 broilers which will add 10 to 15 pounds of manure to the soil every two to three weeks. The roosts should be moved to a new bed every two to three weeks to avoid over fertilization. The farmer benefits from this set up by saving money on feed, fertilizers, and insecticides.

Because the chickens eat weeds, weed seeds, insects and crop or garden waste, less bag feeds are required for proper growth. Their manure fertilizes the soil so less fertilizers are needed. The overall health of the garden is increased because there are fewer insects and weed seeds, and crop waste is used so none is allowed to pile up and attract disease and insects.

This is a simple method by which the farmer can intensify his land and build his soil, to produce more vegetables and meat.

HORSE MANURE -This type of manure is also considered a hot manure. Horse manure breaks down very fast and releases nutrients quickly. When used in large amounts it can cause burning of the plants. Fresh horse manure should be either mixed into the soil or placed in planting holes, covered and allowed to cure in the soil for ten to fourteen days before planting.

A bedding such as rice hulls, saw dust, bagasse, or hay, used in horse stables will increase the value of the manure. The bedding absorbs and holds the nitrogen rich liquid portion of the manure. Since horse manure rots quickly, two month old manure can be used right before or at planting time. Looking at the manure chart, we can see that horse manure is low in phosphorous and potash (as are most animal manures). These manures should be combined and used with other manures and materials which supply phosphorous and potash, such as bat manure, filter press mud, composted banana trash, rabbit and chicken manure, wood ashes, citrus waste, fish trash, lobster trash, shrimp trash, dried blood, butcher wastes and cocoa shell waste. In this manual we have provided a chart that gives the fertilizer value of these and many more organic materials. Remember that these materials must decompose before their nutrients are available to the plant.

On field crops like corn or pumpkin, horse manure should be used at the rate of 5 tons per acre. For intensive raised beds, 1 to 3 cubic yards of horse manure plus five pounds chicken manure, five pounds wood ash, and five pounds filter press or bat manure, should provide a balanced fertilizer for 100 square feet of bed. For less intensive vegetable crops, 25 pounds of horse manure plus 10 pounds filter press should be applied for 100 square feet of garden space.

SHEEP MANURE - This manure is also considered a hot manure and should be used in the same amounts and mixtures as horse manure.

COW MANURE - This manure is usually called a "cold " Manure because it takes a longer time to decompose and release it's nutrients. Cow manure can be used in larger quantities than horse and sheep manure, but it must be well rotted. Cow manure is an excellent soil conditioner for improving the texture and structure of the soil. If fresh manure is used it should be applied to the land

two months before planting. As with most animal manures, phosphorous and potash should be added either in the form of chemical fertilizers or other manures and organic fertilizers. The recommended rate is 10 to 15 tons of cow manure per acre. Cow manure is very valuable as a soil texturizer, and should be used for this purpose at the rate of one to two cubic applications per 100 square feet of raised bed.

RABBIT MANURE - Rabbit manure is one of the finest manures for vegetable production. It is high in nitrogen and phosphorous, but decomposes slowly. Since rabbit manure is a colder manure than chicken manure it can be used in large quantities, and can be used fresh on most crops except root crops.

Rabbit cages with mesh wire floors are very practical, since the manure pile can be cared for right where the manure falls. Litter such as sawdust or bagasse will absorb the liquid part, and will help the manure pile cure. Some farmers dig beds under the cages and supply the bed with earthworms. The earthworms thrive on the rabbit manure, composting it into an odorless very valuable plant food. In this system the earthworms multiply greatly. They can be transferred to the garden to do their soil improving work there or sold to other gardeners.

For intensive raised beds, 40-50 pounds of rabbit manure plus three to four pounds of wood ashes per 100 square feet should provide enough nutrients. In less intensive cultivation, such as row crops, 25 to 30 pounds per 100 square feet, will supply a great portion of the needed nutrients. Rabbit manure also gives good results when placed in planting holes for tomatoes or watermelons. Two quarts of rabbit manure, partly mixed with the soil in the hole should provide adequate nutrients throughtout the growing season.

BAT MANURE - Bat manure is usually found in large amounts in caves, and is a very valuable fertilizer. It is usually very rich in nitrogen and especially high in phosphorous. The most important use of this manure is as a source of phosphorous for the crops, and is useful for mixing with other manures which are low in phosphorous. Since bat manure has no potassium, this nutrient must be supplied. Wood ashes is a good source of potash.

Where bat manure has been protected from rain and water, it can be used in amounts very close to the recommended amounts of chemical fertilizers.

Compared to chemical fertilizers, animal manures are usually lower in nitrogen, phosphorous, and potash but the manures replenish the soil's organic matter and improve the structure also increasing the beneficial soil microbes. Highly soluable chemical fertilizers, that is fertilizers which are very fast acting, speed up the loss of organic matter in the soil. A soil with a good supply of organic matter and good sponge structure will make better use of chemical fertilizers. The sponge structure of the soil absorbs and holds nutrients that would otherwise wash through the soil or wash off of a heavy clay soil.

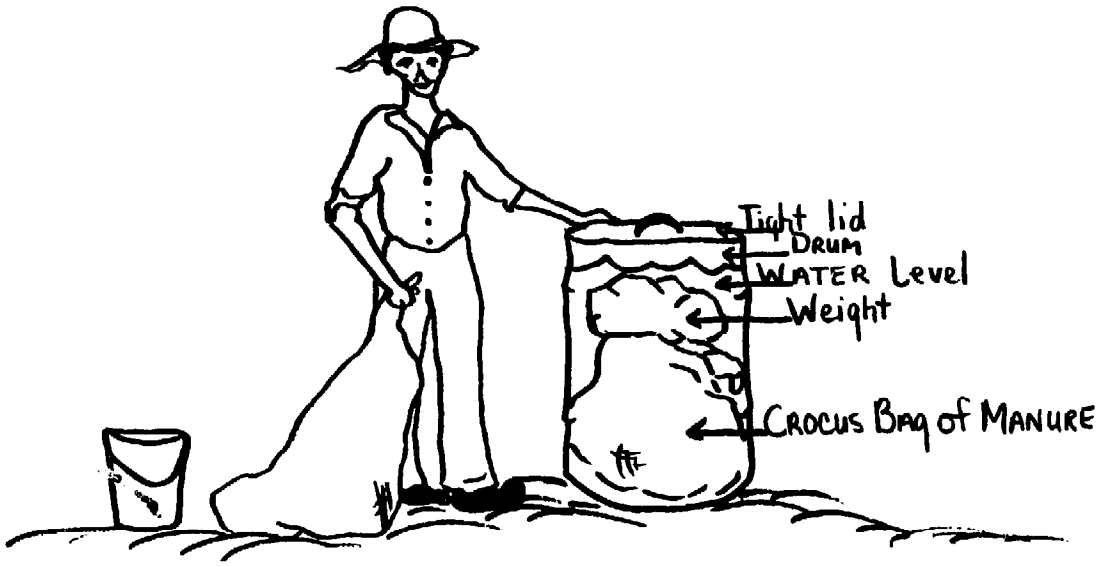
3.2.2 Liquid Fertilizers

In vegetable growing, it is often very helpful to use a liquid fertilizer to give extra feeding to seed beds, seedlings and young transplants.

Manure can be used to make an effective liquid fertilizer usually called "manure tea". Basically all that is done is to soak a portion of the manure in water for a period of time. This permits whatever soluable nutrients there are in the manure to be absorbed by the water.

Any kind of manure can be used to make manure tea. Fresh manure can be used but well rotted manure is best. A very good method requires the use of 55 gallon drums. A sugar sack or crocus bag is filled with a mixture of 1 part chicken manure, 1 part horse manure and 1 part cow manure. The bag is then placed in the drum and covered with water. The bag may have to be weighted with a stone so it will stay completely under water. A tight lid or cover is then placed on the drum and it is allowed to sit for two or four weeks. At the end of two to four weeks the bag should be taken out and water added to the drum until it is full. The manure tea should be the colour of regular drinking tea or even lighter if it is to be used to water young seedlings. The tea can be used to water seed beds, seedlings, new transplants and other plants. The tea should be poured directly around the roots of the transplants at about one cupful per plant.(ref. fig 3.2)

Figure 3.2 MAKING MANURE TEA



3.2.3 Organic Refuse As Fertilizers and Texturizers

Chart 2.6 lists some of the many organic waste materials having fertilizer value as well as being valuable as soil texturizers. As we have mentioned before, the farmer should know all locally available soil building and fertilizing materials. This chart brings, attention to the value of organic materials, many of which can be obtained for free.

As with any organic fertilizer, organic refuse must decompose to release its nutrients. Some valuable organic refuse materials in Jamaica are bagasse, sawdust, filter press mud, citrus waste and chicken feathers. The most valuable and avaialble organic refuse fertilizer is filter press mud from sugar factories. This material has some nitrogen value, but is most valuable for its high phosphorous content. Filter press can be combined with animal manures to form a complete, balanced fertilizer.

Many organic materials must be composted before they are useful as crop fertilizers. When using materials such as sawdust or bagasse they should either be composted or used as mulches on the surface of the soil. If large quantities of these materials are mixed into the soil they will cause a nitrogen lock. This means that nitrogen will be taken from the soil and plants until the material is decomposed enough to release nutrients,

This happens because some materials require much nitrogen for the microbes to decompose them. If a nitrogen lock is suspected in your garden or crop area, a nitrogen fertilizer such as chicken manure or sulfate of ammonia should be applied.

The market gardener should realize that all organic materials are potential fertilizers and soil builders. All sources of these materials should be utilized and conserved. By correctly applying properly prepared organic fertilizers, soil texturizers and composts, the land will eventually become more productive, fruitful and easier to work.

3.2.4 Soil Improving Crops

One method that a farmer can use to return organic matter to his soil and improve its fertility is to grow crops for plowing into the soil. These are known as green manure crops.

Legumes are a group of plants that produce pods, such as red peas, cow peas, broad beans, sugar beans, green beans and many others. These crops have a special microbe which grows on them. This special microbe has the power to take nitrogen, (the most important fertilizer element), from the air and store it in nodules on the roots of the legume. This microbe also feeds nitrogen to the plant. (see figure 3.3)

Air that we breath is 80 percent nitrogen and 20 percent oxygen. So the most important and scarcest plant nutrient is all around us in abundance.

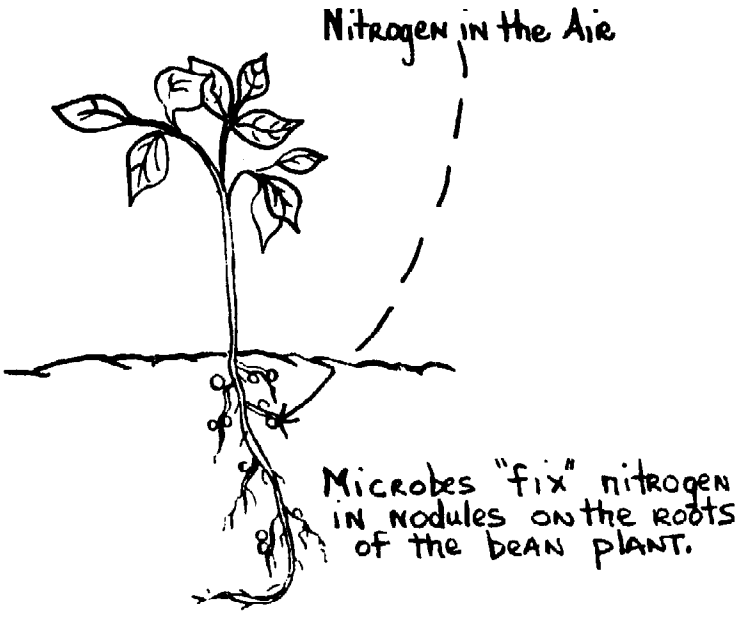


Figure 3.3 ROOTS OF A BEAN WITH NODULES

The legumes and soil microbes are the only way the farmer can take advantage of this free source of nitrogen.

By planting a crop of legumes, allowing them to grow until just before they begin to flower, then chopping them for compost or forking them into the soil, the farmer/gardener can add valuable nitrogen and organic matter to the soil. After plowing them into the soil, one month must pass before crops can be planted. Even if the crop is allowed to mature and the peas are picked, the crop will still improve the soil and add some nitrogen if the roots and crop trash are returned to the soil.

A farmer's land should have a portion planted to green manure crops(legumes) at all times. This allows the farmer to rotate his crops and always be improving a portion of his land. Green manure crops are an excellent source of nitrogen rich material for the compost pile.

3.3 CHEMICAL FERTILIZERS

Chemical fertilizers can be very valuable to the small farmer, but when too much dependence is placed on them and the soil organic matter neglected, trouble is sure to arise. As organic matter in the soil is depleted more chemical fertilizers are needed. This cycle can continue until great quantities of chemicals are required to produce crops from the lifeless soil. Then the farmer is caught in a vicious circle dependent upon large quantities of high cost fertilizers.

3.3.1 The Use of Chemical Fertilizers

Chemical fertilizers are those which are made by a chemical process. The manufacture of these fertilizers require large amounts of petroleum, so the price of chemical fertilizers will always be increasing as the price of petroleum increases.

A complete fertilizer is one that contains a mixture of all three major fertilizer elements, nitrogen, phosphorous and potassium. An example of a

complete fertilizer is sulfate of ammonia which is mostly nitrogen. (figure 3.4)

Numbers on the bags of fertilizers are the grade numbers. They tell the farmer the percentages of each plant nutrient in the fertilizer. For example a fertilizer bag marked 5-10-10, would mean that the mixture in the bag is 5 percent nitrogen, 10 percent phosphorous and 10 percent potash. This means that in 100 pounds of this fertilizer there would be 5 pounds of nitrogen, 10 pounds of phosphorous and 10 pounds of potash. The first number, reading from left to right on the bag, always stands for nitrogen, the second number is phosphorous and the third number is potassium.

Figure 3.4
FERTILIZER BAG WITH GRADE NUMBERS

A farmer provided with a soil test and an understanding of fertilizer grades will be able to select the fertilizer most suited and needed by his soil. Sulfate of ammonia is a very soluable, high potency nitrogen fertilizer. It is used as a"sidedressing" after the crop is growing. It is usually applied right before or in the early stages of fruiting. This gives the plant a boost when much energy is needed for fruit production. On other crops such as cabbage and leaf crops, sulfate of ammonia is applied just before the cabbage begins to fold. Sulfate of ammonia can also be mixed with water at the rate of 2 to 3 tablespoons per gallon, and used to water seedlings. This fertilizer is very potent and must be used with care or plants can be injured.

Complete fertilizers should be placed in a 3 inch deep furrow and covered with soil, or broadcast on the surface and mixed into the top 3 or 4 inches of the soil.

When fertilizing row crops with a complete fertilizer such as 5-10-10 or 6-18-27, one medium hand full for every 3 feet of row length should be applied.

This amount equals 600-800 pounds per acre. The fertilizer should be placed about 3 to 4 inches deep and 2 to 3 inches to the side of where the seed or plant is to be placed. For intensive vegetable culture, one medium hand full of fertilizer per square yard of bed should be applied. Chemical fertilizers should be stored in as dry a place as possible. Moisture tends to dissolve chemical fertilizers and can ruin them. Chemical fertilizers can be harmful when not used with good judgement.

3.3.2 Fertilizer Application

Fertilizer placement is a very important aspect of farming. Many farmers broadcast the fertilizer on the soil surface. This is a very wasteful method. Rain and sun will rob the manures or fertilizers of their nutrients except where the soil is very sandy. The best method is to incorporate or mix the manure, compost or chemical fertilizer into the soil. This method, although it requires more time, labour and skill, is by far the best method. By mixing the fertilizers with the soil, the nutrients are placed where the plant needs them most, around the roots. In the soil the nutrients are also protected from the sun and washing rains. In these days of fertilizer shortages the farmer must learn to use his resources and soil fertility with skill and wisdom.

Fertilizers and compost can be placed in the earth in a few ways. The most common method is "forking" or mixing it in with a fork or spade. When using this method, care must be taken to use the correct amount mixed thoroughly and evenly distributed throughout the soil area. Pockets or lumps of fertilizer in the soil can burn plant roots and damage plant growth. Power hand tractors disc harrowing or rotavation can be used to perform the task. Portable, highly mobile power hand tractors are very useful to small hillside farmers.

Another method commonly used is to dig "planting" holes where the transplants are to be planted and to place manure or fertilizers in the hole then filling the hole with soil. Very good results are obtained if this method is done correctly. With this method a large amount of manure or mixture of manure and chemical fertilizer, can be placed in the bottom of the hole. This

allows the plant to have abundant feeding throughout it's life. The trick is to dig the hole deep enough, 10 to 18 inches is good. Then fill the hole with manure up to about 6 inches from the soil surface. Always provide 4 inches of soil between the transplants roots and the fertilizer. The distance can be smaller if compost or well-rotted manure mixed with soil is used.

Another method of fertilizer placement is to open a furrow with a plow or hoe and then to place the manure or fertilizer in the shallow trench. Then the furrow is pulled back over the fertilizer, covering it about 3 to 4 inches deep.

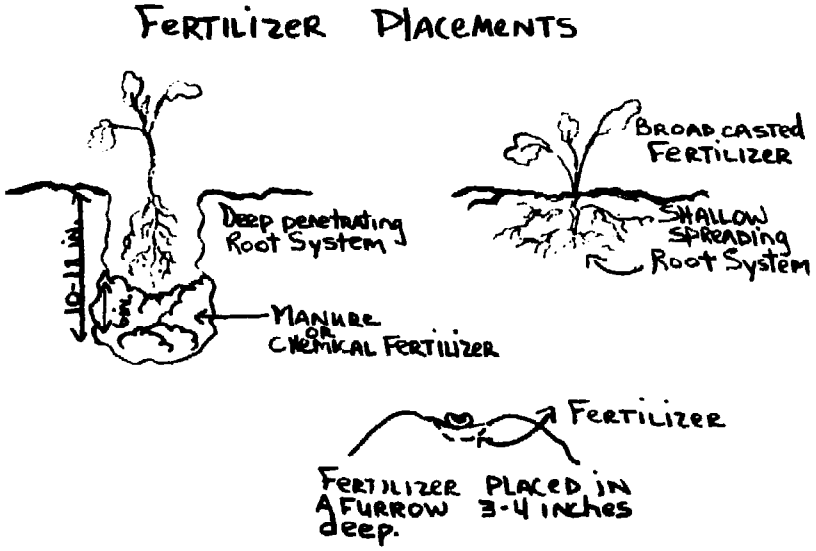


Figure 3.5 FERTILIZER PLACEMENT

When manure and foods are placed beneath the plant, the plant's roots grow deep into the soil to the source of food. These plants are protected in times of drought because of their deep roots. When fertilizers and nutrients are placed on the soil surface, the plants roots tend to grow shallow, near to the surface of the soil. In times of drought the surface soil drys out first and becomes the hottest. Those plants with shallow roots suffer first. The deep soil and roots remain more cool and moist in times of dry weather.

3.4 COMPOSTING

Composting is any system of mixing and decaying natural wastes (manure, garbage, etc.) in a pile or pit, so as to obtain a product resembling what the forest makes on it's floor. Compost is very rich in humus. Humus is the final state of decomposing organic matter. It is humus which feeds the soil microbes and improves the texture of the soil. It makes the soil easier to work, have better aeration and absorb and holds more water. Nutrients are held best by a soil with good sponge structure. Compost provides nutrients for plant growth and the humic acid in compost helps release locked up nutrients.

Figure 3.6 THE FOREST COMPOSTING

3.4 COMPOSTING

Compost also increases the earthworm population of the soil. The lowly earthworm is nature's champion humus maker. The earthworm aereates the soil by its tunnels and brings up nutrients from the deeper subsoil so that the plant roots can use them. As the earthworm burrows the soil, it passes soil through its stomach. Earthworm casts (their manure) are five times richer in nitrogen, 7 times richer in available phosphates and 11 times richer in potash than the soil that it lives in!

Composting is a very clever time saving device. When manure and other raw organic matter is applied to the soil it must be broken down and turned down into humus. This takes time. Compost, with ready made humus gives the plants and soil just exactly the right food, ready to use. By making a compost heap, the farmer "rolls up the floor of the forest" and arranges it in a pile. There he can keep it at just the right moisture to cause it to decay quickly. In applying compost, the small farmer overcomes the smallness of his holdings by increasing the internal surface of the pore spaces of the soil. This provides the maximum possible area on which the root hairs can collect water and food materials. To maintain this maximum pore space the soil must be well supplied with humus and a large soil population.

As we have already mentioned anything that will decompose will provide nutrients for plant growth. So anything that will decompose or rot can also be composted. The materials that can be used vary from kitchen scraps, to green grass, to cow manure. Remember, anything that will rot will make compost.

3.4.1 The Kitchen Compost Method

A compost pile can either be made by arranging the materials in an open pile, or by placing it in what i called a compost bin. A bin is usually made like a large box with three or four sides. It serves to keep the compost pile together in a neat stack. (see figure 3.7)

This type of compost is very suited to the small gardener because very common materials are used. The materials used for this method are kitchen scraps, rich garden soil, and fresh vegetation, such as fresh cut weeds or grass. Fresh vegetation is much better to use than dried vegetation, because it contains more nitrogen which makes it decay quicker.

To make a compost pile, the ground underneath the pile should be loosened or forked in order to expose the bottom of the pile to soil microbes and to provide good drainage. The materials are added to the pile in two inch layers. The vegetation layer is first. Then a layer of soil to cover the vegetation and kitchen scraps. Have enough scraps for a two inch layer, they can be saved in a container with a tight lid, such as a zinc trash can.

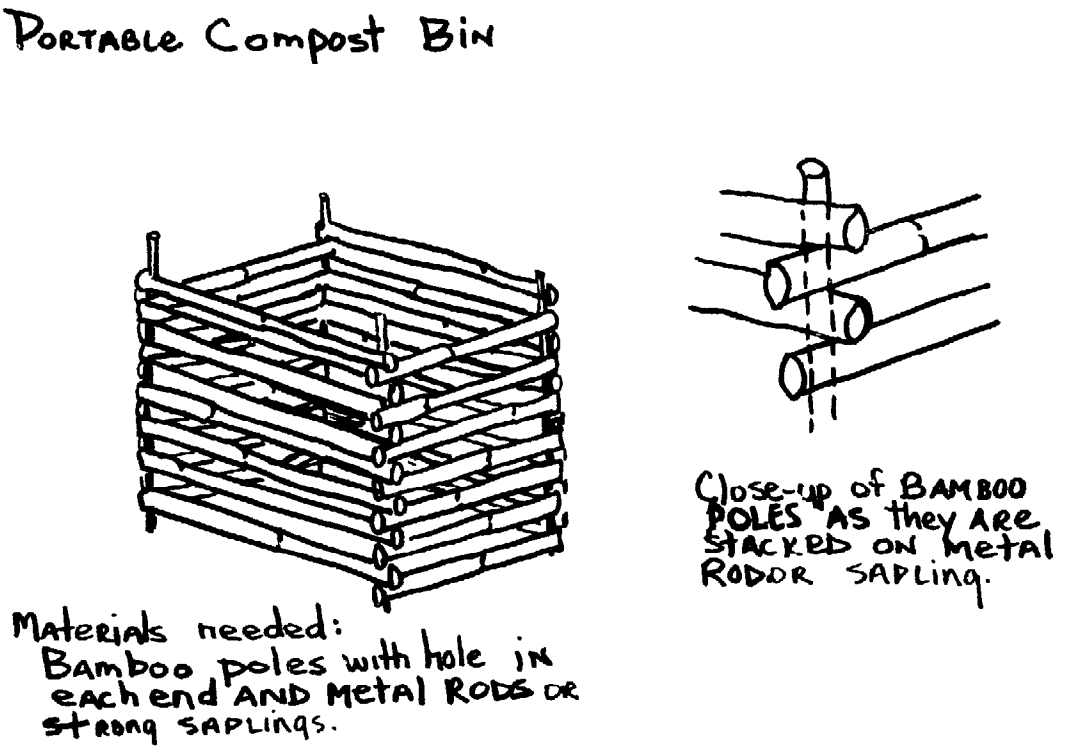
Soil should be added quickly after the vegetation and kitchen scraps are placed in the compost for two reasons. First, the soil contains microbes that will speed up decomposition. Second, the soil layer will help keep the smell down and will prevent flies from laying eggs in the compost.

As each layer is added, it should be watered lightly. When watered,the pile should be evenly moist, like a damp towel. It must be completely wet, but does not give out much water when it is squeezed. Correct watering is a very important step. Too little water will slow down the composting process. Too much water will do the same. For a compost pile to work right, it depends on the proper mixture of air, soil, nutriments, microbes,and water.

To speed up the composting process, three methods can be used: The easiest method to speed up decay in a compost pile is to increase or add nitrogen. If materials contain very little nitrogen, which is the food for microbes, they decay very slowly. Materials with little nitrogen such as sawdust, dry leaves, wood shavings and dry grass will take very long to decay if they are

not mixed with a material which is high in nitrogen. To speed the decay of low-nitrogen materials, nitrogen-rich materials such as cut grass, poultry manure, vegetable wastes, or fertilizers such as 5-10-10 can be added to the compost pile. Three to five pounds of fertilizer per cubic yard of compost should be enough to speed up decay in a slow compost pile. To decompose carbon the microbes must have nitrogen.

Figure 3.7 COMPOSTING BINS



The second method to speed composting is to increase the amount of air in the pile. If the compost pile is packed down, decay will slow down. Care should be taken when the layers of the pile are made to not pack them down. Leave them loose and fluffy. "Turning" the compost pile will also increase air in the pile, speed decomposition, and produce finished compost in a shorter time.

To turn the compost pile simply means to mix the compost by turning it over and rearranging it. When turning the heap, make sure all the materials from the outside of the heap goes into the middle of the newly turned pile. This helps kill weed seeds by the high heat in the inside of the pile. Turning small piles can best be done with a hay fork.

The size of the compost pile should be no smaller than 3 feet by 3 feet by 3 feet high. Smaller piles allow too much air in, and do not build up necessary heat for proper composting.

The third method to speed up decay is by increasing the surface area of the materials in the compost pile. The smaller the size of the materials, the greater the exposed surface area on the materials. Thus microbes have more area to live on. Twigs which are broken up will decompose more quickly than when left whole. Chopped grass will also decay faster.

The compost pile should be located near the garden, and a water supply, so the finished compost can be easily carried to the field, and unfinished piles can be kept at the right level of moisture.

Compost made according to the Kitchen Composting method should be ready in 2½ to 3 months with no turning needed. Compost is ready when it is dark and crumply looking and you cannot tell what materials were used in the compost heap. The compost should smell good!

A pile 3 feet by 3 feet by 3 feet, will yield 1,000 pounds of compost. The minimum amount of compost to be used is ½ pound per square foot, for each crop. This would usually be a layer of 1 to 3 inches thick. A pile 3 feet by 3 feet by 3 feet should supply three 100-square foot beds, with some compost left over.

There are many methods of composting. We have chosen two more methods to give a wider viewpoint on how to compost. The farmer should experiment with the different methods and the materials most available to him to produce the best suited compost for his area and resources.

3.4.2. Indore Composting Method

The Indore compost pile is built 5 to 10 feet wide, 5 feet high and any length. Wooden stakes 3 or 4 inches in diameter and 6 feet tall, are set two feet apart along the centre of the pile. These will serve to allow air into the pile.

The materials which can be used in this method are plant, animal, and garden wastes, kitchen waste, dustpan waste, wood ashes, weed cleanings from roadside ditches, bagasse, saw dust, and any other kind of organic materials that can be found in large enough quantities.

The first layer is of straw or brush about 12 inches thick. This provides a base for the pile. Then the heap is built in layers; first a 6 inch layer of green matter such as weeds, crop wastes, kitchen waste, then a layer of animal manure, less if poultry manure is used, followed by a thin layer of soil. These layers are repeated until the pile is 5 feet high. Each layer is watered so as to resemble a squeezed out sponge. A pile is turned after six weeks, and again after 12 weeks to allow air to penetrate all parts of the pile. The compost should be ready to use in 3 to 4 months.

3.4.3 14 Day Composting Method

This is called the fast method of composting. The main difference in this method is that all materials used in the compost pile are shredded in a gas-powered shredder-grinder. Shredding and chopping the materials increases the speed of decomposition, increases aeration, improves moisture control, and makes the pile much easier to turn.

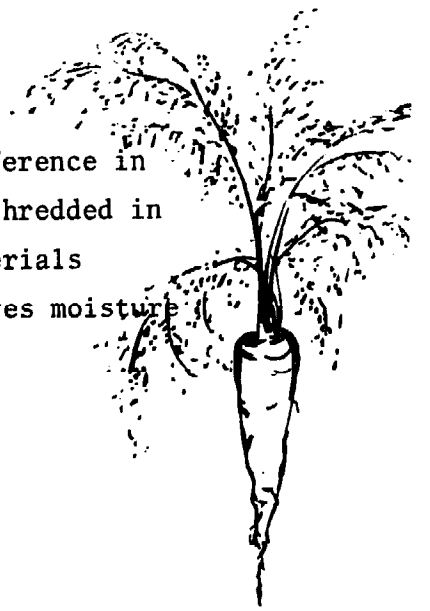
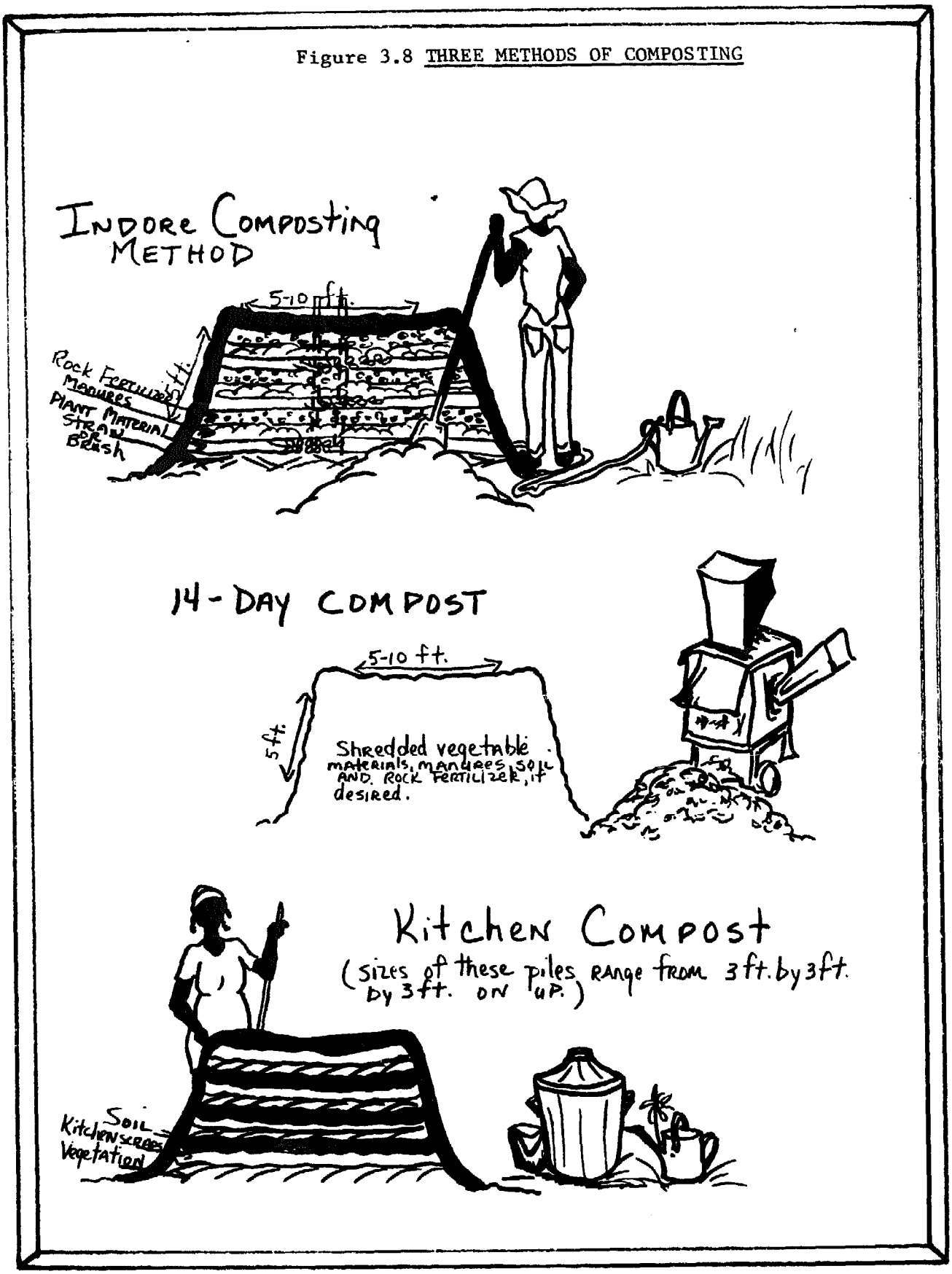


Figure 3.8 THREE METHODS OF COMPOSTING



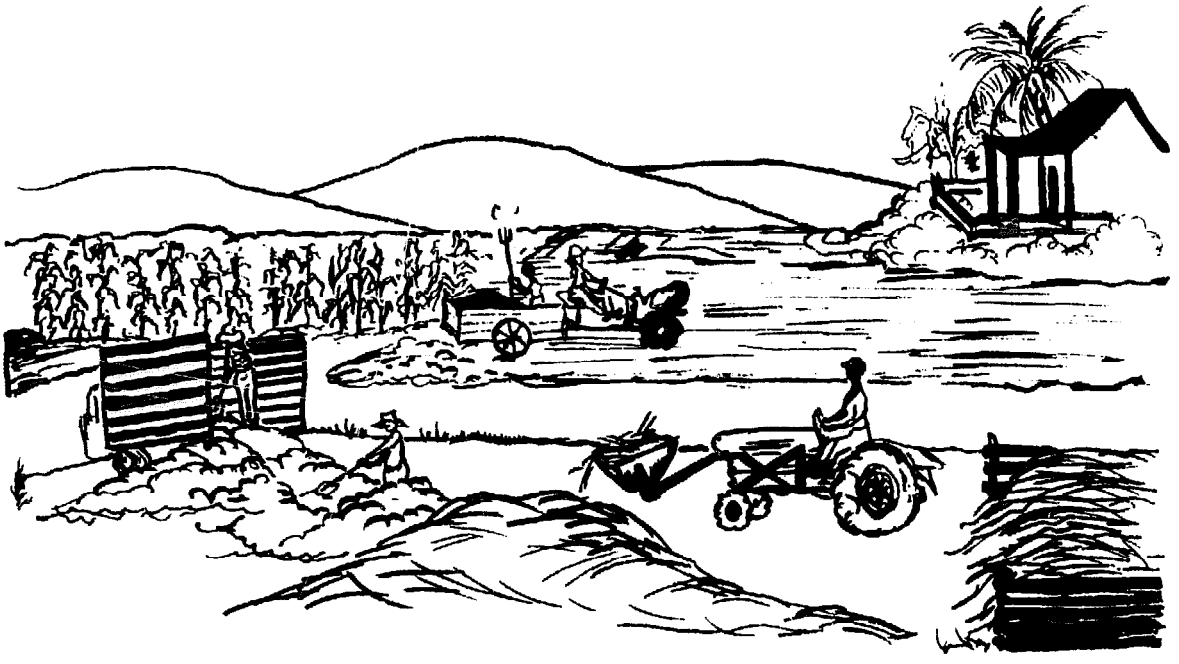


Figure 3.9 LARGE SCALE COMPOSTING

Large scale community compost piles can be turned by tractors equipped with front-end loaders. (see figure 39.)

