What Is This Module About?

Do you earn a living as a farmer? When planting season approaches, how do you decide what seeds to plant, where to plant them and how much of each you should plant? The decisions you make will determine your productivity come harvest time. In our country, almost 60% of the population depend on agriculture for their livelihood. Hence, farming-related decisions are crucial to a lot of Filipinos.

In this module, you will learn the steps involved in the scientific method and learn to apply these in solving problems related to agriculture. You will also plan and carry out simple investigations to identify farming-related problems and formulate ways to address these.

This module is composed of five lessons. These are:

Lesson 1 – *The Scientific Method*

Lesson 2 – *Using the Scientific Method in Seed Selection and Irrigation*

Lesson 3 – *Using the Scientific Method in Choosing Fertilizers*

Lesson 4 – *Using the Scientific Method in Crop Rotation*

Lesson 5 – *Applying the Scientific Method in Contour Planting*

What Will You Learn From This Module?

After studying this module, you should be able to:

- identify the steps in the scientific method; and
- apply the scientific method in solving problems related to agriculture such as seed selection, irrigation, choosing fertilizers, crop rotation and contour planting.

Let's See What You Already Know

Before you start studying this module, find out first how well you know the topics to be discussed by answering the following. Write your answers on the lines provided.

1. Name the steps of the scientific method (in the correct order).
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____
2. Give two advantages of using the scientific method.
   a. _____
   b. _____
3. Give two characteristics of seeds that are ideal for planting.
   a. _____
   b. _____
4. State two reasons why irrigation is needed in farming.
   a. _____
   b. _____
5. Define what a fertilizer is.
   _____
6. Give two advantages of crop rotation.
   a. _____
   b. _____

Well, how was it? Do you think you fared well? Compare your answers with those in the *Answer Key* on page 50 to find out.

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 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 go now to the next page to begin Lesson 1.

The Scientific Method

Every day, you encounter problems that need to be solved. These problems may be simple, like figuring out what to wear for work or for a party. They may also be complex, like thinking how to build a machine for a science project. To solve these problems, you usually follow a series of steps that will lead you to the solutions. The scientific method is a process that you can use to solve problems. It involves a series of organized steps that lead toward a conclusion.

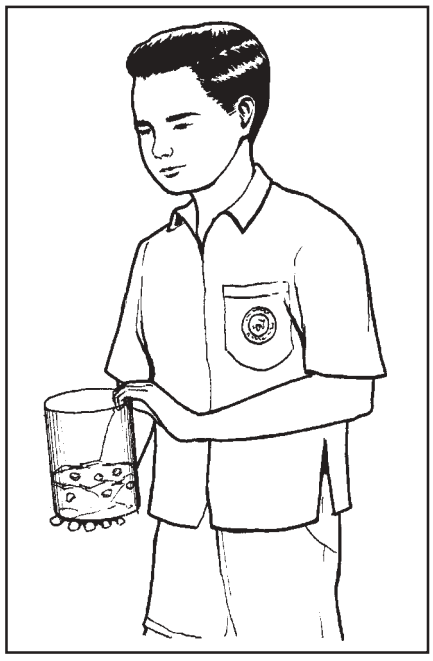
In this lesson, you will study the scientific method of problem solving. You will identify the steps you can follow to solve a problem and how to apply these to simple activities in your daily life.

At the end of this lesson, you should be able to:

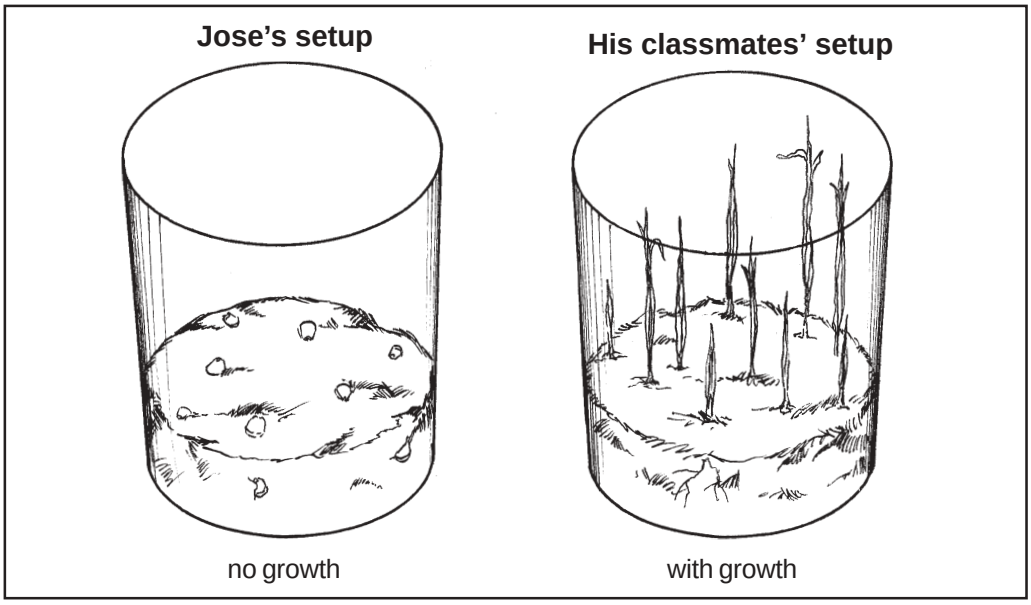
- define **scientific method;**
- enumerate the steps of the scientific method; and
- know how to apply the scientific method in solving a simple problem.

Let's Study and Analyze

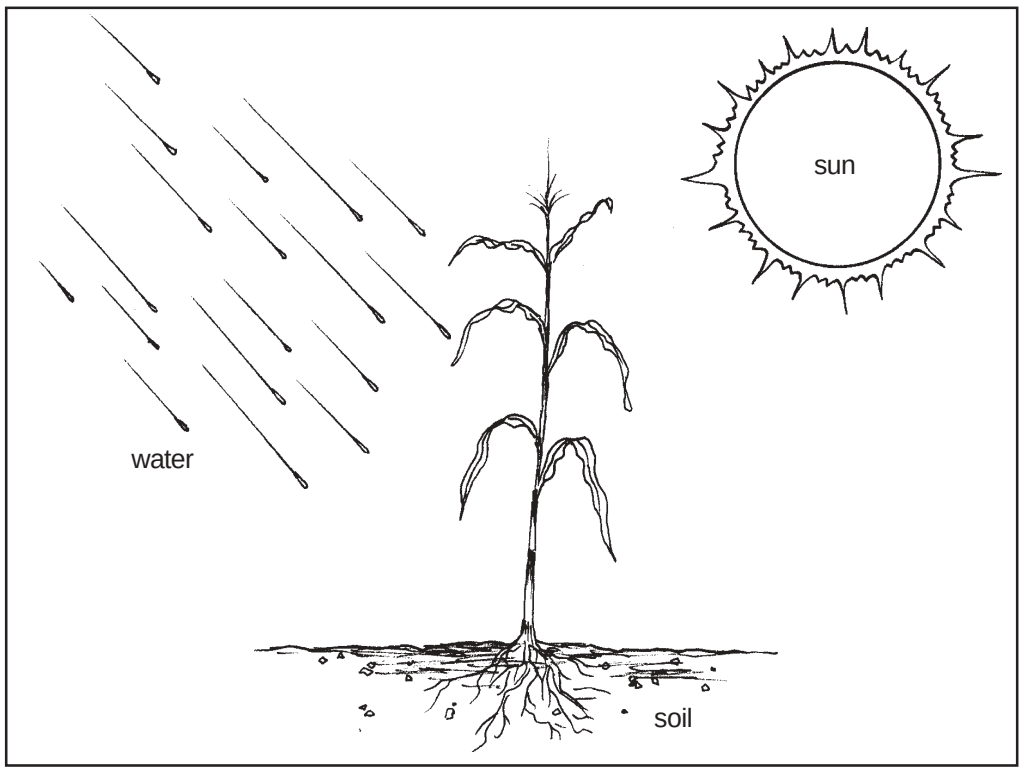
For a class activity in biology, Jose was instructed to plant corn seeds and study their growth. He planted ten corn seeds in a glass jar filled with pieces of newspaper soaked in water. After a week, Jose brought his project to class.



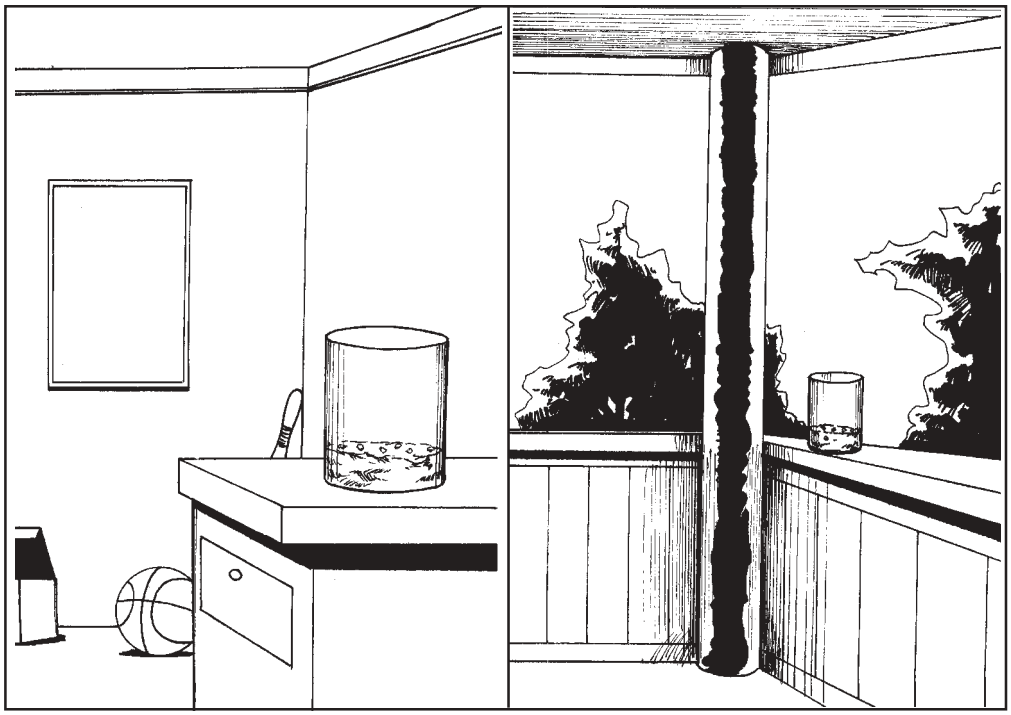
Jose noted that his corn seeds did not become small corn plants, like his classmates'. Their corn seeds had transformed into small plants, complete with roots and leaves.



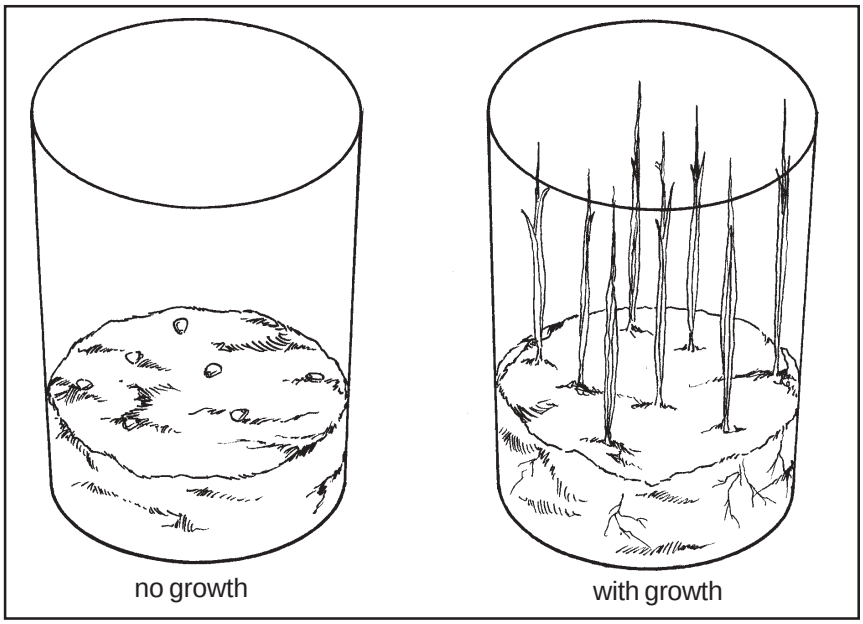
Jose realized that he might have done something wrong, preventing his corn seeds from sprouting. He wanted to find out what this was. He went to the library and read about what makes plants grow. He learned that for plants to grow they need soil, water and sunlight.



