



What Is This Module About?

The world's population, more or less, is now six billion. As the number increases, the need for food increases, too. Unfortunately, the race to produce more food cannot cope with the rapidly growing population, not to mention the climactic changes, and, in some areas, the lack or poor quality of water. This is happening at a time when the available agricultural land and the nutrients in the soil are in different stages of depletion.

These realities are not meant to cause alarm or panic. But it does, however, make us think. The soil, a major natural resource available to mankind, has been subjected to many forms of deterioration as a result of natural and man-made factors. Isn't it about time that we give it a break?

Fortunately, there are other ways by which we could still continue to plant, farm or do gardening. Hydroponics is one way by which plants can grow without using soil. It does not, however, offer to replace the traditional method of planting.

Hydroponics, an alternative method of planting, does not claim that the traditional method no longer works. It is not an answer to our woes and problems as far as food production or world hunger is concerned. Simply put, hydroponics only shows that there are other resources available for us.

In this module, you will learn about an alternative method of planting that hopefully will be used to sustain and maintain life for all.

This module is divided into two lessons:

Lesson 1 – *What Is Hydroponics and Why Is It Important?*

Lesson 2 – *Steps in Hydroponic Gardening*



What Will You Learn From This Module?

After studying this module, you should be able to:

- ◆ describe the features of hydroponic gardening;
- ◆ explain the importance of hydroponics as an alternative method of planting; and
- ◆ describe the advantages and disadvantages of hydroponic gardening.



Let's See What You Already Know

Before you start studying the module, try to answer the questions below. This is to determine how familiar you are with this topic. Don't worry if you are not able to answer all questions correctly.

A. Fill in the blanks.

_____ is an alternative method of planting. It is the science that allows growth of plants without _____. In fact, in this alternative method, _____ can grow even on sand. In the absence of soil, a _____ solution takes over the role of providing food to the plants necessary for their growth and development. This is done by directly feeding the nutrient solution to the _____.

There are many ways by which the nutrient solution is fed to the plants. Although hydroponics shows a lot of promise and hope to many _____ or plant growers, it is not a replacement for the _____ method of planting.

B. Answer the following questions.

1. What is the difference between the traditional method and hydroponics?

2. What do you think are the advantages and disadvantages of hydroponics compared to the traditional method of planting?

3. Will hydroponics help our farmers or plant growers with their problems associated with planting in soil? Why or why not?

Well, how was it? Do you think you fared well? Compare your answers with those in the *Answer Key* on page 37.

If all your answers are correct, very good! This shows that you already know much about the topic. You may still study the module to review what you already know. Who knows? You might learn a few more new things as well.

If you got a low score, don't feel bad. This means that this module is for you. It will help you to understand important concepts that you can apply in your daily life. If you study this module carefully, you will learn the answers to all the items in the test and a lot more! Are you ready?

You may now go to the next page to begin Lesson 1.

What Is Hydroponics and Why Is It Important?

Nature knows best. It has provided us with other natural “materials” which we can use aside from the soil. =It is of great importance that we understand the fact that we cannot let the plants depend on soil at all times. In this lesson, you will learn and understand an alternative way of planting that makes planting possible almost everywhere.

By considering the other possibilities, in this case, alternative methods of planting, the soil is given the chance to restore and maintain its fertility.

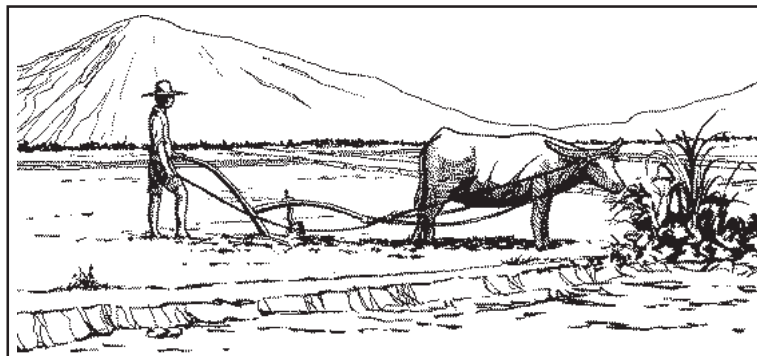
After studying this lesson, you should be able to:

- ◆ explain the meaning of the term “ alternative method” of planting;
- ◆ identify examples of alternative methods of planting such as hydroponics;
- ◆ describe the key features of hydroponics; and
- ◆ explain why alternative methods of planting are important.

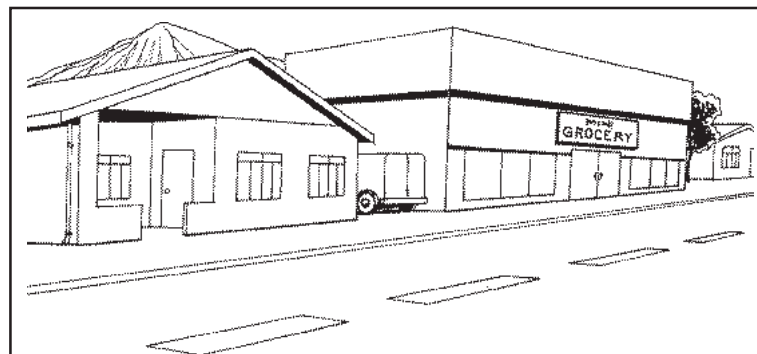


Let's Study and Analyze

Let's us read the following short story.



THEN



NOW

Luis was busy tending his mini-grocery store when Joseph, his childhood friend, came to visit him. Joseph and his family transferred to Manila about twenty years ago. They were so happy to see each other after such a long time. Hours passed, as they remembered the times when all they did was play and have a good time.

Joseph noticed that a lot has changed since he left. He could see a lot of houses and buildings lining up the streets. Gone are the rice fields that used to cover the entire area. He asked Luis whatever happened to the rice fields that his father used to plant rice on. He remembered the many times they had spent running and playing in the fields.

Luis told Joseph that the last few years have been hard for them. Not only have the harvests of palay gone down, the typhoons that came almost every month and the drought made the situation worst.

Luis remembered his father feeling sad about selling half of the one-hectare land to a businessman. His only source of living was about to disappear and he had to do something before everything was lost. And so, a few years before his father passed away, with earnings from the land he sold, he built a two-story house in his remaining half of the one-hectare land where the first floor became a mini-grocery.

Joseph felt a little sad. It was as if a part of his childhood disappeared. He was glad, however, knowing that Luis, with the mini-grocery as his only source of living, is doing okay. Joseph asked Luis if he is thinking of planting again like his father. Luis told Joseph that if only there was a way to avoid the typhoons and the drought, yes, he would certainly begin planting again.

Was it wrong for Luis' father to sell the land? And why build a mini-grocery, instead of just continue planting on the land? Do you think Luis' father would have still sold half of his land had he been able to deal effectively with problems caused by typhoons and drought? What other alternatives, if any, were available to Luis' father?

Several farmers or landowners have sold their lands not only because of reasons mentioned in the story above, but mainly because the lands that they have been planting on all these years no longer have enough nutrients in the soil.

As more rice fields now are turned into commercial or industrial areas, fewer lands are left to plant rice on. As population increases, the number of people who needs to be fed also increases. In a country where planting or farming is a major source of income for many of its people, what are we to do?

Let's pretend that you are Luis. What would you have suggested or advised your father?

PROBLEM#1: Land being cultivated is producing lower and lower crop yields every harvest season

SUGGESTION(S):

PROBLEM#2: Typhoons

SUGGESTION(S):

PROBLEM#3: Drought or scarcity of water

SUGGESTION(S):


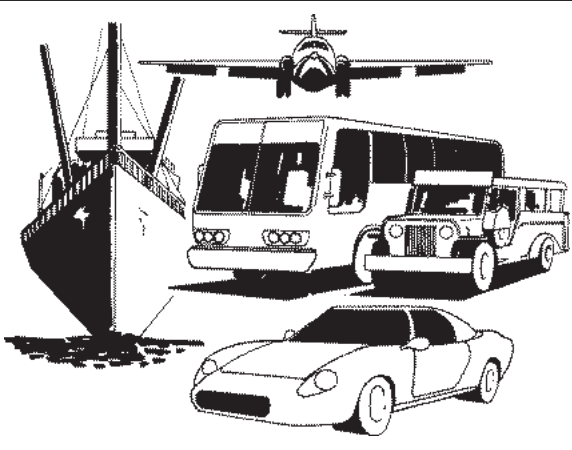

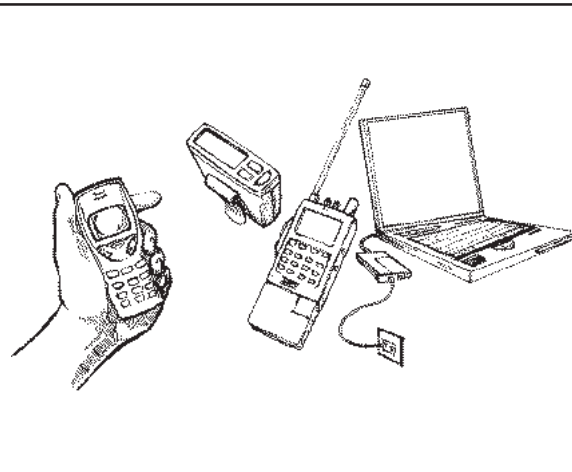
Compare your answers with those in the *Answer Key* on page 38.