There is no layering in this method. All the materials are shredded and mixed together, and piled into piles 5 feet high. In three days the first turning is made and then the pile is turned every two or three days. After 12 to 14 days the heat of the pile has stopped and the compost should be ready for use. Moisture is very important to obtain finished compost in 14 days, and should be carefully attended.

In some dry areas the farmer may have to make his compost in a pit, to protect it from the sun and wind. Covering a finished compost pile with a thick grass or hay mulch will also conserve moisture and protect the pile from the drying sun and wind.

A well made compost heap should begin to heat up in two or three days. This can be checked by sticking a metal rod down into the centre of the pile then feeling the rod for warmth. The temperature should reach about 160 degrees F. and stay at this point for about three weeks. The high temperature insures a proper condition for the growth of various microbes and also destroys weed seeds and diseases.

If the pile does not sink in the first few weeks, or smells of ammonia, it is a sign that the heap has poor aeration, is packed too tightly, or is too wet. In this case the best thing to do is to start the heap over.

A well made compost pile creates an environment in which decay-causing bacteria can live and reproduce at the highest of activity. Fresh manure, garbage, and other organic material changes into humus rich compost, as a result of the activity of microbes. It is up to the farmer to learn how to best provide and maintain these conditions, using his locally available resources.

Some organic materials should not be used in the compost pile. Diseased or insect infested plants for example, should be burned, then the ashes used as compost material. Hard to kill weeds should not be put in the compost pile, and materials which take too long to decay, such as branches of trees should not be used.

3.5 Soil Management Program

For the farmer to intensify and increase his farm or garden's productivity, he must learn to maintain and conserve his soil's fertility. To do this he must design and follow a soil management program suited to his soil needs, and based upon the soil building and fertilizing resources locally available.

An effective soil management program must meet four basic requirements:

1. Conserve and maintain the fertility of the soil;
2. Supply plant nutrients in a balanced form for healthy productive crop growth;
3. Supply soil texturizers and conditioners to build and maintain the sponge structure of the soil; and
4. Return and maintain the soil organic matter and microbe population

When designing a soil management program,the farmer should first have his soil tested to determine the pH (see page 12), and the major

nutrient levels. This will give the farmer the information needed to adjust "sourness" of the soil, if needed. It will also give him an idea of the general fertility of his soil.

The farmer should then locate and list all locally available soil building, fertilizing and composting resources, such as manures, bagasse, filter press, etc. (see charts 23-26). The farmer should make careful note of which materials are easy to obtain near his farm and especially those which can be obtained free of cost or are very cheap.

With the help of charts 2.3, 2.4, 2.5 and 2.6, estimates of the fertilizer value of these materials can be made. With the information in the previous sections, the farmer should figure how much manures, organic fertilizers, and chemical fertilizers he will need. Now the farmer should have enough information to estimate the cost of the amount of fertilizers and manures needed to begin his soil management program. For the small farmer it may be difficult to find or afford the amounts of materials recommended for intensive market gardening. Composting will greatly help this problem. By building compost piles, the farmer can produce a valuable soil building material from common waste materials, kitchen scraps, bagasse, etc. The farmer will find it very helpful to always have a plot of his land planted to a green manure crop, such as cow peas, wing beans, etc. This will add nitrogen and organic matter to his soil and provide a good supply of compost material for cutting.

The basis to good soil management, is the return of decayed organic matter to the soil. Good management of the farm's animal manures will conserve their value, and return much fertility to the soil.

To properly manage his soil, the farmer must develop all of his soil building resources. All organic wastes should be returned to the soil through a soil management program which imitates nature's life cycle to build soil fertility. This natural soil fertility program not only increases present productivity, but ensures that soil capabilities will be preserved for future productivity. This is especially important as demand

for foods increase and as the nation strives to become self reliant in food production. The skilled farmer, through proper soil management, makes important contributions to both the present and future generations of Jamaicans.

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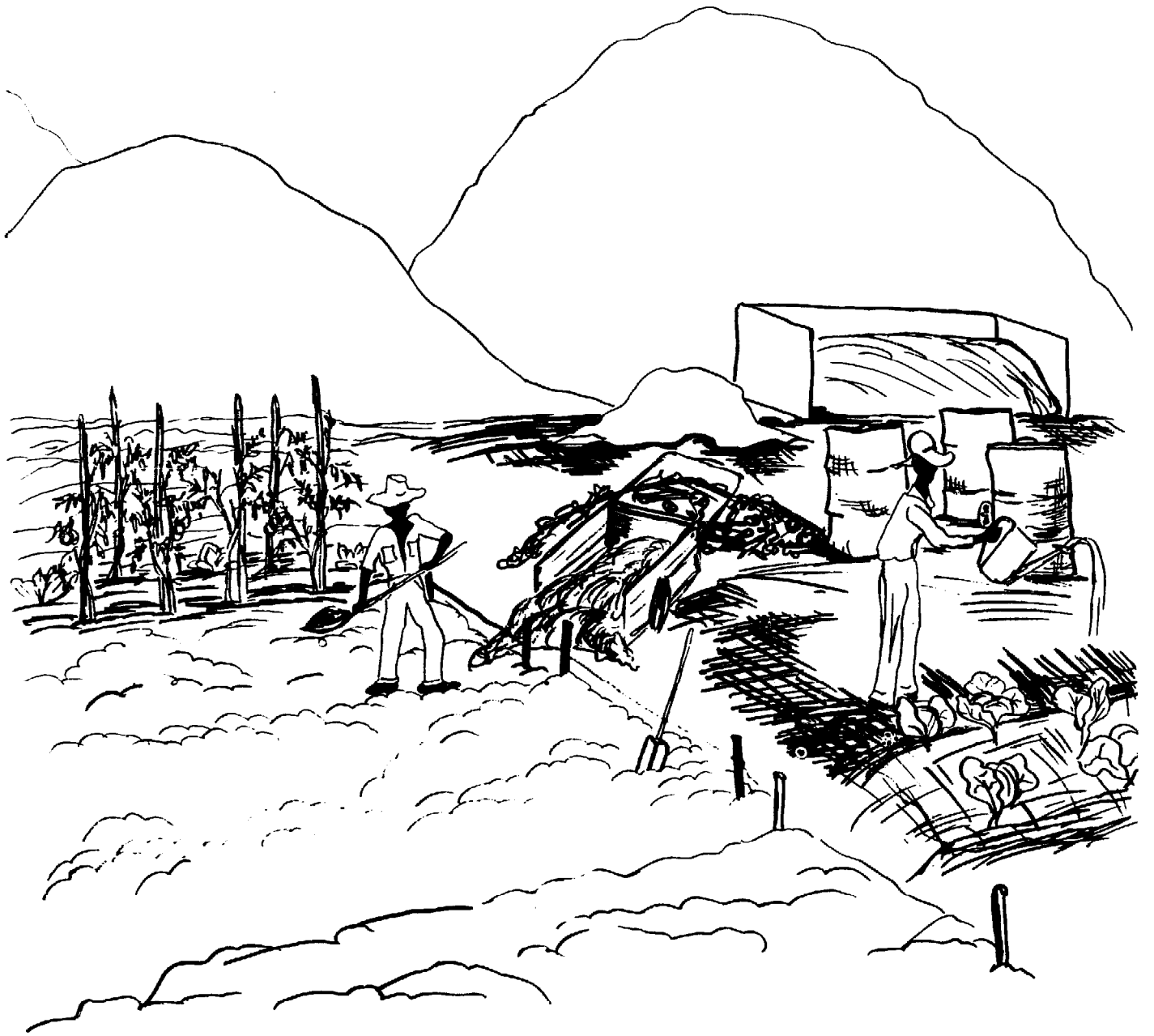


CHAPTER FOUR

GARDEN PLANNING

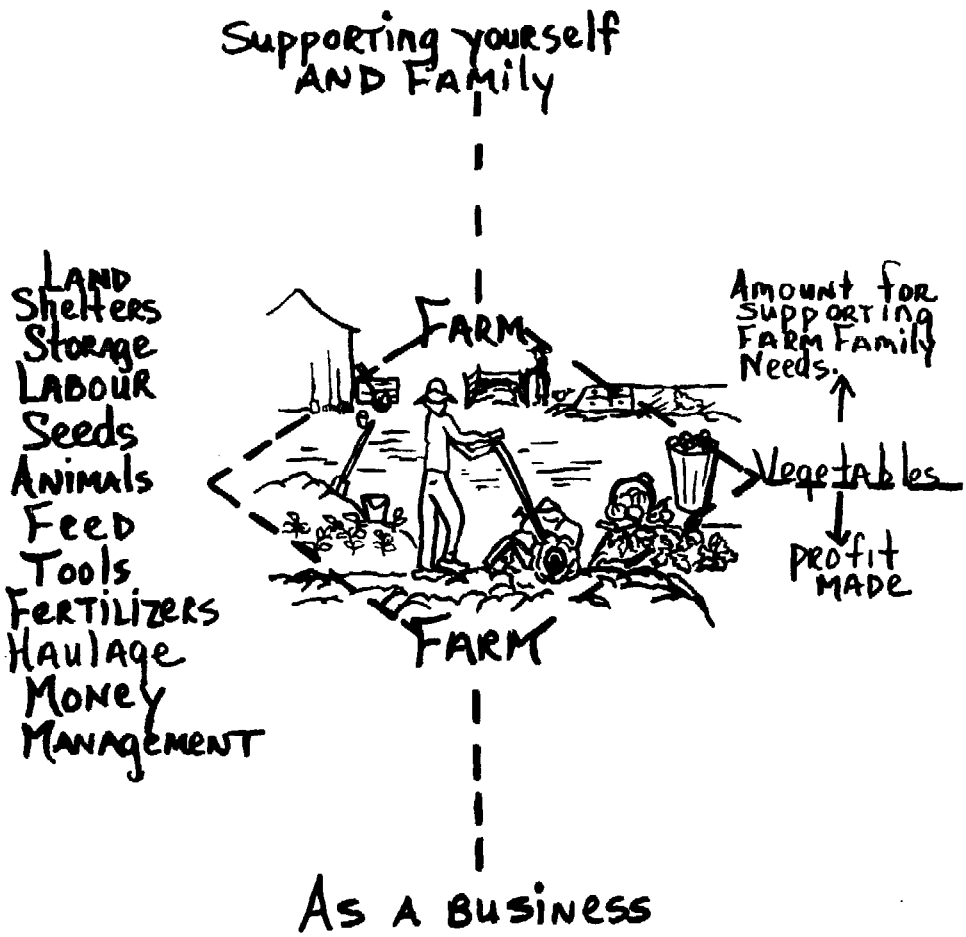


Figure 4.0 GARDEN THINKING

4.1 Garden Location

Many factors must be considered in planning a garden. First of all garden location is very important. The garden site should be located near the home so it can be easily protected and cultivated. The soil should be well drained, deep, and rich. If the area is subject to heavy winds, location of the garden in a protected area is helpful. It could be behind a tree line that acts as a windbreak, or fast growing shrubs or plants can be planted to serve as a windbreak.

The garden should not be near any large trees that would shade, or whose roots would rob nutrients and moisture from the crops.

The farmer should become a keen observer of the climate and seasonal changes in his area. Temperature, rainfall, and wind all affect the types of crops and the times of planting. For instance certain crops prefer cool weather. The skilled farmer/gardener will know when the coolest season of the year occurs, and plant the cool season crops such as cabbage, lettuce or red peas, so they can take advantage of the cool temperatures.

The farmer should also take note of all local resources for building, mulching and composting. A well tended bamboo grove will provide the gardener with much material for building fences, huts,and trellises for vine crops. It also provides leaves for mulch and compost.

4.2 The Garden Plan

The next step to planning the garden is actually drawing up the plan. Having a plan to follow will save the farmer/gardener much time and worry. By properly planning the garden or farm the farmer/gardener can expect maximum production and minimum maintenance.

The best way to draw a plan is to use large sheets of paper and draw out rough lines of the farm or garden. Permanent parts should be drawn in first, such as huts, pathways, trees, and composting areas. North and south should also be marked on the plan. Then the placement of each crop, in order of their importance, should be drawn in, considering the time and space that can be devoted to each. (ref. to figures 4.3,4.4)

Figure 4.1 PLANNING

Figure 4.2 PLANNING FOR FOOD

When considering which crops to be grown the farmer/gardener should note the market value and demand for certain cash crops and their adaptability to his land and climate. The nutritional value of crops should also be given due consideration. By growing a major portion of his family's food, as well as a cash crop, a farmer can save much money and at the same time provide more and better nutritious food for his family. The farmer should seek the local agriculture officer's advice when choosing varieties of crops best adapted to the area.

4.3 Planning To Plant

With the help of tables 1 and 2 the farmer should be able to determine how much seed will be needed. Table No. 1 gives the farmer the number of seeds per ounce for each vegetable crop with the germination rate for each crop. Table No. 2 gives spacings for intensive planting, and the number planting centres per 100 square feet of intensive bed. If the farmer wants to plant 200 square feet of the intensive bed in bush beans, he looks on the spacing chart and sees that bush beans are planted on 4 inch centres. From the same chart he can see that there are 900, 4 inch centres per 100 square feet. That would be 1800 planting centres for 200 square feet. On the seed per ounce chart he sees that bush beans are planted two seeds to the centre. That would mean he needs 3600 seeds (2 seeds per centre x 1800 planting centres). The chart also tells the farmer that there are 100 bush bean seeds to the ounce. So the farmer would need 36 ounces or 2¼ pounds of bush bean seed. By mastering the use of these charts the farmer will be able to estimate yields. For example from the charts the farmer can determine that there are 56 cabbage plants per 100 square foot bed if they are planted on 15 inch centers. If each cabbage produces a one-pound head the yield would be 56 pounds per 100 square foot bed.

4.4 Succession Planting

By careful planning the farmer/gardener can know when one crop will be finished and a next crop can be planted in its place. This is called succession planting, and can increase the productivity of the garden greatly. We have included three succession planting charts. By knowing the time that

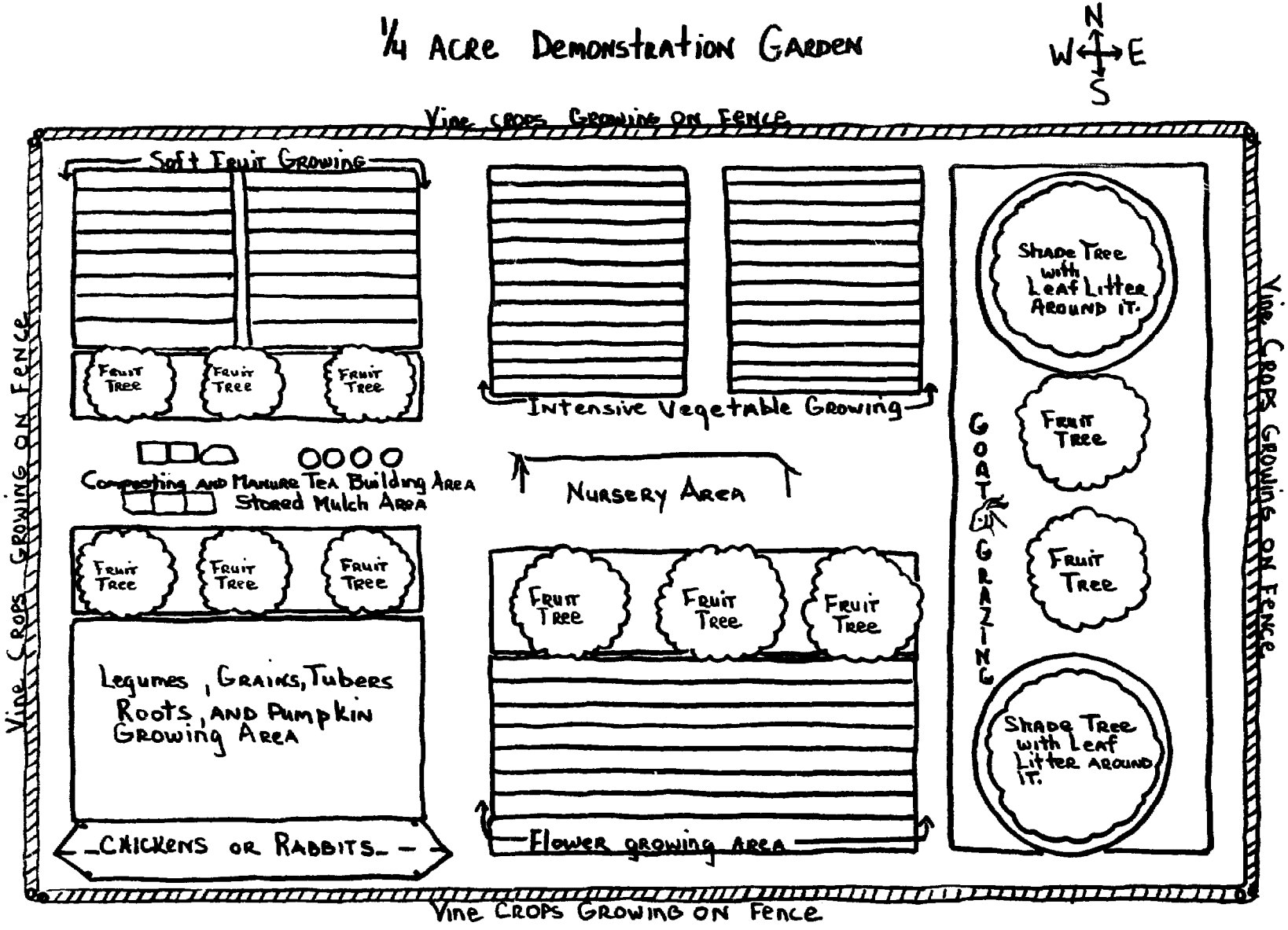
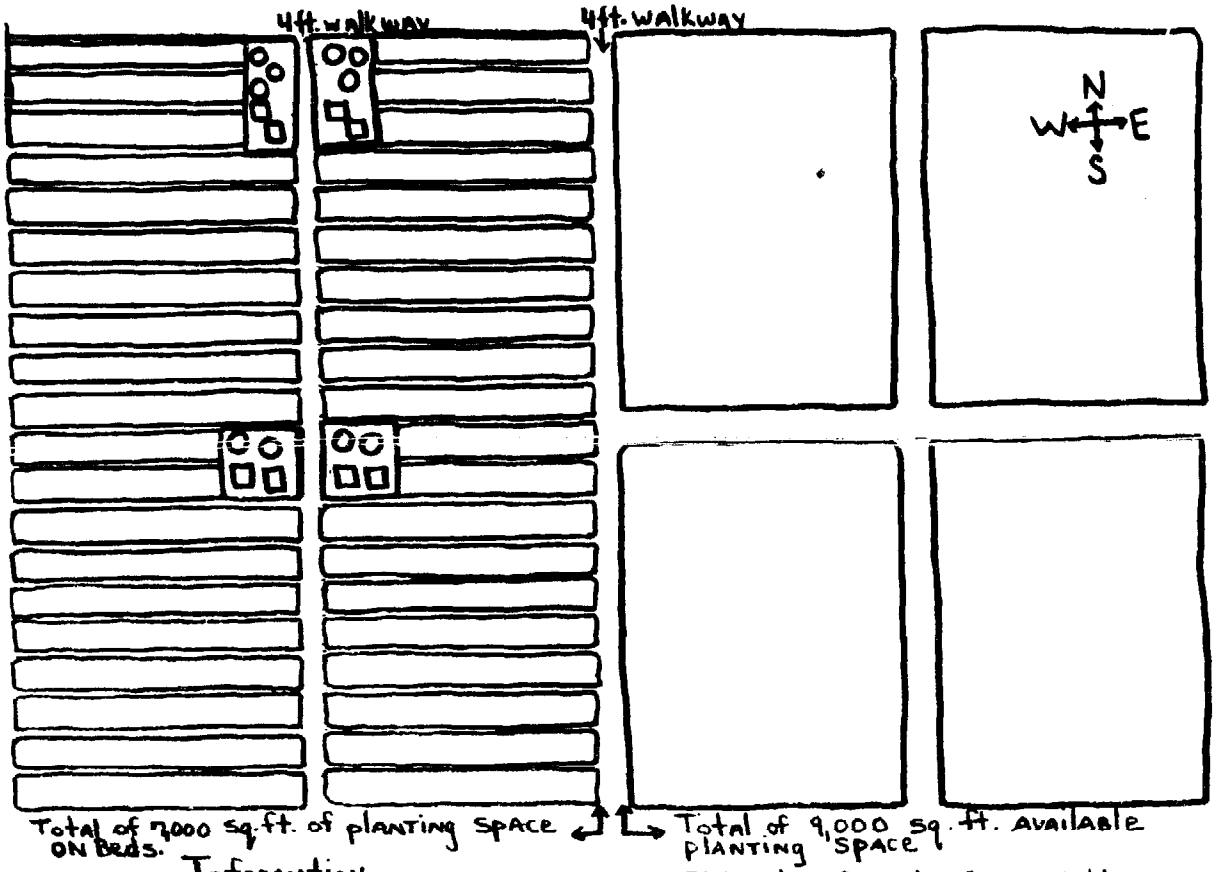

¼ Acre Demonstration Garden
N
W
E
S
Vine Crops Growing on Fence
Soft Fruit Growing
Fruit Tree
Fruit Tree
Fruit Tree
Intensive Vegetable Growing
Shade Tree with Leaf Litter Around it.
Fruit Tree
Goat Grazing
Fruit Tree
Shade Tree with Leaf Litter Around it.
Composting and Manure Tea Building Area
Stored Mulch Area
Nursery Area
Fruit Tree
Fruit Tree
Fruit Tree
Legumes, Grains, Tubers Roots, and Pumpkin Growing Area
Fruit Tree
Fruit Tree
Fruit Tree
Chickens or Rabbits
Flower growing area
Vine Crops Growing on Fence
Vine Crops Growing on Fence
Vine Crops Growing on Fence

Figure 4.3

Figure 4.4 Intensive Garden Plan



Information

A raised bed, 50ft. long by 4ft wide, for vegetables

1ft. wide walkway

A raised bed, 35ft. long by 4 ft. wide, for vegetables

Areas for housing fertilizing materials, making compost and making manure teas.

Large area for growing roots, pumpkins, legumes, and grains in large amounts.

Est. Cost for 7,000 sq. ft. of intensive gardening

Fertilizers and Soil Builders

① Aproximately 210 pounds bat manure/7,000 sq. ft. > phosphorous
420 pounds or of filter press

② Aproximately 140 pounds wood ashes/7,000 sq ft > Potassium

③ Aproximately 350 pounds chicken manure/7,000 sq. ft.
" or 140 cubic yards cow manure/7,000 sq. ft. > Nitrogen

bat manure : $ 7.00
filter press or : 30.00
wood ashes : (free)
chicken manure : 10.00
cow manure or : 250.00
$327.00

Labor: Aprox. 560 hours/7,000 sq. ft. = 70 man days
(70 x $5.00 (standard wages) = $350.00)
: Aprox 30 man days for maintenance
(30 x 5.00 = $150.00)

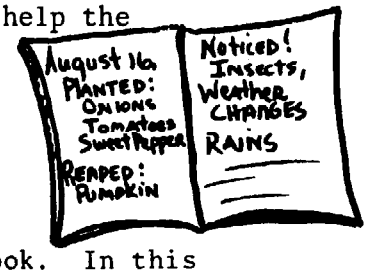
Sprays: Aprox. $30.00
Seeds: " $25.00

TOTAL COSTS $755.00

it takes for a crop to mature the farmer can plan a crop to follow. This will keep the garden producing the year round. (see Succession Planting charts 7.1, 7.2, 7.3)

4.5 Companion Planting

When planning the garden, remember the companion planting chart. (Table 3) Plan the planting scheme so that plants that helps each other grow and resist insects will be near. Keeping a garden plan will help the gardener to remember his crop rotation cycles.



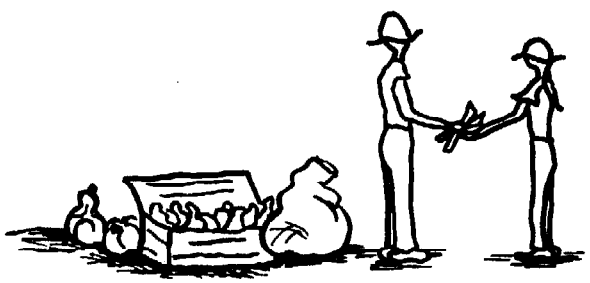
4.6 A Garden Notebook

The serious gardener will always keep a garden notebook. In this notebook he will note crops and varieties which did best and which did poorly. He will also note the dates when certain insects appeared, the dates of planting and reaping, and all other relevant information and observations. This notebook will help the farmer improve his garden and crops every year. It will, for example, help him be prepared to fight insects and remind him of areas of soil that need special attention.

4.7 The Garden Account: Production, Costs, and Income

Small-scale market gardening can be a very profitable business if it is approached by the farmer/gardener as a long term profession rather than a way to make a little money. Planning ahead pays.

The most important thing professional market-gardeners must do is produce good quality fruits and vegetables. This is an important key. If the small grower can't maintain quality, retail customers and buyers won't take the time and trouble to deal with a small producer regularly. If he is truly professional and aware, he will be able to find and use free resources such as, manure bagasse, grass for mulch, bat manure and any other organic materials that can help build the soil fertility for better yields and quality.



When planning the market garden the farmer should keep an account of all his expenses and incomes, so he will be able to better manage his business. Selecting crops best suited to small scale market growing depends on the soil, the climate and the farmer's skill. We have listed some figures of cost and profits for tomatoes grown on a small scale.

4.7.1 Tomatoes On 1 Acre

Tomatoes require a large amount of labour: about 650 to 800 hours per acre spread over the whole season. In a small scale operation, the family could handle the labour without having to hire labour; this would increase profit.

CHART 4.1

Tomatoes

	Cost per acre
Plants	$40
Fertilizer	$200
Pest Control	$100
Machinery operating cost	$45
Machinery fixed cost	$40
Truck haulage and marketing	$285
Stakes, ties, other expenses	$375
	$1085

Yield: 16,000 pounds per acre

@ .20 per pound income.....$3200

cost.....$1085

Return to land, labour and management.....$2115

Although the figures and yields are for the United States, they should not vary that greatly, because the value of fresh vegetables is usually higher in Jamaica.

In the following charts we have given the cost and profits of onions and cabbage grown with the intensive method. These are based on Jamaican costs and prices, using intensive raised beds that have been intensively fertilized and texturized with cow manure and chemical fertilizers, and have been "double-dug" and prepared by hand labour.

4.7.2 One-Tenth Acre Of Onions

We have chosen 1/10th acre as the plot size to demonstrate the benefits of small scale intensive market gardening.

CHART 4.2

Onions

Cost per 1/10th acre (4,000 sq. ft.)

Plants: Onions are grown in seed beds and transplanted to growing beds planted on four inch centres in the growing beds
900 plants needed to plant 100 square feet.
36,000 plants needed to plant 1/10th acre(4000 sq. ft.)
Approximate cost for seeds and growing the seedlings would be.....$20

Fertilizer

one square yard texturizer such as cow manure or compost per 100 square feet, depending on the soil. 1/10th acre would require 40 square yards. The major cost involved in this is haulage.....$100

5 pounds of 5-10-10 fertilizer per 100 square feet. 1/10th acre would require 200 lbs. $40

Sprays.....$40

total cost $200

Labour - Hand Labour

6 hours are required to prepare and plant a bed 5 feet by 20 feet = 100 square feet. Bed preparation includes forking

and weeding, adding and mixing in texturizers, double digging in manure or compost, shaping the raised bed with a rake, and sifting in top soil fertilizers (5-10-10, chicken manure)
210 man hours or 30 man days required for bed preparation.
The labour required for bed preparation can probably be cut in half by the use of a power hand tractor.
2 to 4 hours per day are required for care and maintenance (cultivation, weeding, watering, etc.)
120 days to maturity
360 hours or 40 man days for maintenance for 1/10th acre
Total labour requirement ..... 70 man days @ $5.30 per day valued at $371

Yields

36,000 plants at 1/8 pound per plant	4000 lbs. per 1/10th acre valued at 50¢ per pound
gross income	$2000
costs	$ 200
returns to land, labour and management	$1800
Labour	$ 371
net profit	$1429 from 1/10th acre

A small family could easily handle the labour requirements for this size plot and could probably care for more crops cultivated less intensively such as pumpkin, corn, or sweet potatoes. As mentioned before, with the help of a power hand tractor the family could probably double or triple the amount of land under intensive cultivation as well as that land planted to less intensive field crops.

It might be of some interest to the small farmer to note that from the above figures the farmer's time is worth $3 dollars an hour. ($1800 return to land, labour and management for 600 hours labour)

4.7.3 A Bed Of Cabbage To Help The Food Budget

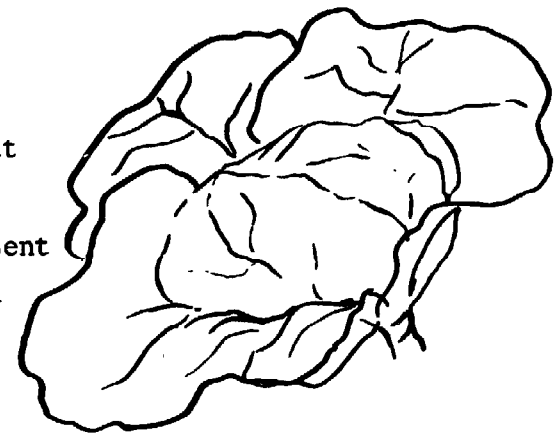
The following chart, Chart 4.3, illustrates the advantages to the family of having their own small intensive vegetable garden as a source of their own food supply. Instead of having to buy vegetables and pulses, the family can produce large quantities of important food crops on very small areas of land with the intensive gardening methods discussed in this manual.

The example given below is for a single plot of cabbage. With the one small plot, the family could easily raise their total supply of cabbage. A small family could supply all the labour for the single bed required to produce this amount of cabbage during their spare times. Gardens are also excellent family projects for learning to live, work and produce together.

The savings for the family budget from this single small plot are quite significant. If the family bought 200 pounds of cabbage in the market at $.60 per pound, it would cost them about $120 for the same amount of cabbage. The production of the single vegetable bed thus represents a savings of $107 for the family food budget. It is likely that a small family of four or five persons could easily cultivate three or four intensive vegetable beds of this size. This would result in substantial savings in normal food purchases, ensure a ready supply of fresh produce, and improve the family diet.

Kitchen Garden Cabbage Bed

CHART 4.3



Cabbage

Cost per 100 square feet bed. This is a very small area 5 feet x 20 feet that could fit into nearly any small yard. We have chosen this small area to present the advantages of the intensive method for kitchen gardens. Even small gardens can be profitable.