Jose thought that his plants must have lacked one of the three factors important for plant growth. He thought that it could not be soil nor water because he placed the corn seeds in a glass jar that contained pieces of newspaper soaked in water. Could it be that his plants lacked sunlight? To find out, Jose prepared two glass jars with corn seeds in pieces of newspaper soaked in water. He placed one jar inside his room just like he did with his previous setup. He placed the other jar on the terrace where there was enough sunlight.



After a week, he checked the two jars. The seeds in the jar he left inside his room did not sprout but the ones in the jar that he left on the terrace had already sprouted. In fact, the small corn plants had already grown about 4 inches tall!



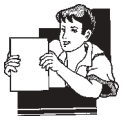
If you were Jose, what would you conclude from your observation? Jose concluded that his corn seeds did not sprout because they lacked sunlight. He reported his findings to his teacher who commended him for his discovery.

Let's Try This

Write on the lines provided the steps that Jose followed to find out what prevented his corn seeds from growing. The first item has been done for you.

1. Jose identified the problem, which was the corn seeds he planted did not sprout.
2. _____
3. _____
4. _____
5. _____

Compare your answers with those found in the *Answer Key* on page 50.



Let's Learn

In the preceding activity, you listed the steps that Jose followed to solve his problem. These steps enabled Jose to arrive at a conclusion, that is, he was able to identify the cause of his problem and find a solution to it. Jose followed the scientific method in solving his problem.

Have you heard of the scientific method before? If you have, what do you remember about it? What do you think being scientific implies? Why is it important?

The **scientific method** is a way or method of learning things and solving problems. It involves a series of steps that are followed when making decisions. It is a very effective process of coming up with the best decision and solution possible based on the available information.

The term **scientific** means of, or employing the procedure or method of science. Recall the definition of **science. Science** is a systematized body of knowledge. Being systematized means being orderly. Science requires that knowledge be based on facts that have been investigated and established. **Facts** are things that are known to exist. The best way to determine if something is factual is to observe it. A fact is an observable event.

Let us recall the steps that Jose followed in solving his problem. First, he identified his problem. His problem was, "Why didn't my corn seeds sprout?" Next, he thought of possible reasons or solutions to his problem. This is called making a hypothesis. A **hypothesis** is a tentative solution or answer to a problem. He read about what makes plants grow and he discovered that most plants need sunlight, water and soil to grow. His three hypotheses were:

1. The seeds lacked soil.
2. The seeds lacked water.
3. The seeds lacked sunlight.

Jose ruled out the first two hypotheses because the newspaper soaked in water substituted for the soil and water. He chose to test the third hypothesis—that the seeds lacked sunlight. The third step he followed is called testing the hypothesis. Jose tested his hypothesis by preparing two sets of jars and placing them in different locations, one exposed to sunlight and one shaded from sunlight.

Testing a hypothesis involves data gathering. **Data** means information. Gathering data involves looking for evidence that will either support or reject a hypothesis. In science, the process of gathering and analyzing data is called **experimentation.** Have you conducted an experiment before? **Experiments** are basically investigations to come up with a solution to a problem. It is the scientific method at work. Jose gathered data by observing his two setups and analyzing the results.

The next step of the scientific method is making a conclusion. A **conclusion** is a statement of decision. Jose concluded that his plants did not grow because they lacked sunlight. The last step is making and implementing recommendations. Jose reported his recommendations to his teacher. He could now implement his recommendations to achieve success in growing his corn plants.

Let's enumerate the steps involved in the scientific method:

1. Identifying the problem
2. Formulating a hypothesis
3. Gathering data (which includes conducting experiments)
4. Analyzing the data
5. Making a conclusion
6. Making and applying recommendations

You have just learned the steps followed in the scientific method of problem solving through Jose's experience. Remember these steps well. Are you now ready to use the scientific method in solving problems in agriculture?

Let's Think About This

You may not notice it, but you use the scientific method every day to solve problems and make decisions. Think of a problem you have had before. It could be a problem related to home or work. Recall the steps you followed in solving that problem. Did you follow the scientific method then?

Now that you learned the scientific method, how will you use it to make your life easier? Imagine how it would be if the scientific method were not applied. Would problems be solved?

Let's See What You Have Learned

Read the statements below. On the line below each statement, write which step of the scientific method is being applied.

1. Your harvest for the year is not as much as last year's.

   _____

2. You assign someone to guard your rice field at night to see if there are any rats.

   _____

3. You decide that this year's harvest is much less because rats infested your rice field.

   _____

4. You set up traps and poisons to eradicate the rats.

   _____

5. You are thinking that a type of disease might have infested your rice plants.

   _____

6. You suspect that somebody is stealing your rice.

   _____

7. You set up scarecrows in the rice field.

   _____

8. You decide that birds are not the reason for this year's lower rice harvest.

   _____

9. You discover that the rice plants are not growing as fast as before.

   _____

10. You decide to assign different varieties of rice for each plot of land.

    _____

Compare your answers with those in the *Answer Key* on page 51. Did you get a perfect score? If you did, that's very good! If not, don't worry. Just review the parts of the lesson that you did not understand very well. Afterward, you may proceed to Lesson 2.

Let's Remember

- The scientific method involves a series of steps that one follows to come up with an effective solution to a problem.
- The steps involved in the scientific method are:

  a. Identifying the problem
  b. Making a hypothesis
  c. Gathering data
  d. Analyzing the data
  e. Making a conclusion
  f. Making and implementing recommendations

LESSON 2

Using the Scientific Method in Seed Selection and Irrigation

In Lesson 1, you learned what the scientific method is and what steps one follows to apply it. The scientific method is a logical and orderly method or procedure of investigation. In the scientific method, the problem is analyzed carefully and a hypothesis is made and tested through a process called experimentation. Data are obtained, analyzed and interpreted. Based on the results of the research and analysis, conclusions and recommendations are made. These recommendations are implemented in order to solve the problem.

Farmers today are encountering many problems. These problems include the mismatch of soil to crops, uneven effects of fertilizer application, planting during the wrong season and the destruction of the environment by pesticide use. These problems all contribute to a lower yield of crops and a reduction in farmers' incomes.

The scientific method of investigation and problem solving combined with scientific-based technologies and approaches can help farmers address these problems. With the scientific way of selecting seeds, for instance, farmers can be assured of a higher percentage of germination and an expectedly higher harvest.

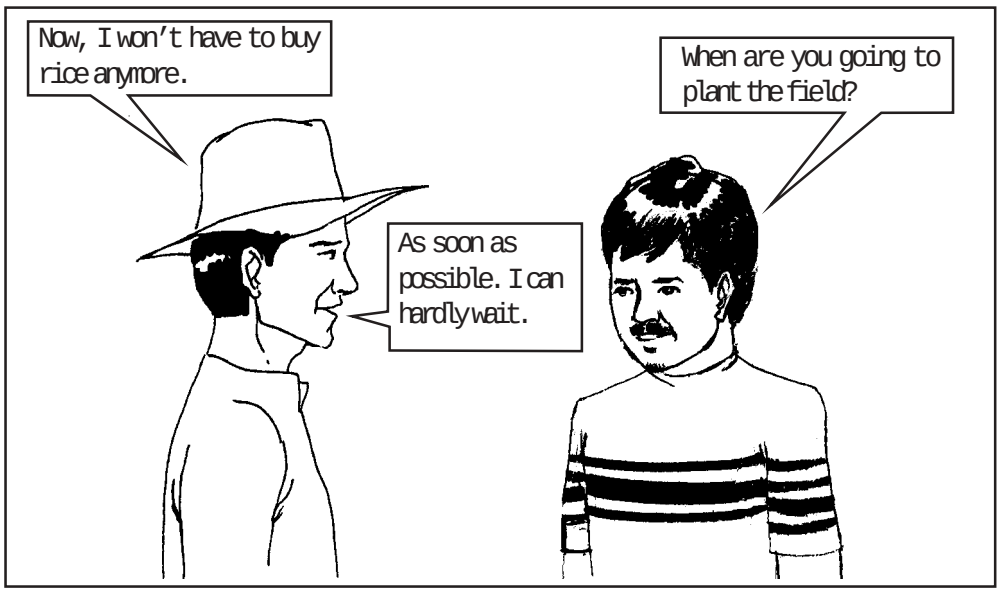
In this lesson, you will learn how to use the scientific method in selecting which seeds to plant and irrigation techniques. You will discover the importance of the scientific method in making decisions that can affect your life as a farmer.

At the end of this lesson, you should be able to:

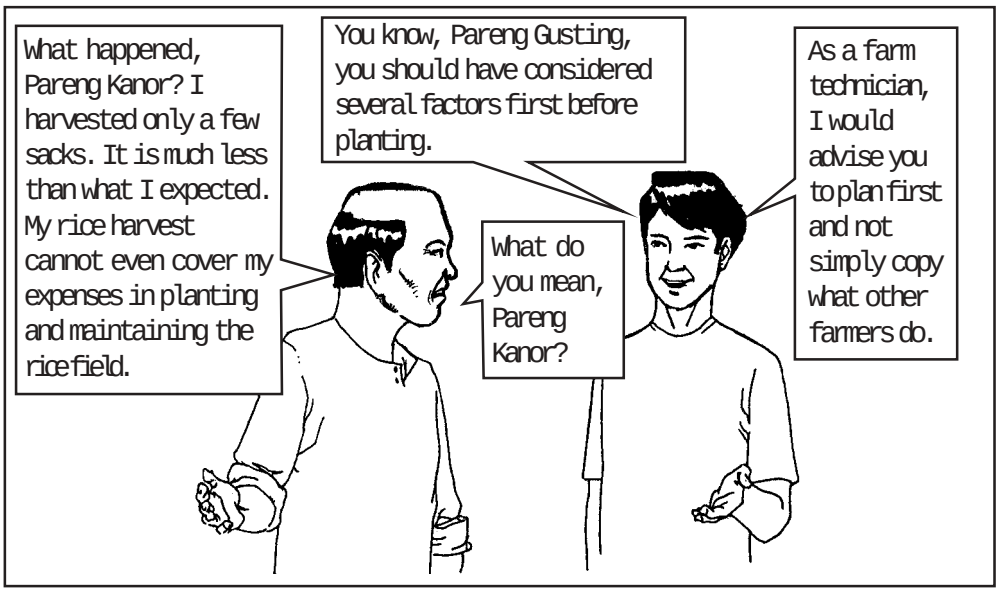
- apply the scientific method in choosing seeds that are good for planting;
- enumerate the characteristics of good seeds;
- know the importance of water and irrigation to plants; and
- learn some irrigation techniques.

Let's Read

Mang Gusting has just bought a piece of land from a friend. He was glad because he could now have more rice and earn more.

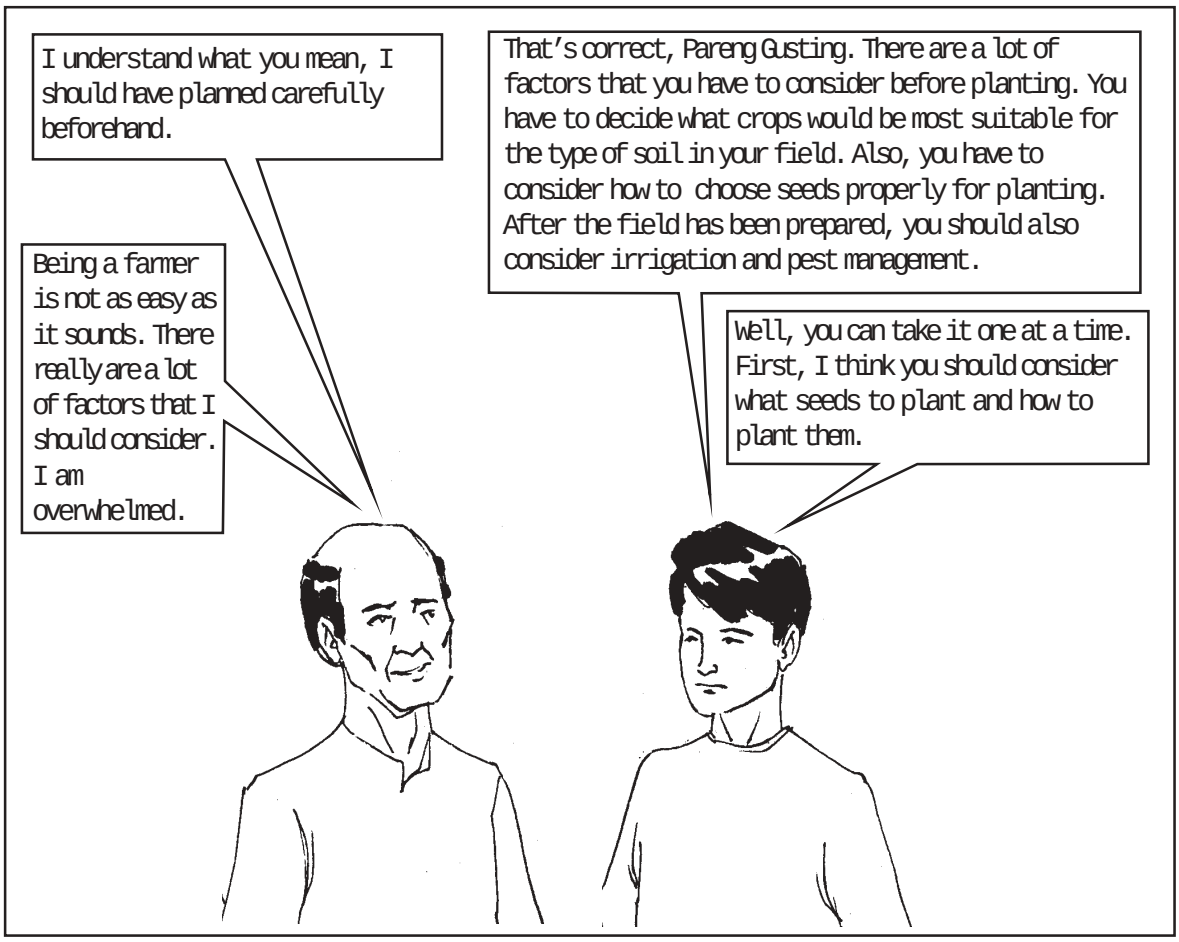


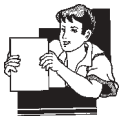
Immediately, Mang Gusting bought rice seeds and planted them in his field. He imitated what other farmers from nearby fields are doing. He was so excited to see the results of his efforts. After three months, it was harvest time. However…