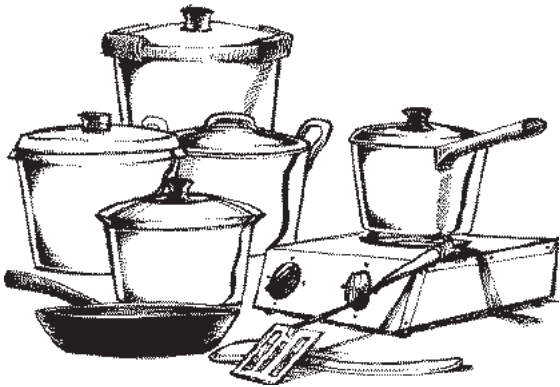
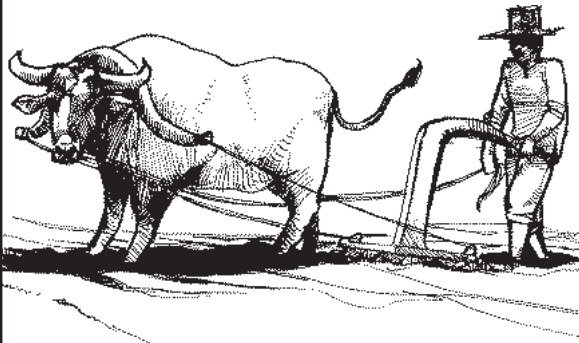

It will also help if you know someone who is knowledgeable in planting or farming. You can discuss your answers with him and find out how you fared with your suggestions.

Were you able to suggest solutions for the problems encountered by Luis' father? You must be thinking if some of your suggestions are even acceptable to begin with. The suggestions you just gave are not meant to give immediate solutions to the problems. But, basically, that is what alternatives do. Alternatives are suggested solutions, some may be workable and possible, or some may not even help at all. More importantly, the alternatives give people, in this case Luis' father, the chance to weigh the "pros" and "cons" of any given situation to arrive at a workable and acceptable plan of action. With alternatives at hand, you are confidently equipped to face the problem because what you have settled to use is the next best thing.

Alternatives have been helpful to people when confronted with different problems. The problem may be the same, but the solutions are varied because of advances in science and technology.

Remember what our parents, grandparents, great grandparents or elders would tell us? They would constantly remind us of how lucky we are. During their time, if they wanted results, they had to rely on hard, physical work or divine intervention. But people now have more alternatives or choices to go about their daily lives. Today almost everything is made easier by new inventions and discoveries. Is this observation or claim actually true? How different was life before and life now?

LIFE BEFORE	LIFE NOW
<p>1. When going to school or to the market, people walk long distances or ride carriages. Sometimes they even travel across ranges of mountain just to get to their destination.</p> 	<p>1. Travelling is made easy by tricycles, pedicabs, cars, jeepneys and buses for public transportation. Long distance travelling is possible because of airplanes and ships.</p> 
<p>2. Telegraphs, telephone or handwritten letters are used to keep in touch with our loved ones.</p> 	<p>2. Recent decades saw the coming of more advances in communication, such as pagers, two-way radios, electronic mail (e-mail), pagers and cellular phones. These gadgets changed the way people now communicate with each other.</p> 

LIFE BEFORE	LIFE NOW
<p>3. Wood or charcoal were used as fuels in cooking.</p> 	<p>3. There are gas or electric stoves and microwave ovens that make cooking faster.</p> 
<p>4. In farming, materials commonly used are the hoe and plough, with assistance from a water buffalo (carabao).</p> 	<p>4. Tractors and other gathering machines have virtually replaced people. From cultivation to harvest, machines have been invented to do the work for us.</p> 

These are just a few of the examples that not only show the obvious benefits of technological advances. It also shows how people, in time, have adjusted for their lives into using new machines or techniques as alternatives doing everyday activities.

This is very much true when it comes to planting or farming. The traditional methods of planting have remained in use for many people for the longest time. For one thing, fertile soil is all around us. Who would even have thought that this is exhaustible? But, they are.

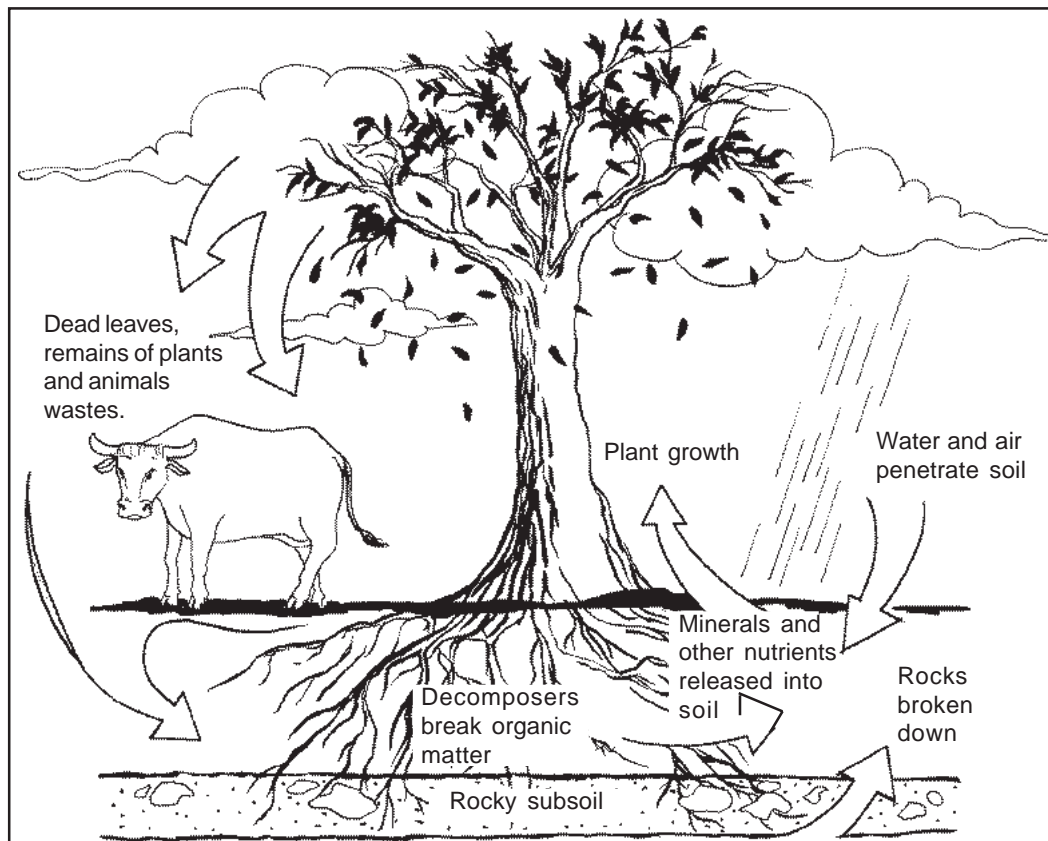
Going back to the story of Luis's father, it was apparent that he could have made better decisions if he only knew what the alternatives to growing plants are. But, who could have shared this information with him?

Although this module does not cover that concern, it must be addressed just the same. The dissemination of information relevant to farmers or plant growers, as far as the discussions in alternative methods of planting are concerned, is the responsibility of both the government and the farmer groups or associations.



Let's Learn

The most common and obvious requirement in traditional planting is the soil. Soil can be seen almost everywhere, as you can also see many plants everywhere. Soil exists in areas where plants are growing or have grown. What is soil, anyway? Let's look at the picture.



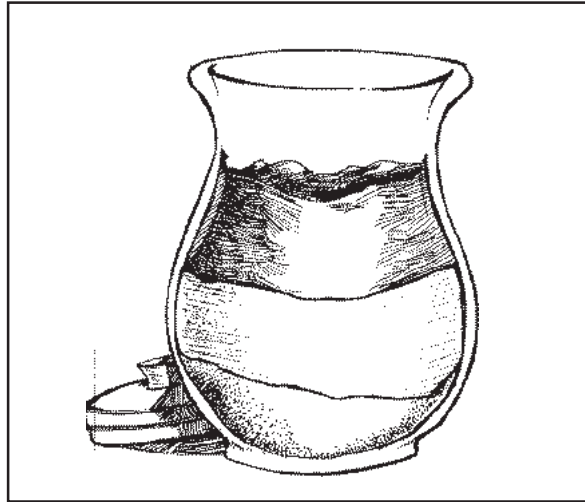
The **soil** is the result of the gradual breakdown of rocks. As these rocks are broken down through a variety of processes like weathering and erosion, smaller and smaller particles, called soil, is formed. It is made up of three parts: mineral material, organic material, and pores.

The **mineral material** is made up of small mineral particles of either sand, silt or, clay. These small mineral particles can be seen separately.



Let's Try This

Fill up $\frac{2}{3}$ of a jar with water. Then, fill the jar almost at the brim with dry, pulverized soil. Put on the lid and shake the jar vigorously. Then, set the jar down and wait for the particles to settle.



After several minutes of allowing the soil to settle, what did you notice? Did you see the sand, silt and clay separating? The bottom part is sand, the middle portion is silt and the top part is clay. The separation of sand, silt and clay is expected simply because the three weigh differently. And so, clay is at the top portion because it weighs the least, followed by silt, and, lastly, sand, the heaviest of the three, at the bottom of the jar.

These three are important parts of the mineral material of the soil. The absence or lack of just one part makes the soil incomplete. This activity could come in handy whenever you have to check if the mineral material of a particular soil to be used is suitable for planting.

There are other parts of the soil that are as vital and important. So continue reading on.



Let's Learn

The **organic material** consists of the dead and living plant and animal matter at varying stages of growth and decay. The **pores** are spaces around the mineral particles. They store water and air in the soil. It is through the water that the nutrients are taken up by the plant roots. Air helps in the growth of plant roots.

The soil is formed continually in this natural cycle, aided by air, water, minerals and organic materials. These elements create life in the soil. But, what does the soil do to plants?



Let's Think About This

Look again at the illustration on page 8. What is obvious is that the soil serves as a medium in which plants anchor their roots, giving them stability to grow upward. But, other than providing physical support for plants to grow, the soil also receives, stores and releases moisture for plant use. A good quality of soil is responsible for holding the water needed by the plants. At the same time, it protects the plants by being “home” to microorganisms that help plants resist diseases.

So, primarily, we can conclude that soil plays the following roles:

1. plant growth supporter;
2. environment buffer; and
3. supplier or source of nutrients and water.

The soil is truly a major source of natural resource available to mankind. But why, despite all the wonderful things that the soil can do for us, are we considering other alternatives for soil as a medium for plant growing?



Let's Read

Asyang came by to visit Doming.