Plants (seed is grown in seed bed and transplanted to growing bed) 100 plants are required to plant the bed. Plants spaced on 12 inch centres	
2 packs of seeds	$1.50
Fertilizer	
2 cubic yards of cow manure or compost	$5.00
2 - 4 pounds of 5-10-10 fertilizer	$4.00
or 5-10 pound chicken manure combined with 5 pounds wood ashes	
Sprays	$2.00
	$12.50

Yields: each plant yields approximately 2 pounds
100 plants yield 200 pounds

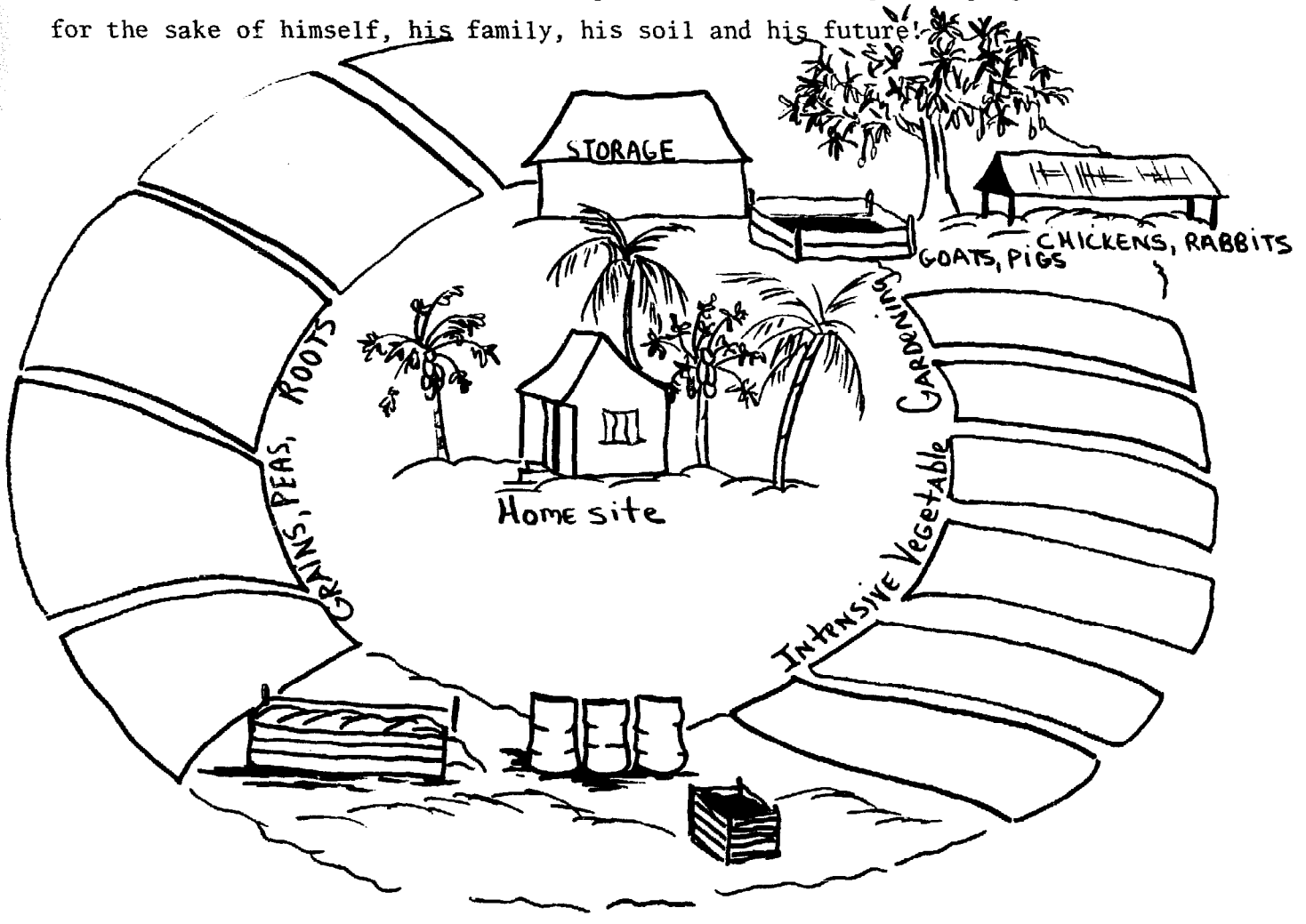
Income: 25¢ /lb farm gate price. crop value ..... $ 50.00
cost 12.50
Return to land labour and management $37.50

Labour 6 - hours required to prepare, fertilize and plant the bed.
10 minutes per day maintenance and care
Total 20 hours, labour value ..... $1.87 per hour

4.7.4 Profits From One Acre For A Skillful Farmer

The next chart, Chart 4.4, illustrates the profits which the skillful farmer or gardener can make from a single acre which is planted with a variety of vegetables and pulses. Some of these would be produced in the raised beds through intensive gardening as discussed above. Others, such as sweet potatoes and melons, would not require raised beds so the labour and land requirements are less intensive for these crops.

The projected profits from a single acre planted with these crops is very conservative. It is likely to be much lower than the skillful farmer could actually achieve. The costs used in these calculations are slightly below those normally received by Jamaican producers. The production levels used in the estimates are also below that which is normally expected with intensive gardening. The example shows, however, the minimum production and income levels which can be easily obtained through skillful farm and garden management. Special attention to the improvement and maintenance of soil fertility is most important to successful farms and gardens. Every farmer should immediately develop a sound soil management program for the sake of himself, his family, his soil and his future!



Small Scale Market Garden

CHART 4.4

Return to land labour and management for various selected crops.

Crop	Return per acre
sweet potatoes	$514 produce sold at $.08 per lb.
snap beans	$1000 " " " " $.20-per lb.
melons	$1800 produce sold at $.10 - $.12 per lb.
cabbage	$900 produce sold at $.06 per lb.

It is best to work with not more that ½ acre in any one crop. For example, a good plan for a one acre is; ¼ acre sweet corn, ¼ acre tomatoes, ¼ acre sweet potatoes, ¼ acre in watermelons and bush beans.

In a small scale operation the farmer and his family should be able to supply the land, labour and management, without any extra expenses. This is a major advantage of the small-scale market-gardener.

Returns on a one acre market garden (return to land, labour and management)

¼ acre tomatoes	$528.75
¼ acre sweet potatoes	$128.50
1/8 acre melons	$225.00
1/8 acre bush beans	$125.00
¼ acre cabbage	$225.00
Total	$1,232.25

Returns based on row crop method of cultivation, which is less intensive.

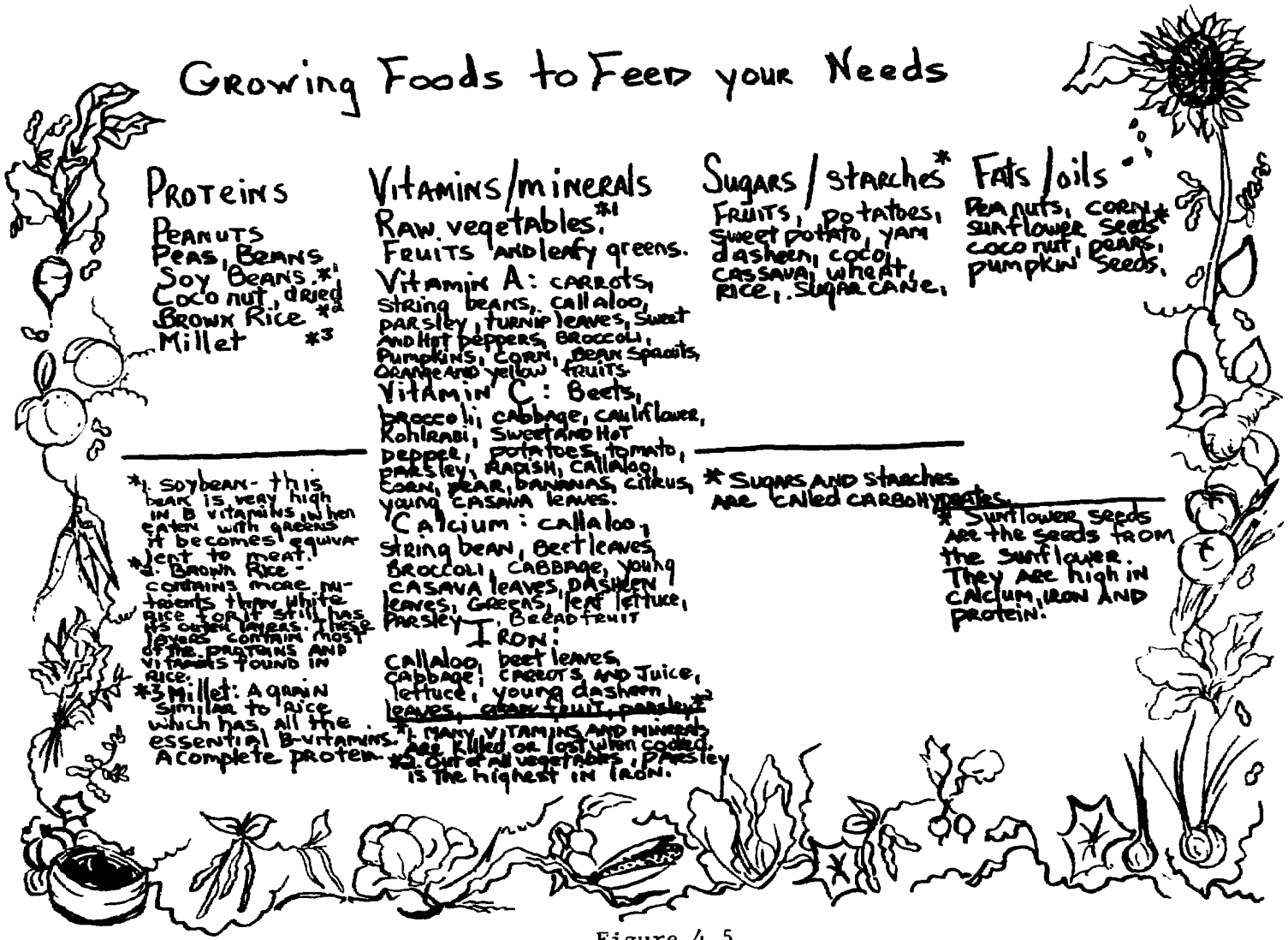

Growing Foods to Feed your Needs
Proteins
Peanuts
Peas, Beans
Soy Beans.*1
Coconut, dried
Brown Rice *2
Millet *3
Vitamins/minerals
Raw vegetables.*1
Fruits and leafy greens.
Vitamin A: carrots, string beans, callaloo, parsley, turnip leaves, sweet and hot peppers, broccoli, pumpkins, corn, bean sprouts, orange and yellow fruits.
Vitamin C: Beets, broccoli, cabbage, cauliflower, Kohlrabi, sweet and hot pepper, potatoes, tomato, parsley, radish, callaloo, corn, pear, bannanas, citrus, young cassava leaves.
Calcium: callaloo, string bean, beet leaves, broccoli, cabbage, young cassava leaves, dasheen leaves, greens, leaf lettuce, parsley, breadfruit
Iron:
callaloo, beet leaves, cabbage, carrots and juice, lettuce, young dasheen leaves, citrus fruit, parsley*2
*1. many vitamins and minerals are killed or lost when cooked.
*2. Out of all vegetables, Parsley is the highest in iron.
Sugars/starches*
Fruits, potatoes, sweet potato, yam dasheen, cocoa, cassava, wheat, rice, sugarcane.
* Sugars and starches are called carbohydrates.
Fats/oils
Peanuts, corn, sunflower seeds* coconut, pears, pumpkin seeds.
* Sunflower seeds are the seeds from the sunflower. They are high in calcium, iron and protein.
*1. Soybean- this bean is very high in B vitamins, when eaten with greens it becomes equivalent to meat.
*2. Brown Rice- contains more nutrients than white rice for it still has its outer layers. These layers contain most of the proteins and vitamins found in rice.
*3 Millet: A grain similar to rice which has all the essential B-vitamins. A complete protein.

Figure 4.5

CHAPTER FIVE

SOIL PREPARATION FOR INTENSIVE GARDENING

Properly prepared beds are the most important part of intensive vegetable production. For the most intensive vegetable production, the beds should be raised with the soil prepared to a depth of two feet to permit healthy root development. If beds are not prepared, fertilized and maintained with proper care, the close intensive planting methods recommended in this manual will cause the crops to do poorly. With properly prepared beds, the plant is provided with the best of growing conditions. Root growth and plant health are improved. Proper preparation of vegetable beds is based upon natural fertility cycles which build the soil while producing crops.

5.1 INTENSIVE RAISED BEDS

A raised bed is a planting area which has been forked and worked so that the planting surface is 4 to 10 inches higher than the original ground level. Raised beds are usually made 3-5 feet wide and any length that the gardener wishes.

The width of a raised bed has a great number of advantages over wider beds. Garden jobs, such as weeding, planting, fertilizing, harvesting and insect control, can be performed from each side of the bed without having to walk on the bed. This is important because vegetables are short-lived plants, so their root growth and health is very important. To walk near vegetable plants compacts the soil around them, making root growth more difficult and even injuring the roots which have grown. Root hairs are the actual "mouth" of the plant as they take in nutriments, water and air for the plants. Plants lose their root hairs when they have to push through tightly packed soil.

When planning an intensive farm and garden, all planting space must be used to maximum advantage. Pathways and roads should be carefully located so as to be convenient while at the same time taking up as little arable and productive land as possible. Permanent raised beds allow maximum use

of a planting area. With permanent raised beds, all fertilizers and soil conditioners are placed directly in the root areas, never in paths. Beds are usually raised 4-10 inches higher than the walkways, so the areas where plants are grown are clearly distinct from other work areas.

Preparing the raised bed is the most important step in intensive vegetable cultivation. The prepared bed should have a loose soil, with good texture and nutriments. This allows steady penetration of the roots for growth and thus uninterupted growth of the plants.

In the intensive method of vegetable cultivation, crops are grown so closely together that when the plants are almost mature, their leaves are barely touching. In other words, when an intensively planted bed of cabbage is almost mature, there is almost no visible ground in the raised bed. You would see a solidly covered bed of cabbage plants.

This method of planting not only allows more plants to be grown, but permits the closely-spaced plants to develop what is called a "mini-climate". That means that the plants are grown so closely together that they shade the soil surface, like a living mulch. This keeps the most important area in the soil, the top soil, cooler and more moist. The shade also keeps down weeds when the plants are large enough. It keeps the soil surface from forming a hard crust and conserves moisture and water for the plants. With the increased number of plants in a bed, it is however very important to prepare, fertilize and maintain the beds properly.

To make room for the roots of this large number of plants, intensive vegetable cultivation requires deep soil preparation. With deep preparation of the soil, roots will grow down instead of spreading out and robbing the nutriments from neighboring plants. The deep growth of the root systems also reduces the need for watering since the deeper soil holds water longer. Deep penetration of the roots also reduces the need for heavy fertilization during the growing season as the deep roots bring up nutrients from the sub-soil. This utilizes those nutrients which travel downward through the soil and are normally lost to shallow-rooted plants.

The raised bed method can be adapted to power hand tractors. Larger four-wheeled tractors could also be used, but hand tractors or h[illegible] cultivation is most suitable for soil preparation, maintenance and care in the intensive raised beds.

An Intensive Raised Bed

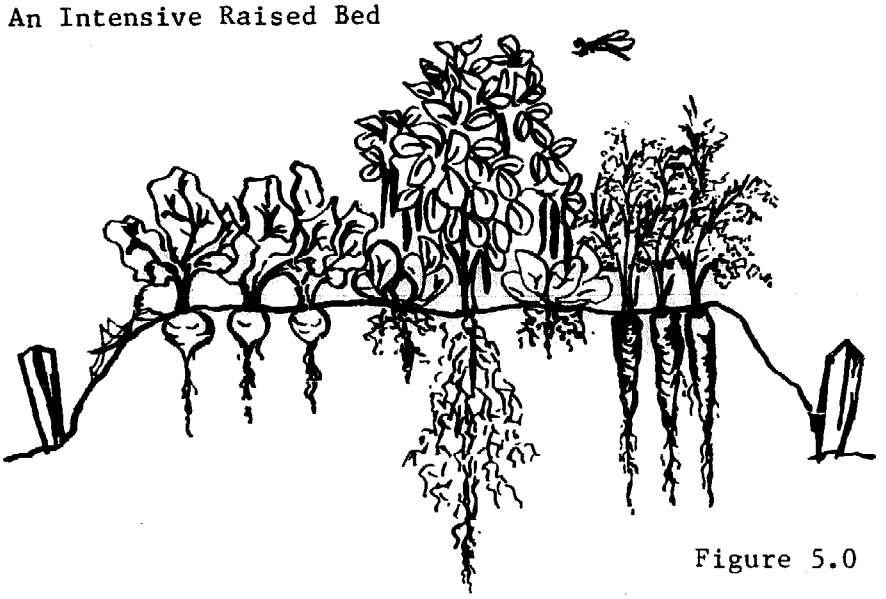


Figure 5.0

5.2 HOW TO MAKE A RAISED BED

Making a raised bed for vegetable production is not difficult, but it is time-consuming the first time. However, it is important that the bed be prepared properly as the effort will pay off in the health of plants and the productivity of the garden. We shall explain the steps which are to be followed to prepare a raised bed.

5.2.1 Step One: Loosening and Cleaning the Soil

When initially preparing the soil, the first operation is to loosen the soil to a depth of 12 inches with a spading fork. This operation should not turn over the soil. The soil is simply loosened and weeds are removed. At this point, any soil texturizers that are needed should be added and mixed well into the soil. For example, add 1-3 cubic yards of compost or aged manure to every 100 square feet of soil if the soil has high clay or sand content. If the soil texture is good, less texturizer is needed. The gardener should develop good judgement on the needs of soil through experience.

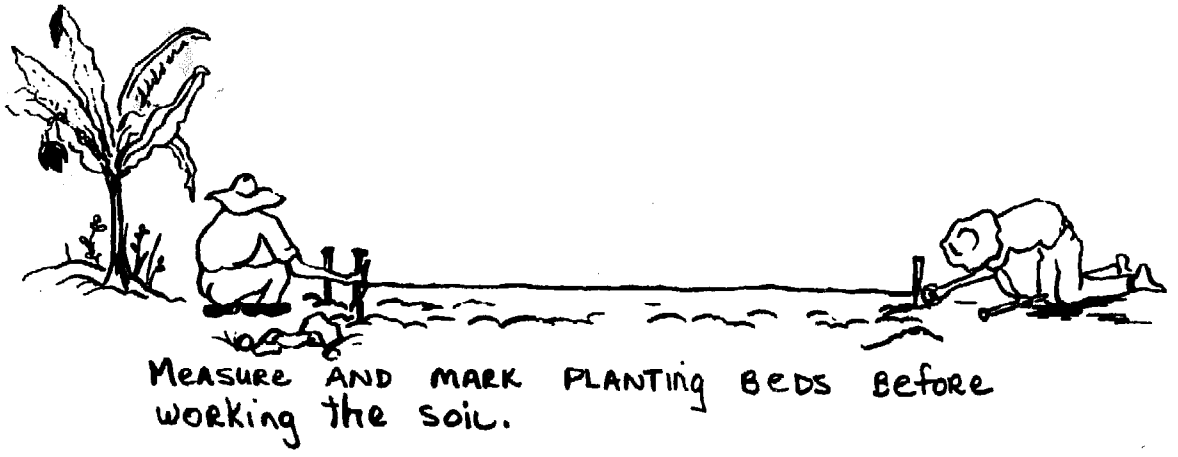


Figure 5.1

5.2.2 Double-digging the Soil

The next operation is to "double-dig" the raised bed. "Double-digging" is a method of deep plowing in soil preparation. The goal of this method is to loosen and improve the soil to a depth of approximately two feet (24 inches). On the first preparation of a raised bed, the gardener may be able to reach a depth of only 10-14 inches with reasonable effort. After several croppings and with improved soil fertility and structure, the depth will be increased gradually to the desired depth. Each time the bed is worked, the depth can be increased from 1 to 3 inches. Beds prepared by this method become easier to work as the soil texture improves. The growing depth should be increased in this way by 3 to 6 inches per year in shallow beds. The best tool to use when double-digging is a D-handled flat spade.

As we have discussed, it is important to build soil fertility and structure to promote healthy plant growth. Before double-digging, first spread a thick layer of compost over the entire bed, 8-24 cubic feet of compost per 100 square feet of raised bed.

The actual steps involved in double-digging the bed are shown in Figure 5.2 on the following page. These are explained on page 74, and should be carefully studied as this is one of the most important aspects of intensive vegetable cultivation.

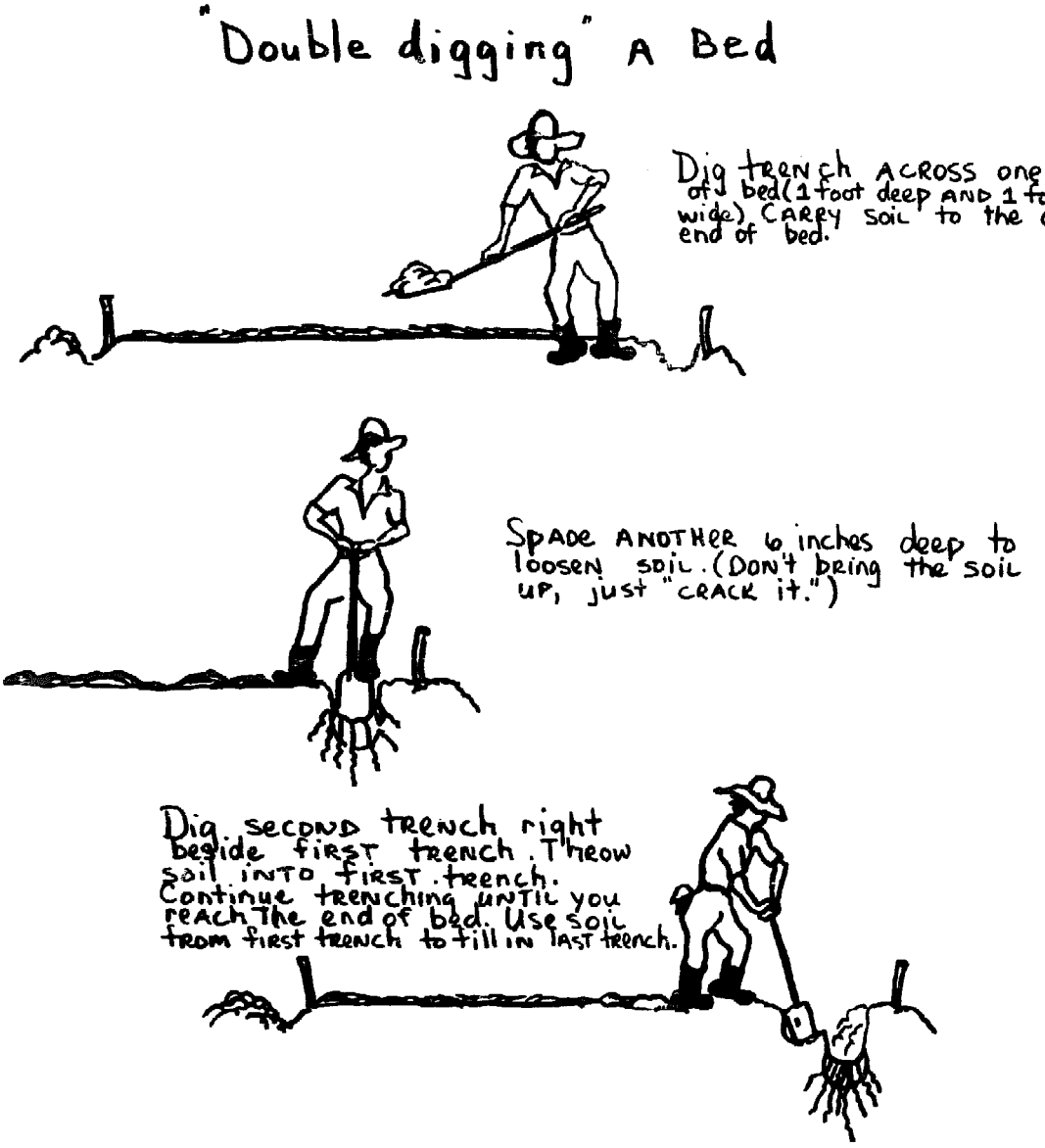

"Double digging" A Bed
Dig trench ACROSS one end of bed (1 foot deep AND 1 foot wide). CARRY soil to the other end of bed.
SPADE ANOTHER 6 inches deep to loosen soil. (DON'T bring the soil UP, just "CRACK it.")
Dig SECOND trench right beside FIRST trench. Throw soil INTO FIRST trench. Continue trenching UNTIL you REACH the end of bed. Use soil from first trench to fill in LAST trench.
Side view of bed ½ finished.

Figure 5.2

Figure 5. 2

SPREADING FERTILIZERS AND TEXTURIZERS ON BED

To double-dig, a trench one foot deep and one foot wide (1 foot by 1 foot) is dug across the width of one end of the bed. (See Fig. 5.3) The soil from this first trench is moved to the opposite end of the bed. This soil will be used later to fill the trench which will be made at that end of the bed when the double-digging is finished.

Next, the trench which has been made should be spaded to loosen the soil at the bottom of the trench. The spade is pushed down into the soil at the bottom of the trench as far as possible. The goal is to loosen the soil at the depth of another 12 inches, but one should just go as deep as is possible with reasonable effort. This time the spade is left in the soil as deep as it has penetrated. The spade is moved forward and backward with a rocking motion until the subsoil is reasonably loosened. Then the spade is returned to to the upright position and removed. Move several inches down and repeat the process until the entire trench bottom has been worked in this manner.

After finishing the first trench, the next task is to go immediately beside the trench and dig another one across the width of the bed. The second trench, beside the first trench, will be formed by throwing each spadeful of soil from the second trench into the first trench. Sometimes you may have to go over each trench as it is made to get the proper size. The task involves moving

the top twelve inches over into the previously made trench from the former digging.

After the second trench has been made by filling the first trench with the soil, the subsoil is then loosened in the second trench. This is done in the same manner as discussed for the first trench above. Then, a third trench is made in the same way, and a fourth trench, and so on, until the entire bed has been double dug. At the end of the bed, spade the soil which was carried from the first trench into the last trench. Now the important task of double-digging is finished and the soil is prepared to support the plants growth to the important depths to maximize the use of moisture and nutrients in the soil.

5.2.3 Step Three: Rest and Fertilization

After the bed has been double-dug, it is usually allowed a day's rest to settle. After a day, a complete bag fertilizer, such as 5-10-10, is added in the amount of 1-2 pounds per 100 square feet of bed. When bat manure, filter press mud, wood ashes, chicken manure of other organic fertilizers are available, they can and should be substituted for extensive use of chemical fertilizers. Superior yields and quality can be achieved if natural fertilizers are used in the correct amounts and combinations along with bag ones.

For example, to fertilize a 100 square foot bed, you would need a combination of 2-4 pounds of bat manure or filter press mud to supply the phosphorous, 2-4 pounds of wood ash to supply potash, and 5-10 pounds of chicken or 25-50 pounds of aged cow manure to supply nitrogen. When bat manure is used as a phosphorous source, it supplies some nitrogen, so less chicken or animal manure would be used. These fertilizers should be broadcast on the surface of the bed after leveling it off and shaping it. They must then be sifted in 2-3 inches deep with a spading fork to avoid losing their value. The bed must then be releveled and reshaped.

5.2.4 Step Four: Forming The "Lip" of the Bed

If the soil is a heavy clay, it is best to form a lip on the outer edges of

the beds. (See Figure 5.4) Forming a lip on the outer edges of the bed will help control erosion. The lip c . be easily made with the use of a heavy duty garden rake or spade. Once the texture of the soil is improved, erosion will not be a problem. In fact, erosion does not occur on good absorbent soils with sponge structure. The sides of the beds should be prepared so as to provide a 45° angle slope. A steeper angle will only encourage erosion. The bed should be 4-10 inches higher than the original surface of the soil and protected by the lip of the bed when it is finished. This is the final step in preparing the raised bed for vegetable cultivation. These steps should be followed carefully in forming and maintaining vegetable beds so that the productivity of the beds is promoted at the highest possible levels.

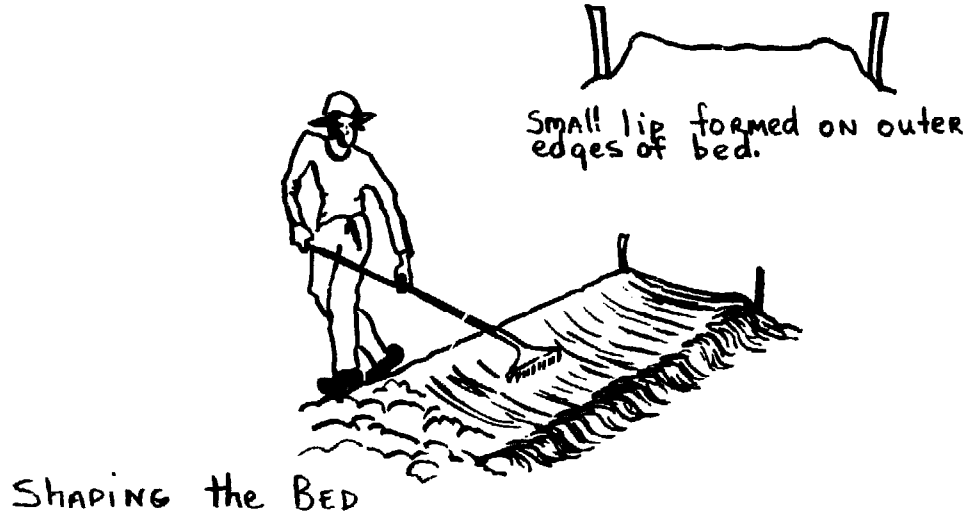


Figure 5.4 FORMING THE "LIP" OF THE BED

5.2.5 Bed Preparation Time Requirements

The initial preparation of a raised bed with moderately heavy soil, including the seeding and transplanting for the bed, will require from 6-12 hours for 100 square feet of bed, that is a bed which is 5 feet by 20 feet. After the first preparation, only 4-6 hours should be required to re-prepare and re-plant the beds. As beds become older, they will be more loose and fertile. Less work and time will be required on them for preparation.

After the beds have been planted, about 15-30 minutes per day are then required to maintain a 500 square foot area. This area is large enough to provide one person with vegetables for 12 months of the year in a climate which

CHART 5.1

Instruction chart for the first preparation of a 100 square foot bed with a heavy clay soil. Including a chart for the repreparation of the bed

Initial Preparation	Repreparation
2 hour soak (for hard dry clays)	
2 day partial drying out	-
12 inch loosening and weeding of soil with spading fork : 1-2 hours	-
1 day rest period for the soil	-
Add 1-3 cubic yards of compost (preferably or aged manure (2 year old cow or 2 month old horse) to soil with poor (very clayed or very sandy) texture -- less if the soil is better --dig in well. Any pH modifiers added at this time. : 1 - 2 hours.	
1 day rest period for heavy soil	-
"Double dig " soil with flat spade after adding 8-24 cubic feet of compost to the top of the bed. 2-4 hours.	
Add 2-4 lbs bat manure, or filler press, 2-4 lbs wood ash and 2-4 cubic feet aged manure or 5-10 lbs of chicken manure. or 1½ -2 lbs of complete chemical fertilizer to surface of bed after leveling off and shaping bed. Sift in fertilizers 2-3 inches deep with spading fork.	These operations make up the ongoing preparations of the bed after the first crop is reaped.
Relevel and shape bed. 1 - 2 hours.	
Planting or transplanting : 1 - 2 hours	
6 - 12 hour Total	4-6 hour total

has a 9-month growing season.

5.3 PRODUCTION ON RAISED BEDS

The intensive methods of vegetable production are best adapted to those areas with adequate rainfall or where some irrigation or water control is available. When there is adequate water available, the raised beds will produce twice as many vegetables as row crop production with the same amounts of water. So, it can be seen that the methods conserve water. However, it is critical that the farmer have control over the water to ensure that there is a sufficient amount of water. The plants must have sufficient water constantly until they have grown enough leaves to supply shade for their roots and the soil underneath them.

Research has been done on intensive raised bed vegetable production which confirms the productivity of these methods. The research indicates that proper application of the methods will result in four times as many vegetables per acre than the amount produced by farmers using mechanized and conventional agricultural methods. The evidence also indicates that the method uses one-half as much water as that consumed by commercial agriculture per pound of vegetables grown. Chart 5.2 shows the results for four crops which were experimented with by a research group in California, U.S.A.

CHART 5.2: Vegetable Yields of Row Cropping and Intensive Gardening Compared

Crop	Vegetable Yields/100 square feet	
	Row-cropping	Intensive Garden
Bush Beans	32 pounds	45 pounds
Lettuce	67 pounds	122 pounds
Cucumber	30 pounds	125 pounds
Bush Squash	40 pounds	200 pounds

When using the intensive raised bed methods, maximum yields may not be reached the first season. Yields will depend upon the natural fertility and structure of the soil and the farmer's ability to obtain natural and chemical fertilizers to return organic matter and humus to the soil.

Maintaining and increasing production is dependent on the fertility and humus content of the soil. This must not be neglected!

5.4 MECHANIZATION AND LAND PREPARATION FOR THE SMALL FARMER

Where tractors are available, they can be of great assistance to the small farmer by reducing the farmer's work and saving time. Heavy soils may require plowing and cross-plowing a few times to be well broken. And, usually harrowing is done last to refine the soil after plowing. Sometimes a tractor is available with a rotorvator attachment. The rotorvator is made to plow and harrow the land in one operation.

There are tractor attachments for preparing beds and furrows for the planting operations. This equipment can help the farmer greatly, leaving only planting and cultivation for hand labour. The most obvious disadvantage of large equipment is that it cannot be used on hillside lands. Also, the use of large machinery does not allow intensive cultivation of land. But there are some forms of power machinery that are very suited to intensive cultivation and sloping lands. A power hand-tractor is one of these.

5.4.1 Power Hand Tractors

A power hand-tractor is a small two-wheel tractor powered by a small gas engine, usually 6-10 horsepower. These tractors are usually equipped with a rotorvator attachment. Hand tractors are guided by two handle bars, similar to bicycle handles, which are controlled by the farmer. On heavy soils, these types of machines will be much slower than the full-size tractors, but are very effective and will save the farmer much time and labour. An advantage of small tractors is that once the farmer has become familiar with this type of machine, most of the maintenance and repairs can be done right on the farm.