From what you have learned about the scientific method in Lesson 1, what could have Mang Gusting done before planting his field?

The scientific method is a very useful tool for farming. Mang Gusting could have followed the steps of the scientific method to prepare his farm for planting.





Let's Learn

Let us help Mang Gusting solve his problem. First, Mang Kanor identified a lot of possible problems. When using the scientific method, it is important to identify a specific problem first. Mang Kanor suggested that Mang Gusting should consider what seeds to plant. Below are the steps to follow when using the scientific method. Below each step is what Mang Gusting can do. Study these steps carefully.

1. Identifying the problem

   Mang Gusting's problem is choosing the right type of crops or seeds to plant on his field.

2. Making a hypothesis

   The right crop to plant depends on a lot of factors, such as the special characteristics of the soil. (For example, some crops grow best in sandy soil rather than in loamy or moist soil.) Other factors are the temperature of the environment and the amount of rainfall and water supply that can affect productivity.

   Since other rice fields surround Mang Gusting's farm, there is a big possibility that crops that grow well in the farms nearby would also grow well in his.

3. Gathering data

   Mang Gusting can ask for seeds from the other farmers and plant these seeds in his own soil. He can observe the growth rates of the seeds he planted in his own soil.

4. Analyzing the data

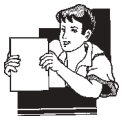
   Mang Gusting will compare the growth rates of his plants with those of the plants in the nearby rice fields.

5. Making a conclusion

   Based on his observations and analysis, Mang Gusting can now tell which type of seeds he should plant in his soil.

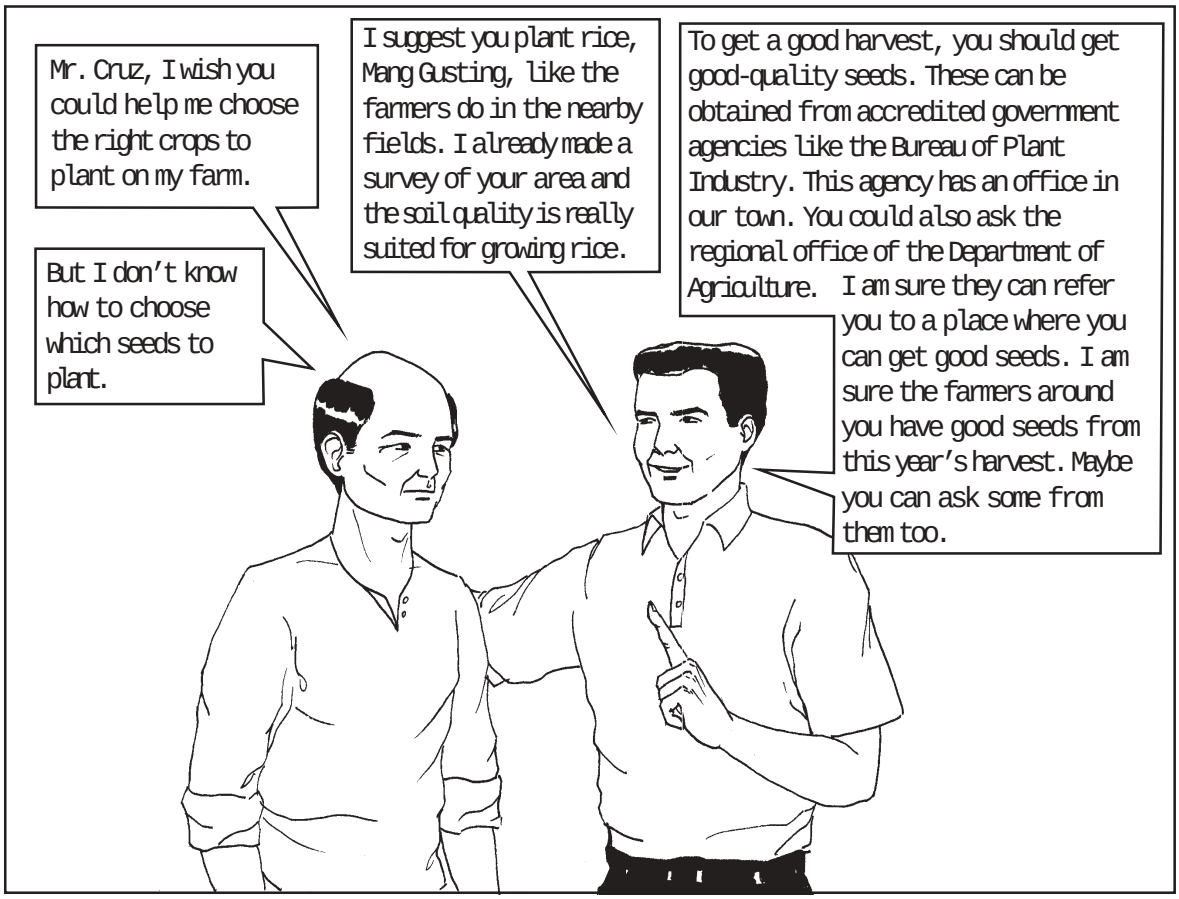
6. Making and implementing recommendations

   Based on his conclusion, Mang Gusting can now choose the type of seed he will plant and he can now go about planting on his farm.



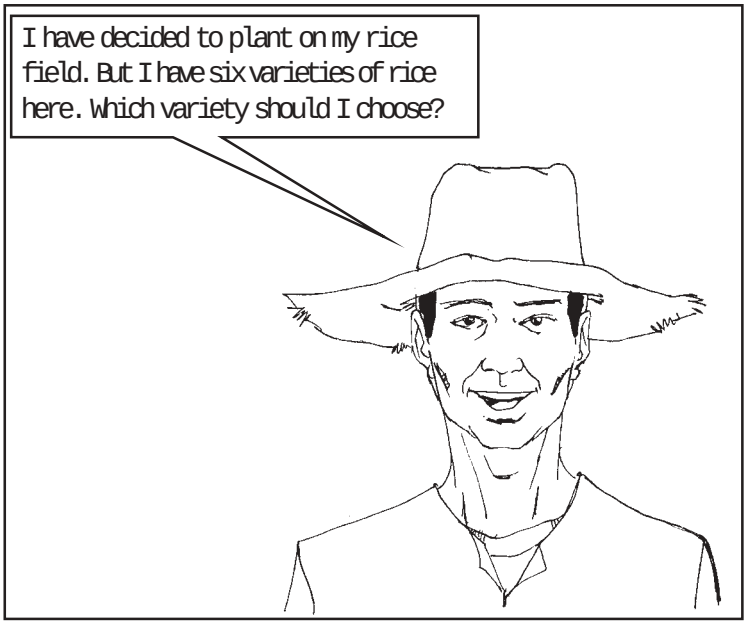
Let's Learn

Early next morning, Mang Gusting consulted Mr. Cruz, a farm technician. A farm technician is someone who can analyze soil characteristics in terms of salinity (salt content) and acidity. A farm technician can help Mang Gusting choose which crops are suitable for his field.



Mang Gusting followed Mr. Cruz's advice. He went to the different government agencies which provided him with some seed samples. He was also able to ask for some seeds from his neighbors.

Let's Try This



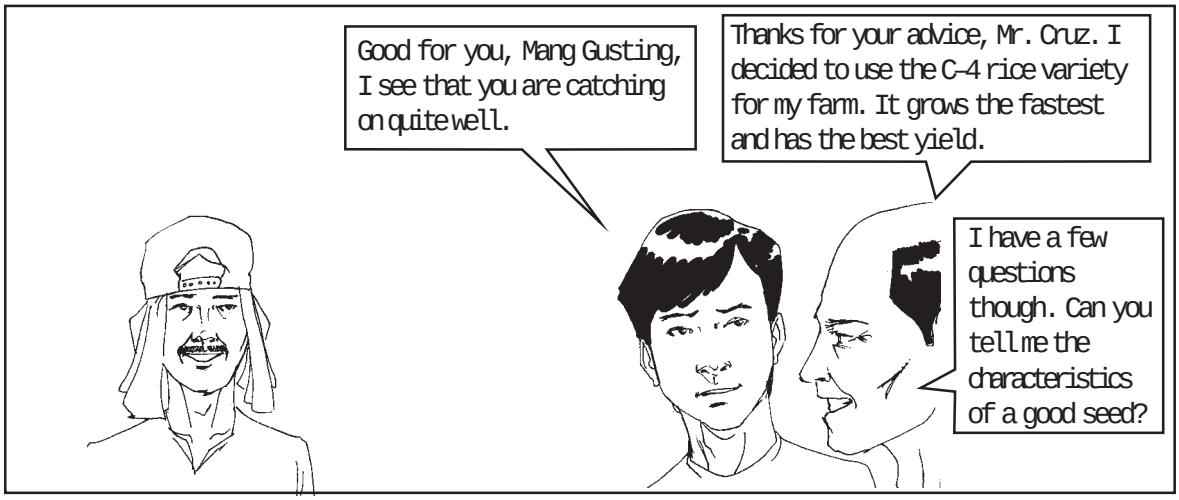
Use the scientific method to help Mang Gusting choose which variety of rice will grow best on his farm. On the lines below, write the steps of the scientific method and how each method can be applied to Mang Gusting's problem. The first step has been done for you.

1. Identifying the problem: Mang Gusting has to choose which rice variety from among the six will grow best on his farm.
2. _____
3. _____
4. _____
5. _____
6. _____

Compare your answers with those found in the *Answer Key* on page 51. Were you able to help Mang Gusting?

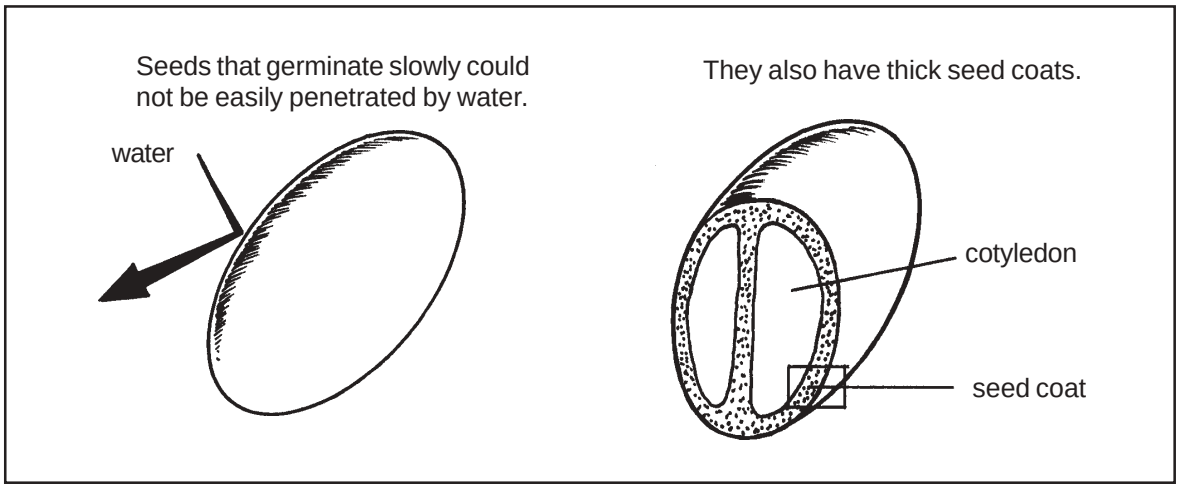
Let's Learn

Mang Gusting has finally decided to choose the C-4 rice variety to plant on his farm. He visited Mr. Cruz once more.