How come you're growing vegetable crops here? All the other crops did not survive the long months of drought or dry spell. You know, the El Niño phenomenon.

Well, guess what! I just used what I learned about hydroponic gardening.

Asyang was confused.

What? Panic gardening? What panic are you talking about?

It's not panic gardening. It's hy-dro-po-nic gardening. It's a way of planting where you don't use soil but water solution instead.

That's nonsense. Where can you find a person planting without using soil?

Well, I do! Look at those tomatoes and eggplants.



Let's Review

Answer the following questions:

1. Are you familiar with the El Niño phenomenon? What do you know about it?

2. Aside from the El Niño, can you think of other possible reasons why Asyong's crops have died?

3. If you were having problems with your plants, would you have immediately considered trying hydroponic gardening? Why or why not?

Compare your answers with those in the *Answer Key* on page 38.


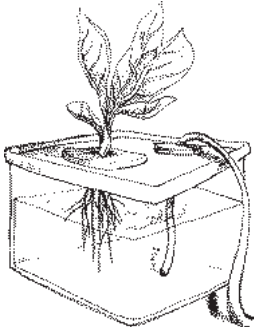


Let's Learn

The El Niño phenomenon or the extreme climactic changes and the depleting nutrients in the soil are some of the problems being faced by farmers like Asyong and Luis's father. Although we do know that life in the soil is a natural, continuous cycle, it will not hurt if we help the soil regain its lost life-giving properties.

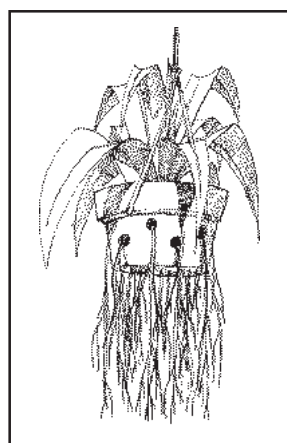
This is where alternative methods of planting come in. Again, we are not replacing the soil as a medium for plant growing. We are simply considering other ways by which we could still plant and avoid or “go-around” the usual problems, man-made or otherwise, associated with planting in soil.

Hydroponics is an alternative method of planting where soil is not used. **Hydroponics or hydroponic gardening** is basically defined as the science of growing plants without soil. It allows planting in areas where the soil is no longer suitable for cultivation, or where water supply is limited. So what replaces the soil? Let us compare the requirements for both the traditional method and hydroponics.

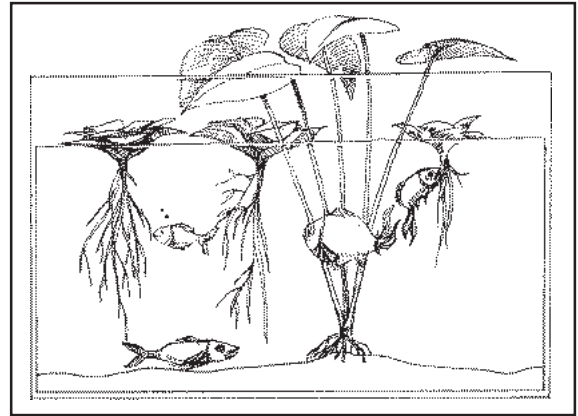
TRADITIONAL METHOD	HYDROPONICS
<ol style="list-style-type: none"> 1. Plants need natural elements such as light, oxygen and carbon dioxide. 2. Plants are grown in soil. 3. The plant roots require water, nutrients and oxygen. They find these requirements in the soil. 4. The plant roots are surrounded by soil to support the growing plant. 	<ol style="list-style-type: none"> 1. Plants need natural elements such as light, oxygen and carbon dioxide. 2. Plants are grown without soil. 3. The nutrients are dissolved in water and are fed directly to the plant roots. This is done by various ways like aerating or immersing the plant roots. 4. A growing medium is used for artificial support. Examples of growing media are strings, stakes, paper towels, filter paper, vermiculite, perlite and petri dishes.
	

So, what do you think of hydroponics so far? Are you interested to know more about it? But, before we learn more about hydroponics, you may want to know that there are other alternative methods of planting. Here are some of them.

1. **Aeroponics** – an alternative method of planting where plant roots are saturated with nutrient solution and oxygen by breaking up the water into small particles, either by fogging or misting.



2. **Aquaponics or aquaculture** – an alternative method of planting where fish are fed, the fish wastes feed the bacteria, the bacteria wastes feed the plants, and the plants clean the water for the fish.



The two other alternative methods of planting show us that the central ingredient this time is water. By concentrating on water and the nutrients, two essential ingredients for plant growth, an alternative method of planting has taken shape.

It must be noted, however, that the word hydroponics came from two Greek words, *hudor* for “water” and *ponos* for “labor,” thus meaning “working with water.” Having said that, it must be pointed out that both aeroponics and aquaponics are variations or different versions of hydroponics.

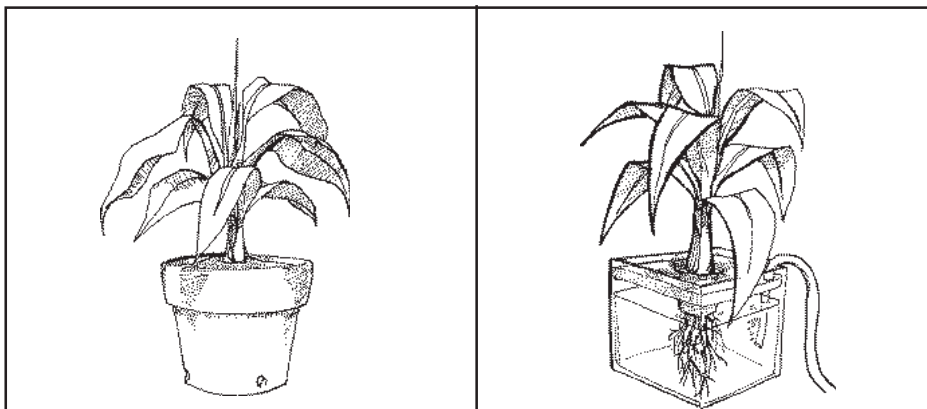
Unfortunately, we cannot discuss lengthily these two other alternative methods of planting. For now, our focus is to learn more about hydroponics as an alternative method of planting.



Let's Study And Analyze

You have learned that hydroponics is an alternative method of planting where soil is not used. How does the plant grow then? To better understand how hydroponics works, let us find out what a plant needs to grow.

A plant needs carbon dioxide, hydrogen and oxygen provided by nature. A plant needs light that is provided naturally by the sun or, artificially, by fluorescent or incandescent lamps. A plant also needs macronutrients, like nitrogen, phosphorus, sulfur, potassium, calcium and magnesium. It also needs micronutrients like iron, chlorine, manganese, boron, zinc, copper and molybdenum.



What have you noticed? Which do you think is a healthier plant: the one grown traditionally or the one grown hydroponically? Why?

Well, the good thing about hydroponics is that the nutrients are “fed” directly into the plants roots. In traditional planting, all the nutrients needed by the plants are not necessarily available in the soil where they are grown. This is the advantage of hydroponics. It is an alternative method of planting wherein the necessary nutrients are dissolved in water and are fed directly into the plant roots, thereby ensuring the growth of a healthy plant. How is that?

It’s like this. Hydroponics offers a wide range of benefits to the farmers or plant growers. And, since soil is no longer used in hydroponics, expect the problems associated with soil to be almost nonexistent. Let’s compare.

TRADITIONAL METHOD (Planting With Soil)	HYDROPONICS (Planting Without Soil)
1. Plant roots get their nutrients from the soil. So much energy is wasted on this activity or process by the plant. Its growth potentials are not realized or maximized.	1. Plants get everything they need all the time. So, they don’t waste time growing a lot of roots or searching for nutrients. Since the plant roots get all the nutrients all the time, they will reward you with a high-quality plant.
2. Growing plants in soil is such physically demanding task. One of the tasks in taking care of the soil is removing weeds. Weeds have to be removed because they compete with plants for nutrients.	2. Without the soil, weeds are not a problem. Therefore, you don’t have to go through that backbreaking activity.
3. The traditional method of planting uses pesticides. This is because the soil is a place for the living and breeding of pests.	3. Without the soil, the use of pesticides is minimal.
4. Mother Nature takes care of providing the plants grown in soil with nutrients, sunlight, and all other natural elements needed by the plant.	4. The farmer or plant grower takes the role of Mother Nature. In hydroponics, all plant requirements are provided in a controlled environment. Hydroponic farmers make use of either natural or artificial materials. For example, you can choose the sun to provide light for your plants or you can use fluorescent or incandescent lamps.
5. The traditional method of planting, whether done outdoors or indoors, cannot be practiced in barren areas like deserts or extremely cold areas like Antarctica because there is no healthy soil suitable for planting.	5. In the absence of soil in hydroponics, planting is possible in areas where temperature and space are major concerns. There are hydroponic farms in deserts, Antarctica, even in submarines and space laboratories.
6. Water is an important ingredient in traditional planting. The plant roots make use of water to distribute the nutrients found in the soil to the different parts of the plant. Water, aids in the breaking down of organic matter for better absorption of plant roots.	6. Water basically plays the same role in hydroponics. A bonus is the fact that this alternative method is more environment-friendly because water is conserved, as the plants roots are flooded with nutrients dissolved in water. The same nutrient solution is drained and reused for the next flooding.

Now that you already know something about hydroponics, let's go back to the problems faced by Luis's father and Asyong. This time, try answering the following questions with hydroponics in mind.

1. Why did Luis' father give up a part of his farm?

2. What were the problems encountered by Asyong in growing his plants?

3. Would hydroponics be able to help with their problems in planting? Why or why not?

4. Will hydroponics be the only answer to their problems in planting? Why or why not?

5. If you were Luis' father or Asyong and you have been told of how hydroponic works, would you have tried? Why or why not?

Compare your answers with those in the *Answer Key* on pages 38–39.



Let Think About This

Again, hydroponics is not the only solution to our problems in farming or plant growing. Like any other system, hydroponics has its disadvantages, too. Can you think of some? Think of reasons why you think hydroponics will not work? Write your answers below.