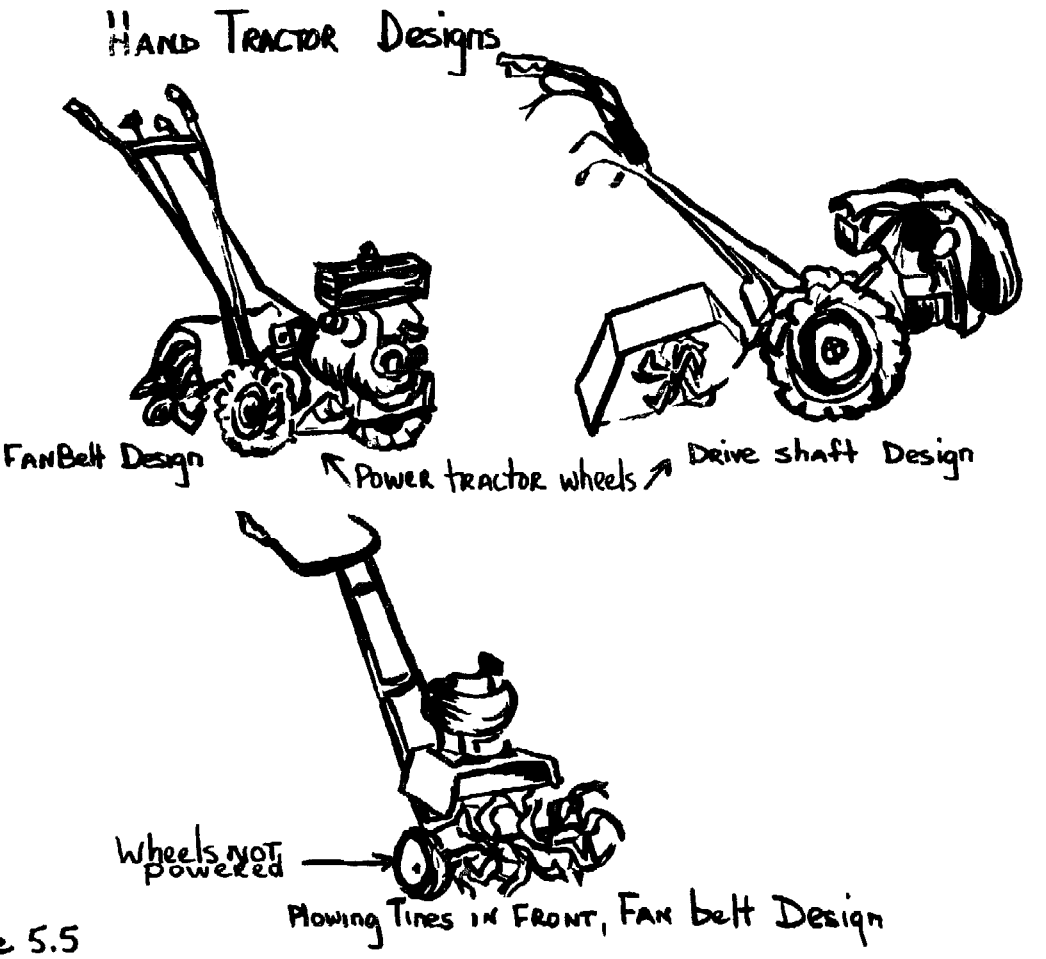


Figure 5.5

Power hand tractors can also be used to turn cover crops, green manures and soil conditioners into the soil. Standing crop residue can be turned and chopped effectively into the soil with these machines.

5.4.2 The Use of Power Hand Tractors in Raised Bed Preparation

Power hand tractors are well suited to preparing raised beds and for deep mixing of soil texturizers and fertilizers used in intensive vegetable production. On heavy soils, the beds should be forked and weeded by hand, then soil texturizers such as compost and animal manure, should be spread on the top of the bed. The hand tractor is run over the bed slowly 2 or 3 times, allowing deep penetration of the manures. Afterwards, fertilizers, such as 5-10-10 or chicken manure, can be applied to the top of the bed. The hand tractor is run over the bed again, but this time allowing only 2-3 inches of penetration into the bed so the fertilizer will not be placed too deep.

After the initial hand-forking of the bed, another forking should not be required when preparing the bed for a next crop. A hand tractor should be able to do these jobs completely. The farmer should then be able to turn large quantities of manure and compost into his beds to improve the bed's fertility and productivity towards the maximum.

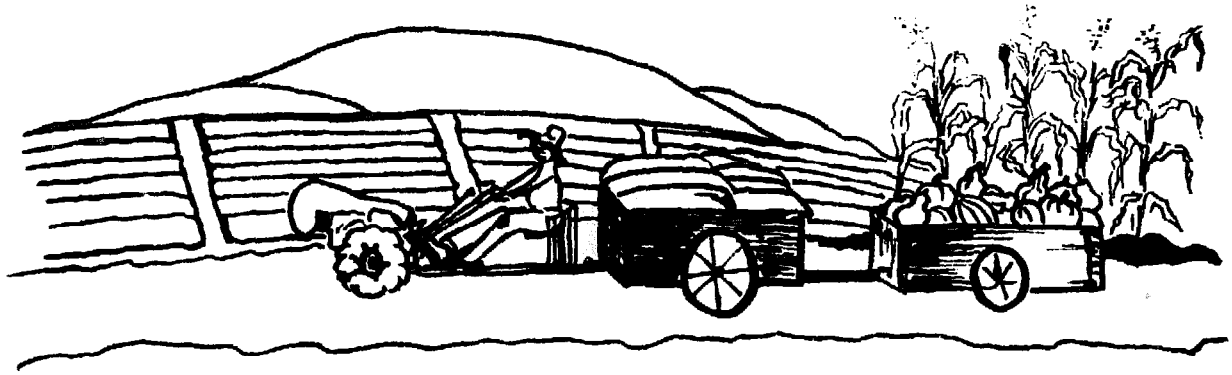
5.4.3 Use of Hand Tractors in Row Crop Production

Power hand tractors are very efficient when used with a row crop production scheme. The greatest role of the hand tractor in crops which are planted in rows is for cultivation. Rows of crops can be spaced to permit the hand tractor to be used to cultivate between the crops for the entire length of the rows. This greatly reduces the time and labour required for clean cultivation of row crops. These hand tractors can also be fitted with a furrowing attachment for placement of fertilizers, seeds or plants.

The hand tractor is very useful to turn under crop residue, especially in row crops where one row at a time can be worked. Legumes, green manure crops and other residue can be easily chopped into the earth at the peak of their vegetative growth so they quickly decompose into the fertility cycle of the soil. It can be said that proper use of this type of power hand tractor can increase and build the fertility and structure of soil.

HAND TRACTOR cultivating weeds IN between rows of soybeans AND CORN.

HAND tractor turning under old bean PLANTS AND weeds IN BED PREPARATION.



A farmer-gardener CAN ATTACH CARTS TO his HAND TRACTOR for TRANSPORT AND for hauling PRODUCE, tools, AND FERTILIZERS.

Figure 5.6

HAND TRACTORS IN USE

In fairly level areas, these hand tractors can be used to pull small loads of up to 200 and 300 pounds. The loads are pulled on two-wheeled carts (bicycle or motorcycle wheels) behind the tractor.

Some manufacturers of the hand tractors provide several useful attachments. These attachments include electric generators, irrigation pumps, and 40-inch sickle bar mowers. The electric generator demonstrates the utility of small machines as it will allow some other power tools to be used in the fields. The sickle bar mower allows steeper slopes to be mowed and utilized for hay or mulch production. The mobility of these machines allows hard-to-get-at plots to be reached and worked effectively. Some uses of the hand tractor are shown in Figure 5.6.

Machines and implements of this type provide the small farmer with a means of farm power suited to his farm size and income. The use and care of small machinery is definitely a skill that should be developed by all professional small farmers.

5.5 OTHER TYPES OF LAND PREPARATION

Although intensive raised beds make the most productive use of the land, other types of land preparation may be more practical sometimes. For example, large plantings (over one acre) of field crops, such as corn, pumpkin or sweet potatoes, are more suited to row crop production. Other factors that influence the type of land preparation are water, type of irrigation, rainfall patterns, and drainage characteristics of the soil.

5.5.1 Raised Ridges

The method of planting on raised ridges is best used when poor soil drainage is a problem, where flood-type irrigation is used, or where heavy rains occur.

Ridges are usually made 8-12 inches high, depending on the drainage of the soil. They are 30 to 36 inches wide, depending on the crop to be grown. For example, a narrow ridge is used for single row crops like corn and wider ridges are used for double or triple row crops like lettuce or cabbage. The ridges can be easily made by tractors with simple ridging plows. Many power hand tractors also have ridging plows that can do the job on most soils, except for very rocky soils. Ridges can also be made by hand with hoes and hand plows in moderate to light soils.

Ridging is illustrated in Figure 5.7. Fertilizers are usually placed in a small furrow which is 3-5 inches deep in the ridge, then covered and re-ridged.

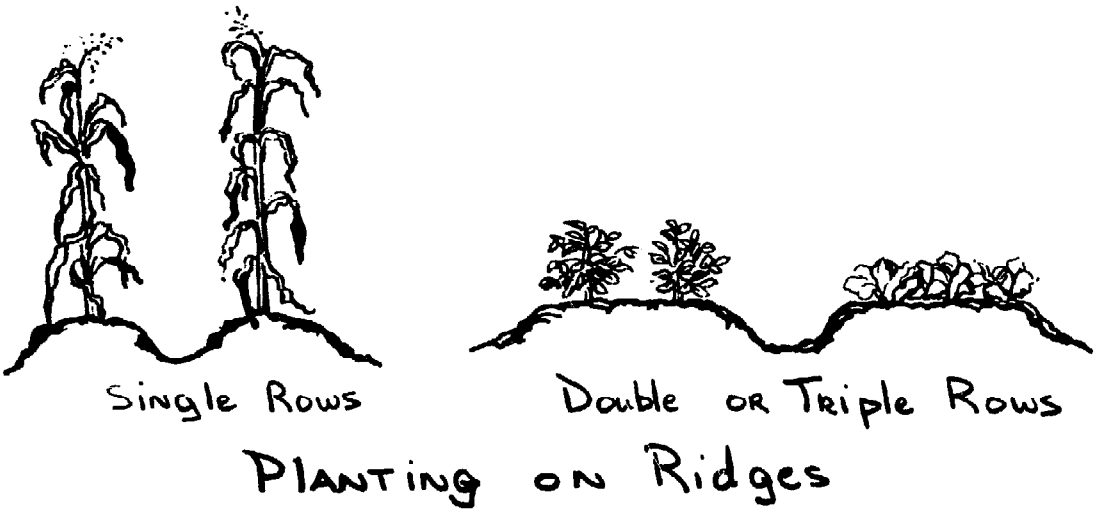


Figure 5.7

5.5.2 Furrows

This method is best adapted to dryland farming areas. By planting in the furrows, plants have more water available to them. There is less loss of water from the plants and soil by wind as the ridges protect the root area from winds.

2. PLANTING in the FURROW

Figure 5.8

Farm tractors and power hand tractors can easily prepare land for this method. Hand tools can also be used, such as hoes and rakes, to prepare the soil in this way. Fertilizer is usually applied by broadcasting, but should be worked in to minimize loss of its nutrient value.

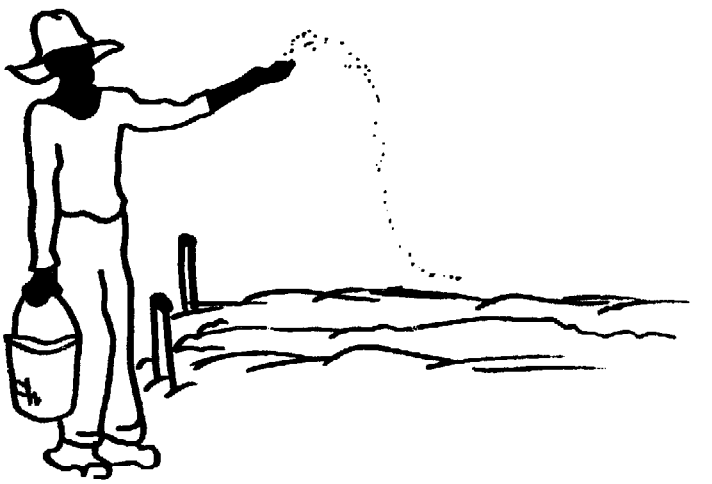
5.5.3 Level Planting

This method is used where soils drain rapidly, but have adequate rain or sprinkler irrigation.

3. PLANTING ON THE LEVEL

Figure 5.9

Fertilizer can be broadcast and worked into the soil or it can be placed in bands or rows underneath the rows where seeds or plants will be placed. After applying fertilizer, the area is smoothed and leveled before planting.



5.6 MULCHING

Mulch is a layer of organic material, such as hay, cut grass or bagasse which is placed on the surface of the soil in order to conserve moisture in the soil, to hold down weeds, and eventually to improve the soil structure and fertility. Mulching is one of nature's methods for treating soil in the forest and can be imitated by the skillful farmer.

5.6.1 Advantages of Mulching

Plants that are mulched are protected from harsh temperatures. The mulch keeps the soil cooler. This is especially helpful in hot climates. The mulch stops the hot, drying sun and winds from penetrating the soil and thus conserves soil moisture and coolness. The layer of mulch also protects the soil from erosion, caused by wind and heavy rains.

Mulching helps soil fertility. Mulch materials contain minerals and plant nutrients. Rains wash some nutrients from the mulch into the soil. When the mulch rots down into the soil, the soil's structure is improved and plant nutrients are added to improve the fertility of the soil.

Mulching can save the farmer time and labour. A mulched garden will have very few weeds, especially if the mulch is applied before the weeds get a start. The mulch also keeps the soil loose, and thus reduces the need for cultivation.

Crops such as tomatoes, melons and cucumbers are especially benefited by mulch. The mulch stops soil from coming in contact with the fruit and leaves, thus reducing fruit rot and fungus disease. Soil that is mulched will not allow mud to splash leaves of crop plants which are susceptible to leaf fungus diseases.

Low lying soils, that are usually wet, should not be mulched. These soils are likely to harbour fungus diseases which thrive in humid and moist conditions.

5.6.2 How To Mulch

Mulches can be applied at three different times--before the seed is planted, after the plants or seeds are planted, and after the plants are growing.

The mulch should be layed over the soil without mixing it into the soil. It should be applied thick enough to prevent the growth of weeds.

A finely shreded mulch is easier to work with, especially around young seedlings or transplants. A heavy, coarse material, such as hay, if not applied carefully, will break the leaves off young transplants and seedlings. A material such as bagasse, rice trash, peanut hulls, chopped grass, leaves and cow manure makes fine mulch.

To mulch a newly sowed seed bed, the mulch should be loose and thin over the row of seeds and more thickly compacted over the spaces between the rows of seeds.

Young seedlings should be allowed to become well established and hardened before mulching. Mulching young seedlings is likely to cause dampening-off fungus disease. This fungus causes young seedlings to rot at the soil line.

When using mulches such as saw dust or bagasse, a nitrogen deficiency may occur. This would cause the plants to be unable to take up nitrogen nutrients from the soil. This is only temporary and can be quickly corrected by applying some nitrogen fertilizer, chicken manure or manure tea.

5.6.3 Mulching Materials

Many mulching materials can be commonly found in Jamaica. These include the following:

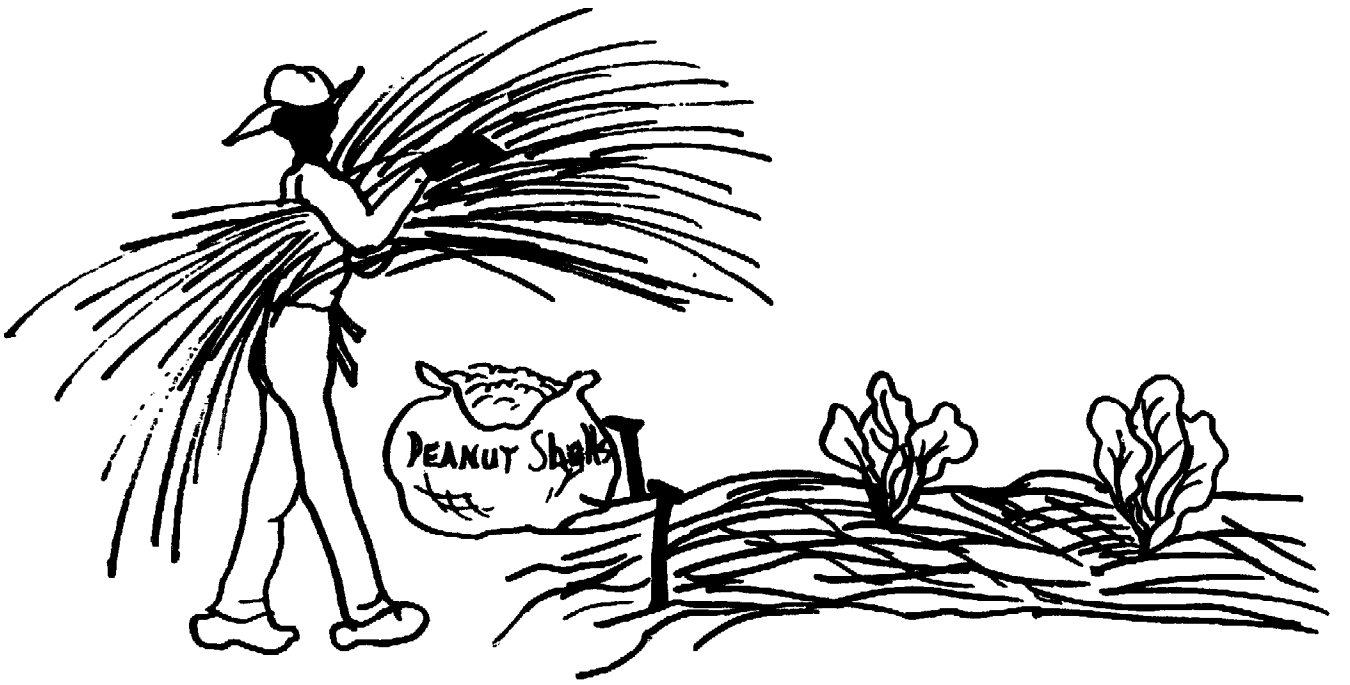
Saw dust, wood shavings, bagasse, guinea grass, bahima grass, rice straw, rice hulls, bamboo leaves, cocoa shells, peanut hulls, banana trash, cow manure, pig manure, stable litter.

The experienced farmer can identify many others which will be available to him.

Mulching is a simple, time and labour saving gardening method. It makes use of local resources and waste materials. If the common mulch materials, such as grass, sawdust etc., are not available, materials such as newspaper can be used very effectively. The farmer's imagination is the only limit. Organic materials that will eventually rot and enrich the soil are best.

The real beauty of mulch, besides conserving water, is the labour saving advantage. A crop that is mulched will require much less weeding and cultivating.

Mulching presents another method which the farmer can make use of for providing better growing conditions for his crops, and at the same time save himself labour.



CHAPTER SIX

WATER !

Conservation and use of water is very important, especially for farmers in developing countries like Jamaica where water is often a major limiting aspect of agricultural production and development.

In order to take advantage of the potential year-around growing seasons of the tropics and the resulting increased production, well-developed irrigation systems are often essential. A reliable supply of water is critical to intensive vegetable production.

When the farmer has an irrigation system, even though he may seem to have an unlimited amount of water, it should be used with care. Too much water, besides being a waste of energy and water, will leach down through the soil and carry nutrients out of the reach of the roots of plants. Water run-off on a soil which absorbs water slowly will also wash away topsoil and nutrients.

Plants in a waterlogged soil may starve for oxygen and the roots may rot. It is important for plants to have a good supply of water, especially when fruit formation begins. Young seedlings or newly planted transplants are very sensitive to dry soil.

The farmer may have to irrigate before planting to make sure the seeds or transplants have enough water to germinate and grow. Generally, water should be applied when the crop makes its fastest growth, especially if the soil moisture is low at the time. If pools of water form in an irrigated area, it is a sign that water is being applied faster than it can be taken in by the soil. This is wasteful, destructive and unnecessary. It should be definitely avoided. The farmer should take careful note of the weather before irrigating. A heavy rain following irrigation can drown out the crops.

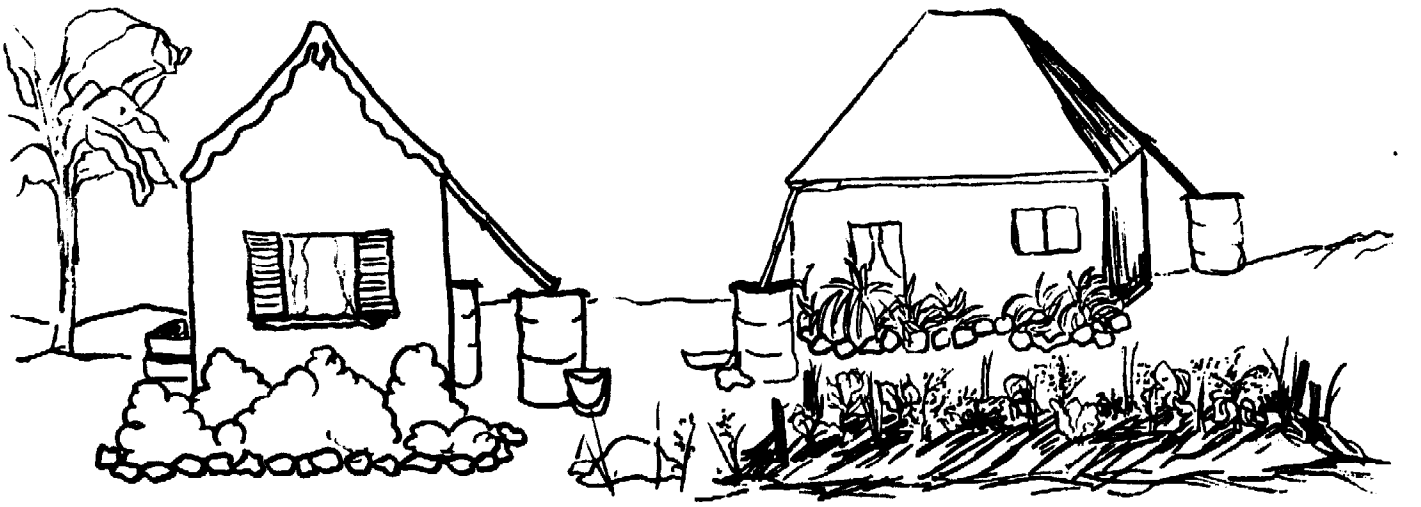
Better soil and fertility management will conserve and stretch rain and irrigation water. Better soil texture will increase the soil's ability to absorb and hold water. Once again, the importance of improving and maintaining the soil's sponge structure is demonstrated. This is a most important concern and duty of all farmers.

6.1 WATER CATCHMENT

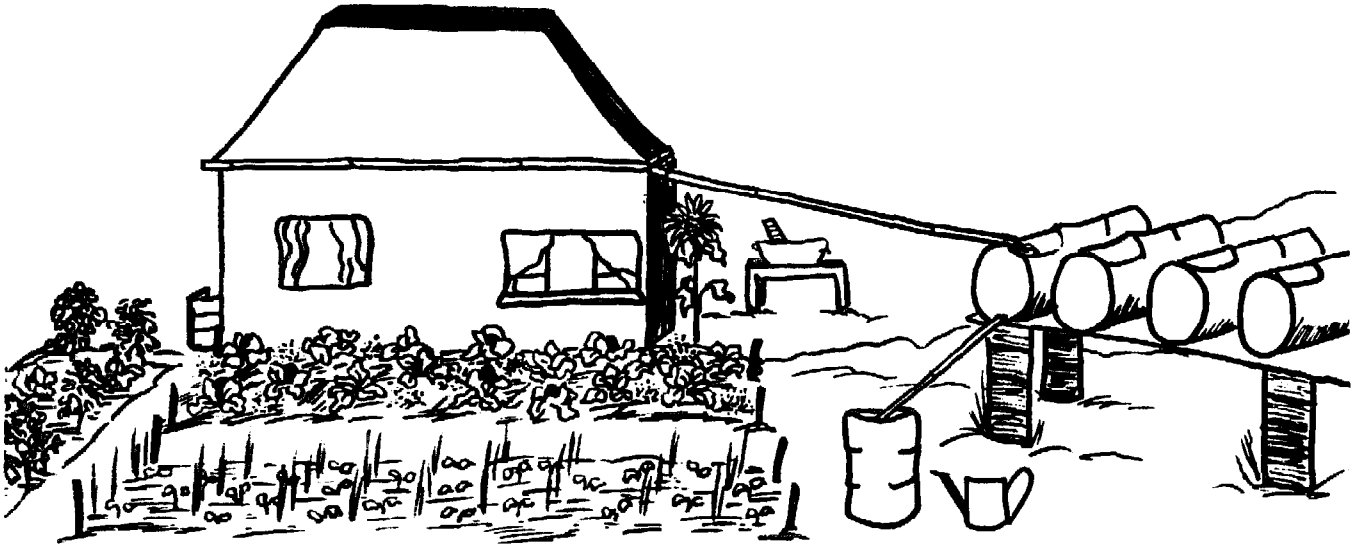
In Jamaica, the most immediate and common source for conserving water is water catchments. This is the most common source because every man who has a roof has a potential water catchment system. Many houses in Jamaica have gutters and a tank to collect rain water, but others still do not have such simple devices.

A small roof with gutters and several 50 gallon drums can collect a sizeable amount of water which can be used for household use or can be used to irrigate at least 3 or 4 small intensive vegetable beds to supply the kitchen with greens, onions, carrots, peppers, peas and other vegetables. Efficient gutters and collecting systems should be added to all houses in areas where no irrigation is available.

Figure 6.0 Water Catchment



Even when irrigation water is available, catchment can be used for small garden plots and ensures wise use of all water sources. Rain water can be regularly and easily drained into garden plots as part of a well-planned gardening scheme.



6.2 SHADE, SOIL TEXTURE AND WATER CONSERVATION

To the farmer with no irrigation facilities available, the only means of conserving and stretching his water is by increasing the water-holding capacity of the soil. Of course, all farmers should pay attention to this critical characteristic of their soil. Soil structure and texture can be improved by adding composts, manures and decaying organic matter to the soil to build up the sponge structure. A mulch can also be used to cover the soil.

Sun and winds deplete soil moisture. Windbreaks, such as a row of hedges or tall crops (e.g., corn or sunflowers) can be located and planted so as to reduce wind movement around the crops. In the case of a small kitchen garden, a bamboo wall or fence can be constructed to reduce wind movement in the garden.

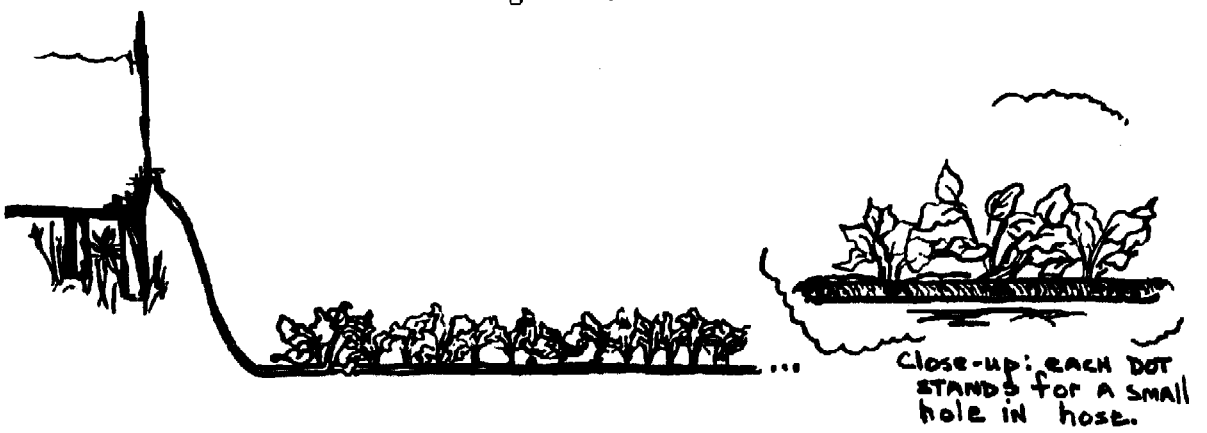
Shade can be very helpful for seed beds and special vegetable crops such as lettuce. Shade roofs can be built from bamboo or young saplings as the frame with coconut branches for roofing. This shade will keep the soil cooler and more moist, thus protecting tender crop plants from the sun. In very hot climates with much sun, shade may be required for the production of most vegetables. Large shade roofs should be built in such climates where possible.

6.3 TRICKLE IRRIGATION

One method of irrigation that looks very promising to the small farmer who must depend on rain and catchment water is trickle or drip irrigation. Drip irrigation (as well as pitcher irrigation which is discussed below) requires a minimum amount of water and is very efficient in water use.

Trickle irrigation utilizes small plastic hoses with small water outlets spaced along the length of the hose. The small outlets have very small holes which allow single drops of water to come out at a time. The hose should be arranged so that an outlet is located at the base of each plant that is to be watered. Trickle irrigation is very efficient because all the water is utilized by the plant. No water is wasted to run off or lost by moving down through the soil too quickly for the roots to take it in. This method requires very little water pressure to operate. In many cases, no pump is needed because the gravity feed from a tank can supply adequate pressure to operate a trickle irrigation system.

Figure 6.1



Trickle Irrigation

6.4 PITCHER IRRIGATION

Pitcher irrigation uses unglazed baked earthen pots or pitchers buried in the soil to water the garden area. The pots are buried in the ground to the neck, then filled with clean water. Vegetable seeds are planted around the pot. Enough water soaks through the pot into the root zone to supply and maintain plant growth. Excellent results have been achieved with both pumpkins and watermelons with this method.

Although this is an excellent method to conservatively use water, it must be noted that care of the irrigation pitchers is very important. The pitchers can become breeding places for mosquitoes and other insects if they are not properly covered.

Figure 6.2

Pitcher Irrigation

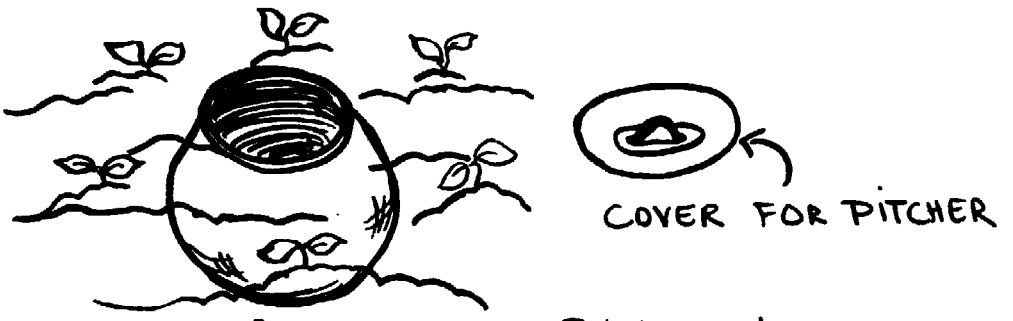
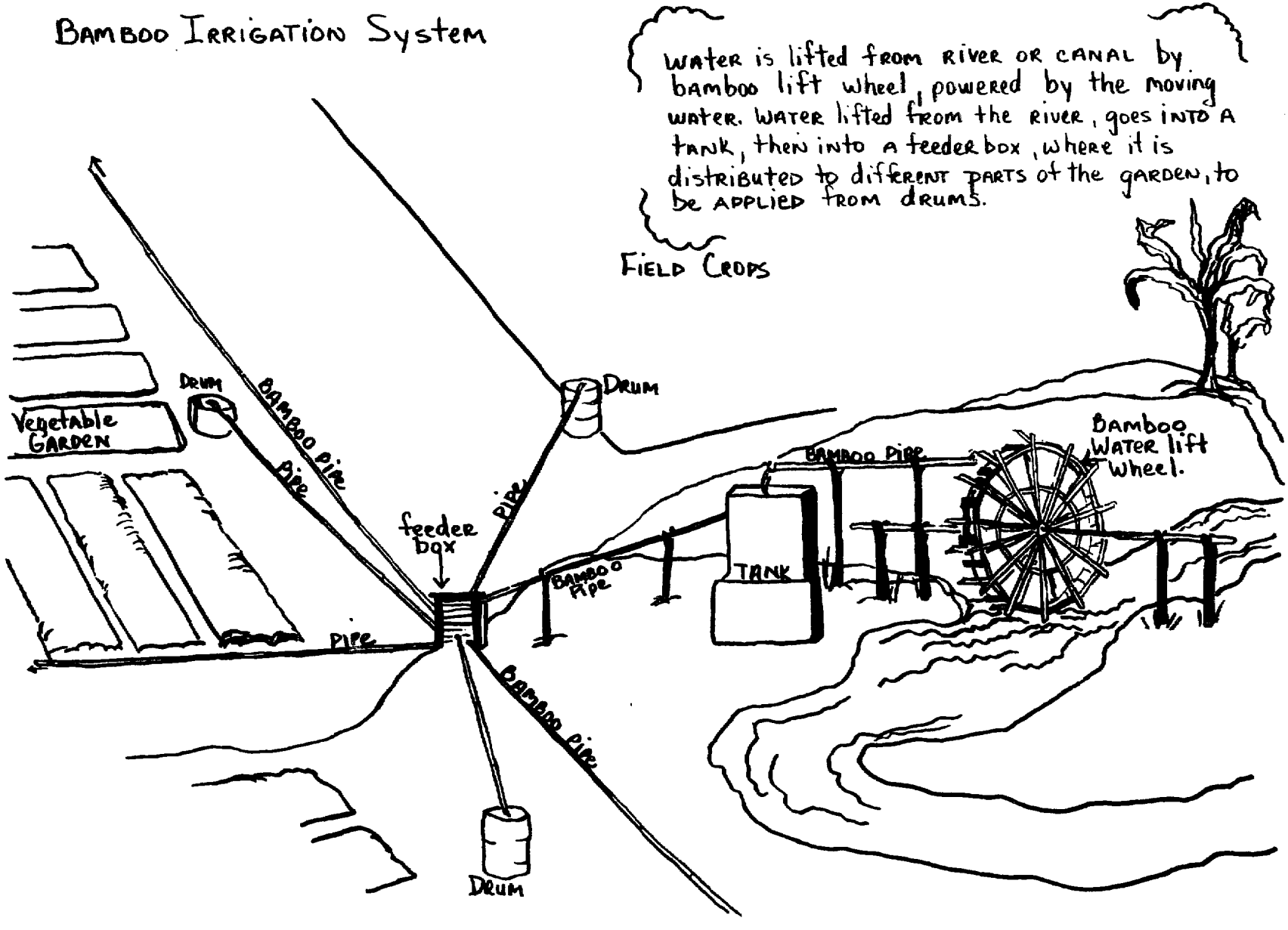


DIAGRAM OF AN EARTHEN PITCHER PLANTED IN THE SOIL WITH SMALL SEEDLINGS PLANTED AROUND IT.