Mr. Cruz explained to Mang Gusting the characteristics of a good seed which are:

1. Good seeds easily germinate or develop seedlings.



You can do any of the following to make a seed germinate faster:

a. Mechanical scarring

For bigger and thicker seeds, such as *anonas, atis* and *guyabano* seeds, scarring can be done mechanically by rubbing the seeds lightly with sandpaper. This promotes the development of the embryo within the seed.

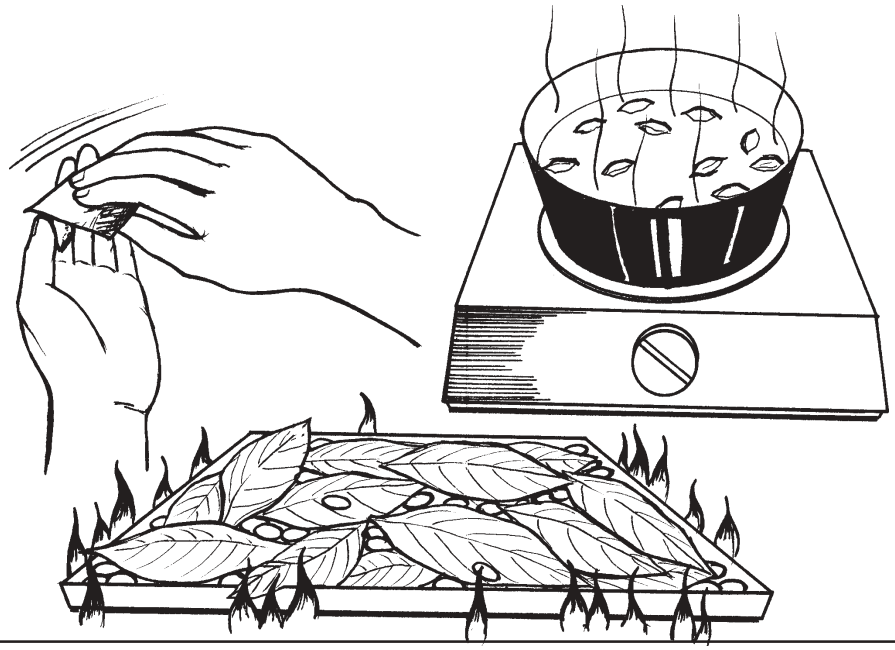
b. Scalding

Scalding is good for hard seeds with waxy coatings such as atis seeds. Scalding is done by pouring very hot (but not boiling) water over the seeds and allowing the seeds to soak until they swell and sink. The water decreases the waxiness of a seed's outer covering to enable it to absorb water better.

c. Fire treatment

For very hard seeds such as *lumbang* and acacia, fire treatment can be done to promote cracking and seed germination. Place the seeds in a tray with a depth about twice the diameter of each seed. Place a layer of dry leaves and small twigs on top of the tray and set on fire for 5 to 10 minutes.

Shown below are the different ways of promoting seed germination.



2. **Good seeds must be smooth and harvested from mature fruits.** Small and wrinkled seeds may not contain enough food to sustain their initial growth.
3. **Good seeds are plump, well developed and without insect marks.** Insects often leave scars on seeds. Such seeds seldom bear good embryos.
4. **Good seeds come from good plants.** Healthy plants usually bear fruits with healthy seeds.
5. **Good seeds are well stored.** Moist, smelly seeds with fungal growth are usually not healthy.

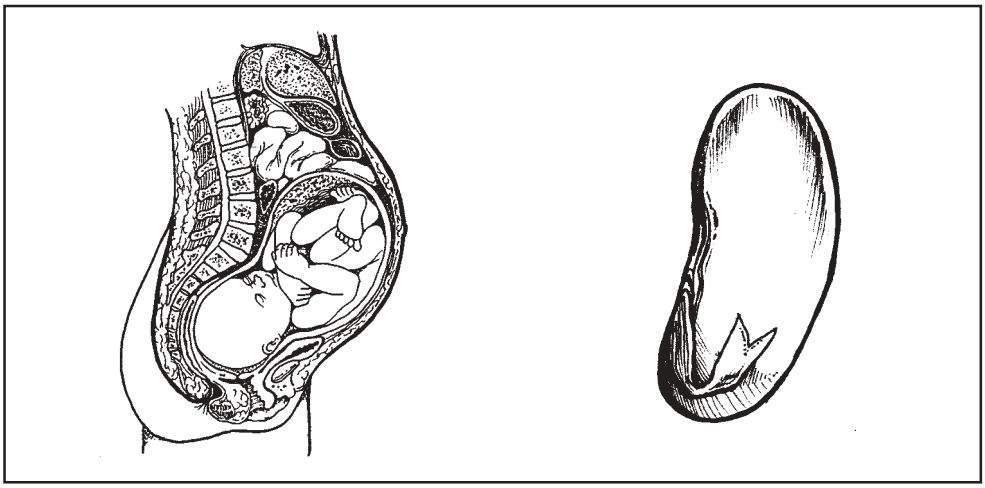
Mang Gusting's healthy rice seeds are plump and even in appearance. Rice seeds from a good harvest will likely produce good rice later on.

Let's Think About This

Seeds are "baby plants" inside a protective covering. Why do healthy-looking seeds usually develop into healthy plants?

Like healthy babies having a better chance of developing into healthy children and adults, healthy-looking seeds are more likely to develop into healthy plants. This is because the plant embryo inside a seed is very delicate. If the seed appears unhealthy, (that is, it has insect marks or signs of fungal growth), there is a big chance that the embryo inside is also unhealthy or may even be destroyed already.

Study the illustration below to understand this better.



A healthy plant embryo is similar to a healthy human fetus.

Let's Try This

Help Mang Dado, a fruit farmer, choose which seeds are good for planting. Draw an arrow from Mang Dado to the characteristics of the seeds that he should choose for planting. An example is given.

Comes from a healthy plant

Well stored

Discolored

With scars from insect infestation

Easily germinates

Wrinkled

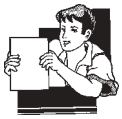
Smaller than usual size

Evenly colored

Compare your answers with those in the *Answer Key* on page 52.

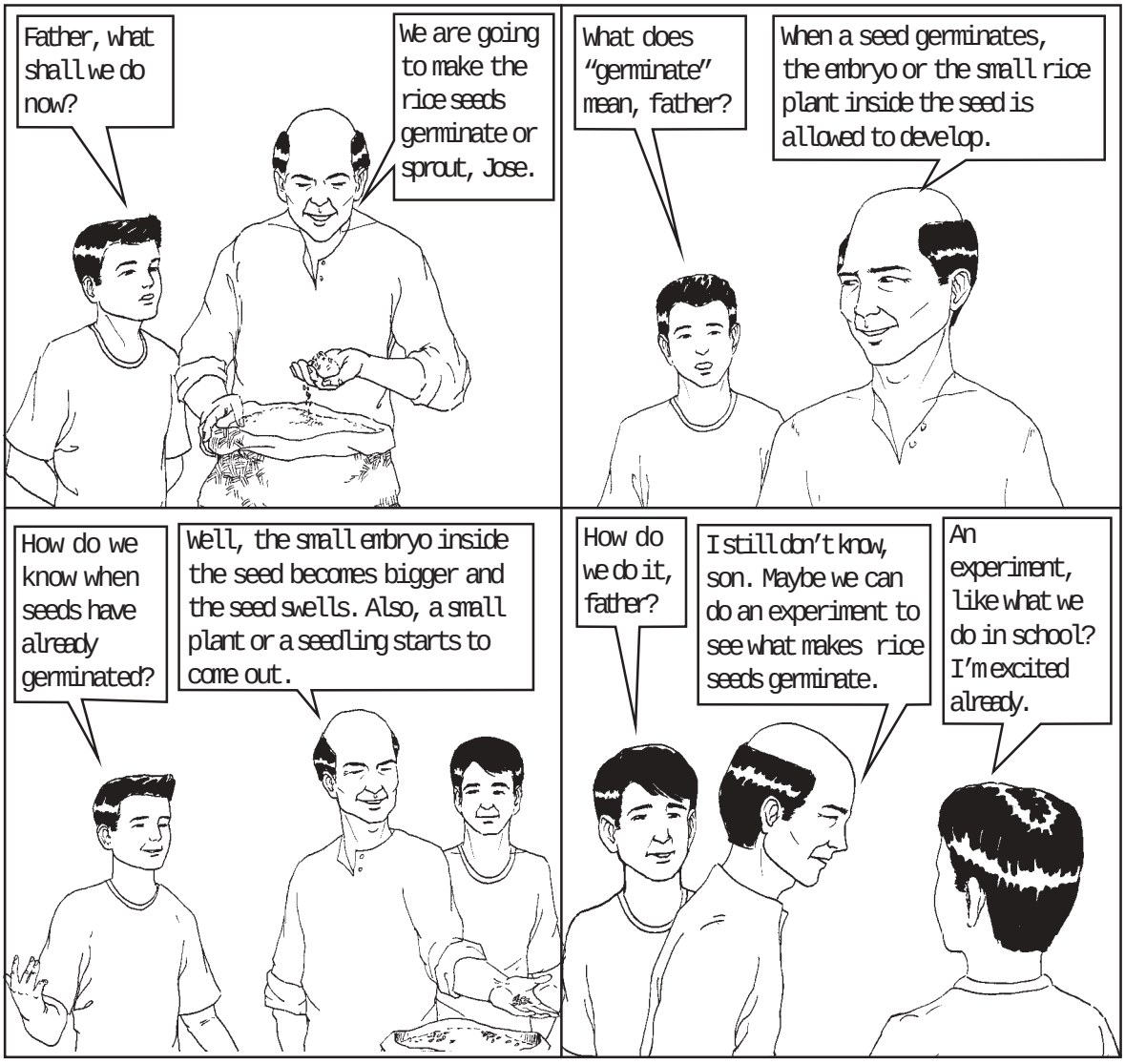
Don't Forget!

For a better harvest, use only seeds from well-ripened fruits of healthy parent plants that consistently yield high-quality fruits. The parent plant should be free from disease and insect scars.

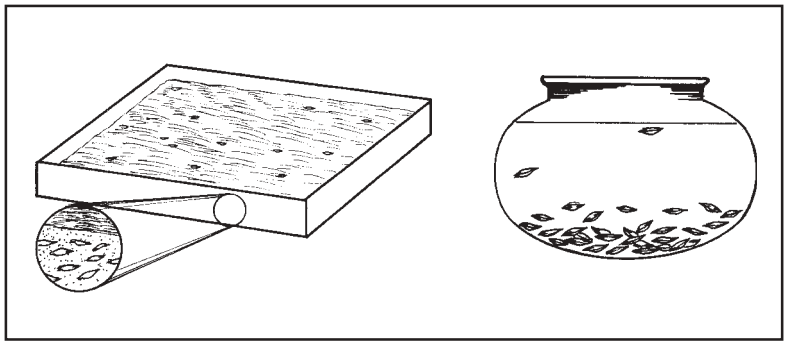


Let's Learn

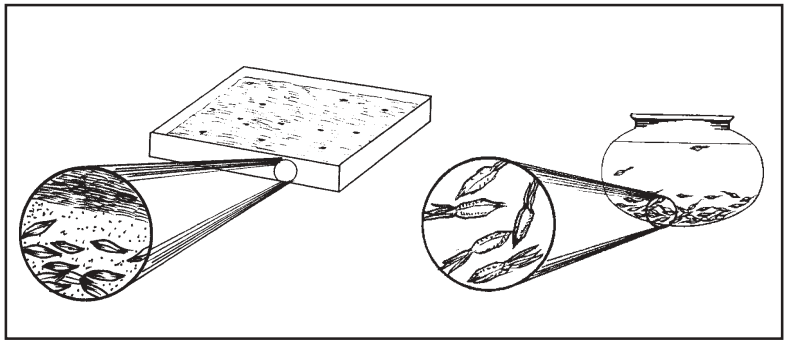
After consulting a farm technician, Mang Gusting went to a certified rice grower and purchased the rice seeds he needed. He then asked the help of his sons, Jose and Pong, in preparing the seeds for planting.