Compare your answers with those in the *Answer Key* on page 39.

If you think that hydroponics may be expensive for the common farmer or plant grower, you are right. The materials used in hydroponics may be expensive, may be difficult for many farmers to produce. However, the initial cost is immediately compensated when you see the high quality and quantity of the crop grown and produced hydroponically. Hydroponically grown plants are greener, leafier, healthier and, more importantly, they can be grown all year round.

If you also made mention of the variety of plants that can be grown hydroponically, you are right again. Not all plants can be grown hydroponically – only those plants with stringy roots.

So you see, hydroponics is not a perfect alternative method. Like any other system, it does have its disadvantages. The most important lesson that hydroponics teaches is that the dependence on soil cannot go on forever. Food can still be produced if we only consider trying other “materials” that maybe as versatile and as abundant.



Let's See What You Have Learned

Answer the following:

1. Define the following terms in your own words:

a. alternative method

b. hydroponics or hydroponic gardening

c. aeroponics

d. aquaponics or aquaculture

e. nutrient solution

2. Enumerate the problems encountered by plant growers.

3. Explain how hydroponics, as an alternative method of planting, will be able to address these problems.

Compare your answers with those in the *Answer Key* on page 39. Did you get all the correct answers? If you did, very good! If you made some mistakes, don't feel bad. Just review the items in this lesson that aren't clear to you.



Let's Remember

In this lesson, you have learned the following:

- ◆ The problems of farmers or plant growers, are brought about by natural or man-made factors.
- ◆ Advances in science and technology have helped people, like farmers, to find ways to address their problems.
- ◆ The two methods of planting are the traditional and the alternative methods.
- ◆ Hydroponics or hydroponic gardening, a system for growing plants without soil, is an alternative method of planting that helps address the problems commonly faced in planting.
- ◆ Hydroponics offers a way of solving problems affecting planting, like:
 1. depletion of soil nutrients;
 2. conversion of lands into non-agricultural uses; and
 3. typhoons or drought.
- ◆ In the absence of soil, the nutrients that are dissolved in water are directly fed into the plant roots.
- ◆ The use of hydroponics offers many advantages to farmers or plant growers who seem helpless when problems arise as a result of changes, whether natural or man-made, in the environment.
- ◆ Hydroponics is not a perfect alternative method of planting. It has limitations, too. These limitations can be seen as opportunities to continuously work on perfecting this alternative method.

Steps in Hydroponic Gardening

In the first lesson, you were introduced to an alternative method of planting, which is hydroponics. Like any other alternative system, whether in planting or otherwise, hydroponics has advantages and disadvantages. The real test of its effectiveness as an alternative method lies on how it is exactly done. Are the hydroponic preparations needed to grow plants easy? Are the materials needed for hydroponics readily available?

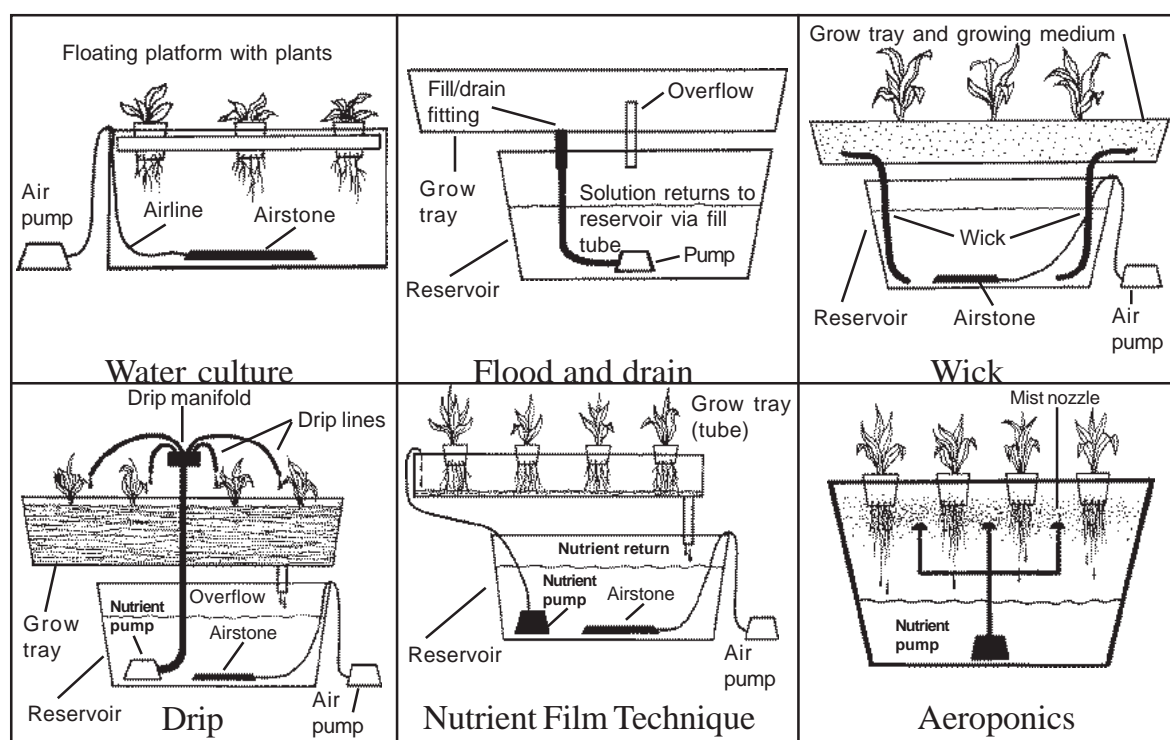
After studying this lesson, you should be able to:

- ◆ describe the steps in hydroponics or hydroponics gardening;
- ◆ describe the materials needed for hydroponics gardening; and
- ◆ explain the sequence of the steps in hydroponic gardening.



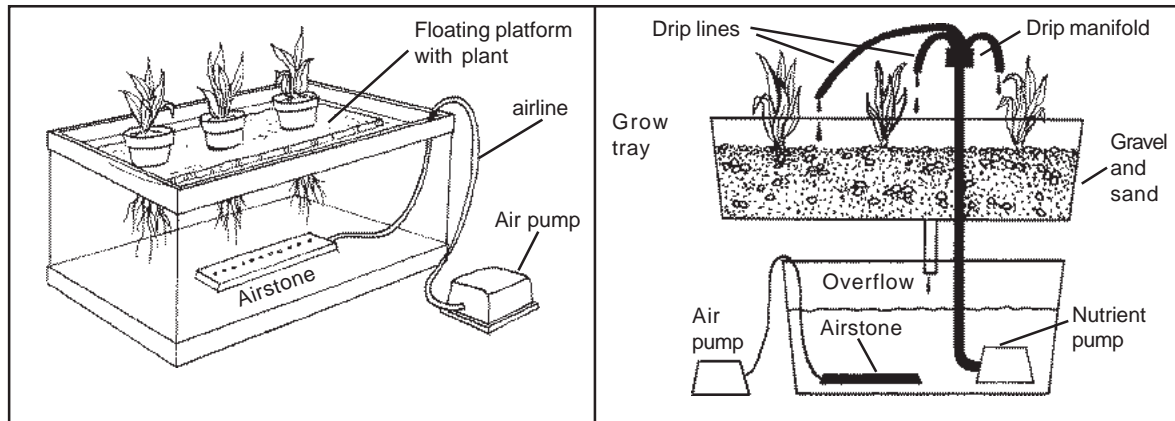
Let's Learn

There are many hydroponic systems we can use. The most basic are the water culture, flood and drain, wick, drip, nutrient film technique and aeroponics. To give you an idea or how the different hydroponic systems are setup, refer to the illustrations below. You may have encountered some hydroponic systems other than what you may see here, but those are probably just variations of these basic systems.



This lesson will focus on learning two of the more simple hydroponic systems: the water culture and the sand and gravel or drip systems. These systems are easier to do and do not require that much material.

Look at the pictures below showing these two hydroponic systems.



Water Culture System

Sand and Gravel System

What do you think are the similarities and differences between the two hydroponic systems, if any? Write down your ideas in the table below.

SIMILARITIES	DIFFERENCES

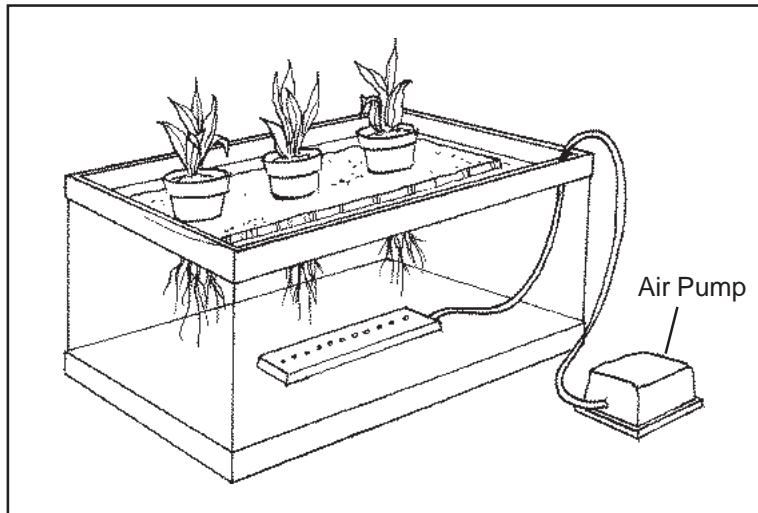
Compare your answers with those in the *Answer Key* on page 40.



Let's Study and Analyze

The Water Culture System

The Water Culture System is the simplest hydroponic system. The plants, placed on a styrofoam or chicken wire, are supported by a growing medium, like wood shavings, rice shaff or small shards of stone. Plants are suspended a few centimeters above a container filled with nutrient solution. The roots are immersed in the solution. Oxygen is supplied to the plants roots through air bubbles from an air pump.