6.5 BAMBOO IRRIGATION SYSTEMS

Bamboo can be used very effectively in irrigation by the small farmer. In areas near a river, stream or canal, very inexpensive and easily constructed bamboo lift wheels can be used with a simple bamboo piping system to bring water to crops and raised vegetable beds. This can be seen in the following illustrations. It is a system which is often overlooked in favor of more expensive systems with metal piping and expensive machinery and materials. But it is well suited to the needs of the small farmer or gardener.

Figure 6.3


BAMBOO IRRIGATION SYSTEM
WATER is lifted from RIVER OR CANAL by bamboo lift wheel, powered by the moving WATER. WATER lifted from the RIVER, goes INTO A TANK, then into a feeder box, where it is distributed to different PARTS of the GARDEN, to be APPLIED FROM DRUMS.
FIELD CROPS
Vegetable GARDEN
DRUM
BAMBOO PIPE
PIPE
feeder box
PIPE
DRUM
BAMBOO PIPE
TANK
BAMBOO WATER lift wheel.
PIPE
BAMBOO PIPE
DRUM

In areas with much bamboo, its use (or potential usefulness) has often been neglected and the use of more expensive and imported materials promoted. It is important for the people of Jamaica to make full use of their natural resources. Bamboo is an important local resource for the farmer.

Bamboo can be used to make very effective water piping systems. The only liability is the relatively short life of bamboo when it is in direct contact with earth and water. But bamboo has many advantages.

A grove of bamboo, with little care, can come into commercial production in five years. Quality construction material can be produced and harvested easily. Although the life of the construction material (bamboo piping is a common example) is not as long as metal or aluminum piping, the relative inexpensiveness of bamboo and the amount of production from a properly managed grove gives the farmer a reliable supply of replacement materials.

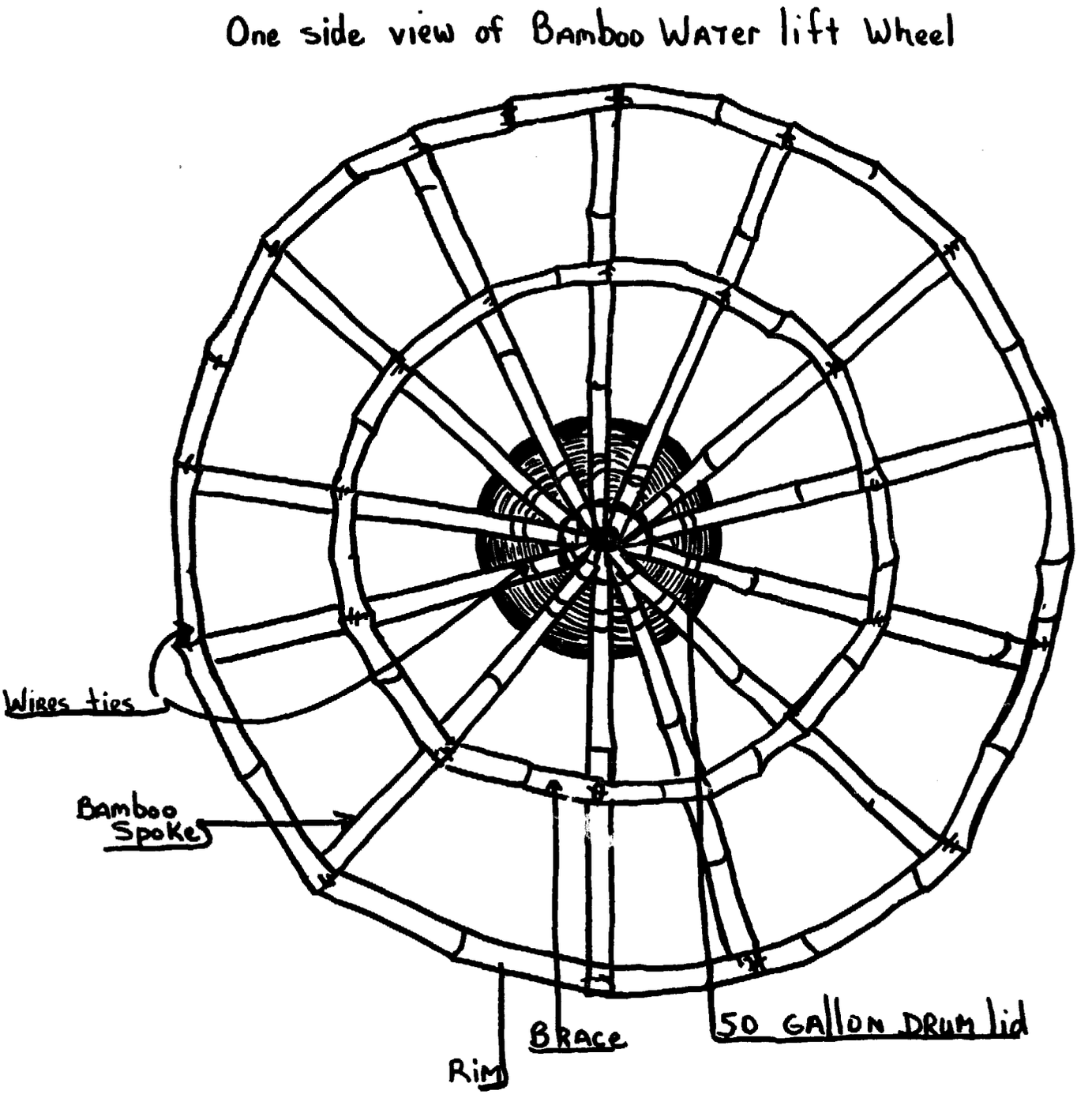
For the small farmer near a stream or river who cannot afford a power irrigation system or aluminum irrigation piping, bamboo will easily serve his needs. Examples of a bamboo water lift wheel is given in Figures 6.4-6.11 and of bamboo piping in Figure 6.3.

The use of bamboo is just one method by which the skillful and clever small farmer can utilize local resources to increase production and save money.

6.6 IRRIGATION AND WATERING OF INTENSIVE GARDENS IN RAISED BEDS

It must be remembered that the large yield produced by the intensive gardening methods requires a constant and adequate supply of water. Deep water penetration is required to support the large number of plants in each bed. Deep watering and soaking makes the roots go deep into the soil. Shallow watering, where only the top few inches of the soil is soaked, causes the plant roots to grow shallow. Shallow roots are more likely to be damaged and affected by dry contitions. Also, the top soil dries out more quickly than the deeper soil.

Figure 6.4


One side view of Bamboo Water lift Wheel
Wires ties
Bamboo Spoke
Rim
Brace
50 Gallon Drum lid

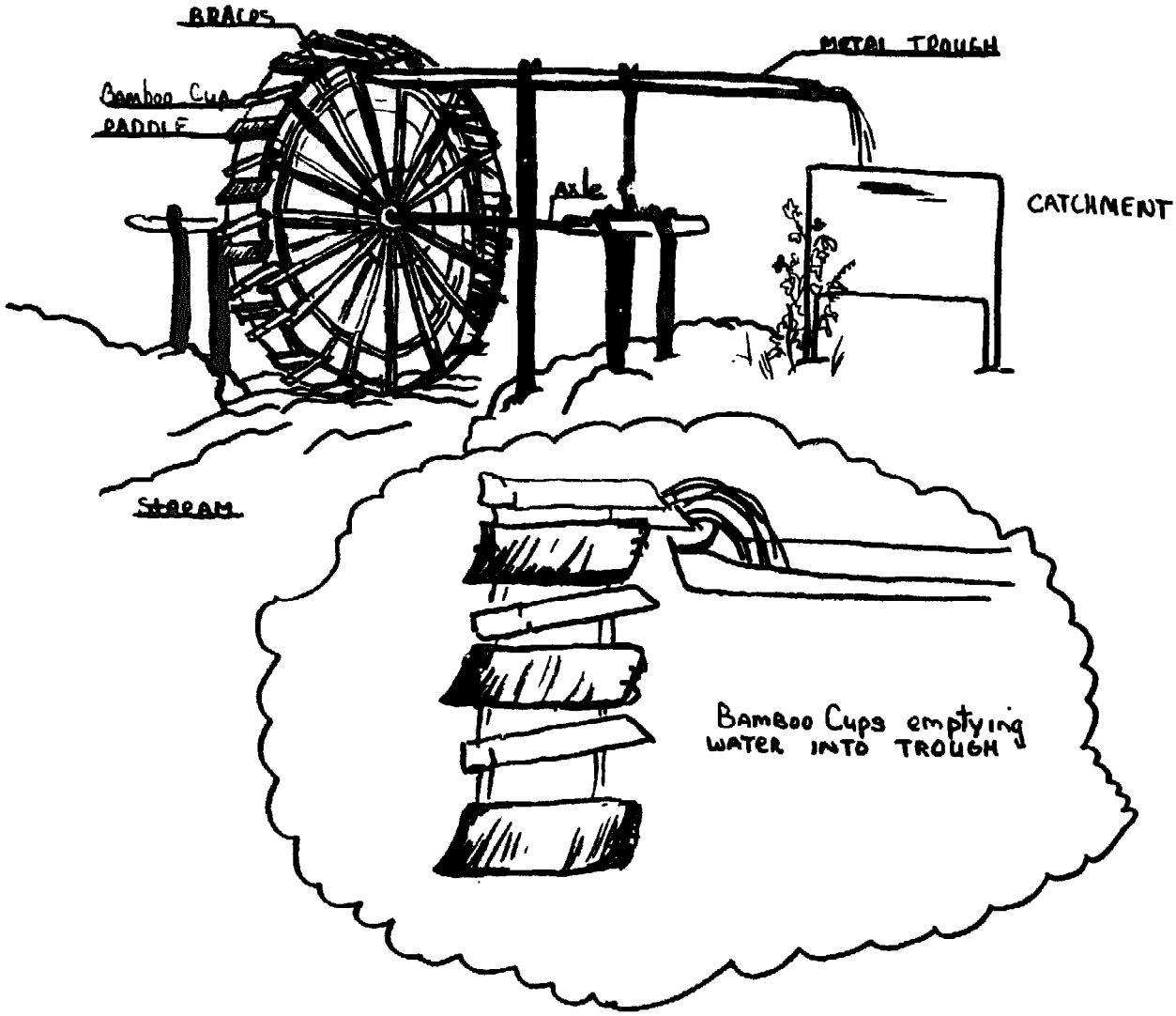


Figure 6.5

Bamboo Lift Wheel In Action

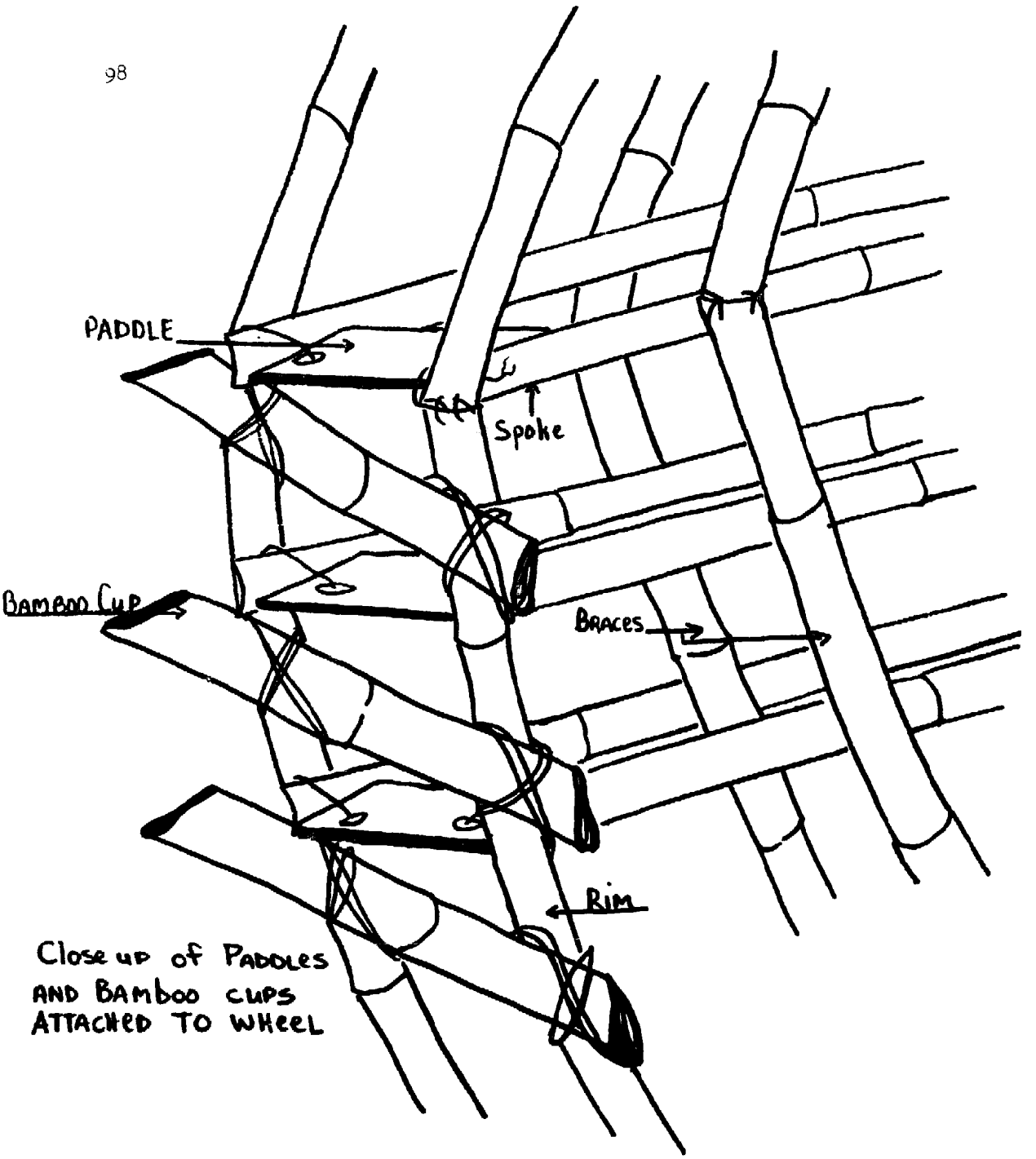
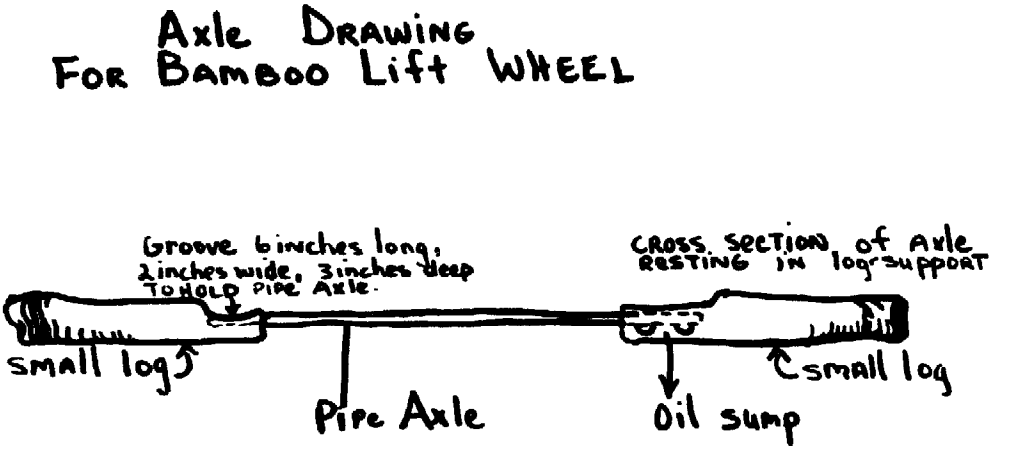


Figure 6.6

Attachment Of Cups And Paddles To A Water Wheel

Figure 6.7



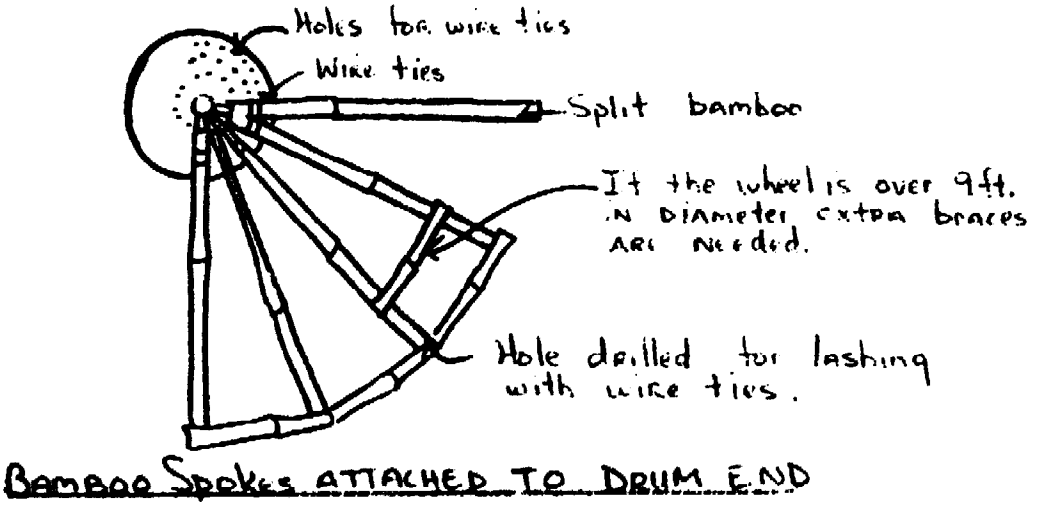


Figure 6.8

Figure 6.9

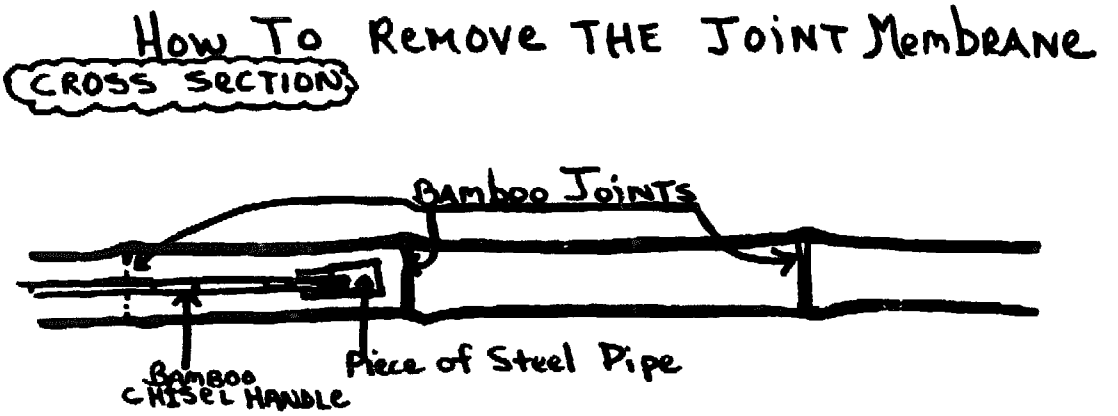
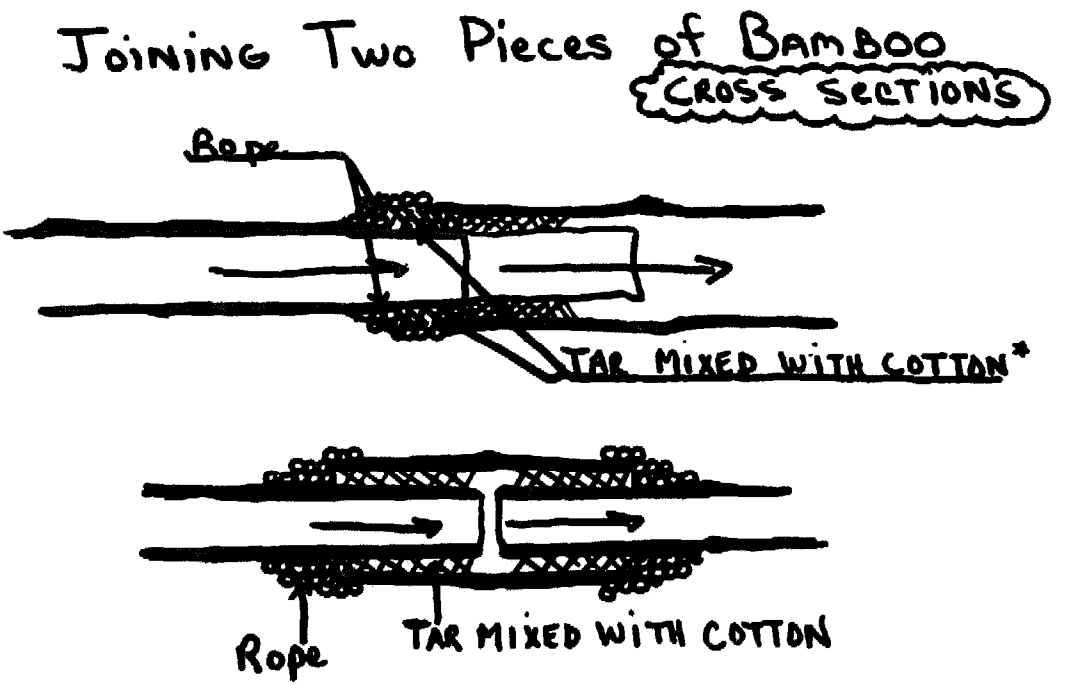


Figure 6.10

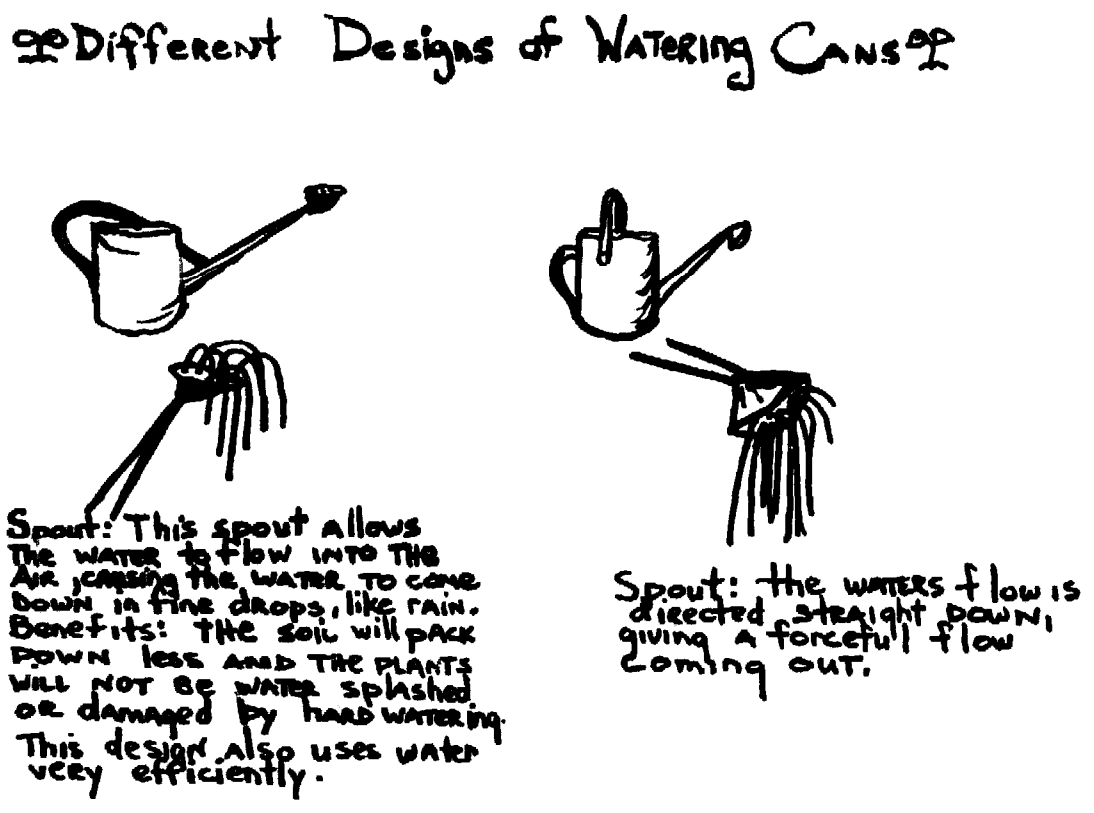


* THE cotton from the Silk Cotton Tree may be used for cotton

Two methods best suited to irrigate raised vegetable beds are sprinkler irrigation and watering by hand with a hose or watering can. When watering seed beds and young seedlings, it must be remembered that these small plants are very delicate and can be damaged by a forceful water flow. A water can with a sprinkler nozzel is a very helpful tool. Water cans with the sprinkler nozzle turned up are best for watering tiny plants in seed beds because the water coming out has less pressure when it hits the plants. It is more like natural rainfall.

Figure 6.11

TWO DESIGNS FOR WATERING CANS



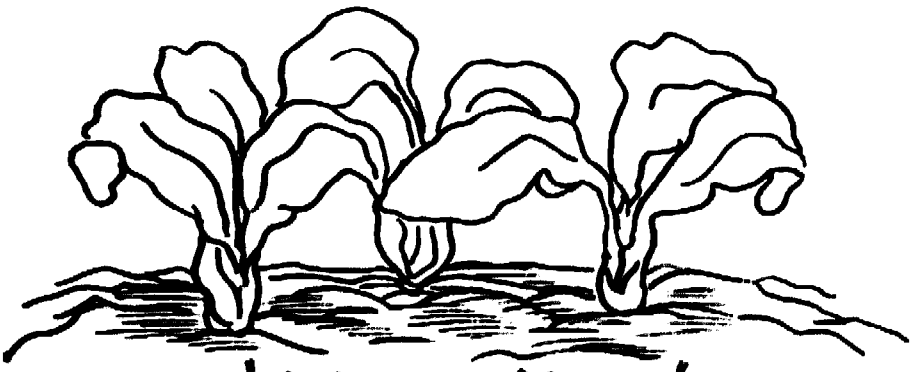
Heavy irrigation or watering with forceful streams of water can damage the plants, pack down the soil and cause erosion of the soil. Whatever the type of irrigation used, the farmer must be alert and aware for negative as well as positive effects of watering methods on the plants, the soils, and the future of the land.

6.7 WATER PREFERENCES OF PLANTS

The skilled farmer, through experience, will strive to learn the water preferences of each of his crops. For example, crops such as melon, cucumbers or tomatoes, are more likely to get diseased when their leaves are wet. It is best to water these crops at the roots only, striving to keep the leaves as dry as possible. When crops are watered in such a way that the leaves are splashed with muck or soil, they are more likely to be attacked by disease.

Older, well-established plants should be watered when the hottest part of the day has passed. This usually occurs around mid-afternoon. When watering at this time of day, the cool water is warmed by the soil so that as it reaches the roots there is less shock to the plant. Also, the plants have more time to absorb water during the night. This is important because plants do a good amount of their growing in the night. If watering is done early in the morning, much water will be lost to the sun and wind through drying so that less water is available to the plants. If watering is done in the evening, the plants will be more likely to be attacked by fungus and mildew caused by standing water left on the leaves in the damp nights.

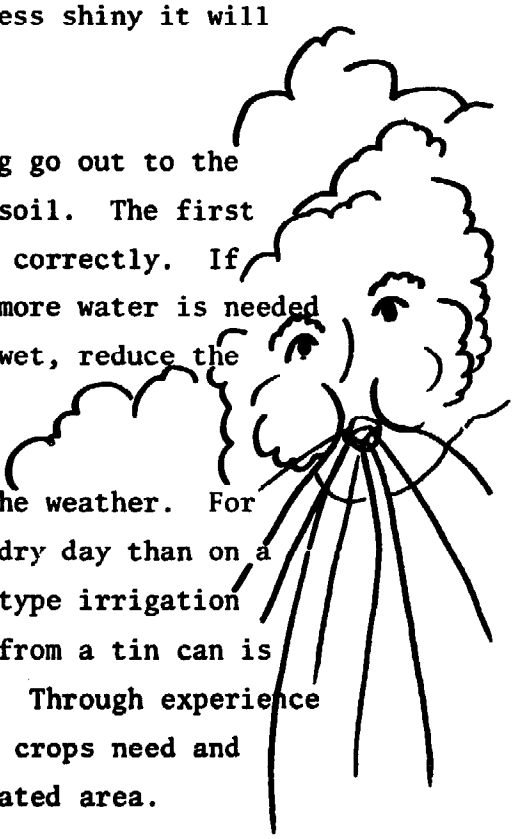
As plants begin to cover the raised bed of an intensive garden with their leaves, the "living mulch" conserves the water and moisture so less watering is necessary. Until the plants begin to shade a good portion of the bed, strict attention should be given to make certain that the bed is well supplied with water. Seeds, seedlings and young transplants may need to be watered two or three times a day.



"A Living Mulch"

6.8 ADEQUATE WATERING

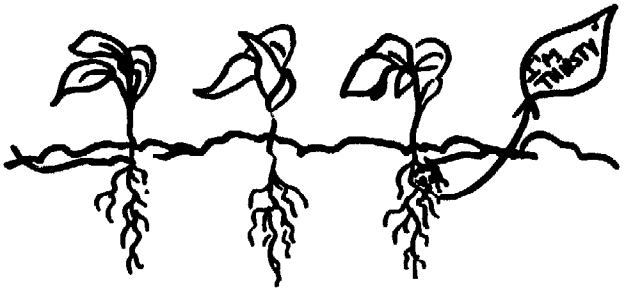
When watering by hand, a very good method to determine when a bed has been watered enough is by observing the shiny layer of water that forms on top of the soil. You will notice how the soil becomes shiny on the surface when watered. If the watering is stopped, the shiny layer will disappear quickly. The length of time that the "shiny" remains will tell you when the soil has received enough water. The shiny layer should remain for 5 to 15 seconds after you have stopped watering. This time will differ with different types of soil. The more clay a soil has, the less shiny it will need.



To see if you have watered correctly, the next morning go out to the bed watered the day before and push your finger into the soil. The first two inches (or a little below) should be moist if watered correctly. If the soil is dry for all or part of the first two inches, more water is needed so increase the shiny. If the soil feels soggy and very wet, reduce the watering by shortening the shiny time.

The farmer should learn to adjust his watering with the weather. For example, a bed may lose more moisture on a cloudy, windy dry day than on a clear, hot humid day with no wind. When using sprinkler-type irrigation with movable pipes and rainers, a simple rain gauge made from a tin can is very useful to determine how much water has been applied. Through experience the farmer should note the amount of irrigation different crops need and measure application with a rain gauge placed in the irrigated area.

The successful farmer must learn to become sensitive to the needs of his crops and plants. Watering should be practiced for good vegetable and fruit production, and should not be the minimum just to keep plants alive. The farmer should come to know and understand the soils and crops upon which he depends. He should know the farm and the plants, their watering needs and preferences. Just as each farmer is different, so is each crop, each soil and each farm. Only the farmer can truly know and learn how to best care for his own farm.



CHAPTER SEVEN
PLANTING

Planting involves the placement of seeds and plants in the earth. This is a basic skill for all farmers. The amount of care and thought given to this task will show in the yields and health of the farmer's crops.

7.1 SOWING SEEDS

Sowing seeds is an important skill that all farmers and gardeners must master. Poorly sown seeds will result in poor, thin crop stands and cause the farmer more work for replanting. It is better to take time and care when sowing seeds to insure good germination and less replanting.

A good guide to follow when planting seeds is to cover the seed with no more than twice its thickness of soil. When planting seeds in rows, a furrow should be made with a hoe. Then the seeds can be scattered thinly in the furrow and covered with a layer of soil or compost. The soil is then firmed down slightly by patting it with the hand or the blade of a hoe. This firms the soil and gives good contact between the seed and soil. Be careful not to pack the soil too tight, as this would make it difficult for the young plants to come up through the soil.

There are three methods of sowing seeds used in intensive vegetable production: broadcasting, diagonal offset planting, and closely spaced rows.

7.1.1 Broadcasting

Broadcast planting is the method of sowing seeds by scattering them over the surface of the soil. Broadcasting is usually done by hand. Although broadcasting may require some practice before it is

mastered, when properly performed broadcasting can increase yields and extend the reaping season.

Most vegetables that are to be transplanted can be broadcast in the seed beds. Carrots, mustard, turnips and radishes give very good results when broadcast planted.

Small seeds such as lettuce, cabbage, carrots, onions, or turnips, should be broadcast so that the seeds will be one to two inches apart. If the seed is sown too thick, some thinning of the young plants will be necessary. Carrots can be mixed with sand or cornmeal at the rate of one part seed to eight parts sand or cornmeal. This mixture will help the farmer sow the seeds more evenly so less thinning will be needed.

Broadcasting seeds allows the young plants to create and benefit from the living mulch, "mini-climate" effect much earlier in the season.

7.1.2 Intensive Spacing of Seeds

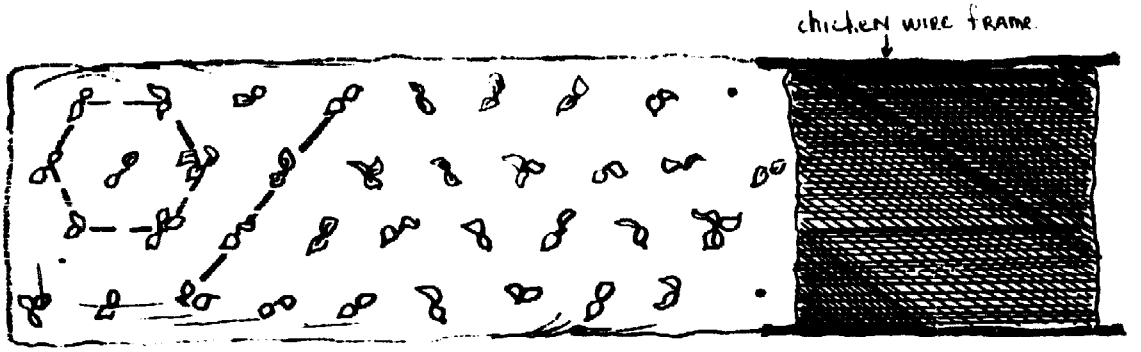
To plant seeds on intensive raised-beds, the farmer can either make closely spaced rows across the width of the bed or plant in a diagonally offset pattern, which gives each seed the same amount of room from every other seed.