Mang Gusting decided to follow the scientific method. He indicated that he and his sons needed to find out what makes rice seeds germinate best. He stated that maybe moisture is needed because water makes plants grow. He tested this hypothesis by preparing two sets of seeds. One set was soaked in water first, while the other seeds were placed in a tray and covered with an inch of soil.



After four days, Mang Gusting and his two sons checked the seeds. This is what they saw.

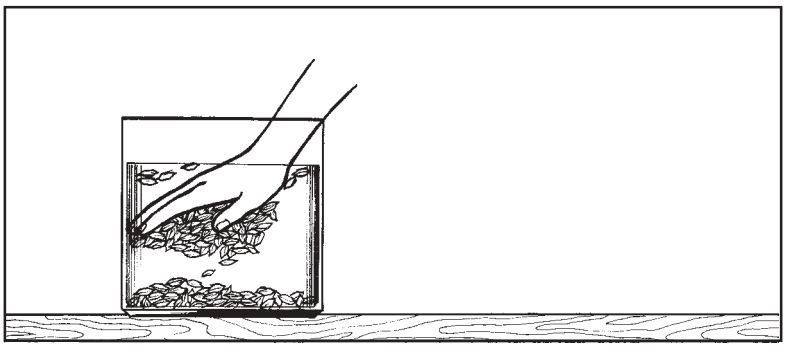


What can you conclude from Mang Gusting's experiment?

Mang Gusting discovered that moisture is needed by the rice seeds to germinate. The seeds soaked in water developed into small plants while the seeds covered with soil did not.

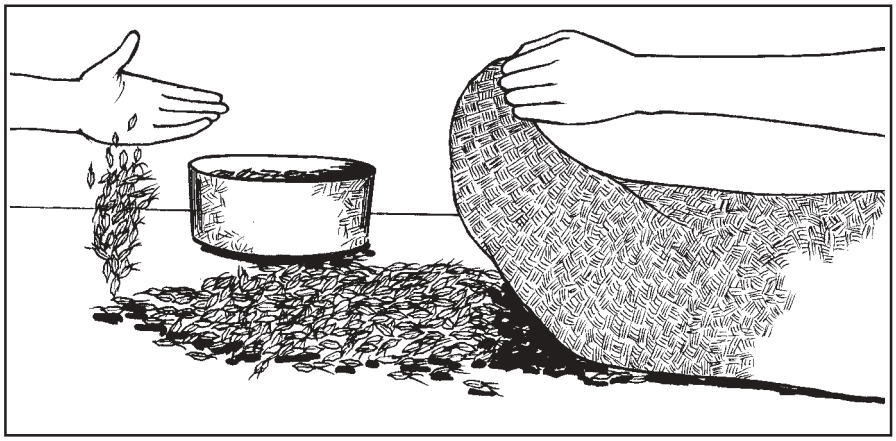
Mang Gusting visited Mr. Cruz, the farm technician, once more. From Mr. Cruz, he learned the proper way to germinate rice seeds. He was correct. Moisture is needed for the seeds to germinate. He found out that heat is needed as well. He learned that rice seeds are germinated in the following manner:

1. Soak the rice seeds in water overnight so that water can penetrate them and make the embryos develop.



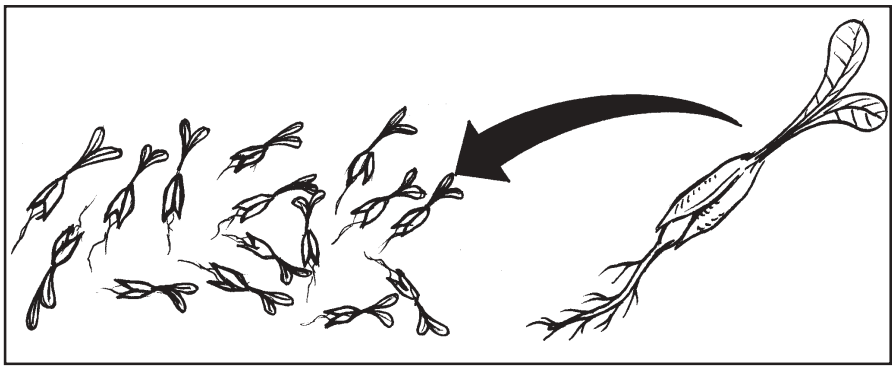
2. Collect the seeds and drain the excess water from the container where the seeds were soaked.

3. Transfer the seeds to a cemented surface and cover the seeds with thick layers of sacks or damp cloth for warmth. Heat is needed for seed germination.

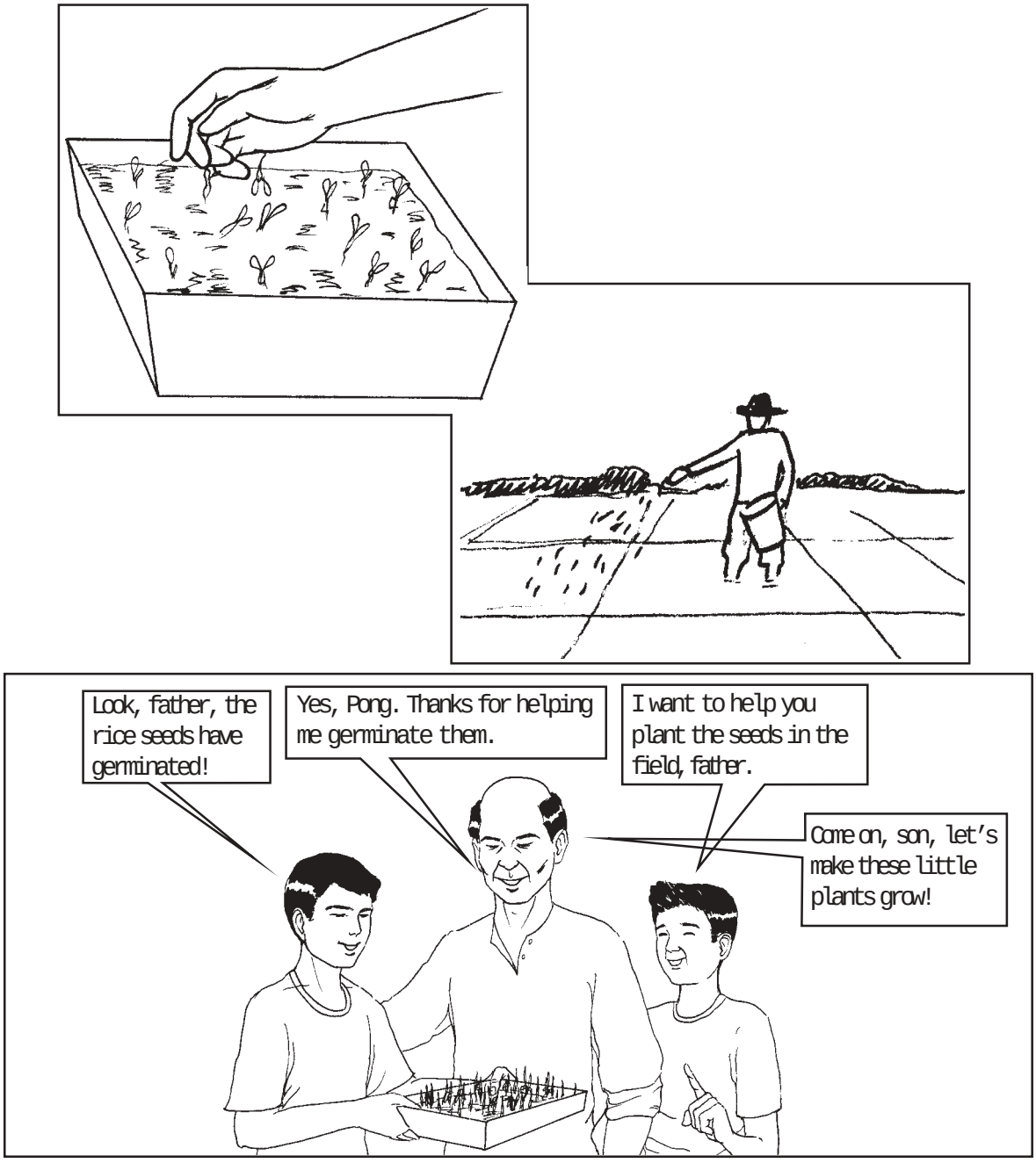


4. After three days, the seeds should have already germinated. If the seeds failed to germinate, further heating may be necessary. This can be achieved by adding more layers of damp cloth.

5. When the seeds have swollen and started to look like small plants, they have already germinated.



6. They can then be transferred to trays of moist soil to encourage further development into seedlings. These can later on be transferred to the field.



Let's Review

On the lines provided, write down your answers to the following questions.

1. What does **seed germination** mean?

_____

_____

_____

2. How can you tell if the seeds have already germinated?

_____

_____

_____

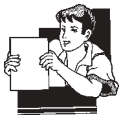
3. If the rice seeds failed to germinate after 3 days, what should you do?

_____

_____

_____

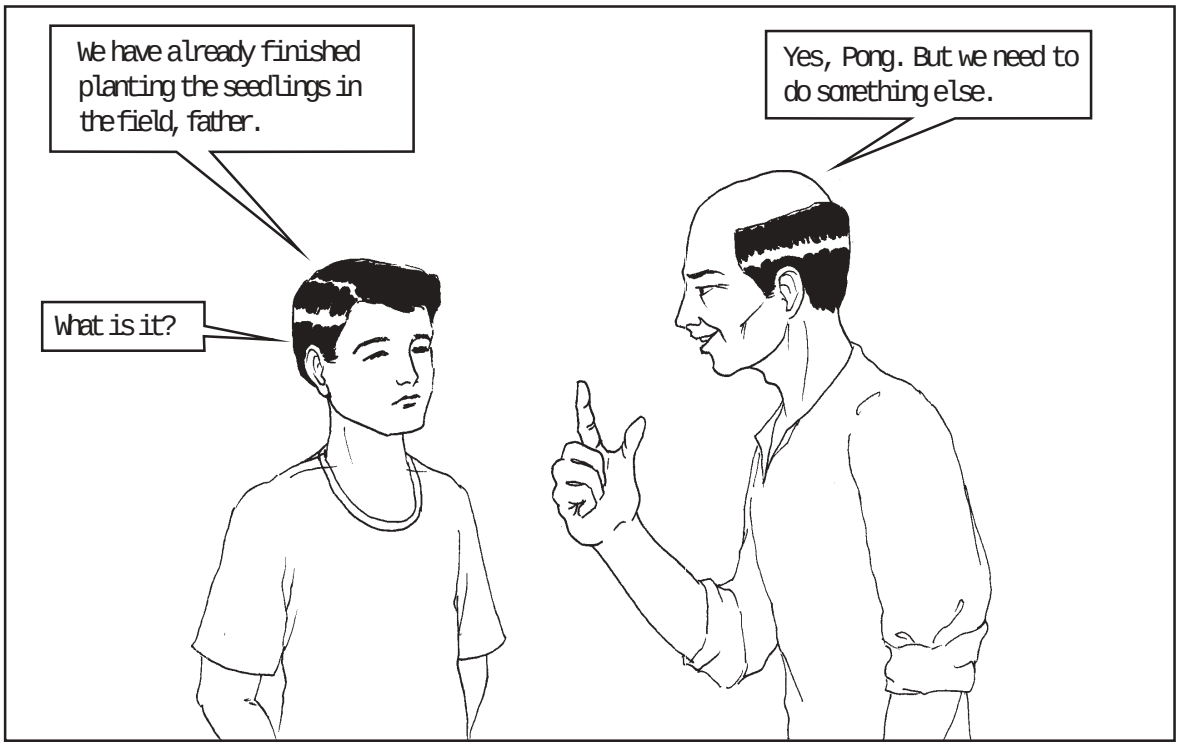
Compare your answers with those in the *Answer Key* on page 52.