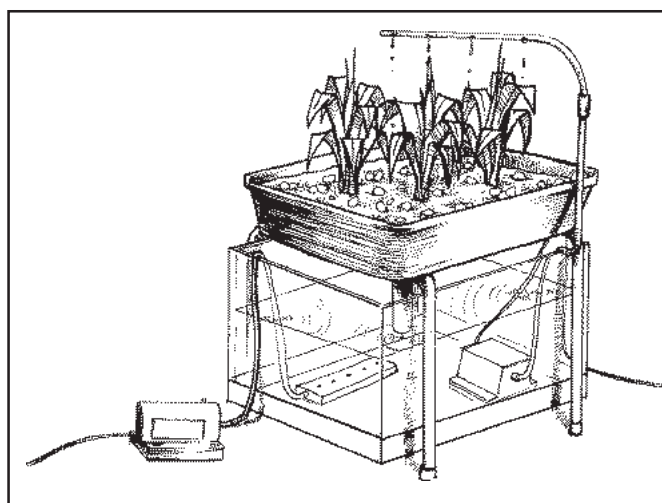


The most common method of supplying oxygen through the solution is to produce air bubbles using the air pump. The air pump, the one you can find in a regular aquarium, is used primarily for this purpose. Plants, like people, need oxygen to meet their energy needs and important plant processes such as photosynthesis.

But, you may be wondering. What about for large-scale hydroponic farming where you will be planting on acres of land? Where can you find an air pump big enough to supply oxygen to the plants? Well, you may use many of these regular air pumps. Or, for farmers who have ventured into commercial hydroponic farming, these air pumps can be custom-made or fabricated.

The Sand and Gravel System

The Sand and Gravel or Drip System is the widely used system of hydroponics. The plants are grown on a growing medium such as sand or gravel placed on earthen jars, clay pots or boxes or any container where the plant will be stable. The nutrient solution is dripped onto the plants through a hose or plastic tubing slightly above the base of the plants. Excess nutrient is drained into a container below the plants. The collected nutrients are then pumped back to the hose or plastic tubing where it again continues to drip onto the plants.



So far, what do you notice between the two hydroponic systems? How are they similar? If you say that they have the same method by which the plants receive the nutrients and water, you are right.

It was explained earlier that in hydroponics, plants could grow without soil. The soil, being the source of nutrients, is replaced by a nutrient solution directly fed to the plant for its survival. In Lesson 1, you learned that, aside from light, water and air, plants also need nutrients in order to survive.

So, what is a nutrient solution?

A **nutrient solution** is a mixture of water and nutrient. The nutrients are composed of primary or trace elements.

Remember the activity on Lesson 1 where you tried to determine the basic requirements of the two planting methods that are all very important for the plants' growth and development? The absence of one or two of these important materials will result in the poor quality of plant life. In hydroponics, where do we get all these plant requirements if soil is not used?

COMPOSITION OF SOIL	COMPOSITION OF NUTRIENT SOLUTION
<ul style="list-style-type: none"> ♦ Organic materials such as decayed plants, trees and decomposed fungi accumulate and provide soil nutrients. ♦ Mineral materials such as sand, silt and clay. Sand, as a component of soil, keeps the soil aerated. Clay and silt are made up of other minerals like calcium carbonate, aluminum and iron. ♦ Pores in the soil allow for water and air to be absorbed by the plant roots. 	<ul style="list-style-type: none"> ♦ Water ♦ Primary elements or macronutrients. These elements, essential to plant growth and are, therefore, required in great amounts, are as follows: nitrogen, phosphorus, sulfur, potassium, calcium and magnesium. ♦ Trace elements or micronutrients, like iron, chlorine, manganese, boron, zinc, copper and molybdenum. These elements are fed to plants in small amounts only. ♦ Air, such as oxygen, maybe supplied by air bubbles produced by air pumps.

Would you agree that the nutrient solution is an acceptable alternative for the soil? Why or why not? Are plants better off with hydroponics as it provides a complete nutrient solution compared to the nutrients found in soil? What are your thoughts about the nutrient solution as a soil substitute? Write them down in the space provided below.

Plants, in a way, are better off with hydroponics. The soil, sometimes, do not have the necessary nutrients needed by the plants. Whereas, in hydroponics, the nutrient solutions that are fed to the plants contain all the elements necessary for plant growth.

These nutrient solutions can be purchased ready for mixing. They are available at garden-supply stores, fertilizer suppliers or farmers' cooperatives. You can also prepare your own nutrient solution. This is cheaper compared to pre-mixed nutrient solutions.

When preparing your own nutrient solution, you will need other materials so that you could check its pH. The pH is a measure of acidity or alkalinity. It determines the availability of various plant foods in the plant roots. A hydroponically grown plant requires a pH of between 5.8 and 7, slightly acidic for proper nutrient food intake. A litmus paper, for example, is used to check the pH of nutrient solution to be used.

All of the information regarding the nutrient solution is proof to its being a more reliable and complete source of food for the plants than the soil.

Whether you have decided to use hydroponics for a small or large-scale farming, it is strongly recommended that you seek help from an experienced hydroponic farmer. This is in case you've decided to prepare the nutrient solution yourself.

For this lesson, let us assume that the nutrient solution we have right now is of the ready-mixed kind or the kind ready for mixing. Let's do this part of the nutrient solution preparation, so that we will have at least an idea of what these elements look like.

Ingredients	Amounts for 25 gallons of solution
1. Potassium Phosphate – monobasic (KH_2PO_4)	½ ounce or 1 teaspoon
2. Potassium nitrate (KNO_3)	2 ounces or 4 teaspoons of powdered salt
3. Calcium nitrate (CaNO_3)	3 ounces or 7 teaspoons
4. Magnesium sulfate (MgSO_4)	1 ½ ounces or 4 teaspoons

Note: These should be dissolved in warm water separately and then added to the solution tank separately.

Ingredients	Amounts for 25 gallons of solution
5. Boric Acid (H_3BO_3)	½ pint
6. Manganese chloride ($\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$)	½ pint
7. Zinc sulfate ($\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$)	½ teaspoon
8. Copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)	½ teaspoon
9. Iron sulfate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$)	½ pint

Note: If tap water is used, there is no need to add copper and zinc sulfate as small amounts of these elements are present in the water.

Also remember to paint the container of your nutrient solution with a dark color, preferably black, to prevent the nutrient solution from being exposed to light. Likewise, close the lids or covers of the containers to prevent getting in contact with air. These preventive measures are meant to prevent the nutrient solution from evaporating.

Again, do not hesitate to ask the help of an experienced farmer before you proceed with the preparation of the nutrient solution.



Let's Review

Now that you have an idea of hydroponics, are you ready to do hydroponic gardening? Let's see. Encircle the correct letter.

1. What are the two systems of hydroponic gardening described so far?
 - a. water culture, sand and gravel systems
 - b. water and nutrients
 - c. traditional and alternative
 - d. wick, flood and drain systems
2. If you use the water culture system, how exactly does the plant get its nutrient solution?
 - a. Nutrient solution is poured into the plants.
 - b. Roots are immersed in the nutrient solution.
 - c. Nutrient solution is dripped onto the plants.
 - d. Nutrient solution is directly fed to the plants.
3. A nutrient solution is composed of _____.
 - a. plant roots
 - b. water and nutrients
 - c. soil and water
 - d. decaying plant matter
4. If you use sand and gravel system, how exactly does the plant get its nutrient solution?
 - a. Nutrient solution is poured onto the plants.
 - b. Roots are immersed in the nutrient solution.
 - c. Nutrient solution is dripped onto the plants
 - d. Nutrient solution is fed by an air pump.
5. In the sand and gravel system, what is used in dripping the nutrient solution onto the plant?
 - a. hose
 - b. platform
 - c. air
 - d. chicken wire

Compare your answer with those in the *Answer Key* on pages 40–41.



Let's Learn

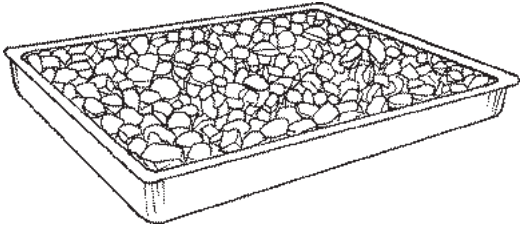
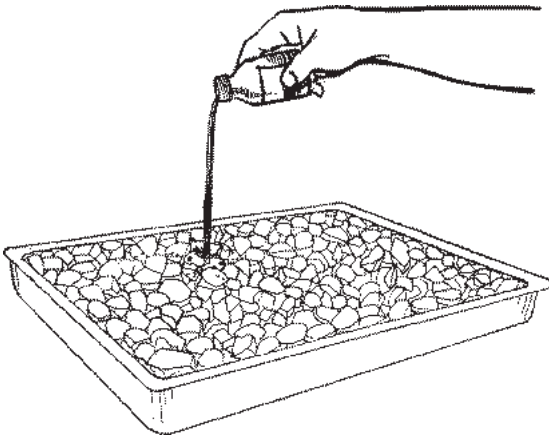
Before we start learning the step by step procedures for each of the two basic system of hydroponic gardening introduced earlier, let us learn how to plant the seeds first.

In hydroponic gardening, whichever system is used, the seeds are grown and planted first. As the seed reaches a height of about four to five inches, it is transferred to a hydroponic setup.