7.1.3 Diagonal Offset Planting

The diagonally offset pattern of planting may seem somewhat difficult to the beginning intensive gardener. A four sided frame the width of the bed, made of small bamboo with 1 inch mesh chicken wire stretch across will greatly simplify the seeding method. (see figure 7.0)

The one.inch chicken wire is made in a hexagonal pattern, that is a six sided pattern. When planting seeds that are to be spaced 1 inch apart, you would drop one seed in each hole of the mesh. (see figure 7.1)

CHICKEN WIRE GUIDE
FOR DIAGONAL OFFSET PLANTING



Chicken wire with Bamboo Frame laying on a bed for use in Diagonal offset planting.

Figure 7.0

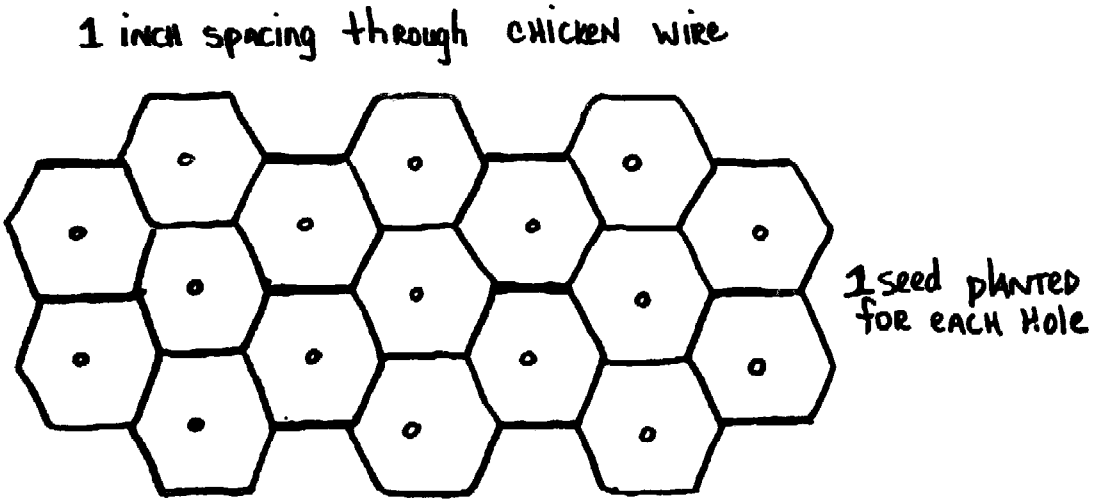


Figure 7.1

For seeds to be spaced further apart, for instance 4 inches, you would drop a seed then count four holes and drop the next seed.(see figure 7.2)

Once the planter is familiar with this method, he will find that it will save time and work. For example, less thinning will be required. This method makes the most intensive use of the growing space, with the plants covering the soil quickly and evenly.

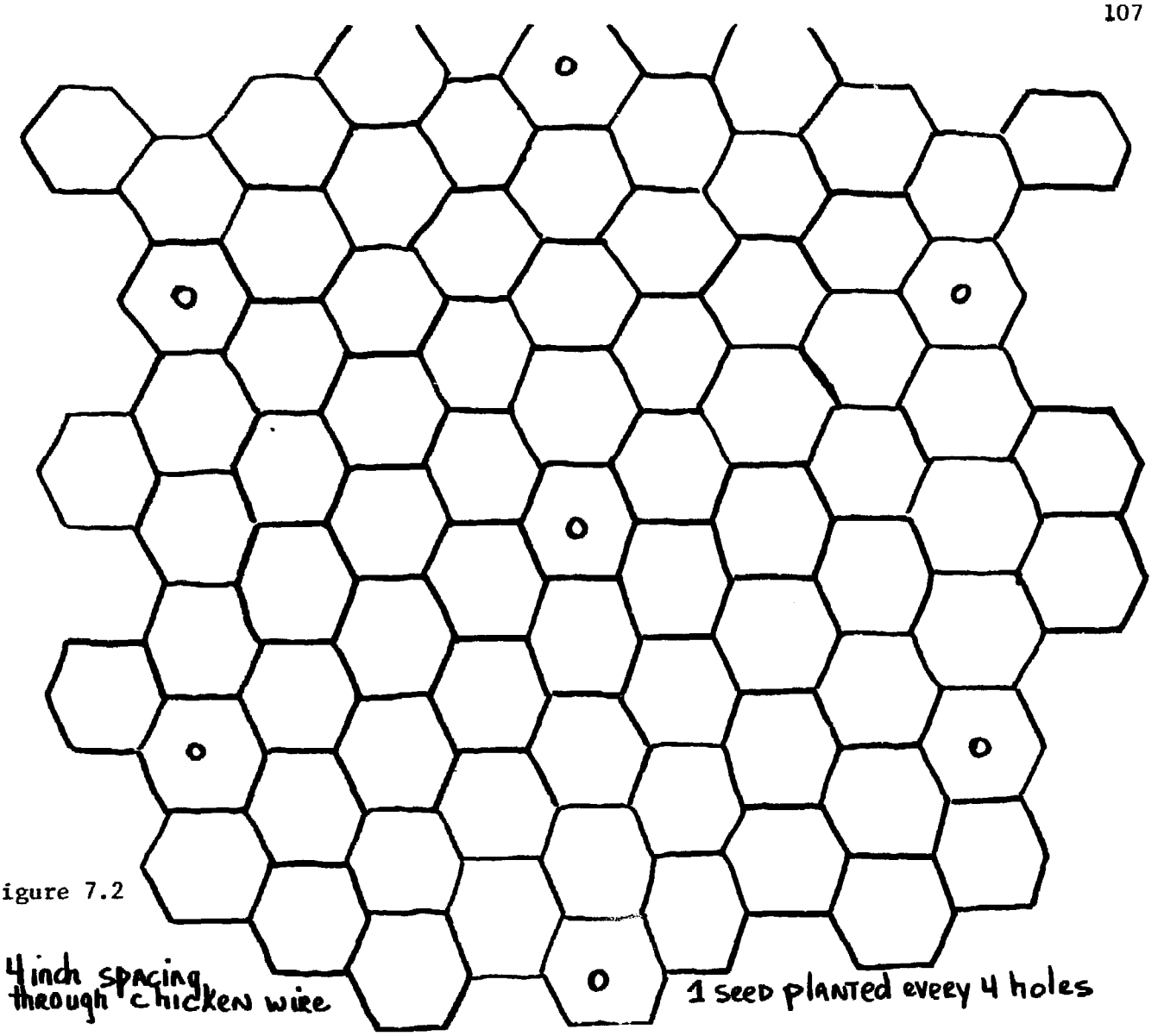


Figure 7.2

7.1.4 Close Row Planting

This method is a little easier than the diagonal offset method but usually requires more thinning of the young plants, which can be very tedious and time consuming work.

When planting rows on an intensive bed it is best to plant across the width of the bed. From table 2 , page 145, determine spacing for vegetables to be planted and mark rows with a stick across the width of the bed. For example, if onion seeds are to be sowed, you look on the chart and see that they are planted at 4 inch spacings. You then mark the rows 4 inches apart, sow the seeds thinly in the furrows, cover them, and firm the seed bed by patting with the hand where the seeds were sown. The seeds should be sown so that they are 1 to 2 inches apart. After the

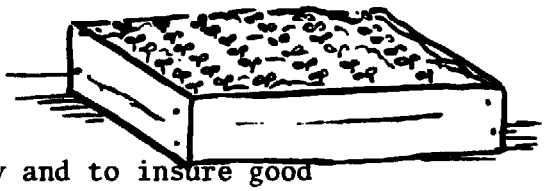
plants are growing, they will be thinned out to 1 plant every 4 inches.

7.2 GROWING TRANSPLANTS

Transplanting refers to removing young plants and planting them in a new place where they can grow to maturity. In this section we have presented methods by which the farmer can produce strong transplants, and ways the farmer can reduce the shock of transplanting.

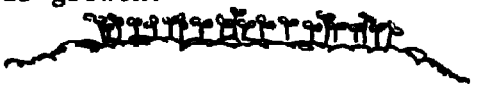
When growing seedlings to transplant, it is very important to keep them growing strong and healthy. Strong transplants will increase yields.

7.2.1 Where To Grow Transplants



To keep the young seedlings strong and healthy and to insure good germination of the seed, a well-prepared fertile seed bed is an important step.

Seed can be sown in flats or trays which can be moved and protected from harsh weather conditions or heavy insect attacks. Seed flats should be 3 inches deep by 14 inches wide and 23 inches long. If the flat or tray is too shallow the young plants roots will touch bottom too soon and cause the plant to age quicker and slow down their growth.

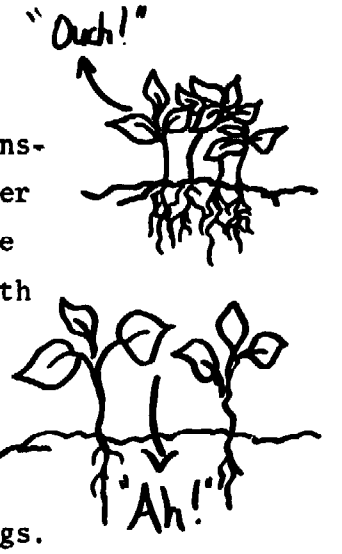


7.2.2 Soil For Growing Transplants

A good soil mix for the seed flats is one part sand to three parts top soil. This will insure good germination and growth. If compost or well rotted manure is available some should be added to the mixture or spread on top of the seeds.

Seeds for transplants can also be sown in well-prepared seed beds, that have been refined and smoothed with a rake and enriched with fertilizer, manure or compost. Seed beds are usually made 4 feet wide and any length. The seeds are sown in rows 4 to 6 inches apart, across the width of the bed.

7.2.3 Spacing and Thinning



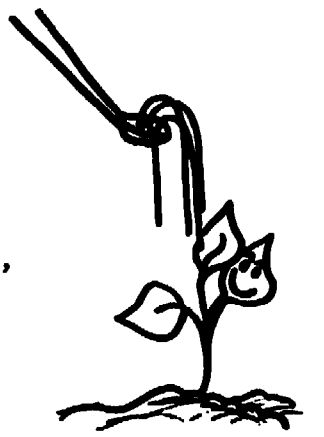
It is very important for the seedlings not to be crowded. Transplants that are grown too close together in the seed bed are weaker and more susceptible to disease and transplanting shock. Therefore the seedlings should be thinned early to provide each seedling with enough room to grow.

Seedlings should be thinned when they have 3 or 4 leaves, and each seedling should have 4 to 6 inches between it and all other seedlings in the bed. Remember crowded seedlings are weak seedlings.

7.2.4 Care and Watering

When seedlings are grown during the hot part of the year, a simple shade structure will protect them from the burning sun and conserve moisture. A simple shade structure can be made from local materials, such as, coconut leaves, bamboo, or young trees. The roof should be made tall enough to allow easy watering and working of the seed bed. The shade should not be too heavy but should allow some sun to come through. Each farmer must experiment to discover the key for best transplant cultivation on his farm.

Seed beds should never be allowed to dry out completely. At the same time the farmer-gardener must be careful not to overwater. Overwatering or watering late in the evening before sunset can cause damping-off disease in young seedlings. This is a fungus disease that thrives in cool moist areas. When a plant goes into the cool night with wet leaves and stems, chances of fungus attack are increased. Seed beds and young plants may require watering 2 or 3 times a day. Always try to finish watering 2 to 3 hours before the sun goes down.



The gardener can produce stronger, seedlings by watering them with liquid fertilizer or manure tea once a week. Liquid fertilizer can be made by adding 2or3 level tablespoons of a complete fertilizer, such as 10-10-10, to 3 gallons of water. Manure tea can be made by

soaking rotted animal manure in water.(see figure 3.2)

Transplants should be gradually exposed to sun one week before transplanting. Watering should also be gradually decreased to harden the plants to prepare them for transplanting. To help the plant get a good start one pint of manure tea can be applied immediately after transplanting.

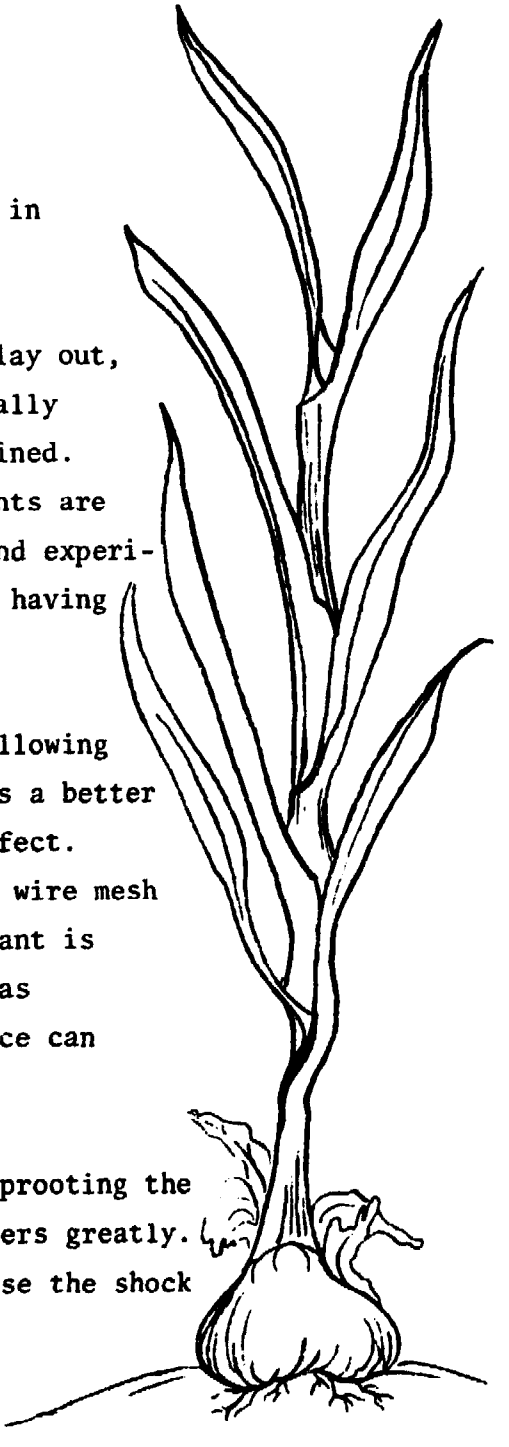
7.3 TRANSPLANTING AND REDUCING PLANT SHOCK

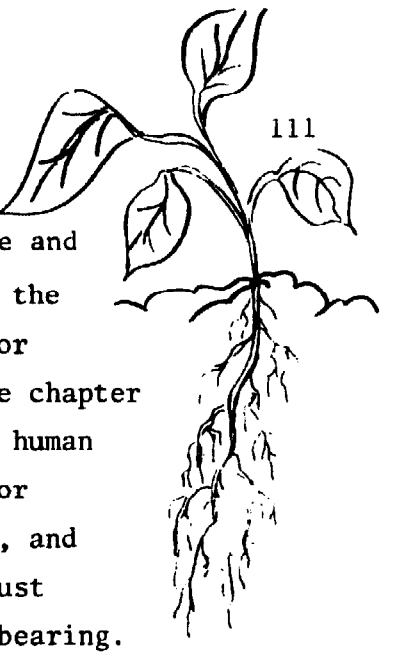
On intensive raised beds, transplants should be planted in straight rows or in diagonally offset rows.

Straight rows across the width of beds are easier to lay out, but do not make as intensive use of the bed space as diagonally offset rows. The spacing for the vegetable should be determined. Then rows are spaced that distance apart and layed out. Plants are then placed the same distance apart in the row. With time and experience the gardener should be able to plant correctly without having to measure.

Diagonally offset rows make better use of the bed. by allowing more plants to be planted in the bed. This method also gives a better total plant cover for the bed providing the living mulch effect. (see figure 7.0) With plants such as celery and onions, the wire mesh frame can be used as a guide to mark the spot where each plant is to be planted. When plants are planted further apart, such as cabbage and lettuce, measuring sticks of the desired distance can be used to determine where each plant should be placed.

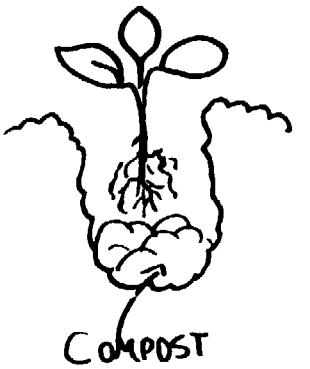
The greatest problem in transplanting is the shock of uprooting the plant. When a young plant is removed from the soil, it suffers greatly. It is up to the farmer-gardener to do all that he can to ease the shock and provide for the quick recovery of the young plant.





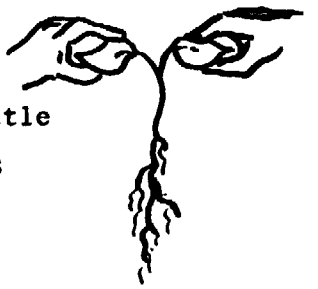
When removing seedlings from the seedbed, the greatest damage and shock is to the roots. These are the "mouth" of the plant, where the plant takes in its food. If these roots are exposed to air, sun or rough handling, many of them will be destroyed. Remember from the chapter on Botany that the root hairs, which can hardly be seen with the human eye, absorb nutrients for the plants. If root hairs are damaged or shocked in transplanting, they stop absorbing food for the plant, and the plant growth is slowed down. The intensive market gardener must develop his transplanting skill to insure good yields and early bearing. Transplanting, and the time it takes the plant to recover, affects how soon the crop will mature and can be reaped. These are very important facts to the intensive market gardener who wishes to catch an early market when the prices are high.

One way to minimize transplanting shock is to have strong, healthy, growing plants. Plants that have been crowded, have slowed down, or have stopped growing are poor transplants and will give poor yields. Transplant seedlings before this happens. The timing of transplanting is critical for strong plants and high productivity.



To keep the plants growing and healthy, high quality and abundant plant foods must be provided for transplants. If these are provided, transplanting a plant can actually help it grow faster, rather than slowing it down. Compost can provide a helpful"meal" for the new transplant. Just put some in the planting hole. It is important to remember that beds should be prepared and fertilized before the plants are transplanted into them.

Before removing seedlings from the bed, the bed should be thoroughly watered. This will help keep more soil around the roots and reduce root damage.



Seedlings are very fragile. It is important to handle them as little as possible. The seedlings should be held by the tips of their leaves or by the soil around their roots. Removing seedlings from beds or flats should be done with the help of a handfork. Gently loosen

and take up a 4 inch section or square of soil and plants. This section should be placed on the ground; then one plant at a time should be gently pulled away for transplanting. If the day is hot, dry, or windy, the seedlings should be protected by wrapping them with a wet paper bag. The planter should always strive to keep as much soil around the roots as possible.

When transplanting the seedlings, make holes large enough that the plant can be set a little deeper than it was in the seed bed or flat. This will insure that the upper roots do not become exposed. The soil should be pressed firmly around the plant but not too tight. Soil packed too tightly can damage the roots and also prevents water, air and nutriments from reaching the roots. Soil that is too loose around the roots will allow too much air and water to gather around the roots, causing root burn and decay. Firm contact of the roots with the soil will help the plant roots absorb nutriments and water.

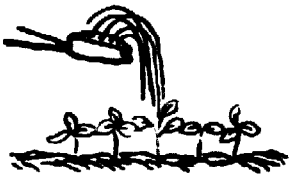
When setting transplants, be certain they are placed deep enough that they will not bend over. Cabbage seedlings should be planted up to their first two leaves. This will prevent them from bending over. Plants that have bent over will develop very tough stems, which reduces the size and quality of the vegetable produced.

After seedlings are planted, they should be watered-in. Manure tea or liquid fertilizer can be used to water-in the transplants. About a pint per plant should be enough. This gives the plant a quick boost of stength to help overcome the shock of transplanting. Watering helps to remove air pockets around the roots, and prevents the roots from drying out. The growing bed where the plants are to be transplanted should also be watered before planting. This will do much to help the plants catch. Seedlings transplanted to dry soil will dry quickly and thus require watering sooner and more often.

Cloudy days with no wind are the best days for transplanting. Late afternoons and evenings are the best times of day to transplant.

Figure 7.3

Transplanting



SOAK THE SOIL AROUND seedlings Before REMOVAL.

Loosen SOIL AROUND seedlings with a HAND tool.

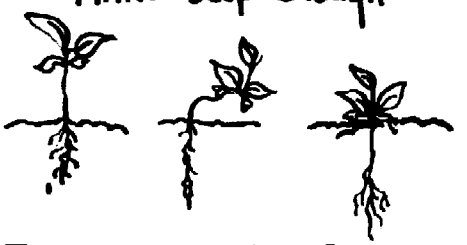
If seedling is IN A POT, CAREfully TURN upside down HOLDING PLANT BETWEEN 2nd AND 3RD FINGER, AND TAP POT WITH OTHER HAND.

When HANDLING seedlings, hold by two leaves OR ...

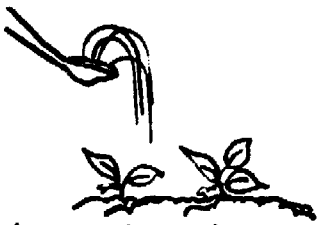
...Hold by ball of ROOTS IN palm of your HAND.

MAKE SURE the Hole is big enough for the ROOT System.

PLANT Deep enough



Improper Result Proper



WATER in the Seedlings AFTER TRANSPLANTING.

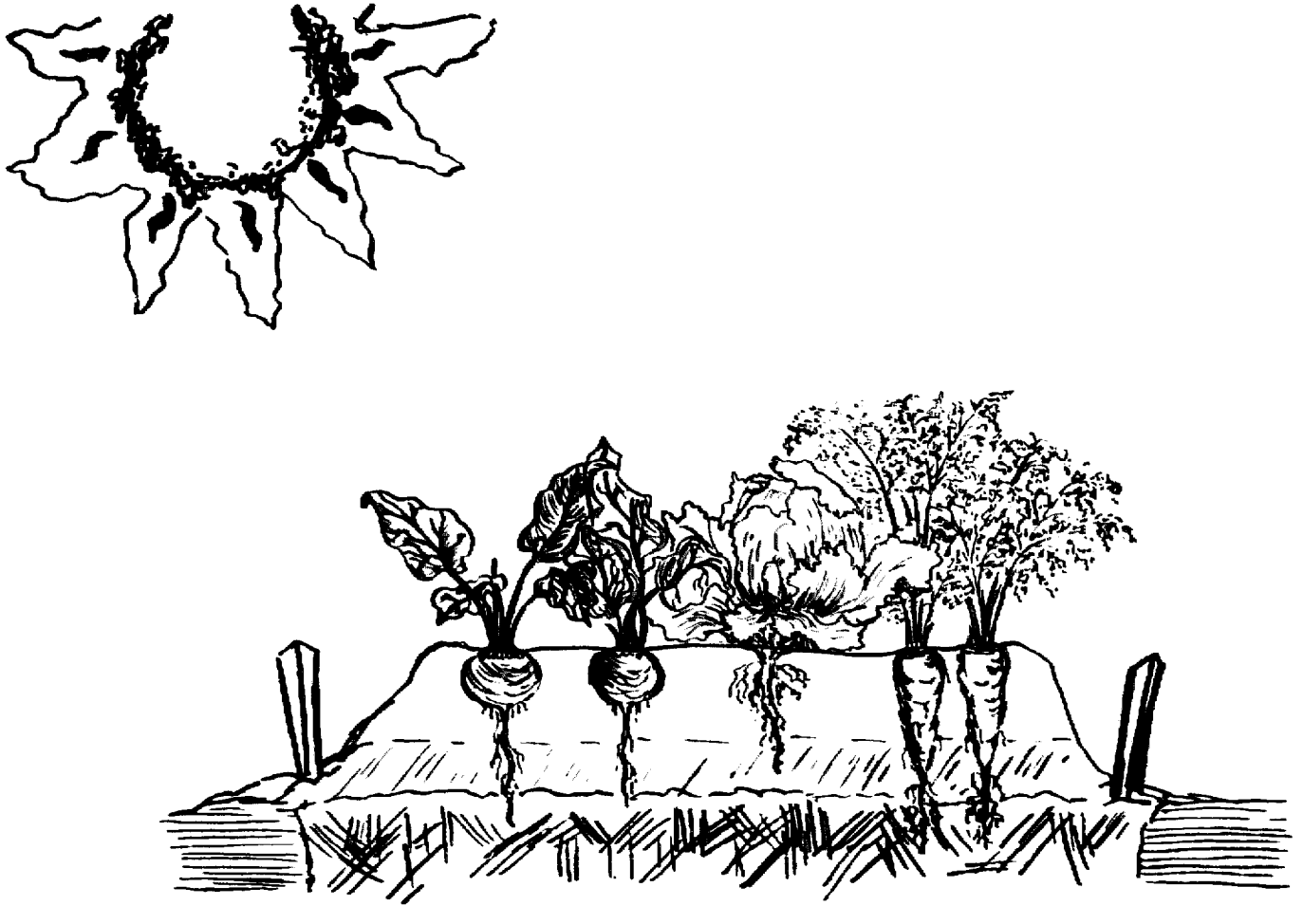


Figure 7.4
COMPANION PLANTING

Raised Bed planted with Beets, Lettuce, and Carrots

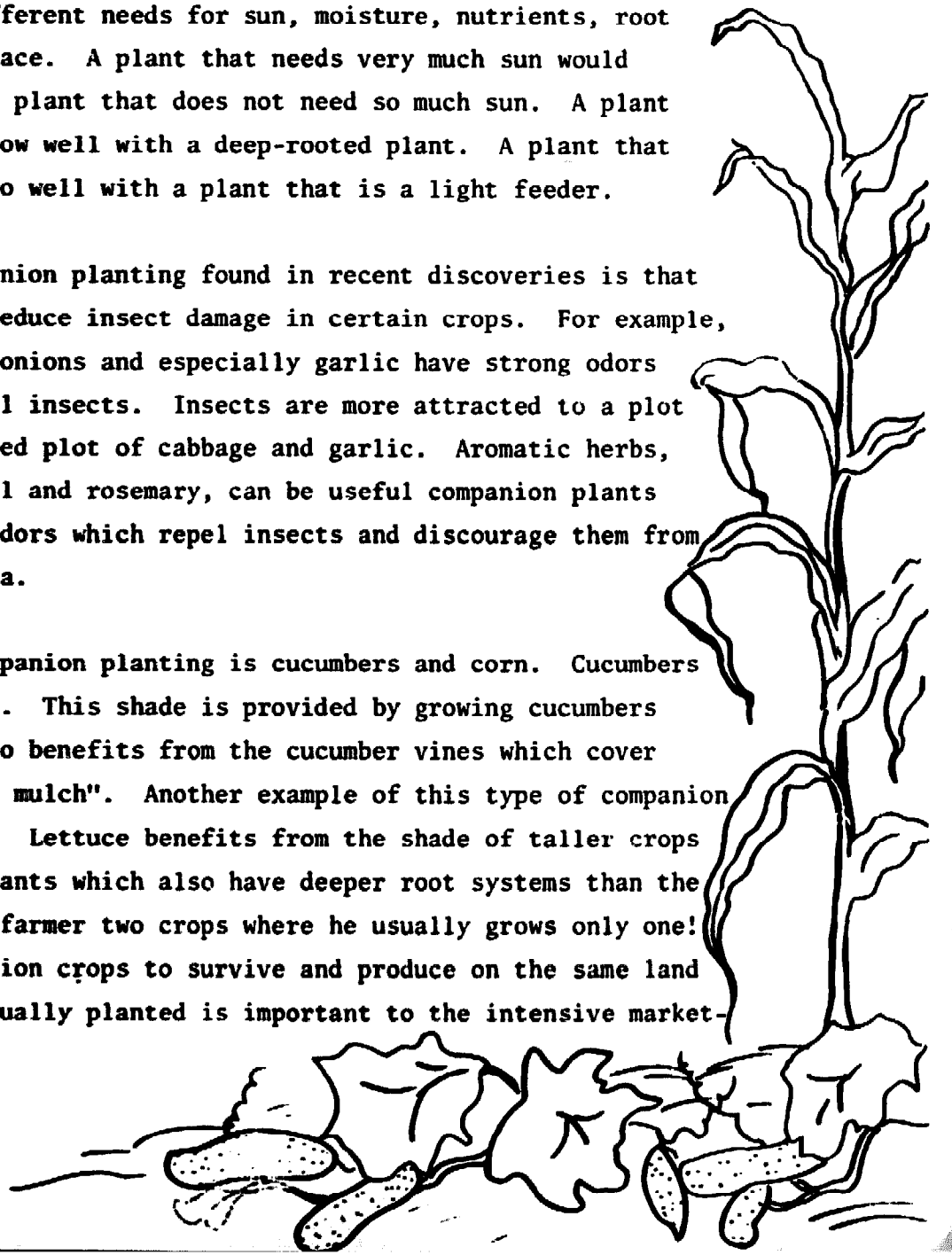
7.4 COMPANION PLANTING

Companion planting is the planting together of certain plants and vegetables which help each other to grow or which have different growing habits and can be grown together without harming or taking nutrients from each other. Through years of practical work, observation and research, farmers and gardeners have found that certain crops can be grown together in the same field or bed with increased health for both of the crops and increased production from the land. These crops are called companions.

There are several reasons why certain plant combinations are successful. Different plants have different needs for sun, moisture, nutrients, root space and above-ground space. A plant that needs very much sun would possibly grow well with a plant that does not need so much sun. A plant with shallow roots may grow well with a deep-rooted plant. A plant that is a heavy feeder might do well with a plant that is a light feeder.

An advantage of companion planting found in recent discoveries is that compantion planting can reduce insect damage in certain crops. For example, crops such as scallions, onions and especially garlic have strong odors that repel certain harmful insects. Insects are more attracted to a plot of cabbages than to a mixed plot of cabbage and garlic. Aromatic herbs, such as mint, thyme, basil and rosemary, can be useful companion plants because of their strong odors which repel insects and discourage them from landing in the garden area.

A good example of companion planting is cucumbers and corn. Cucumbers grow best with some shade. This shade is provided by growing cucumbers under corn. The corn also benefits from the cucumber vines which cover the ground like a "living mulch". Another example of this type of companion planting is with lettuce. Lettuce benefits from the shade of taller crops such as tomatoes or eggplants which also have deeper root systems than the lettuce. This gives the farmer two crops where he usually grows only one! The ability of two companion crops to survive and produce on the same land where only one crop is usually planted is important to the intensive market-



gardener. It allows him to intensify his garden and to produce more from the same land area. By planting together those crops which help each other grow and resist insects, the gardener exhibits another skill in using nature to ensure the productivity and health of his garden.

It has also been observed that certain plants do poorly when planted together. Some plants give off substances which suppress any plants growing near them. For instance, sunflowers give off substances which slow down the growth of any plants growing near them.

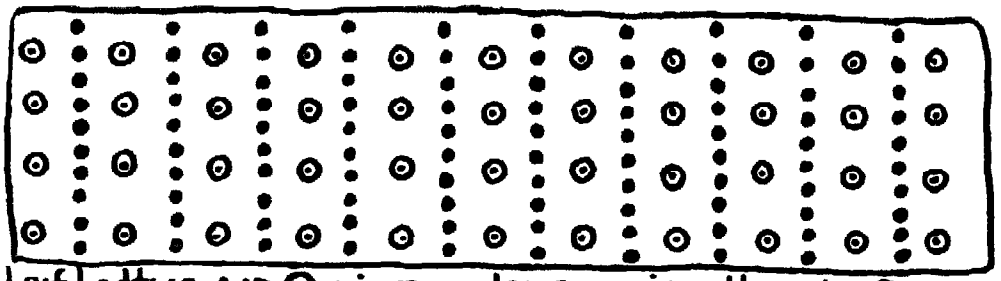
The intensive market gardener should strive to observe and take notice of the plant relationships in the garden. He should experiment to utilize the companion crops that work best in his circumstances. Again, the farmer must learn to be his own scientist, to experiment and learn through his own experience on his own lands.

Interplanting or intercropping is a form of companion planting. Companion planting mainly is based on the benefit that one crop gets by being planted near another crop. The importance of interplanting is that total production can be increased by planting two crops on the same piece of land at once. This practice is very old and can be observed all over the world, including China, Japan, India, Nigeria, United States and Jamaica.

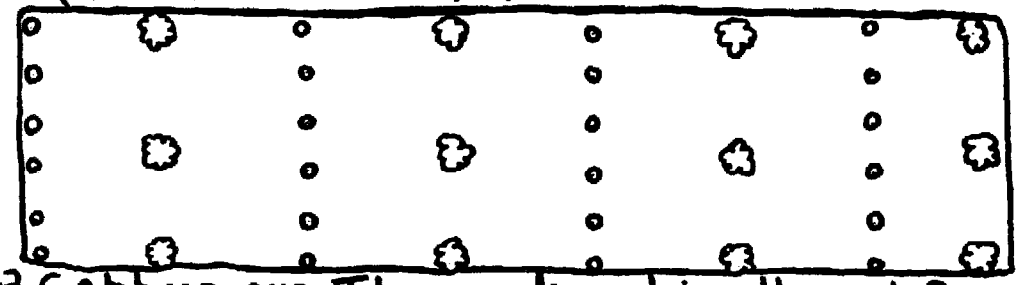
It has recently been proven that a field interplanted with corn and soybeans can yield a full crop of corn and three-quarters of a full crop of soybeans. In these experiments, corn was planted as usual in rows, and between the rows, two rows of soybeans were planted. The yields were compared to the yields of pure stands of corn and soybeans. The three-quarters of a soybean crop means that the interplanted soybean crop yielded less than a pure stand. But the fact is that the soybeans were a bonus because a full crop of corn was harvested! Looked at in this way, one acre of interplanted corn and soybeans yielded as much as one acre of corn and three-quarters acre of soybeans. In fact, the one acre which was intercropped produced nearly twice as much, or as much as two acres with single crops.