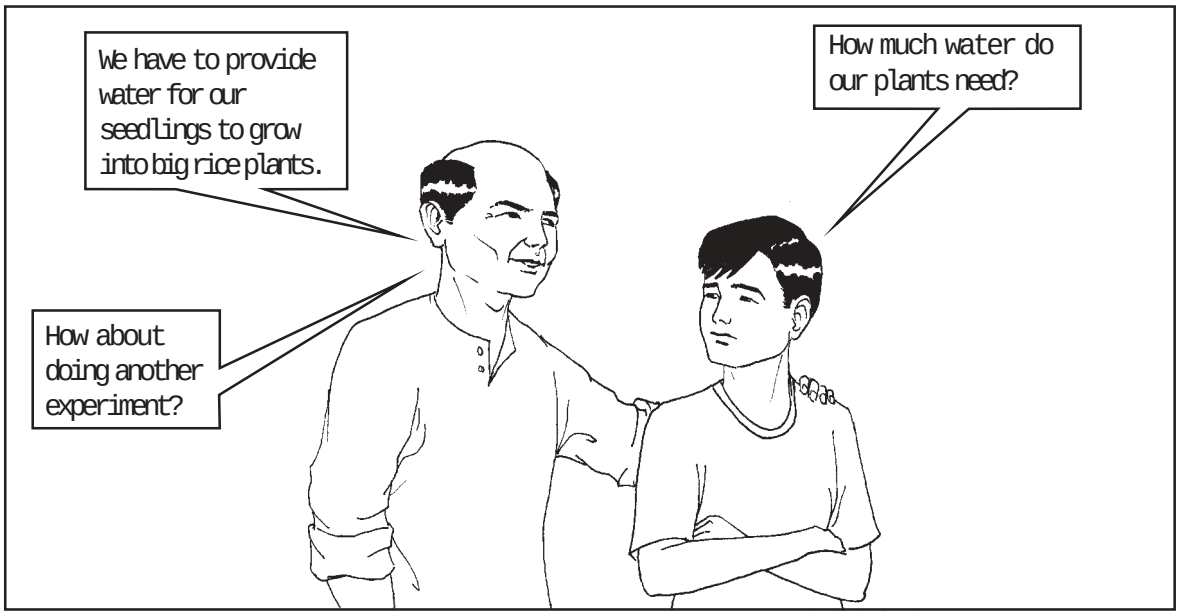


Let's Learn

You learned that moisture is needed for seed germination. In this part of the lesson, you will learn that plants need water to grow and mature. As a farmer, you should keep in mind that the water that your plants receive has to be regulated.

Water is essential for plants to perform photosynthesis. **Photosynthesis** is the process by which plants make their own food. Water is also important for dissolving the mineral nutrients in the soil so that plants can absorb them through their roots.





Let's Try This

Let us help Mang Gusting decide how much water his rice plants need. Can you recall the scientific method? First, identify what the problem is. Mang Gusting needs to determine how much water to provide his plants. Now, follow the other steps of the scientific method and do the following experiment.

You will need:

3 big cans half-filled with soil

3 rice plants about 6 inches high. (You may also use other plants such as tomato, corn or mungo.)

a marking pen

Procedure:

1. Using the marking pen, label one can **Dry**, another can **Moist** and the third can, **Wet.**
2. Plant the rice plants in the cans. The plant in the can labeled **Dry** should not be watered. The plant in the can labeled **Moist** should be watered until the soil feels moist or damp to touch. The plant in the can labeled **Wet** should be watered until the water reaches a height of about 2 inches above the soil. Place the cans beside one another under adequate sunlight.

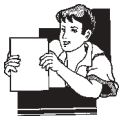
Check the plants every day for 5 days. Record the height of each plant each day.

Plant	Day 1	Day 2	Day 3	Day 4	Day 5
Dry					
Moist					
Wet					

Afterward, answer the following questions:

1. Which plant grew tallest?
2. Which plant was the shortest?
3. What could be the reasons for the differences in the growth of the three plants?

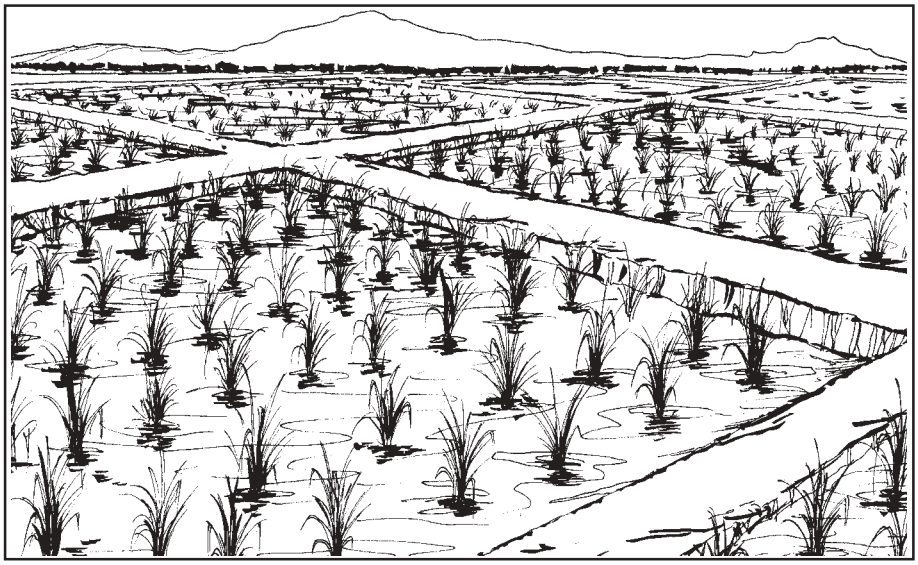
Seeds from different plants require different amounts of water to make them grow best. These differences in water requirement are determined by the structure and other unique characteristics of the plants. This experiment is one way to determine how much water is needed by the plants you chose. You may also consult a farm technician about this.



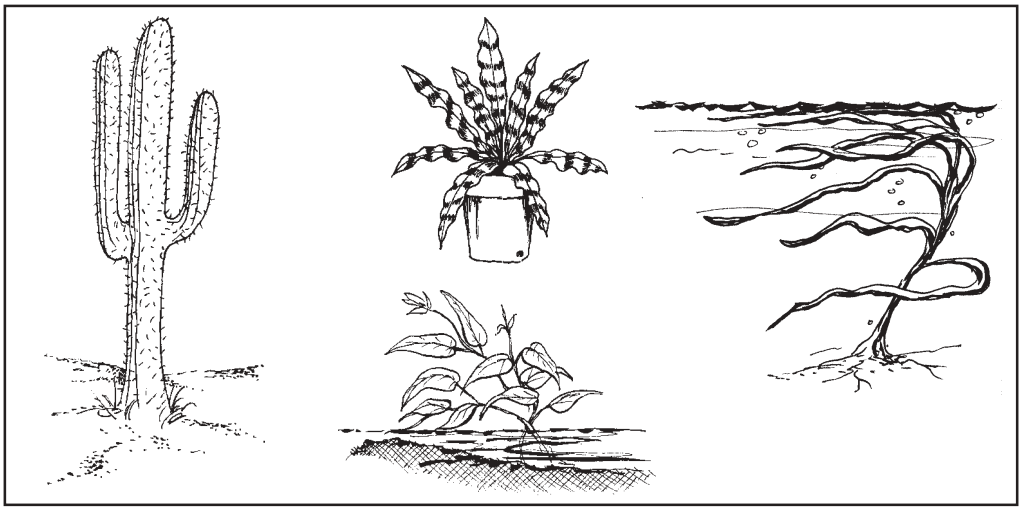
Let's Learn

Irrigation

If you used rice for the above activity, like Mang Gusting, you will discover that rice grows best in wet soil. Rice farmers often keep their rice fields wet through a process called **irrigation.** Irrigation refers to the regulated water supply of a plot of land that is available for plants. Rice fields usually require at least 5 inches of water above the soil for optimum plant growth.



Other plants may have different water needs. Cacti thrive in deserts. These plants do not need a lot of water to survive. Garden plants usually need moderate amounts of water, just enough to keep the soil damp. *Kangkong* needs muddy water while seaweeds need to be submerged in salt water to survive.

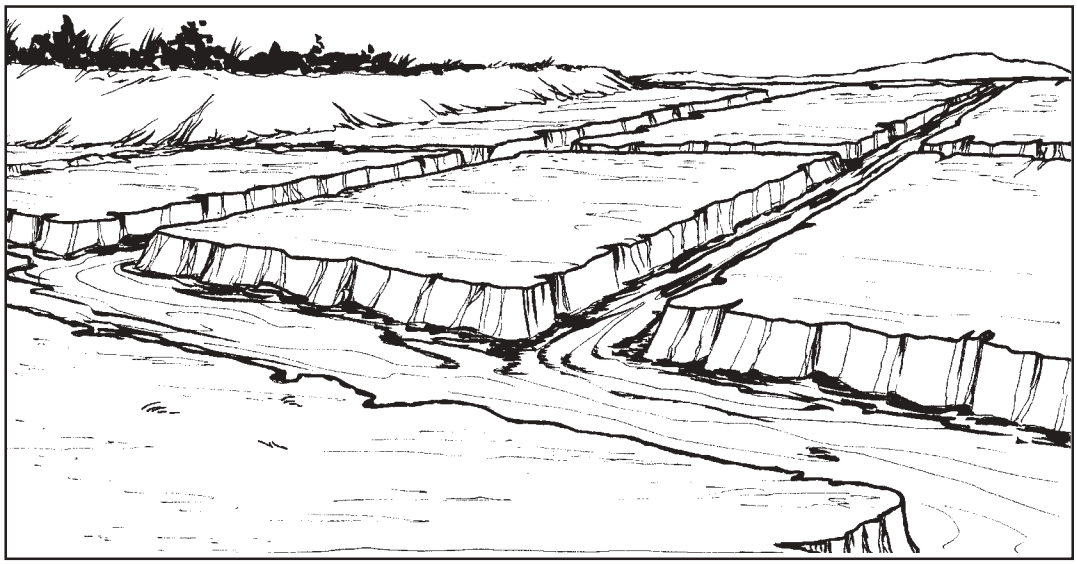


Why do plants have different water requirements? What is it about these plants that make them need a certain amount of water?

Plants, like human beings, are different from one another. Each plant has a structure and function that helps it adapt to its environment. For example, the cacti in the desert have very thick coverings that prevent water loss. Seaweeds, on the contrary, have very thin, almost transparent membrane coverings. Their specific structures make these plants adapt well to their environment.

Since plants have different water needs, there are also many ways of irrigation. Water can be artificially supplied to plants through the following means:

1. **Sprinklers** are very useful for places with sandy soil and where the water supply is limited.
2. **Trickle irrigation** is the process by which water is supplied to the roots of the plants from fine plastic tubes or drippers. Fine spray nozzles are sometimes fitted to give a wider spread of water.
3. **Furrow irrigation** is the process in which water is channeled toward a plot of land through a system of canals or furrows. This method is commonly used in rice fields and orchards and requires a large water supply.



You have studied the different ways of artificially delivering water to plants. The effective delivery of water to plants is very important in agriculture. The scientific method can be used to devise ways through which this need is met.

Let's See What You Have Learned

Answer the following questions. Write your answers on the lines provided.

1. Why is water important to plants?

   _____
   _____
   _____

2. What is irrigation?

   _____
   _____
   _____

3. Why do plants need different amounts of water?

   _____
   _____
   _____

Compare your answers with those found in the *Answer Key* on page 52. Did you get everything right? If you did, that's very good. If not, that's okay. Just review the parts of the lesson that you did not understand very well. Afterward, you may move on to Lesson 3.

Let's Remember

- Healthy plants grow from healthy seeds. It is best to choose seeds carefully before planting. Healthy seeds come from healthy parent plants, are well stored and appear plump. Also, healthy seeds do not have insect scars and other signs of infection.
- Seeds can be made to germinate better through mechanical scarring, scalding or fire treatment.
- Irrigation is the process of artificially delivering a controlled amount of water to plants. All plants need water to survive. However, the amount of water needed varies from plant to plant.

Using the Scientific Method in Choosing Fertilizers

In Lesson 2, you learned the characteristics of good seeds and how to irrigate plants. However, this is not enough. For you to become a successful farmer, you need to know more about plants and how to take care of them.