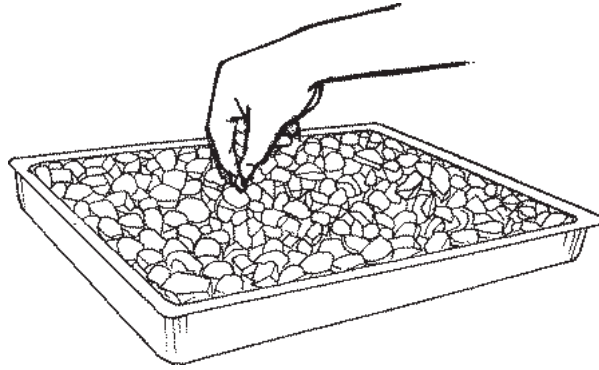
Materials needed:

- 1 ruler
- 1 plastic tray about 18 inches long
- 1 bag or sack of rough stones
- 1 piece of plywood about 20 inches long and 14 inches wide
- Nutrient solution
- Seeds, crop of your choice

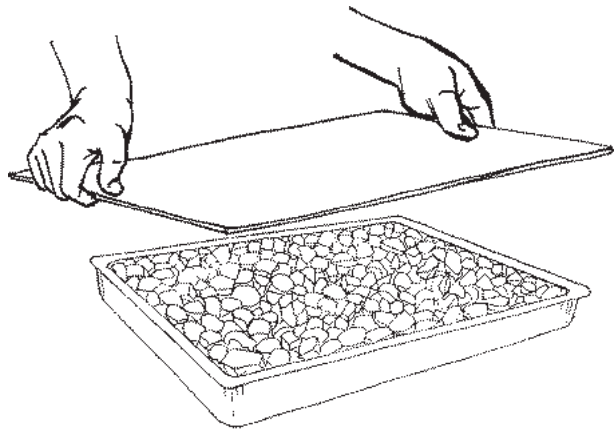
Below are pictures of the steps in growing the seeds. Based on these pictures, try to write the steps that describe the process presented in each picture. The first step has been described to serve as an example.

<p>1. Place the rough stones on the plastic tray enough to cover the base.</p>	
<p>2. _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	

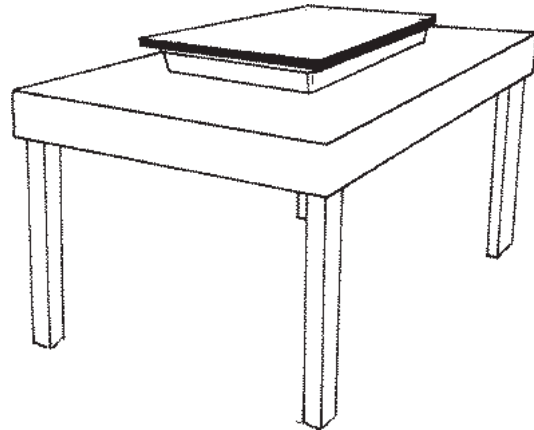
3. _____



4. _____



5. _____



Compare your answers with those in the *Answer Key* on page 41.



Let's Study and Analyze

After two weeks, your seedlings have grown and are now ready to be planted in a hydroponic system. Shown below are the steps for a water culture system of hydroponics.

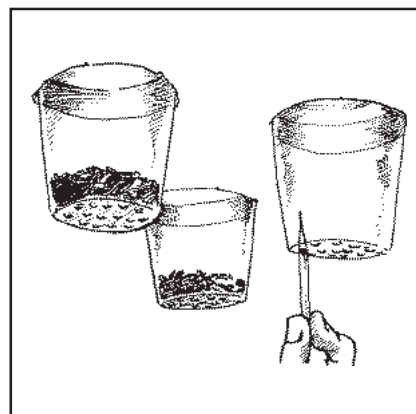
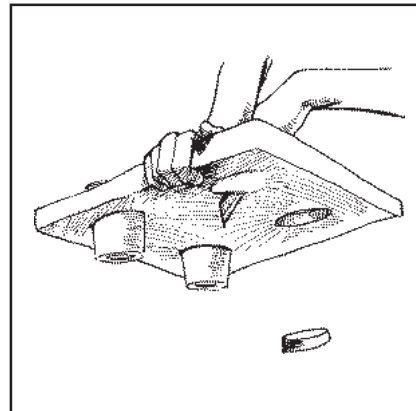
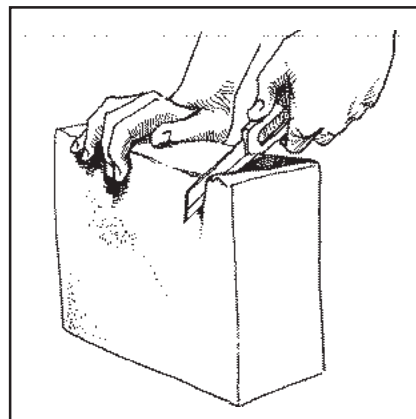
Materials needed:

aquarium
a piece of styrofoam, 1 1/2 to 2 inches thick
growing medium, like the ones mentioned earlier, perlite, or vermiculite
plastic cups
air pump
air stone or plastic tubing poked with holes
nutrient solution
pH test kit

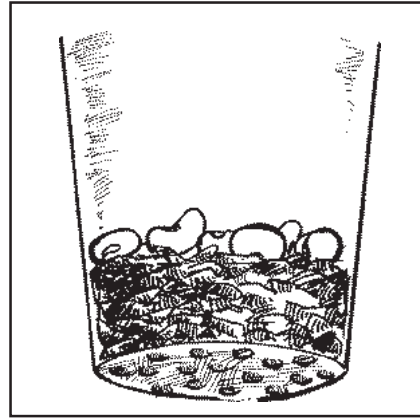
Steps:

1. Cut the styrofoam to fit the aquarium. The styrofoam should be able to float so cut it a little smaller than the opening of the aquarium.
2. Cut holes in the float to the proper size for the plastic cups that you are using, the bottom of the cups should be able to hang but not fall through.
3. Cut several holes, about $\frac{1}{8}$ to $\frac{1}{4}$ inches in diameter, at the bottom of the cups. Add the growing medium to the cup.

NOTE: If the growing medium falls out through the holes you can put a small piece of cloth over the holes before adding the growing medium.

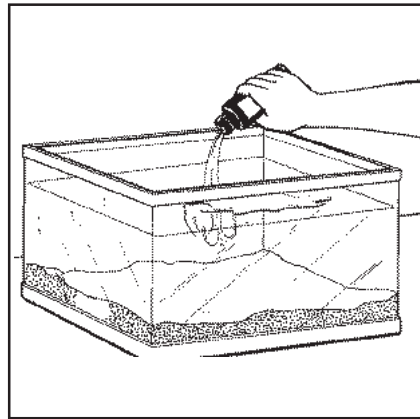


4. Plant seedlings using the growth medium to hold them in place.

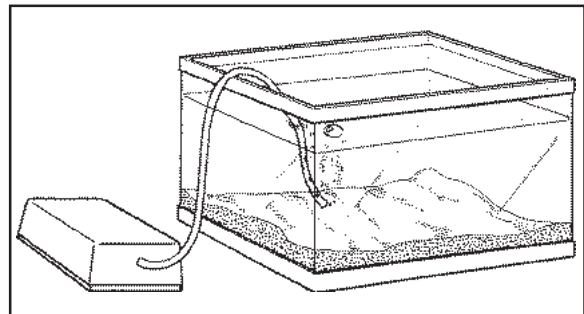


Care and Feeding Instructions:

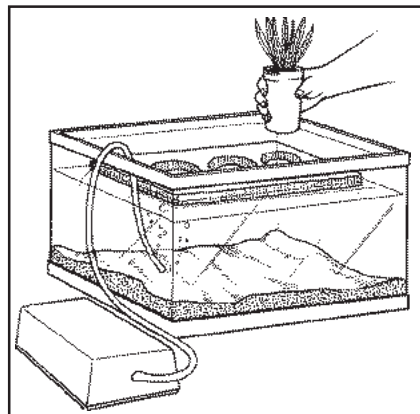
1. Fill the aquarium with water. Mix your nutrient solution instructed on the nutrient package (assuming that you are using the pre-mixed variety). Check the pH and adjust accordingly.



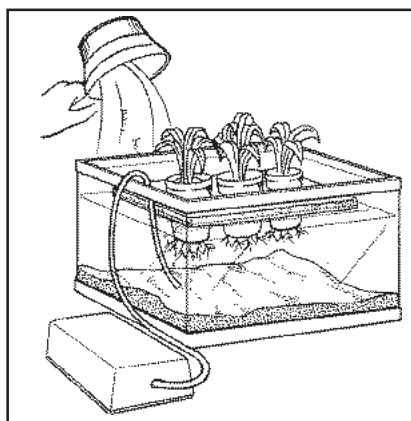
2. Attach $\frac{1}{4}$ inch (in diameter) airline to the air stone. If no air stone is available, you can poke holes into the plastic tubing where air bubbles can come out. Attach the free end of the plastic tubing to the air pump and plug in the air pump to the outlet. Make sure that there are bubbles coming from the air stone or poked holes. (NOTE: Never submerge the air pump in water because it may cause electric shock.)



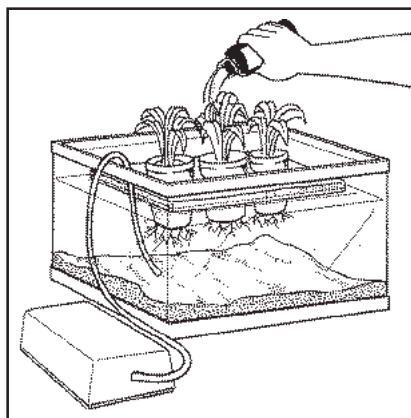
3. Place the floating (styrofoam) platform on top of the nutrient solution. Put the plastic cups into the holes in the floating (styrofoam) platform.



4. When the plants have used up about half of the nutrient solution you can add **only water** to bring the level back up. Recheck pH and adjust if necessary.



5. When the plants have used half of the nutrient for the second time, you need to change out the nutrient solution by draining the reservoir. Then, mix a fresh batch. Use the old nutrient solution to water plants in your area.



Do not forget to check the pH of your nutrient solution before it is “fed” to the plant roots. Make adjustments, if necessary. Again, this particular step may be best accomplished if you’d ask assistance from an experienced hydroponic farmer, especially if you do not have the instruments to measure the pH of the nutrient solution.



Let's Learn

Like any other system, there may be problems, imperfections or limitations as you go along each step. Here are some reminders to guide you so that you will be able to make adjustments accordingly.