Figure 7.5

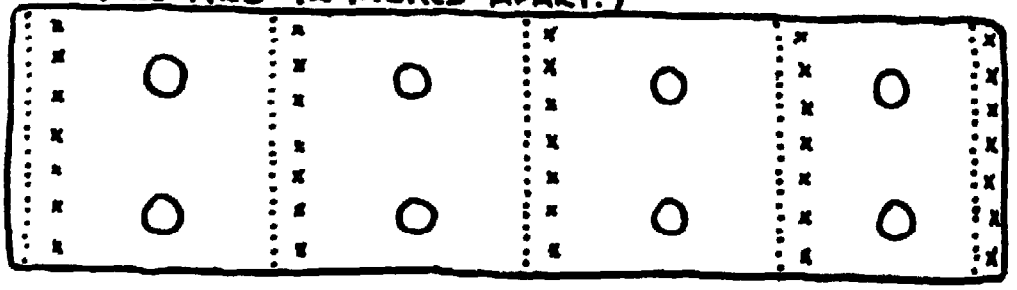
Companion Planted Beds



Ex.1 Leaf Lettuce and Onions planted in Alternate Rows (Rows are 6 inches apart.)



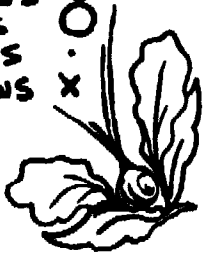
Ex.2 Cabbage and Thyme planted in Alternate Rows (Rows are 12 inches apart.)



Ex.3 Tomatoes, Carrots, Parsley planted in Alternate Rows. Tomato Rows planted 24 inches apart; Carrots and Parsley planted in between Tomato Rows. (Carrot and Parsley Rows are 4 inches apart.

Information

L. Lettuce spaced 8 inches apart in rows ⊙
Onions spaced 2-3 inches apart in rows •
Cabbage spaced 12-15 inches apart in rows ✿
Thyme spaced 4-6 inches apart in Rows ❀
Tomatoes spaced 24 inches apart in Rows ○
Carrots spaced 1-2 inches apart in Rows ·
Parsley spaced 4 inches apart in rows x



Thus, intercropping is yet another method which the skillful farmer can use to make more intensive and productive use of his land. This also demonstrates how the farmer can learn through experimentation on his own crops and land. A farmer, to become successful, must learn both from the relevant experiences of others and from his own.

7.5 SUCCESSION PLANTING

Succession planting is the planting of a crop in a field or bed immediately where another crop has just been reaped. This practice makes very intensive use of the land by keeping it under cultivation at all times.

Succession planting requires good planning and timing. For example, if a crop of green beans is to be followed by a crop of lettuce, the gardener would have to plan and plant so that the lettuce seedlings would be ready to transplant when the beens have been reaped.

An important part of this method is the quick preparation and fertilizing of the vegetable bed. It is here that a power hand tractor can be useful on raised beds to improve land productivity. With a power hand tractor, on beds that have been forked and double dug for the first crop, the time required for re-preparation of the beds will be greatly reduced. But, even with hand labour, the time of preparation is never as great the second cropping as it was for the first.

The key to succession cropping is careful planning. A planting chart will greatly simplify the planning. To make a succession planting chart, first list all the crops to be grown. Then determine when each crop will be planted and the length of time and estimated date of harvest.

Making two or three staggered plantings of the same crop can also be part of a succession cropping plan. This will extend the crop season for those gardeners wishing to have fresh vegetables stretched over a longer season. For instance, staggered plantings of carrots, sowed three times

CHART 7.1: Succession Planting Chart for a Vegetable Garden at elevation between sea level and 1,000 feet with a 12 month growing season

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Bush Beans		out / in		in / out		out / in		in / out		out / in		in / out	
Beets			out / in			in / out			out / in			in / out	
Head Cabbage	in / out			out / out in					out	in	in		out
Callaloo		in / out		out / in			in / out		out / in	in / out		out / in	
Carrots		in / out				out		in				out / in	
Garden Egg			out	in / out				out		in			
Leaf Lettuce	in / out	in / out		out / in	in	out	in	out	in / out	in	out	in / out	
Okra		in / out				in / out		out		in			out
Pepper			out	in / out				out		in			
Radish										in	in	out	out
Lima Bean	in / out			out / in			out			in			out
Tomato	in / out	out		in / out		out	in / out	out / in		out	in / out		
Turnip				out / out				in					out / in

CHART 7.2: Succession planting chart for vegetable garden at elevation 1,000 feet with a 12 month growing season

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Bush Beans		out / in		in / out		in / out		out / in		out / in		in / out	
Beets			out / in			in / out			out / in			in / out	
Cabbage				out / in			out					in	
		in			out								
Carrot				out		in / out			out / in			in / out	
			in										
Chinese Cabbage						in		in / out		in	out		out
Cucumber		out	in		out							in	
Garden Egg			in				out						
Leaf Lettuce		in / out	out	out / in		in / out	in	out / in	out	in / out		out / in	
Pepper			in			out							
Radish			in	out								in	out
Tomato			out / in / in		in	out	out	out / in		in	out	in	out
Turnip		out	in		out							in	
Scallion						in			out				

CHART 7.3: Succession planting chart for a vegetable garden at elevation 2,500 -3,500 feet for a 12 month growing season

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Bush Beans		out / in		in / out		out / in		in / out		out / in		in / out	
Beets			out / in			in / out			out / in			in / out	
Chinese Cabbage						in		in	out	out / in			out
Head Cabbage		in	out	in	out		out					in	
Carrot		in	out	in	out / in		out	in	out	out / in		in	out
New Zeland Spinich						in			in / out			out	
Turnip			out / in			out						in	
Mustard Greens				in	out	in	out	in		out			
Cauliflower			in / out			out						in	
Callaleo		out	in		out							in	
Scallions			in			out		in				out	

with each sowing a week or so apart, can also benefit the market-gardener. It saves labour because all the crop does not have to be reaped at one time. Also, the late crop may reach the market when the season is ending and prices are usually higher. The longer reaping season gives the market-gardener the advantage of having a reliable supply of produce over a longer period of time. This allows the gardener to establish and supply markets where buyers prefer fresh and reliable produce.

From the succession planting charts (Charts 7.1, 7.2 and 7.3), the gardener can see when crops can be harvested and others planted. An up-to-date succession planting plan allows the gardener to see when beds will be empty and which crops can be planted in them.

For instance, in April, the first crop of cabbage can be reaped. By looking at the chart, it can be seen that April is the month to plant carrots, string beans and lettuce. So the area which was planted to the cabbage can be planted to one of these three crops.

Soil fertility is a critical element to successful succession planting. Because succession planting keeps the land under continual cropping, it takes much fertility out of the land. Fertility must be returned if the productivity is to be maintained. If this is done, succession planting can double and triple a farm's production!

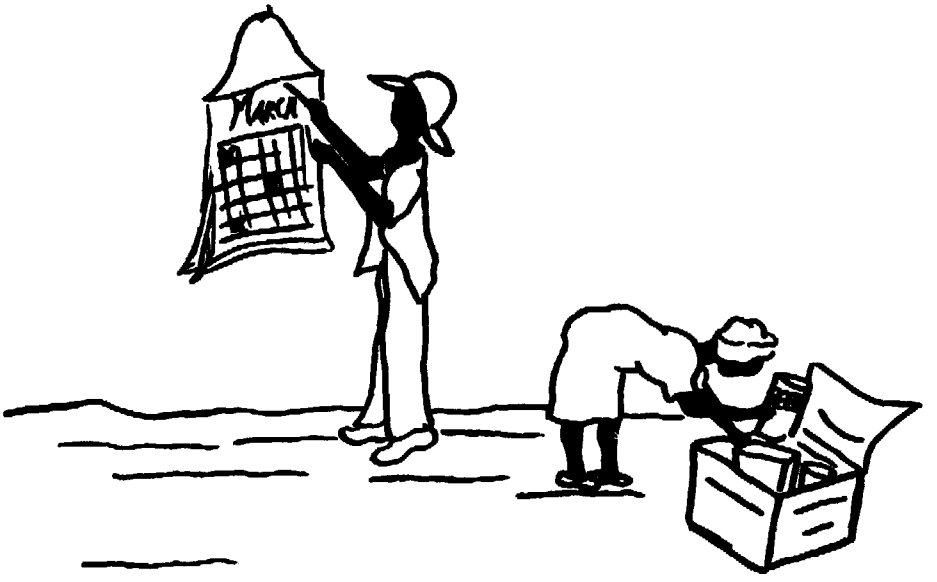


Figure 7.6
INTERPLANTED CORN, BEANS, AND PUMPKIN

7.6 CROP ROTATION

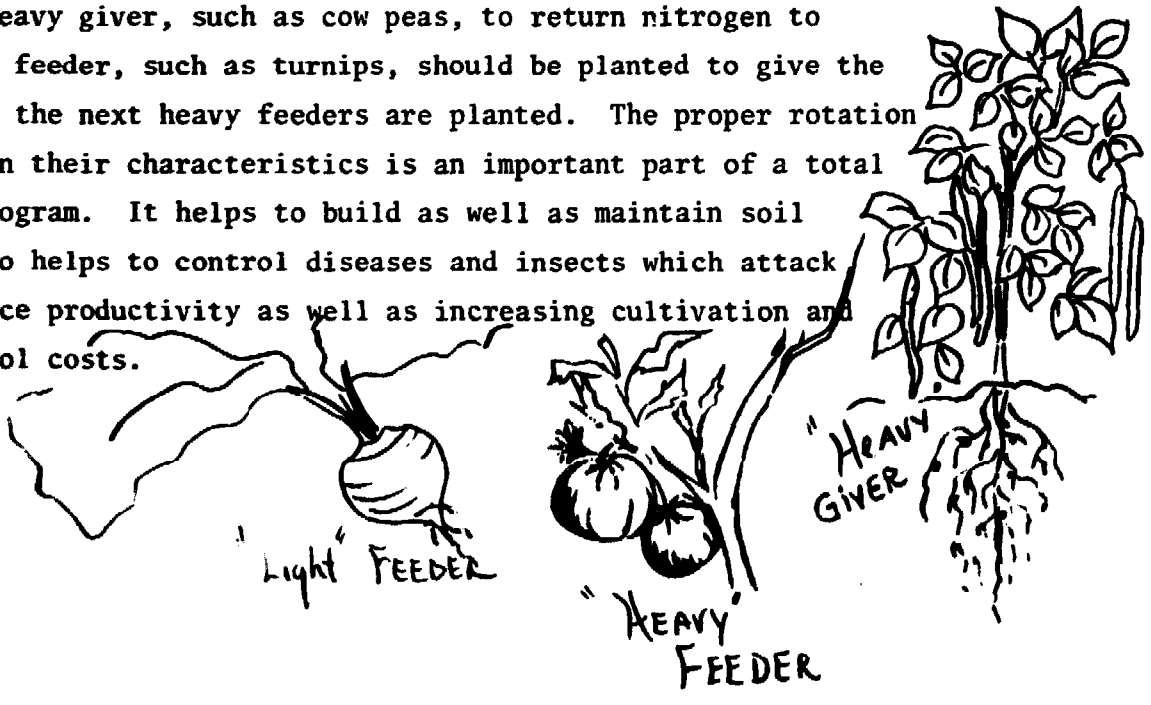
Crop rotation is the planting of different crops in sequence on a piece of land. Crop rotation is a good farming/gardening practice for several reasons.

A most common reason for crop rotation is that it inhibits the growth and spread of insects and diseases which are destructive to crops. Insects and diseases usually prefer to feed and breed in certain crops or families of crops. Planting the same crop in the same land every year allows insects and disease to build up in that area. By planting a crop that the insects and disease do not attack causes them to die off or move to another area. Then the first crop could be replanted if desired.

Another good reason for crop rotation is that different crops take different minerals from the soil. Also, different crop's roots feed in different areas of the soil. By rotating crops, the land is not depleted and is given a rest. For example, some crops such as legumes (cow peas, red peas,) add nutrients back to the soil.

7.7 CROP TYPES AND FAMILIES

Crops can generally be divided into three groups according to their feeding habits: heavy feeders, light feeders, and heavy givers. For conservation of soil fertility, a heavy feeder, such as tomatoes, should be followed by a heavy giver, such as cow peas, to return nitrogen to the soil. A light feeder, such as turnips, should be planted to give the soil a rest before the next heavy feeders are planted. The proper rotation of crops based upon their characteristics is an important part of a total soil management program. It helps to build as well as maintain soil fertility. It also helps to control diseases and insects which attack the crops and reduce productivity as well as increasing cultivation and pest/disease control costs.



In Charts 7.4, 7.5, and 7.6, some of the common vegetables and pulses are divided into their respective families and types, along with an example of rotation patterns which will be generally healthy for the soil and crops.

Chart 7.4: Common Crops And Their Feeding Habits

Plants which are:

Heavy Feeders	Light Feeders	Heavy Givers
Tomatoes	Turnips	Legumes
Eggplants	Beets	Cow Peas
Peppers,	Carrots	String Beans
Cabbage	Sweet Potato	Soy Beans
Broccoli	Radishes	Broad Beans
Cauliflower	Root Crops	Gungo Peas
Corn		Red Peas
Melons		
Pumpkin		
Cucumbers		

Chart 7.5: Crop Families

Tomato Family	Melon Family	Cabbage Family	Legume Family
Tomatoes	Watermelon	Cabbage	Red Peas
Garden Egg	Cucumber	Cauliflower	Cow Peas
Peppers	Pumpkin	Broccoli	Gungo Peas
Irish Potato	Squash	Turnips	Broad Beans
		Mustard	Soy Beans
		Chinese Cabbage	String Beans

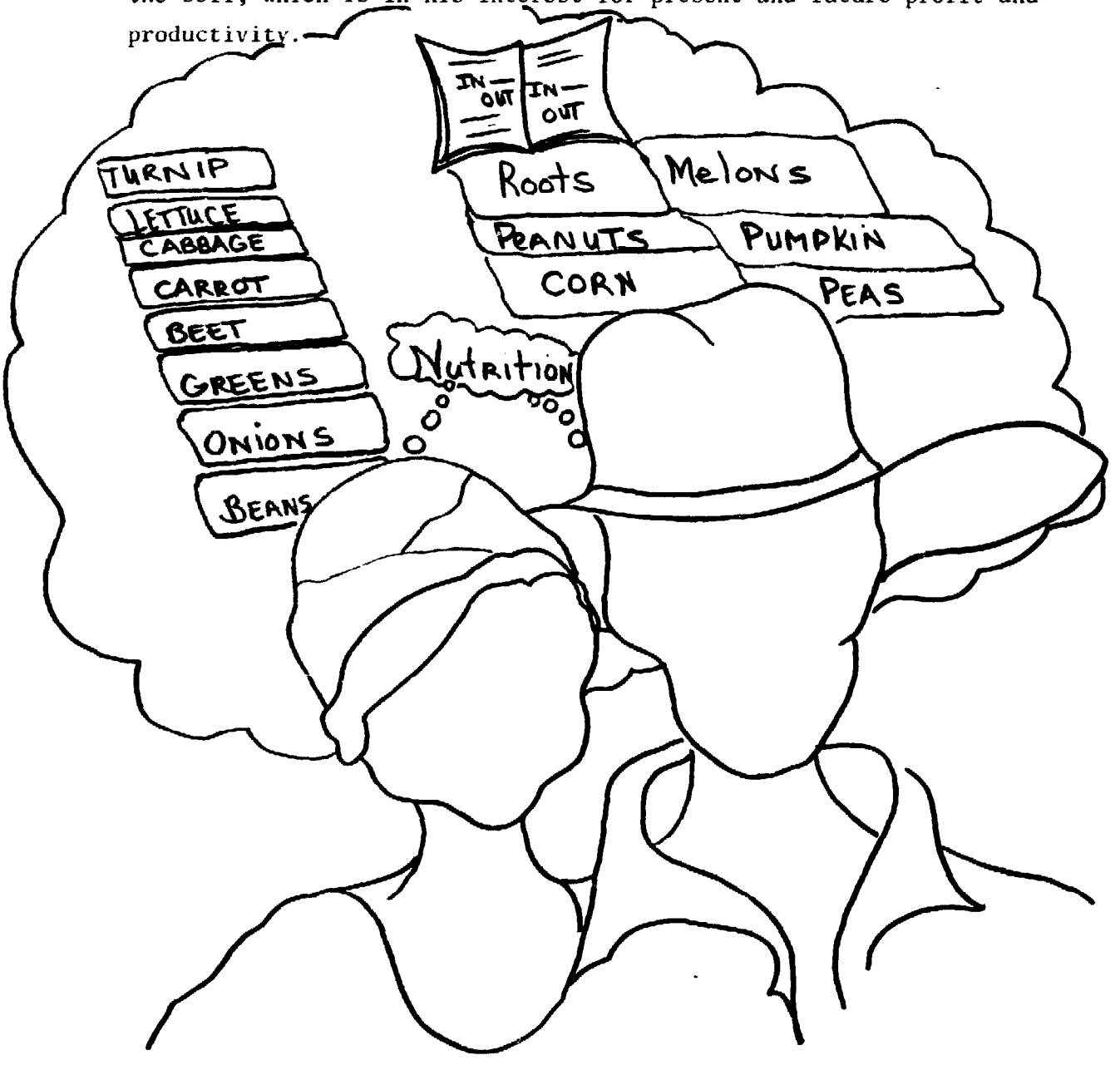
Chart 7.6: Examples of Crop Rotations

Example	Crop 1	Crop 2	Crop 3
A	Corn	Red Peas	
B	Cabbage	String Beans	Turnips
C	Lettuce	Cow Peas	Carrots
D	Pumpkin	Red Peas	Sweet Potato
E	Peppers	Soy Beans	Beets

7.8 CONCLUSIONS ON PLANTING

Planning is very important for crop rotation so the farmer can look at the actual plan for his lands, see where each crop is planted and its timing for harvesting, cultivation, watering and re-planting. Through carefully organized plans, proper rotations can be maintained.

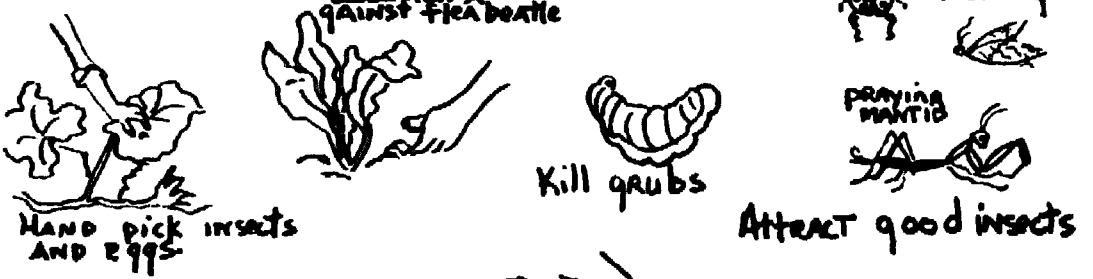
Planning and planting are skills that work together for the farmer. They help the farmer get maximum production from his land. And the wise use of a variety of planting methods helps the farmer produce healthier crops through a longer reaping period. Good planning and planting, as in crop rotation, even helps the farmer maintain the fertility and health of the soil, which is in his interest for present and future profit and productivity.



Garden Tips Figure 8.0

Keep garden clean of weeds and old weed piles

Keep plants thinned to desired spacings.



Keep out of garden when wet. (working in wet gardens can spread disease.)

Keep soil moist for best plant growth.

CHAPTER EIGHT

CULTIVATION FOR HIGHLY PRODUCTIVE GARDENS

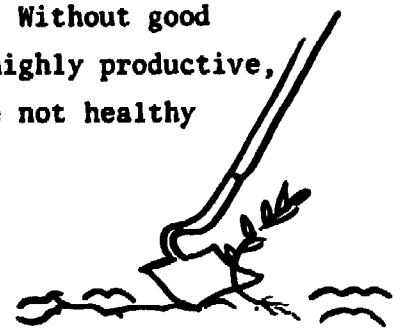
Cultivation is a very important task that should not be neglected or postponed. Good cultivation requires constant attention to the health of the crops, the conditions of the soil and the total environment within the garden setting. Cultivation generally refers specifically to the land tilling operations which remove weeds and break up the crust of the soil so that maximum plant growth is encouraged. But, the good garden cultivator will see the task of cultivation as a concern for the total health of the garden, so that he looks for indications of disease and insects, decreased soil fertility and plant starvation throughout the total growing season.

Removal of weeds is, of course, an important task of cultivation. The removal of weeds when they are young will be less work and will prevent root damage to the crop. The farmer who lets his weeds become large before weeding shows his lack of skill and interest in the garden.

8.1 CULTIVATION

Cultivation is basically comprised of two tasks--removing weeds from the soil and loosening the top 2-3 inches of soil. However, these tasks must be seen as only a part of cultivation as cultivation is actually the on-going attention that the farmer gives to the growing crop.

The importance of cultivation is clear. It protects plant health and promotes high productivity. Destroying weeds that would rob nutrients from the soil increases yields. Shallow cultivation of the top 2-3 inches of soil forms a soil mulch to conserve moisture. The surface of the soil tends to form a crust. Light cultivation breaks up the crust and improves the soil's capacity to absorb water and air for the plants. Without good supplies of air and water, the vegetable beds cannot be highly productive, and plants that must compete with weeds for nutrients are not healthy high producers.



The best time to cultivate is one or two days after a good rain or an irrigation. Working land too soon after a rain or irrigation, or when the soil is muddy, will destroy the structure of the soil. This makes it more difficult for plants to grow.

For the cultivation of row crops, a power hand tractor, a push wheel hoe or a regular hand hoe can be used. Care should be taken not to cultivate deeper than 1-2 inches and to avoid coming too close the roots and stems of the crops. (See Figure 8.0) When using a power hand tractor, the rows of crops should be spaced wide enough that the tractor can pass between the plants without damaging the roots.

For the intensive market-gardener who uses raised beds, small hand cultivators are very useful. They allow the farmer to cultivate between closely-spaced plants. In intensive bed gardening, the farmer will find that less cultivation will be needed since the bed is quickly covered with the leaves of the crop. The shading effect keeps out weeds. Another advantage of a properly prepared raised bed is that the weed's roots will pull out of the loose soil easily. Consequently, less weeding will be done since the entire weed and root are removed. After several seasons, the beds will have very few weeds, further reducing the need for this type of work.

8.2 GARDEN TOOLS

Good tools are essential to the professional market-gardener. Good tools must not only be obtained, but they must be cared for diligently so they will last and be effective. In the tropics, it is important to clean and oil tools regularly because the humid climate is very destructive to the materials. Tools should be carefully oiled before storing. Old motor oil can be used to oil the metal parts of the spades, rakes, hoes and forks. Of course, they should be cleaned regularly and after every use. Good tool care will prevent the tools from being damaged by rust and will help them last longer. Taking care of tools reduces costs.

Some sort of simple shelter should be provided to protect the tools when they are not being used. A thatched hut with thatched walls located near the garden area is convenient for storing tools, fertilizers and sprays. A hut also provides good protection for the gardeners and workers in times of rain or intense heat.

8.2.1 Useful And Necessary Tools For The Market-Gardener

In Figures 8.1, 8.2 and 8.3, a number of useful and necessary tools for the market-gardener are illustrated. These include the following:

Fork: A four-pointed spading fork for loosening or plowing the ground is shown in Figure 8.1.

Hand Spade: This is a D-handled, square pointed spade. It is used for double-digging raised beds, digging trenches and shovelling manures, compost and soil. See Figure 8.1.

Hand Spade: This is a small spade used with only one hand. It is very useful for working with young transplants or seedlings. (See Figure 8.1)

Hand Fork: This is a small fork used in only one hand and is good for taking up small seedlings and transplants. See Figure 8.1.

Hand Cultivator: This is a claw-shaped hand tool for cultivating seed beds and intensively planted raised beds. See Figure 8.1.

Shallow Weeding Hoe: This hoe with a long handle works well for cultivating weeds and working with row crops. See Figure 8.1.

Heavy-duty Hoe: This hoe has a short handle. It works well when breaking up large clods of soil or for hoeing up sides of beds. See Figure 8.1.

Wheelbarrow/ Two-wheel Cart: This is a very useful tool for transporting manure, compost, fertilizers, tools and vegetables. It will save the gardener much time and labour. See Figure 8.6.

Sickle: This is a good tool for cutting grasses or grains and can be used in place of machetes effectively for such work. See Figure 8.1.

Stake and Lines: A good set of solid stakes and strong line are invaluable in measuring distances and marking out beds or rows.

Water Can: This tool is good for watering seedlings and other tender crops and for intensive beds. See Figures 8.1 and 6.11.

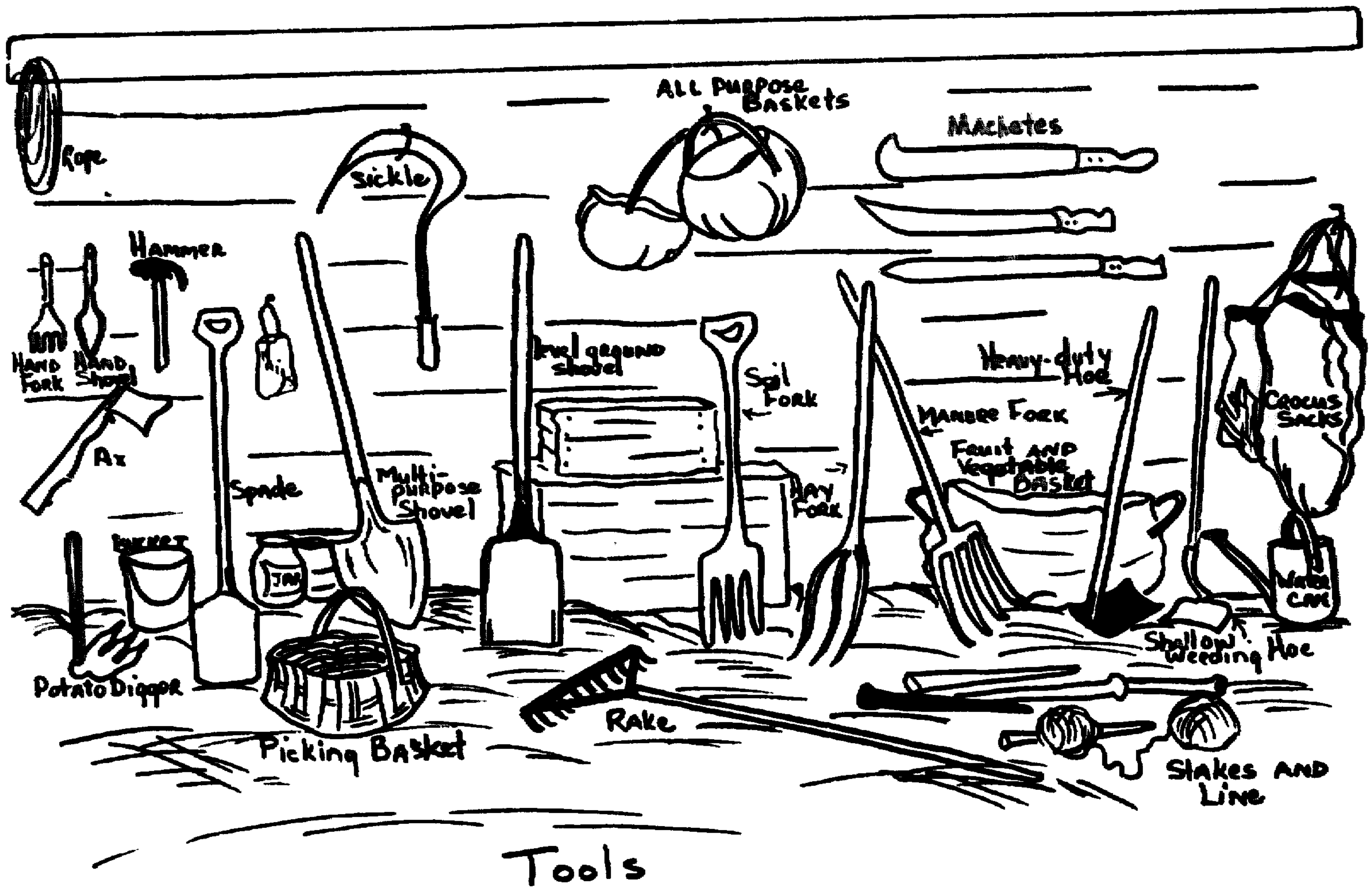

Rope
All Purpose Baskets
Machetes
Sickle
Hammer
Hand Fork
Hand Shovel
Ax
Spade
Multi-purpose Shovel
Soil Fork
Hay Fork
Heavy-duty Hoe
Fruit and Vegetable Basket
Crocus Sacks
Potato Digger
Picking Basket
Rake
Shallow Weeding Hoe
Stakes and Line
Tools

Figure 8.1

Wheel Hoe: This is a very useful tool for cultivating row crops. See Figure 8.2.

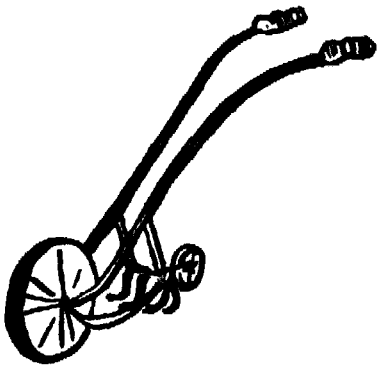
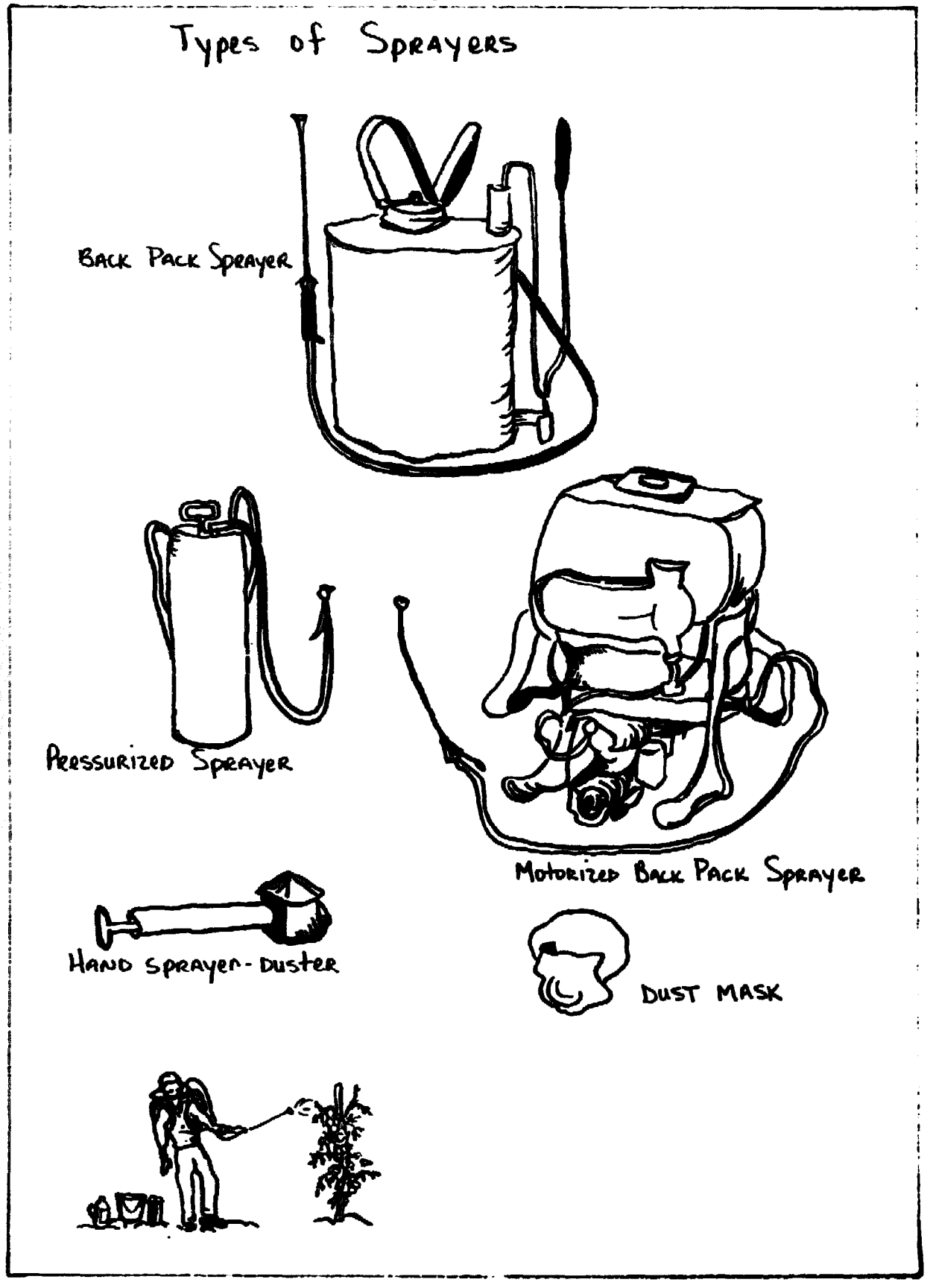


Figure 8.2

Seed Planter: This is a very helpful tool for seeding crops which are to be planted in rows. See Figure 8.3

Figure 8.3

Figure 8.4


Types of Sprayers
Back Pack Sprayer
Pressurized Sprayer
Motorized Back Pack Sprayer
Hand Sprayer-Duster
Dust Mask

8.2.2 Sprayers

Sprayers come in many sizes and designs. For the professional market-gardener, a large backpack sprayer with either a hand-operated pump or a gas engine-powered pump is best. (See Figure 8.4.)

These sprayers will give long service with good care and maintenance. After being used, the sprayer should be cleaned and placed upside-down so any moisture will run out. A strainer usually comes with these tools to remove any debris or trash from the spray liquid. When cleaning the sprayer thoroughly, it is best to pump clean water through it. Remember also to take the nozzle apart and clean it very carefully.

8.2.3 Power Hand Tractors

These machines are very useful to the professional market-gardener. Although the use of power hand-tractors has been discussed in a previous chapter of this manual, we re-emphasize their value and potential uses. (See Figures 5.5 and 5.6.)