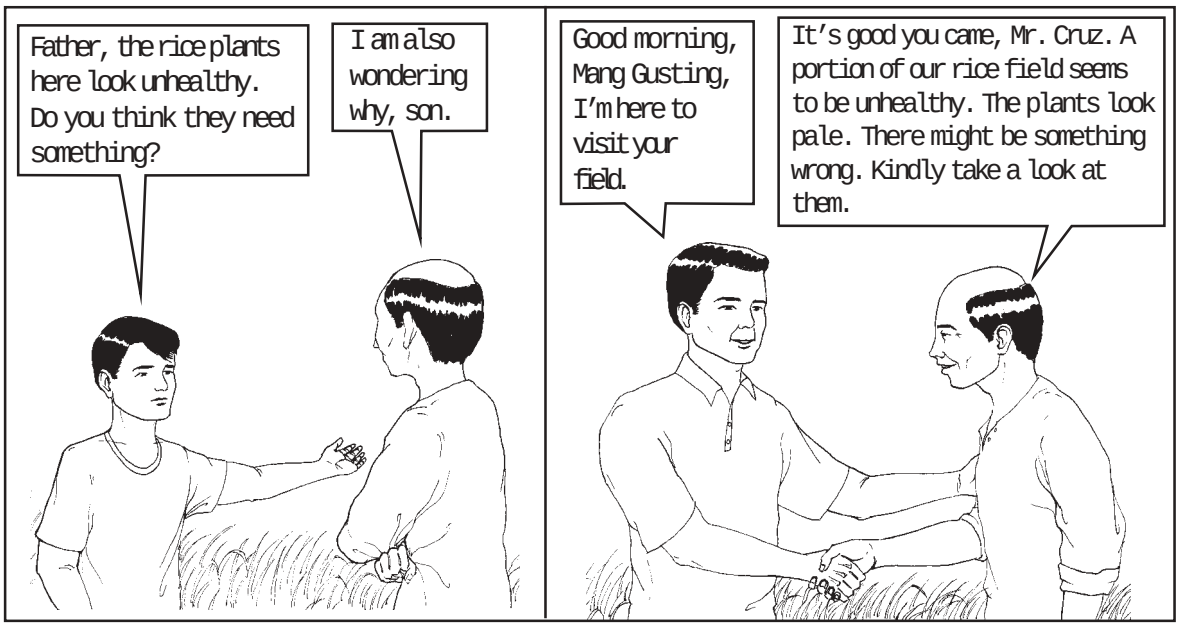
In this lesson, you will learn how to identify some of the nutrients needed by plants to grow as well as differentiate between natural and commercial fertilizers. Knowledge about fertilizers is very important in agriculture. The scientific method, too, can be used in choosing fertilizers that are best suited for plants.

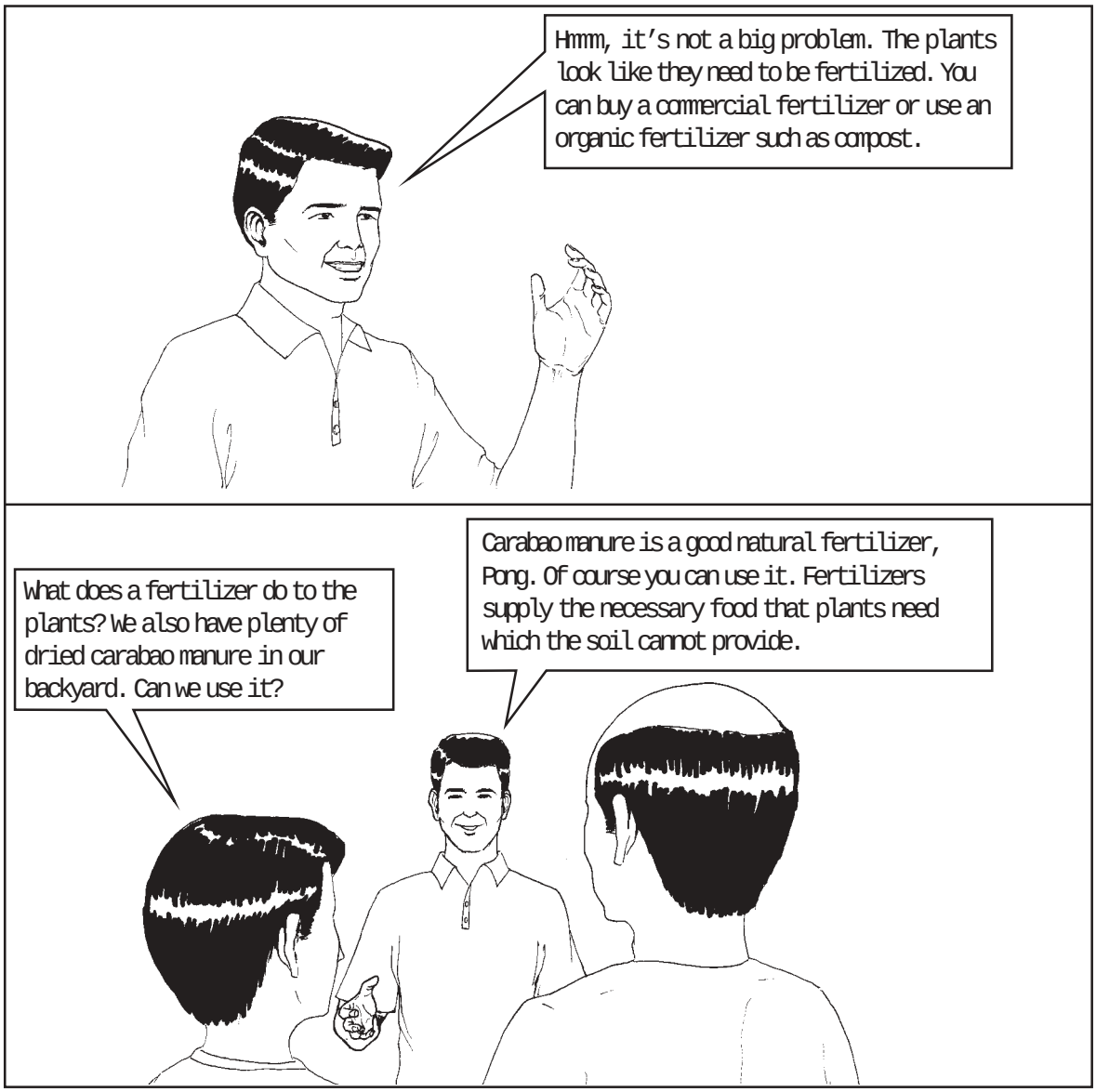
At the end of this lesson, you should be able to:

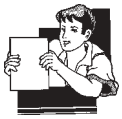
- identify some of the nutrients needed by plants;
- know what fertilizers are and state their importance in agriculture; and
- differentiate between commercial and natural fertilizers.

Let's Read

Three weeks have passed and the rice plants were already tall. Mang Gusting and his sons started to pull out weeds from the rice field. In one part of their field, Pong noticed that the rice plants were small and pale; their growth seemed to be stunted. What might have happened?





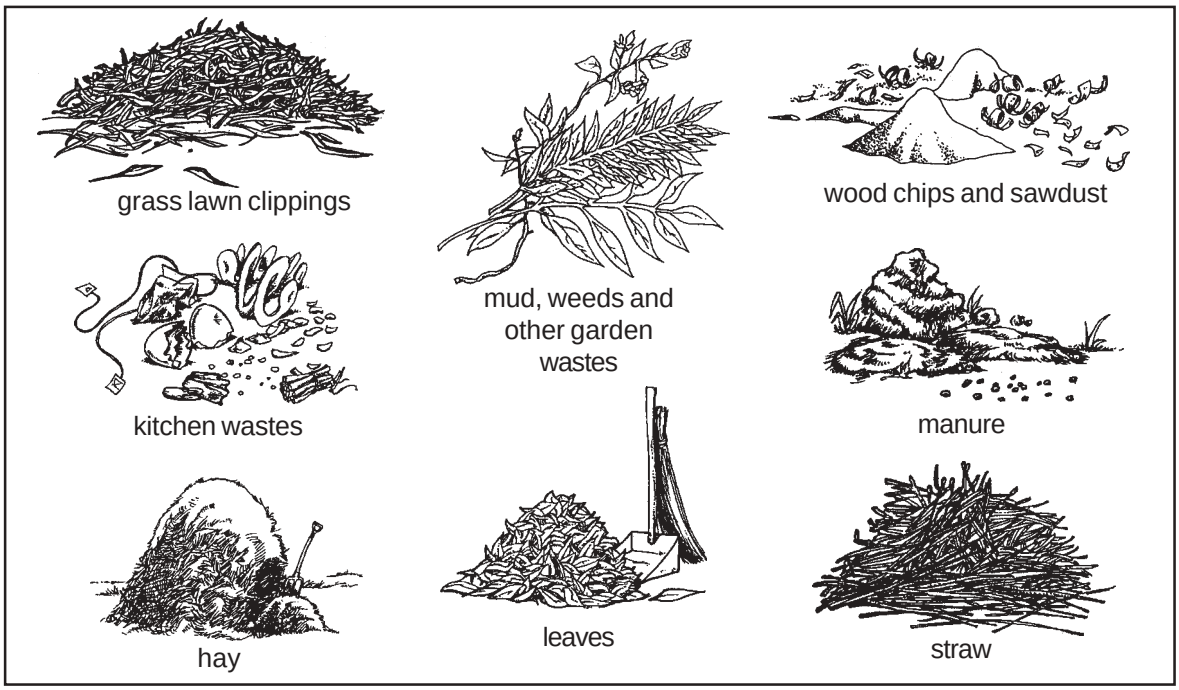


Let's Learn

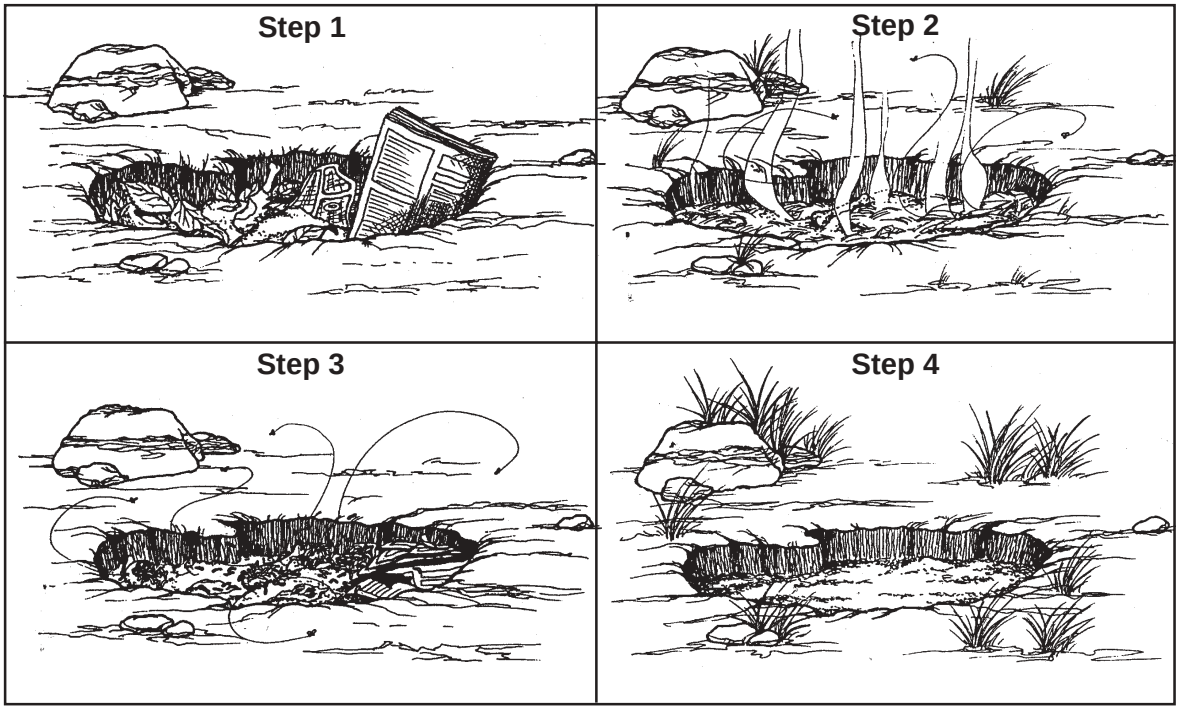
Mr. Cruz was right. Plants need nutrients too. Most of these nutrients are supplied by the soil. However, the nutrients from the soil may not be enough. That's why fertilizers are needed. These nutrients are elements that are essential to the plants' growth. Nitrogen, phosphorus, potassium and sodium are just some of them. If nutrients are lacking, plants will not grow healthy and strong.

There are two main kinds of fertilizers. The first type is called **commercial fertilizer.** Commercial fertilizers are chemicals that are produced and sold by a chemical company. A farmer adds them to the soil to make plants grow faster and healthier. Commercial fertilizers are readily available. However, since they are chemicals, they can be harmful to the environment and even to the plants themselves when not properly applied. They are also more expensive than natural fertilizers.

Natural fertilizers are derived from decayed plants and animal. Decomposing plants, animal manure and vegetable refuse can be made into a compost. A **compost** is a layered heap of decayed organic matter.