1. In hydroponics, the farmer or plant grower takes over nature. He/she should use materials or resources that is readily available to him/her. He/she should keep in mind that the materials to be used should not be prone to pests and can be sterilized and are abundant.
2. If no air pump is available, raise the seed bed, which, in this case example would be the styrofoam. Allot a space of about a fraction of an inch or put holes in the container (for example, aquarium) just above the highest solution level. The space between the seed bed and the nutrient solution may provide enough air for the roots of certain plants.
3. Almost all plants can be grown hydroponically. It may be wise to start working on the most common vegetable crops.



Let's Try This

By this time, you have learned the basic steps in hydroponic gardening. Are you ready to do it yourself? Probably you can make your own manual using the sand and gravel system. But before you start, it would be good to review the materials connecting Lessons 1 and 2 and try to write a simple manual on how to go about hydroponic gardening.

Writing your own simple manual of instructions will help you review the material you have learned in the module and will also serve as a reference guide when you try hydroponic gardening yourself.

1. Cover Of The Manual

<div><div>-----</div><div>TITLE</div><div>-----</div></div> <div><div>-----</div><div>PREPARED BY:</div><div>-----</div></div> <div><div>-----</div><div>YOUR NAME</div><div>-----</div></div> <div><div>-----</div><div>Date</div><div>-----</div></div>

2. Introduction

- ◆ What is hydroponic gardening?

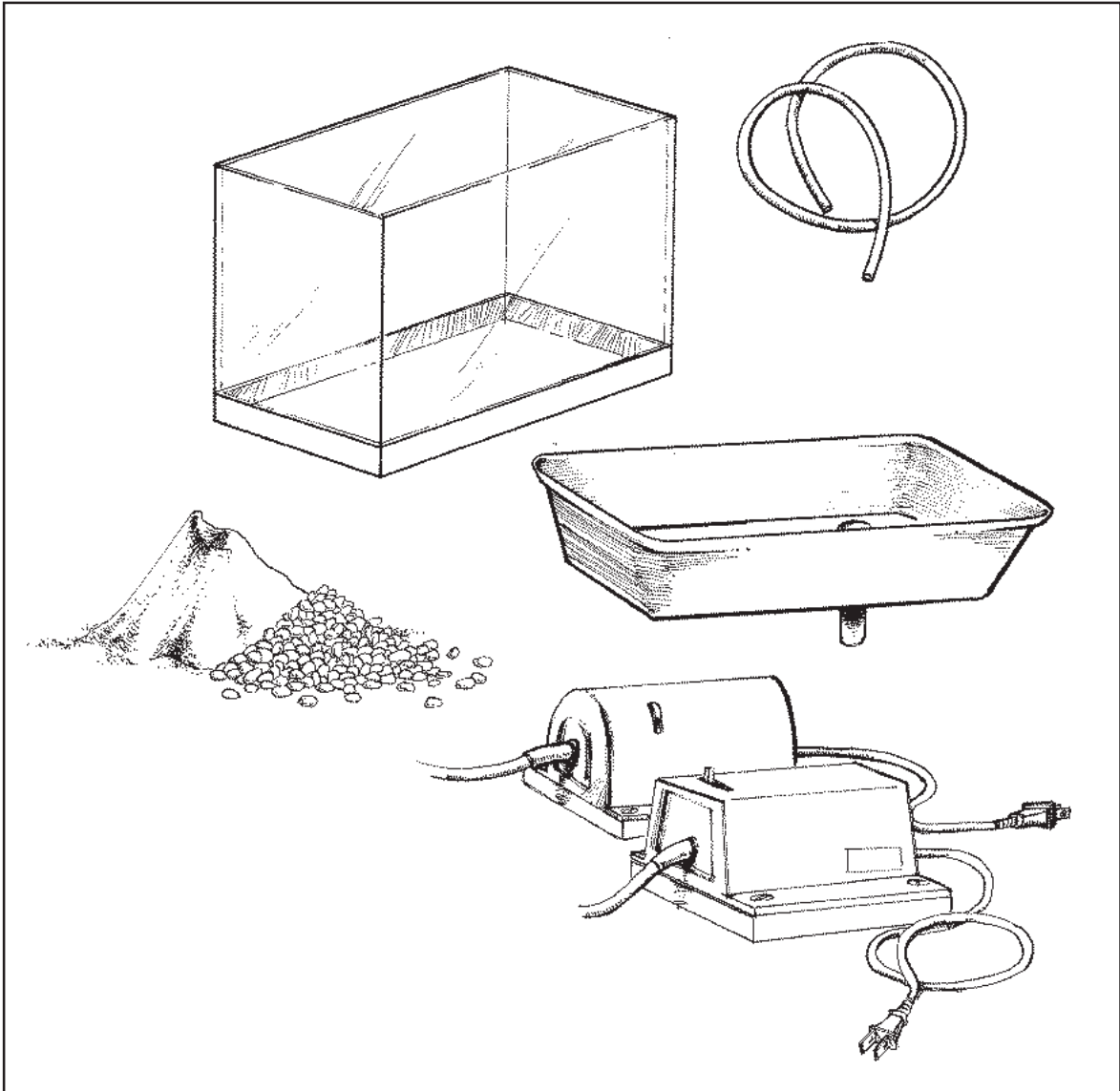
This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the paper.

- ◆ How is hydroponic gardening different from traditional gardening? (Remember to mention the advantages and disadvantages of hydroponic gardening over traditional gardening.)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

3. Materials

The following materials are needed for the sand and gravel system. Identify all of them below.



4. Steps

A. GROWING THE SEEDLINGS

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

B. PLANTING THE SEEDLINGS

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

C. CARING FOR THE GROWING PLANTS

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

You may wish to seek assistance from your Instructional Manager and fellow learners in the preparation of your manual.

When you have finished your simple manual on hydroponic gardening, please show it to your Instructional Manager for further feedback, comments and suggestions.

If you are done with the lesson, congratulations! You are ready to practice what you have learned. You may share the manual that you wrote with your friends and neighbors.

Before you end with this lesson, try to answer the final quiz to see how much you have learned from Lesson 2.



Let's See What You Have Learned

Answer the following questions.

1. Enumerate the six basic hydroponic systems.

2. Between the water culture and the sand and gravel or drip system, which system do you think is easier to do? Why?

3. Define, in your own words, the word “nutrient solution.”

4. Which of the advantages of hydroponics is the most helpful to you or one that you like most? Why?

5. Which limitation of hydroponics makes you hesitant in using this alternative method?

Compare your answers with those in the *Answer Key* on pages 41–42. Did you get all the correct answers? If you did, very good! If you made some mistakes, don't feel bad. Just review the items in this lesson that aren't clear to you.



Let's Remember

In this lesson, you have learned that:

- ◆ There are six basic systems of hydroponic. These are the water culture, flood and drain, wick, drip, nutrient film technique and aeroponics.
- ◆ **Water culture** is a system where the plant roots are immersed in a nutrient solution.
- ◆ **Sand and gravel system** is a system where the plants are planted on sand or gravel. The nutrient solution passes through a hose and drips the solution into the plants. The collected solution is pumped back to the hose that drips the solution again in a continuous cycle.
- ◆ A **nutrient solution** is a mixture of water and nutrients. Unlike the soil, the nutrients in a hydroponic system are directly fed to the plant roots.
- ◆ Steps in growing the seeds:
 1. Place the rough stones on the plastic tray enough to cover the base;
 2. Pour the nutrient solution on the plastic tray;
 3. Put the seedlings carefully;
 4. Cover with plywood; and
 5. Place the plastic tray in a secure place.
- ◆ Steps in planting using the water culture hydroponic system:
 1. Cut the styrofoam to fit the aquarium. The styrofoam should be able to float, so cut it a little smaller than the opening of the aquarium.
 2. Cut the holes in the float to the proper size for the plastic cups that you are using. The bottom of the cups should be able to hang but not fall through.
 3. Cut several holes, about $\frac{1}{8}$ to $\frac{1}{4}$ inches in diameter, at the bottom of the cups. Add the growing medium to the cup. (NOTE: If the growing medium falls out through the holes you can put a small piece of cloth over the holes before adding the growing medium.)
 4. Plant seedlings using the growth medium to hold them in place.
- ◆ Care and feeding instructions:
 1. Fill the aquarium with water. Mix your nutrient solution as instructed on the nutrient package (assuming that you are using the pre-mixed variety). Check the pH and adjust accordingly.
 2. Attach $\frac{1}{4}$ inch (in diameter) airline to the air stone. If no air stone is available, you can poke holes into the plastic tubing where air bubbles can come out. Attach the free end of the plastic tubing to the air pump and plug in the air pump to the outlet. Make sure that there are bubbles coming from the air stone or poked holes. (NOTE: Never submerge the air pump in water as it may cause electric shock.)

3. Place the floating (styrofoam) platform on top of the nutrient solution. Put plastic cups into the holes of the floating (styrofoam) platform.
4. When the plants have used up about half of the nutrient solution, you can add **only water** to bring the level back up. Recheck the pH and adjust if necessary.
5. When the plants have used half of the nutrient for the second time, you need to change the nutrient solution by draining the reservoir and then mixing a fresh batch. Use the old nutrient solution to water the plants in your area.



Let's Sum Up

In this module, you learned that:

- ◆ There is still hope for our food producers. Because of man's ingenuity and nature's self-preserving quality, planting can no longer be dependent on soil alone.
- ◆ **Hydroponics**, an alternative method of planting, allows the growth of plant without the soil.
- ◆ The problems associated with traditional method of planting, admittedly, are both brought about by man-made and natural factors.
- ◆ Hydroponics is environment-friendly.
 - The use of pesticides is minimal and the recycling of water is practiced.
- ◆ The plant roots are directly fed by a nutrient solution in hydroponic gardening.
 - Roots systems no longer have to compete for the nutrients in the soil.
- ◆ The two most basic components of hydroponics are: water and nutrient solution.
- ◆ The success of hydroponics as an alternative planting method also lies on its strict procedural requirements.
 - From the seed preparation and actual planting to its care feeding instructions, a hydroponically grown plant requires careful attention and care.



What Have You Learned?

Answer the following questions.

1. In what way is the traditional method of planting more effective than hydroponics?

2. Can you try hydroponics in your area? Why or why not?

3. If you were a selling the idea of hydroponics to a group of farmers, what would you tell them to convince them to try this alternative method of planting?