The most useful design among the power hand-tractor is one in which the wheels, as well as the tines or tillage implements, are driven by the engine. This design is easy to operate, much easier than other types, and is more adaptable to different garden locations. It can be maneuvered easily on hillsides as well as on terraces and beds.

Power hand-tractors often have many attachments that can be very useful. For example, there is a 40" sickle bar mower, which could be used to cut grass on hillsides for mulch or hay. Other attachments include a small irrigation pump, electricity generator and two-wheel carts for pulling loads.

All farmers who own or operate these machines should understand proper care and maintenance of the equipment and engines. Although maintenance manuals are available, the development of these skills does not require that

one be able to read or write. One can learn to care for machines through observation, demonstrations and common sense. Short demonstrations or demonstration courses are invaluable for learning machine maintenance and care. For machines to truly make a lasting impact on agriculture and to be a valuable investment for the farmer, maintenance is a must!

8.2.4 Shredder-Grinder

The shredder-grinder is a small machine powered by a gas engine. See Figure 8.5. It can shred and grind organic materials, such as leaves, twigs, branches, straw, grass, bark, manures, etc. The shredding and grinding of organic materials causes them to decompose quickly for the garden. Mature compost, ready to use, can be produced in 14 days. If a large amount of grass and manure is available, this is a great help. It helps the farmer to maintain soil fertility at the high levels necessary for intensive gardens and for continuous cropping.

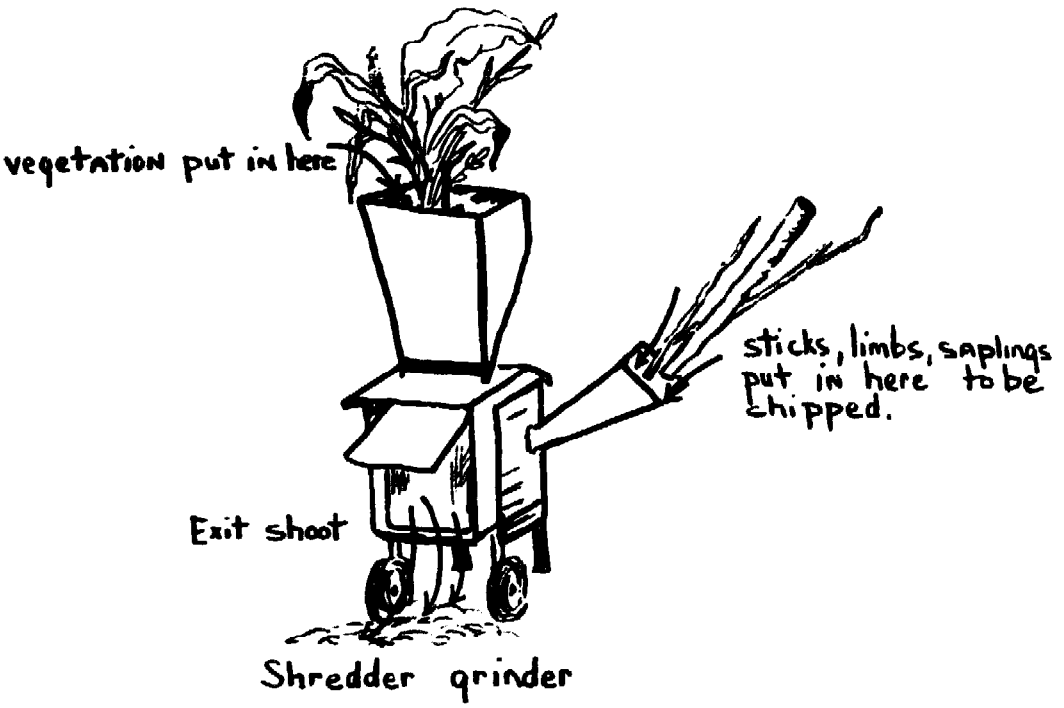
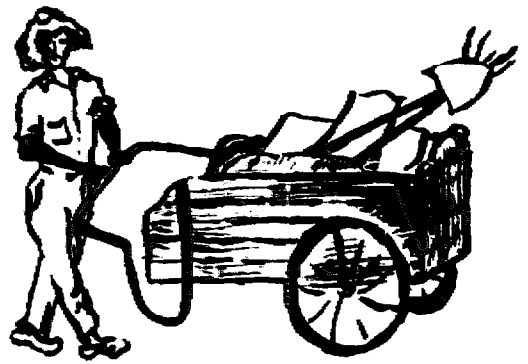


Figure 8.5

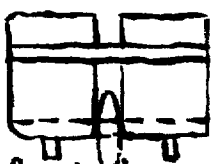
Tools for Hauling Figure 8.6

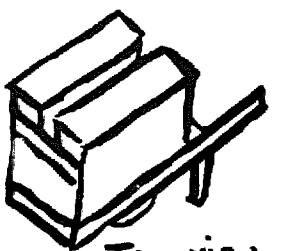


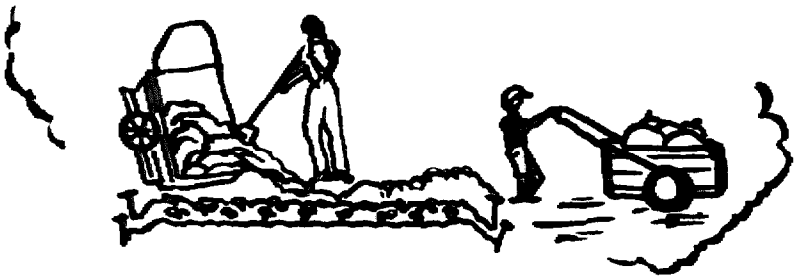
① Bicycle Wheel Cart

(This cart can haul hundreds of pounds with ease, and is easy for a man, woman or child to use.)

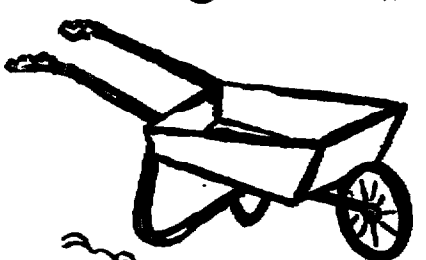
② One-wheel Platform Wheelbarrow

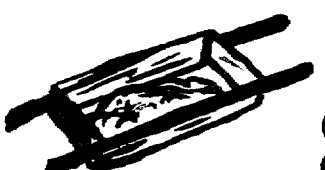




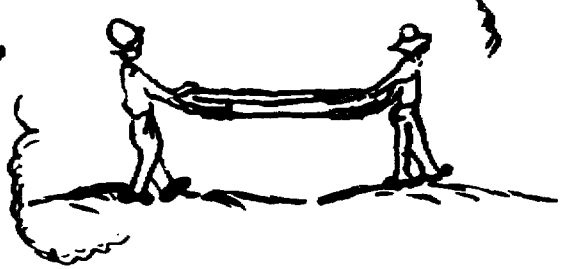


③ Standard Wheelbarrow

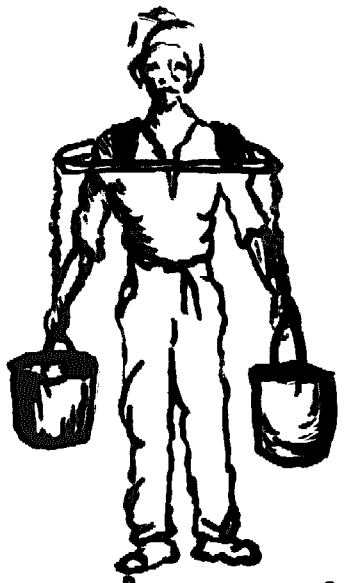




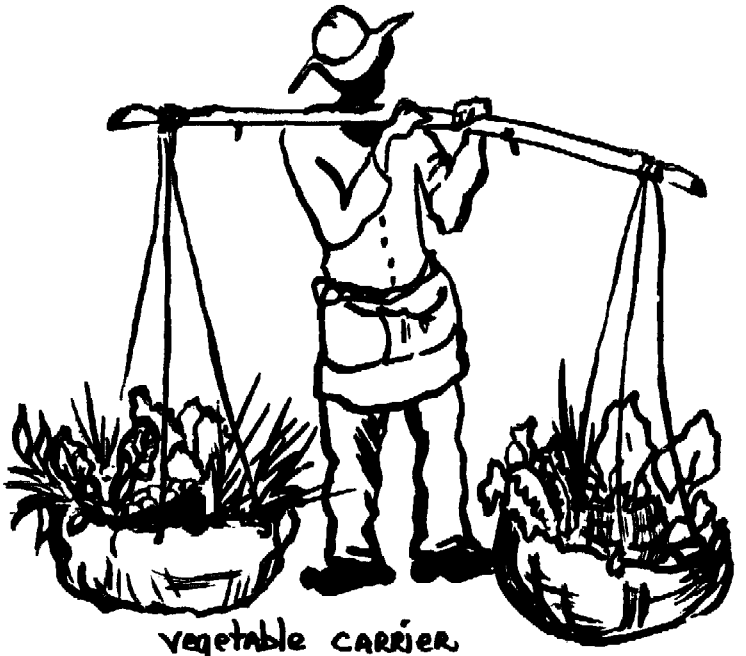
④ 2-man carrier



Carrying Aids Figure 8.7



Harness for carrying Buckets

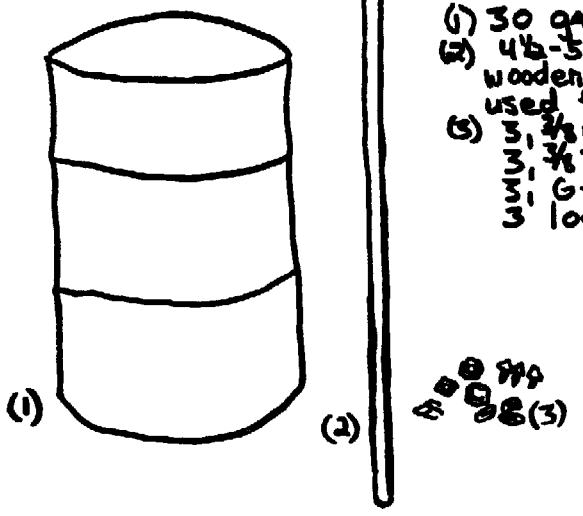


vegetable carrier

Carrying Pole with supporting stick

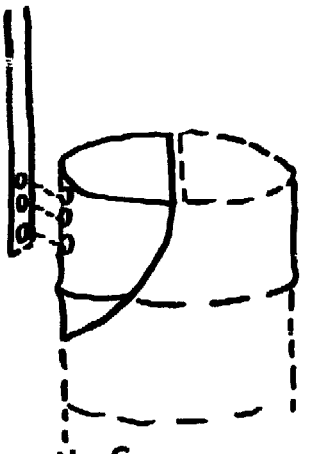
Figure 8.8

How to make A Heavy-Duty Shovel-scoop



Materials Needed:

(1) 30 gallon oil drum
(2) 4½-5 ft. long, 1½-2 inch sq. wooden stick. This will be used for the handle.
(3) 3, ⅜ inch nuts
3, ⅜ inch bolts
3 G-flat washers
3 lock washers



Cutting the Scoop:

1. Draw an outline of the scoop on outside of drum. It should be drawn so that the bottom tip of the scoop will have no sides. The top of the scoop will be angled slightly away from the bottom. The top should be cut straight across.

Cutting the Handle:

1. Cut one end at 45° angle.

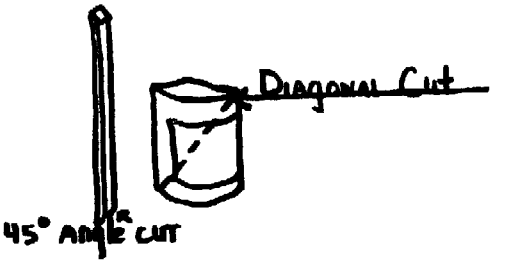
Putting it Together:

1. Set bolt and washer through handle and scoop holes, add another flat washer then the lock washer and attach nut.
* File sides down for better digging.

Completed Heavy-duty Shovel-scoop

Figure 8.9

How to make a Hand Shovel with a tin can



Materials needed:

(1) A 1-inch square piece of wood, 9 inches long. This will be used for the handle.

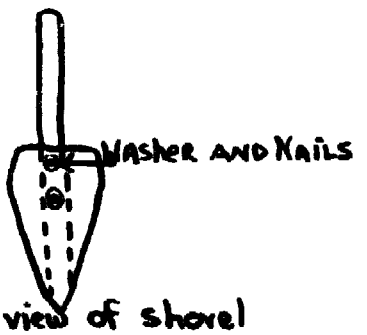
(2) A tin can. We will use a juice can. The size of your can will determine the size of your shovel, (handle size will change with a different size can.)

(3) Two flat head nails and two washers.

Steps in making:

1. Cut one end of the wood to a 45° Angle. (This angle will line up with cut made on the can.)

2. Cut the can diagonally in half. (Take note that you do not cut either end of the can.)



Inside view of shovel

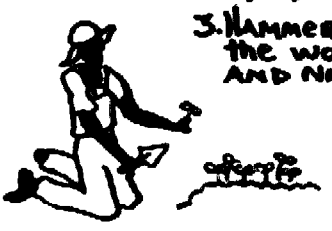
Completed Hand Shovel

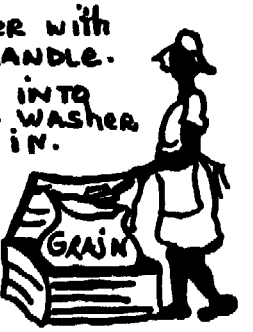
Putting the pieces together

1. The wooden handle goes flat up against the can. Place pointed end of wood at pointed end of can.

2. From the inside of can, place washer with nail, lining them up with middle of handle.

3. Hammer nail through can and well into the wooden handle. Place second washer and nail 1 inch away and hammer in.





INSECT LIFE IN THE GARDEN

Figure 8.10

8.3 PEST MANAGEMENT

We do not feel it is within the scope of this book to provide a detailed discussion on insect and disease control There are many government publications available from the Ministry of Agriculture and the extension service on the subject already. The gardener should acquaint himself with any information available on this important subject. The skillful farmer must develop a keen awareness concerning the nature of insects and diseases.

8.3.1 Natural Controls Of Insects And Diseases

The farmer should learn to observe the actions and life cycles of insects in his garden and surrounding areas. By observing nature, the farmer will learn which insects are harmful and which are helpful. He will discover that some insects help him by eating other insects which are harmful to the plants. The gardener with the watchful eye will soon discover the breeding places of pests and diseases and will immediately remove or destroy them. Control of breeding places will do much toward keeping down the pests they can harbour.

All trash and crop waste should be composted. If any material is diseased it should be burned. This is a key step in pest management. No time should be wasted in doing this. The longer waste stays on the land, the more insects which will build up in it. Gardener, it is very important for you to take care of your waste piles quickly!

The farmer must realize that healthy, well-fed plants are less likely to be attacked by disease and insects. Just as poorly fed people cannot survive well without proper food and are weak to fight off attacks of sickness, neither can a weak plant survive well or fight off attacks from insects or diseases. It is wise for the farmer to spend time on providing a balanced diet of nutrients for the crops. He must pay close attention to the health and fertility of the soil in which his plants live. Unhealthy plants often mean that the soil is unhealthy too!

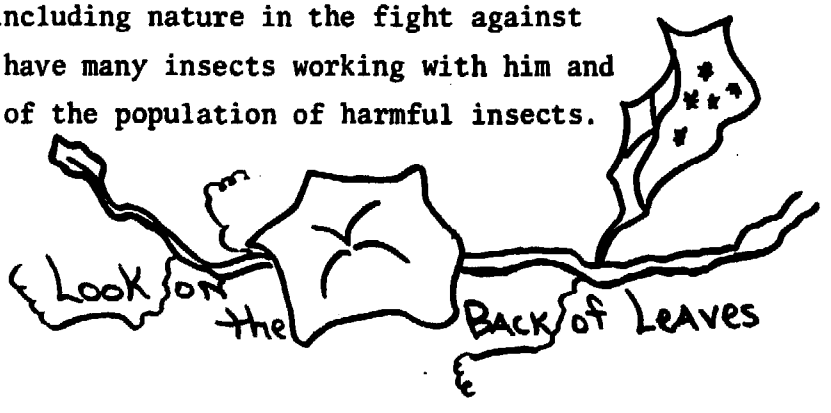
8.3.2 Spraying

In the tropics, it is often necessary to use sprays in your pest management program. The humid climate and warm season all year promote rapid insect breeding.

Farmers could become acquainted with the local agriculture officer who has information concerning pest control and the use of chemical sprays. Spraying should be done exactly as recommended by the officer. Some sprays have very strict rules to follow because they are dangerous to the health and well-being of man, animals and the environment.

Many insects carry disease organisms. It is important to spray these insects in early stages of their life so they will not spread the disease any more than can be helped. For example, there is no chemical spray that can control the mosaic disease that attacks red peas. Only careful observation for the insect (the white fly) that spreads the disease and an early spraying for white flies with the proper insecticide or spray will give proper control over this disease.

Once again the farmer must take steps to join hands with nature. Local information available through the agricultural officer will help devise a good control system for crops. By including nature in the fight against pests and diseases, the farmer will have many insects working with him and thus provide a more natural control of the population of harmful insects.



8.4 SUMMARY

Farmers the world over are becoming aware of the fact that proper maintenance of the soil fertility and structure will help reduce pest damage. For instance, the Australian Ministry of Agriculture advised large scale avocado pear growers to return organic matter to their soil to reduce damage from root rot fungus that is attacking the trees. The organic matter increases the population of a certain soil microbe which gives off ethylene gas which kills the fungus.

Pest control is very important to the farmer. The health of the crops and fertility of the soil is a very important part of this. Note that a careful, skillful use of chemical sprays will also require the attention and study of the serious farmer.

The best pest management program is one in which the farmer strives for healthy, resistent plant growth by providing a healthy balanced soil fertility, and then treatsany damaging pests with careful, studied use of chemical sprays.

A Final Word

In this book we have presented the basic knowledge needed to do intensive vegetable growing. The most important part of intensive vegetable production is soil preparation. In intensive gardening the idea is to increase the number of plants that a given area of soil will support. There are two ways this can be accomplished: by increasing the depth of the root zone (double-digging) and by increasing the fertility of the soil. If the farmer or gardener follows the intensive planting chart and plants many plants very close together without giving due attention to the soil fertility the result will be poor yields. The intensive planting methods must be combined with intensive soil building. Again we emphasize the importance of the soil.

To get the most from this book the farmer-gardener should spend the time it takes to really understand the chapters on soils, soil fertility, fertilizers, composting, and soil preparation. These chapters will provide the reader with a good background to understanding how he can improve his soil, which is so important to all agriculture.

This book does not present an easy way to grow vegetables. Intensive vegetable growing for market requires the farmer-gardener to develop his gardening skills and spend many hours carefully: planning his farm's planting schedule, crop rotations, soil management program, and pest management program. Planning is a very important skill in intensive farming.

For the readers who wish to do further study, we have included a bibliography of books that can be used to increase the gardeners knowledge and understanding of intensive vegetable production and soil improvement. In the back of the book there is a collection of tables that will be very helpful to the farmer-gardener in planning and planting his farm.

Our main purpose in writing this book is to put forth the knowledge and ideas that it takes to make a very good living on a small farm.

The farmer with five acres of good land can become totally self-sufficient from that land if he so desires. Intensive vegetable gardening is just one

aspect of the self-sufficient small farm. The ideal self-sufficient homestead should first provide quality protein(pulses, meat, milk) for the family. This homestead should also provide all or a major portion of the vegetables, fruits, and roots so necessary for a balanced nutritious diet. The small homestead that is devoted to providing these foods will present a healthier, happier life for the small farm family. Mastering of the skills of intensive vegetable production moves farmers one big step towards self-sufficiency for himself and for the nation.

It is often argued that one thing which is lacking in the small farmer's life is the freedom and time to pursue certain cultural and esthetic aspects of life. This has always been the lure of the city. But a young small farmer that intensifies his farm and strives for self-sufficiency from his farm will, after three or four years of building his farm and soil up and into high production be able to devote more time to developing cultural awareness for himself, his family and his community.

Cultural events can be brought to, as well as generated in rural areas, and local muscians, dance troupes, and drama groups can adapt routines and performances to natural, rural settings by reducing dependence on elaborate stage props, and lighting. Supporting cultural revival while promoting increased production and prosperity in the rural areas will do much to enhance the quality of farm life and to encourage youth to seek their future in a commitment to the development of rural Jamaica.

We hope that this manual will inspire the youth of Jamaica to return to the good life and independence of intensive self-sufficient farming. Health, happiness, and prosperity can be realized through small farming.

TABLE 1

Seeds per ounce and Germination Rates

Seeds Per Ounce	Germination Rate Percentage
Bush beans 100	75
Pole beans 100	75
Bush Lima Beans 20-70	70
Pole Lima Beans 20-70	70
Beets 1,600	65
Broccoil 9,000	75
Cabbage 8,500	75
Carrot 23,000	55
Cauliflower 10,000	75
Celery 70,000	55
Swiss Chard 1200	65
Chinese Cabbage 9500	75
Corn 100-200	75
Cowpea 125	75
Cucumber 1,000	80
Eggplant 6,000	60
Lettuce 25,000	80
Melon 1200	75
Okra 500	50
New Zealand Spinach 350	40
Onion 9500	70
Parsley 18,000	60
Pepper 4500	55
Pumpkin 110	75
Radish 2000	75
Tomato 11,000	75
Turnip 13,000	80
Watermelon 225-300	70

Special planting guide

Bush bean Pole beans Bush Lima beans Pole Lima beans Corn Swiss Chard	Plant two seeds per center, thin out extra plants.
Carrot Beets	Plant two seeds per center.

TABLE 2

SPACINGS FOR INTENSIVE METHOD OF GROWING PLANTS IN BEDS

CROP	SPACINGS
Broad beans	8"
Bush beans, green	4"
Lima pole beans	8"
Lima bush beans	8"
Pole beans	6"
Beets	3"
Broccoli	14"
Cabbage	14"
Carrots	2"
Cauliflower	15"
Celery	6"
Chard	8"
Chinese cabbage	10"
Cucumbers	12"
Garden egg	18"
Kale	15"
Lettuce	12"
Leaf Lettuce	8"
Mustard	6"
Okra	12"
Onions	3"
Parsley	4"
Peppers, hot	16"
sweet	12"
Radish	1"
Spinich	2"
Tomatoes	24"
Turnips	3"

PLANTING CENTERS PER 100 sq. FEET

SPACINGS	CENTERS
1"	14,400
2"	3,600
3"	1,600
4"	900
6"	400
8"	225
9"	178
10"	144
12"	100
15"	56
18"	44
24"	25
30"	16
72"	3

TABLE 3

A LIST OF COMMON GARDEN VEGETABLES WITH THEIR COMPANIONS AND ANTAGONIST

VEGETABLES	LIKES	DISLIKES
Beans	Potatoes, carrots, cucumbers, cauliflower, cabbage	Onions
Pole beans	Corn	Onions, beets, sunflowers
Beets	Onions	Pole beans
Cabbage Cauliflower Kale Broccoli	Thyme peppermint, rosemary, Potatoes, celery, beets, onions scallion, garlic	
Carrots	Tomatoes, beans, cauliflower, cabbage	
Corn	Potatoes, peas, beans, cucumbers, pumpkin, squash	
Cucumber	Beans, corn, peas, radishes	Potatoes
Garden egg	Bean	
Lettuce	Carrots, radishes	
Onion	Beets, tomatoes, lettuce	
Parsley	Tomatoes	
Peas	Carrots, turnips, radishes, cucumber, corn, beans	
Potatoes	Beans, corn, cabbage	
Pumpkin	Corn	Potatoes
Soybeans	Helps everything to grow better.	
Tomatoes	Onion, parsley, carrots	Cabbage, potatoes
Turnips	Peas	

TABLE 4

TIME REQUIRED TO RAISE VEGETABLE SEEDS TO TRANSPLANTING SIZE

CROPS	WEEKS
Broccoli	4-6
Brussel Sprouts	4-6
Cabbage	4-6
Cauliflower	4-6
Celery	8-12
Garden egg	6-8
Onion	10-12
Pepper, sweet	6-8
Tomatoes	6-8

SEEDS TO START IN PLANTING BEDS

Bush beans, Beets, Carrots, Chard, Radish, Spinich, and, Turnips

SEEDS TO PLANT IN SEED BEDS AND TRANSPLANT

Broccoli, Brussel Sprouts, Cabbage, Cauliflower, Celery, Garden egg, Lettuce, Onions, and Peppers

TABLE 5

COOL SEASON AND WARM SEASON CROPS

SEASONAL TEMPERATURES	55°	60°	70°	75°	80°	85°	90°
VEGETABLE GROUPS							
COOL SEASON CROPS	Cauliflower, Spinich	Broccoli, Chinese cabbage, Celery, Radish, Collards, Kale,* Garlic, Head lettuce, Turnips	Beet, Bulb onion, cho-cho, Carrot Leaf lettuce,** Mustard, Irish Potato				
YEAR AROUND GROWING CROPS		Cucumber, Scallion, Squash, Muskmelon, Leek	Beans, Chard, Corn, Parsley, Cowpea, Red pea, Sweet and Hot pepper, Soybean, New Zealand Spinich, Yam, Callaloo, Tomato				
WARM SEASON CROPS			Garden egg, pumpkin, Sweet Potato, Okra, Watermelon, Muskmelon				

* Kale has been known to survive drought conditions.

**Leaf lettuce may be grown in warmer temperatures with some shading.

TABLE 6

ESTIMATED YIELDS PER 25 ft. ROW

CROP	YIELDS
Bush beans, green	12 pds.
Bush beans, limas	6 pds.
Beets	20 pds.
Broccoli	8 pds.
Chinese Cabbage	18-30
Head Cabbage	12-25
Carrot	20 pds.
Cauliflower	16-20 heads
Celery	35-50 heads
Chard	25 pds.
Corn	30 ears
Cucumber	30 pds.
Garden egg	50 pds.
Kale	15 pds.
Kohlrabi	15 pds.
Head lettuce	20-25 heads
Leaf lettuce	25-30 bunches
Mustard	25 pds.
Okra	30-40 pds.
Bulb onion	25-30 pds.
Scallions	10 pds.
Parsley	5 pds.
Sweet Pepper	15 pds.
Potato	20 pds.
Pumpkin	30-40 pds.
Radish	20 dozen
New Zealand spinich	10 pds.
Squash	30-45 pds.
Tomato	50 pds.
Turnip	10-15 pds.
Watermelon	100 pds.

TABLE 7

ESTIMATED YIELDS PER 100 sq. ft. BED

CROP	YIELDS
Bush beans, green	48 pds.
Bush beans, lima	24 pds.
Beets	80 pds.
Broccoli	32 pds.
Chinese cabbage	72- 120 pds.
Head cabbage	48-100 pds.
Carrot	80 pds.
Cauliflower	64-80 heads
Celery	140-200 heads
Chard	100 pds.
Corn	120 pds.
Cucumber	125 pds.
Garden egg	200 pds.
Kale	60 pds.
Kohlrabi	60 pds.
Head lettuce	80-100 heads
Leaf lettuce	100-120 bunches
Mustard	100 pds.
Okra	120-160 pds.
Bulb onion	100-120 pds.
Scallions	40 pds.
Parsley	20 pds.
Sweet pepper	60 pds.
Potato	80 pds.
Pumpkin	120-160 pds.
Radish	80 dozen
New Zealand spinich	40 pds.
Squash	120-180 pds.
Tomato	200 pds.
Watermelon	400 pds.
Red peas	12 pds.
Rice	16 pds.

TABLE 8

ROW CROP SPACINGS

Crops	Inches spaced
Bush beans, green	3-6
Bush beans, lima	6-8
Beets	2-3
Broccoli	15-18
Chinese Cabbage	6-12
Head Cabbage	12-24
Callaloo	10-12
Carrot	2-3
Cauliflower	15-18
Celery	6-12
Chard	6-12
Corn	12-16
Cucumber	24-36
Garden egg	18-30
Kale	15-20
Kohlrabi	10-18
Leek	5-10
Head lettuce	12-15
Leaf lettuce	6-12
Mustard	4-6
Okra	12-15
Bulb onion	4-6
Scallion	4-6
Parsley	4-6
Pepper, hot and sweet	12-16
Potato	12-14
Pumpkin	30-36
Radish	1-2
New Zealand spinich	10-12
Squash	36-48
Tomato	24-48
Turnip	3-6
Watermelon	36-48

TABLE 9

ESTIMATED YIELDS PER 1 ACRE OF INTENSELY PLANTED GROUND

CROP	YIELDS
Bush beans, green	19,000 pds.
Bush beans, lima	9,600 pds.
Beets	32,000 pds.
Broccoli	12,800 pds.
Chinese cabbage	36,000 pds.
Head cabbage	30,000 pds.
Carrots	32,000 pds.
Cauliflower	28,000 heads
Celery	68,000 heads
Chard	40,000 pds.
Corn	48,000 pds.
Cucumber	24,000 pds.
Garden egg	80,000 pds.
Kale	24,000 pds.
Kohlrabi	24,000 pds.
Head lettuce	36,000 heads
Leaf lettuce	48,000 bunches
Mustard	40,000 pds.
Okra	56,000 pds.
Bulb onion	48,000 pds.
Scallions	16,000 pds.
Parsley	8,000 pds.
Sweet pepper	24,000 pds.
Potato	32,000 pds.
Pumpkin	56,000 pds.
Radish	32,000 pds.
New Zealand spinich	16,000 pds.
Red peas	4,800 pds.
Squash	64,000 pds.
Tomato	80,000 pds.
Turnip	20,000 pds.
Watermelon	160,000 pds.
Rice	6,450 pds.

Bibliography

Jeavons, John. How To Grow More Vegetables Than You Ever Thought Possible On Less Land Than You Can Imagine. Ecology Action 2225 El Camino, Palo Alto, California USA 1974

Heckel, A. (ed.). Pfeiffer Garden Book. Bio-Dynamic Farming and Gardening Association, Stroudsbery, PA. USA 1967

Howard, A. The Soil and Health: A Study of Organic Agriculture. Devin-Adair (now Schoker Books, New York NY. USA 1947

King, F.H. . Farmers of Forty Centuries: Permanent Agriculture In China, Korea and Japan. Rodale Press, Emmaus, PA. USA 1911

Cocanouer, J.. Weeds: Guardians of the Soil. Devin-Adair Co., NY. USA 1964

Rodale, J.I. (ed.) The Complete Book of Composting. Rodale Books, Inc., Emmaus, Pennsylvania,USA 1960

Composting for the Tropics. Henry Doubleday Research Association, 20 Convent Lane, Bocking Braintree, Essex, England. 1963

Goleuke, C., Composting: A Study of the Process and Its Principles. Rodale Press, Inc. Emmaus, PA USA 1972

Buckman, H.O., Brady, N.C. The Nature and Properties of Soils. The Macmillan Company/Collier-Macmillan Limited, London, England 1969

Tesdale, S.L., Nelson, W.L. Soil Fertility and Fertilizers. Macmillan Publishing Co., Inc. NY USA 1975

Homer C.T., Kelly, W.C. Vegetable Crops. McGraw-Hill Book Company New York, New York, USA 1957

Yepsen, R.B. Jr., (ed.) Organic Plant Protection. Rodale Press, Inc., Emmaus, Pennsylvania, USA 1967

Hopfen, H.J. Farm Implements For Arid And Tropical Regions. Food and Agriculture Organization of the United Nations, Rome

More Water for Arid Lands, Report of an Ad Hoc Panel of the Advisory Committee on Technology Innovation Board on Science and Technology for International Development Commission on International Relations. Nation Academy of Sciences. Washington, D.C.

Phibrick, H., Gregg, R.B. Companion Plants. The Devin-Adair Company Old Greenwich, Connecticut USA 1966

The Farm Hey Beatnik, This Is The Farm Book. The Book Publishing Company, Summertown Tennesse, USA

Rodale, J.I. and staff Encyclopedia of Organic Gardening. Rodale Books, Inc., Emmaus, Pennsylvania USA

Vegetable Grower's Handbook. Agricultural Information Service, Ministry of Agriculture, Kingston, Jamaica 1973

Alther, R., Raymond, R.O. Improving Garden Soil With Green Manures. Garden Way Publishing Co. 1974

Winters, H.F., Miskimen, G.W. Vegetable Gardening In The Caribbean Area. Agricultural Research Service U.S. Department Of Agriculture, U.S. Government Printing Office Washington D.C. 1967

Philbrick, J.&H. Gardening for Health and Nutrition. Steiner Publications, Blauvelt, NY. USA

Rodale, J.I. (ed.) How to Grow Vegetables and Fruits by the Organic Method. Rodale Press, Emmaus, PA. USA

Farvar, M.T. & J.P. (eds.) The Careless Technology: Ecology and International Developement. Natural History Press, Garden City, NY USA

The following list is a collection of some of the publications issued by the Agricultural Information Service for the Ministry of Agriculture. These materials are available the small farmer through local agricultural extension officiers. Get in touch with the local agriculture officier in your area. His job is to answer questions and provide farmers with the information they need.

ROOT CROPS ARE "ROOTS" FOOD
CORN, MAIZE INVESTIGATION IN JAMAICA
THE GROWING OF AVOCADO
MONEY MANAGEMENT, KEY TO SUCCESS IN FARMING
RED PEAS
GINGER
GROWING ONIONS IN JAMAICA
SPRAYING RED PEAS FOR HIGHER YIELDS
OPERATION GROW, PROJECT LAND LEASE 1977
HOW TO GROW PUMPKINS
LET'S GROW PEANUTS FOR PROFIT
BACKYARD GARDENING
A NEW PEST TO JAMAICA, THE TOMATO PINWORM
GARLIC
SOIL EROSION, KINDS CAUSES
INVERTIGATIONS 1970-1974
"LET US GROW" FARMER's CALENDAR 1977
ANNUAL REPORT MINISTRY OF AGRICULTURE
DISEASES OF CROPS IN JAMAICA

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