How did you do? Compare your answers with those in the *Answer Key* on page 42. You are now very knowledgeable about the hydroponics as an alternative method of planting. You can study this module again to review what you learned. If you missed some answers, don't worry. Review the parts of the module that you did not understand.

Once you are able to answer all the review questions correctly, then you are finished with this module. You may now move on to the next module. Congratulations and keep up the good work!



Answer Key

A. Let's See What You Already Know (page 2)

- A. Hydroponics or hydroponic gardening is an alternative method of planting. It is the science that allows growth of plants without soil. In fact, in this alternative method, plants can grow even on sand. In the absence of soil, a nutrient solution takes over the role of providing food to the plants necessary for their growth and development. This is done by directly feeding the nutrient solution to the plant roots.

There are many ways by which the nutrient solution is fed to the plants. Although hydroponics shows a lot of promise and hope to many farmers or plant growers, it is not a replacement for the traditional method of planting.

- B. 1. The traditional method of planting is the method where plants are grown in the soil, while hydroponics or hydroponic gardening is an alternative method of planting where plants are grown in the absence of soil.
2. The advantages of hydroponics are:
- It allows plants to grow in areas where planting seems impossible—for example, deserts, ice-covered areas, submarines and even in space laboratories.
 - Dependency on soil is lessened. So, even if the nutrients in the soil have been depleted, this can be substituted by a nutrient solution that can either be purchased pre-mixed or ready to prepare.
 - It ensures faster-growing and healthier plants because the nutrients are directly fed into the plant roots. It is unlike traditional planting, where the plant roots waste a lot of energy just from “looking” for nutrients rather than growing.
 - It is environment friendly. The elimination of soil-born diseases lead to the minimal use of pesticides.
 - It allows the soil to restore itself without any disturbance from farmers or plant growers.
3. Yes, because, aside from the advantages mentioned above, hydroponics show that farmers do not have to be dependent on the soil all the time. Farmers or plant growers do not have to feel helpless everytime the soil seems to be unproductive. There is a way for farmers to sustain their only source of livelihood.

B. Lesson 1

Let's Study and Analyze (pages 3–5)

Problem#1

- ◆ Consider changing the crops being planted.
- ◆ Alternate the use of chemical and organic fertilizers.

Problem#2

- ◆ Plant indoors or in greenhouses.
- ◆ Plant crops that are grown and harvested for a shorter period of time so as to avoid the rainy season.

Problem#3

- ◆ Plant crops that do not require much water.
- ◆ Build an irrigation system or small dam.

Let's Review (page 11)

1. The El Niño phenomenon is characterized by an unusually long period of dry spell. When this occurs, water shortage and very high temperatures are very prevalent.
2. Probable reasons for the death of Asyong's crops:
 - ◆ There were no longer nutrients in the soil.
 - ◆ Crops were pest or disease-infested.
 - ◆ There was no adequate light for the crops.
 - ◆ There was no adequate space for the plants to grow.
3. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments:
No, not immediately. In fact, the concept of hydroponics seemed unbelievable at first. I would want to learn its advantages and disadvantages as an alternative method of planting because if its disadvantages far outweigh the advantages, then it would not be of any use to me.

Let's Study and Analyze (pages 13–15)

1. Crop harvests have gone down every year. The drought and the long months of visiting typhoons did not make things easy either.
2. All his crops died because of the drought or the El Niño phenomenon.
3. Yes, hydroponics allows plants to grow even in the harshest environment. In hydroponic gardening, the farmer is in control of the plant's environment. He can make use of artificial materials aside from the natural ones to ensure the continued growth of plants.
4. No, hydroponics is not the only effective method of planting. The traditional method is still the most popular and commonly used method of planting. It just gives farmers or plant growers the option to use other means of planting when traditional means fail.

5. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.
- No, because I would have chosen to learn more about hydroponics. Studying this alternative method would be more beneficial for me in the long run.

Let's Think About This (page 15)

1. Whether it is for small or large scale farming, the initial and maintenance costs for a hydroponic garden or farm, seems too expensive for the average farmer.
2. The average farmer will have a difficult time following the strict plant requirements in hydroponic gardening.

Let's See What You Have Learned (pages 16–17)

1.
 - a. It is not a traditional method; It is another way of doing things; It means a different system.
 - b. It is the science of growing plants without soil; It is an alternative method of planting that mostly uses water.
 - c. It is an alternative method of planting where plant roots are filled with nutrient solution and oxygen. Water is broken up into small particles, either by fogging or misting.
 - d. It is an alternative method of planting where fish and plants are together in one system, both of which depend on each other for food or nutrients.
 - e. It is composed of the primary and trace elements dissolved in water.
2.
 - a. depletion of nutrients in the soil;
 - b. extreme climactic changes such as typhoons or drought; and
 - c. scarcity of good quality of water.
3.
 - a. For item a, soil nutrients can be substituted with a nutrient solution that can be purchased commercially or prepared on your own. The solution is directly fed to the plant roots.
 - b. For item b, hydroponics can be done indoors or outdoors. Although this can also be done for the traditional method of planting, hydroponics allows this to be practiced without the use of soil.
 - c. For item c, the use of water is not that much compared to the traditional method. Therefore, water is conserved.

C. Lesson 2

Let's Learn (pages 18–19)

SIMILARITIES	DIFFERENCES
<ol style="list-style-type: none">Both systems do not use soil to grow the plants.A nutrient solution is fed directly to the plants for both systems.Both use a growing medium to support the plants.Both systems make use of air pumps to give oxygen to the plants roots.	<ol style="list-style-type: none">The nutrient solutions are fed differently. The water culture system “feeds” its nutrient solution by immersing the plant roots. On other hand, the sand and gravel or drip system “feeds” its nutrient solution by dripping onto the base of the plant.

Let's Review (page 23)

- (a)** is the answer. The two hydroponic systems discussed in this module are water culture and sand and gravel system.
- (b)** is the answer. In the water culture system, the plant roots are immersed in a nutrient solution. In the traditional method of planting, the nutrient solution is poured into the plants (a). In the sand and gravel or drip system of hydroponic gardening, the nutrient solution is dripped onto the plants (c). Although (d) may be considered a possible answer because it is true that in the water culture system the nutrients are fed to the plants, the question was how exactly does the plant get the nutrient solution.
- (b)** is the answer. a nutrient solution is composed of water and nutrients. Plants roots (a) are parts of the plant. Soil and water are important requirements for plants grown traditionally and not hydroponically (c). Decaying plant matter makes up parts of the organic matter in the soil (d).
- (c)** is the answer. In the traditional method of growing plants the nutrient solution is poured into the plants (a). The water culture is a hydroponic system where plant roots are immersed in a nutrient solution (b). In the sand and gravel or drip system of hydroponic gardening the nutrient solution is dripped onto the plants. Although this may be considered a possible answer because, for one thing, it is true that the nutrients are fed to the plants the question was how exactly does the plant get the nutrient solution.
- (a)** is the answer. A hose or a plastic tubing, about $\frac{1}{4}$ inches in diameter, is used to drip the nutrient solution onto the base of the plant. A platform (b) is used to support plant growth. Air (c) is an important natural element necessary for plant growth, but it is not used in dripping the nutrient solution onto the plant. Like the platform, a chicken wire (d) may be used to support the plants placed on growing medium.

Let's Learn (pages 24–25)

Steps in growing seeds: (First step already given as an example.)

1. Place the rough stones on the plastic tray enough to cover the base.
2. Pour the nutrient solution onto the plastic tray.
3. Put the seedlings carefully.
4. Cover the tray with plywood.
5. Place the plastic tray in a secure place.

Let's See What You Have Learned (page 33)

1.
 - a. water culture
 - b. flood and drain
 - c. wick
 - d. drip
 - e. nutrient film technique
 - f. aeroponics
2. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.
The water culture system seems much easier to do. The plant roots are just immersed in the nutrient solution and the air pump does its job by providing oxygen the plant roots.
3. A nutrient solution is composed of the primary and trace elements that are dissolved in water. The solution is directly fed to the plants thereby ensuring a good quality of plant.
4. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.
What I like about hydroponics is that it is environment-friendly. It addresses not just one problem but other serious environmental concerns as well. It is a very responsible planting system.
5. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.
What makes me hesitant in using hydroponics is the fact that it cannot grow all plants. What if these non-hydroponic plants happen to be the most common ones. Then, it would not be very useful

D. What Have You Learned (page 36)

1. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.
The advantage of the traditional method of planting over hydroponics is that any plant can be planted in the soil. Only selected plants can be planted using the hydroponics system.

3. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.

Yes. In hydroponics, space or area is not a problem. The most important requirement for a successful hydroponic gardening is a complete nutrient solution.

4. This is a sample answer. Your answer may be different. You may show your answer to your Instructional Manager for comments.

I would tell them that this alternative method of planting is environment-friendly. Therefore, the environment is not harmed. I can tell them that hydroponic gardening is possible even in outer space. That will surely catch their attention.



Glossary

Activity The state, quality, or degree of being acid

Alkalinity The alkali concentration of a substance

Alternative Not traditional; not following or accepting of the usual methods or styles

Hydroponics Science of growing plants without using soil

Mineral materials Is made up of small mineral particles of either sand, silt or clay

Nutrients Food, or chemical substances necessary for growth; essential elements are nitrogen, phosphorus, and potassium; other primary and trace elements

Nutrients solution A mixture of water and nutrients

Organic material Consists of the dead and living plant and animal matter at varying stages of growth and decay

Perlite A plant growth medium made from heat-expanded silicate or glass

Photosynthesis The process by which plants build chemical compounds (carbohydrates) from light energy, water and carbon dioxide

Pores Are spaces of air around the mineral particles

Root The part of the plant that absorbs moisture and nutrients. Roots also stabilize the plant, keeping it from being blown or washed away

Soil Upper layer of the Earth where plants grow

Traditional According to tradition or what has been accustomed to

Vermiculite A plant growth medium made from heat-expanded silicate or glass



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