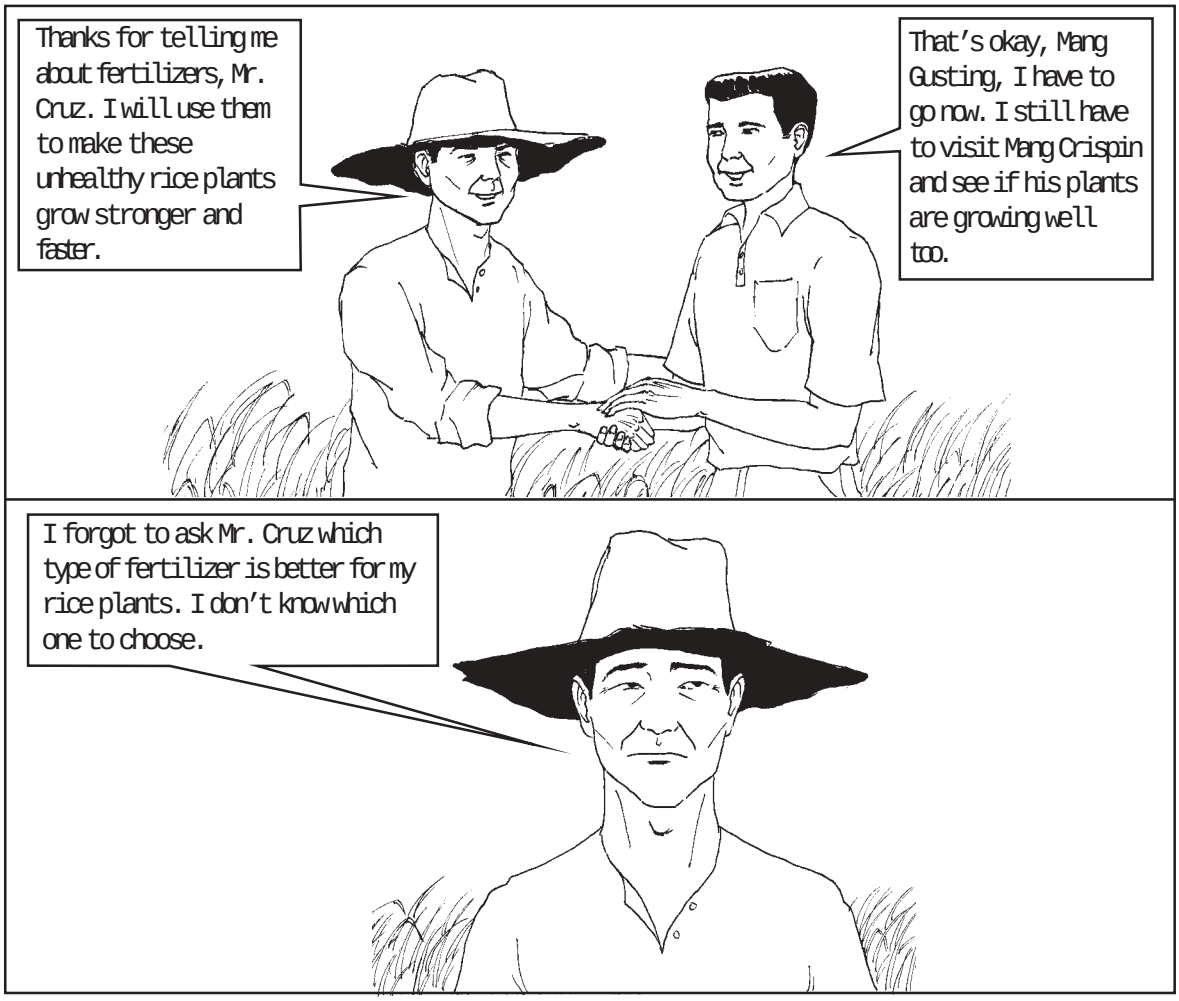


If you would like to find out more about preparing compost, you may study the module on composting. Compost and other natural fertilizers are preferred because they are inexpensive and effective. However, natural materials need to undergo decomposition first and hence, may take time to prepare. Handling them can be quite messy too.

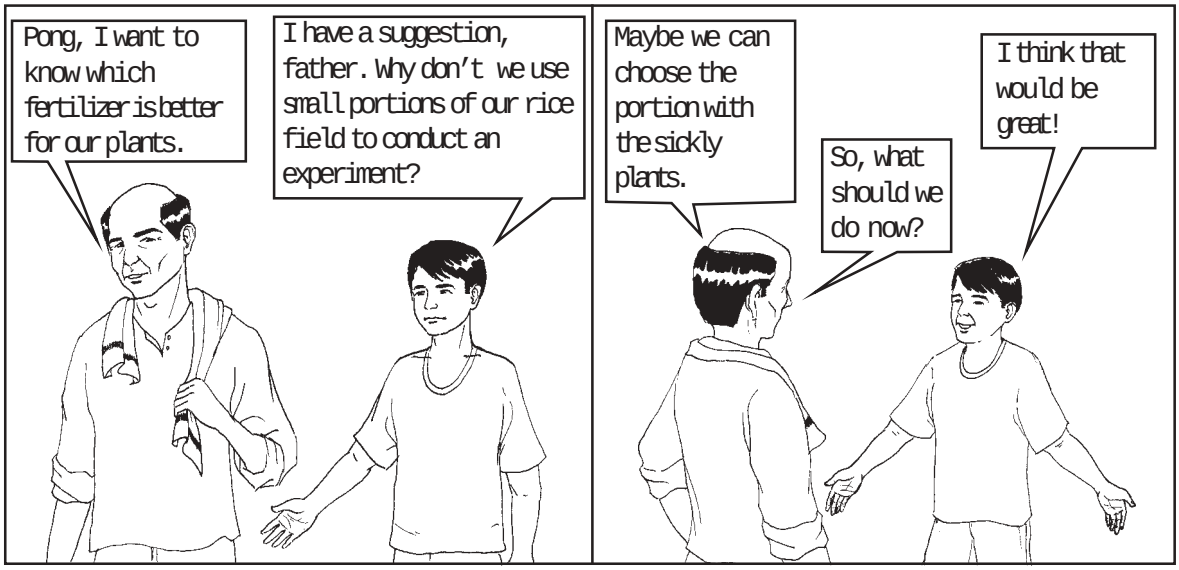


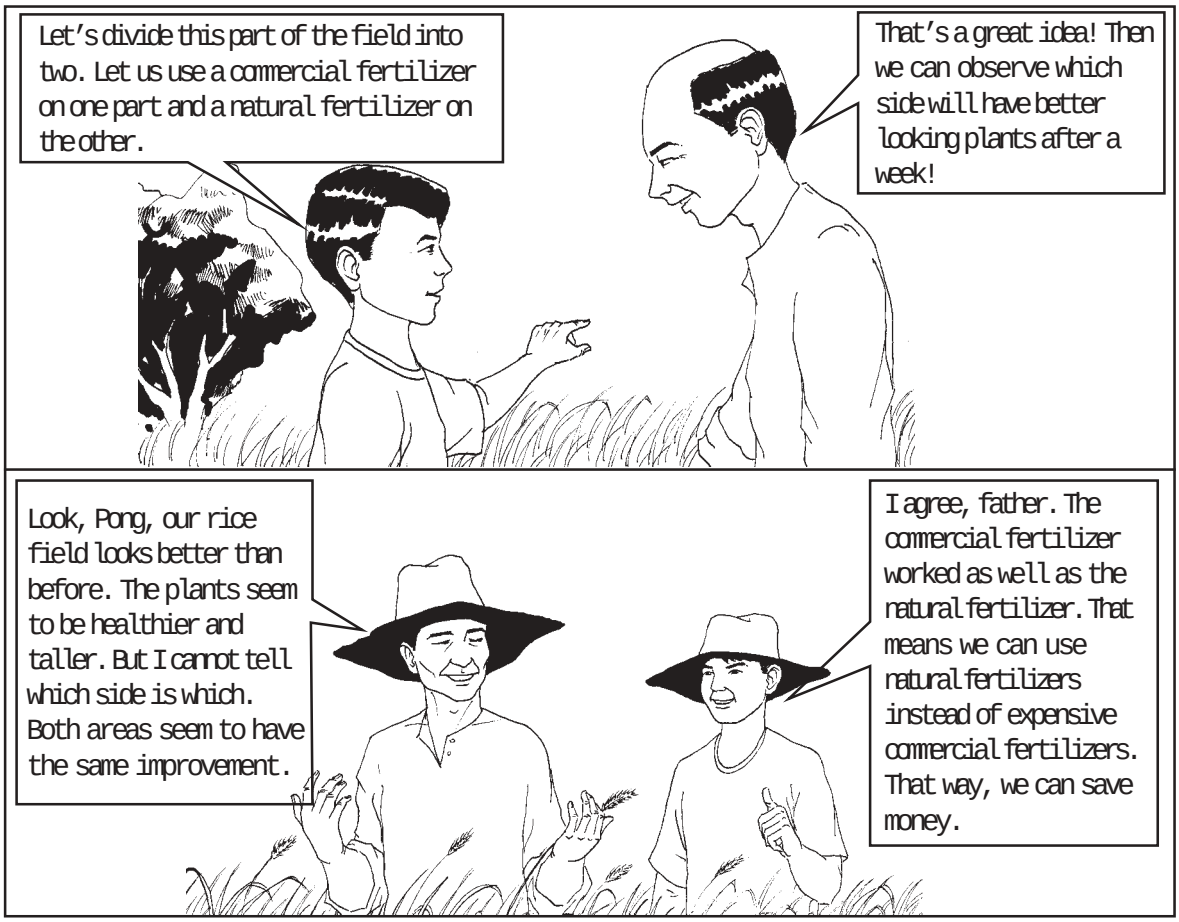
The steps in composting

Whether natural or commercial, fertilizers are mixed with the soil where plants grow. Plants will absorb the nutrients supplied by these fertilizers and use these for growth.



When Mang Gusting identified his problem of choosing which type of fertilizer to use for his rice field, he decided to use the scientific method and find out for himself.





Mang Gusting and Pong were able to arrive at a decision because they used the scientific method. Can you identify the steps they took? What did you learn from them?

Mang Gusting first identified the problem: which type of fertilizer is best for their plants. They conducted an experiment by dividing a small portion of their rice field—the one with the unhealthy rice plants—into two. They added a commercial fertilizer to one portion and a natural fertilizer to the other. The rice plants in both areas showed the same degree of improvement. Mang Gusting and Pong concluded that since both fertilizers are effective, they would use the cheaper natural fertilizer. Through the scientific method, Mang Gusting and Pong were able to come up with an effective solution to their problem.

Farming requires a lot of decision making. Mang Gusting and Pong were able to make a sound decision because they followed the scientific method.

Let's See What You Have Learned

Encircle the letter of the correct answer.

1. Which of the following is **not** needed by plants to grow?

   a. water
   b. nutrients from the soil
   c. sunlight
   d. shade

2. Which of the following chemicals provided by the soil is utilized by plants?

   a. sodium
   b. glucose
   c. phosphorus
   d. both **a** and **c**

3. This is something that farmers add to the soil to restore nutrients.

   a. fertilizer
   b. water
   c. seed
   d. irrigation

4. Which of the following is **not** an example of a natural fertilizer?

   a. compost
   b. vegetable refuse
   c. chemical
   d. animal manure

5. What refers to the process of decomposing plant materials for use as fertilizer?

   a. germination
   b. composting
   c. irrigation
   d. sprouting

6. Which of the following is **not** an advantage of natural fertilizers over commercial fertilizers?

   a. easier to prepare
   b. less expensive
   c. less harmful to the environment
   d. does not need to be decomposed

7. This is how fertilizers are applied.

   a. added to water
   b. added to the soil
   c. sprinkled on plants
   d. irrigated

8. Carabao manure is a form of _____.

   a. commercial fertilizer
   b. irrigation
   c. natural fertilizer
   d. insecticide

Compare your answers with those found in the *Answer Key* on page 52. Did you get everything right? If you did, that's good! If not, that's okay. Just review the parts of the lesson that you did not understand very well before moving on to Lesson 4.

Let's Remember

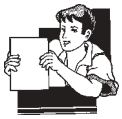
- Plants need nutrients from the soil in order to grow. Some of these nutrients are nitrogen, phosphorus, sodium and potassium. However, the soil may not be able to provide all the nutrients that plants need. Hence, farmers need to fertilize the soil.
- Fertilizers can either be commercial or natural. Both are effective in enhancing the growth of plants.

Using the Scientific Method in Crop Rotation

In the last two lessons, you learned about choosing seeds, irrigation methods and fertilizers. You also learned how to use the scientific method in solving problems in agriculture. In this lesson you will study crop rotation, a technique in farming that could help you increase your harvest and protect the soil.

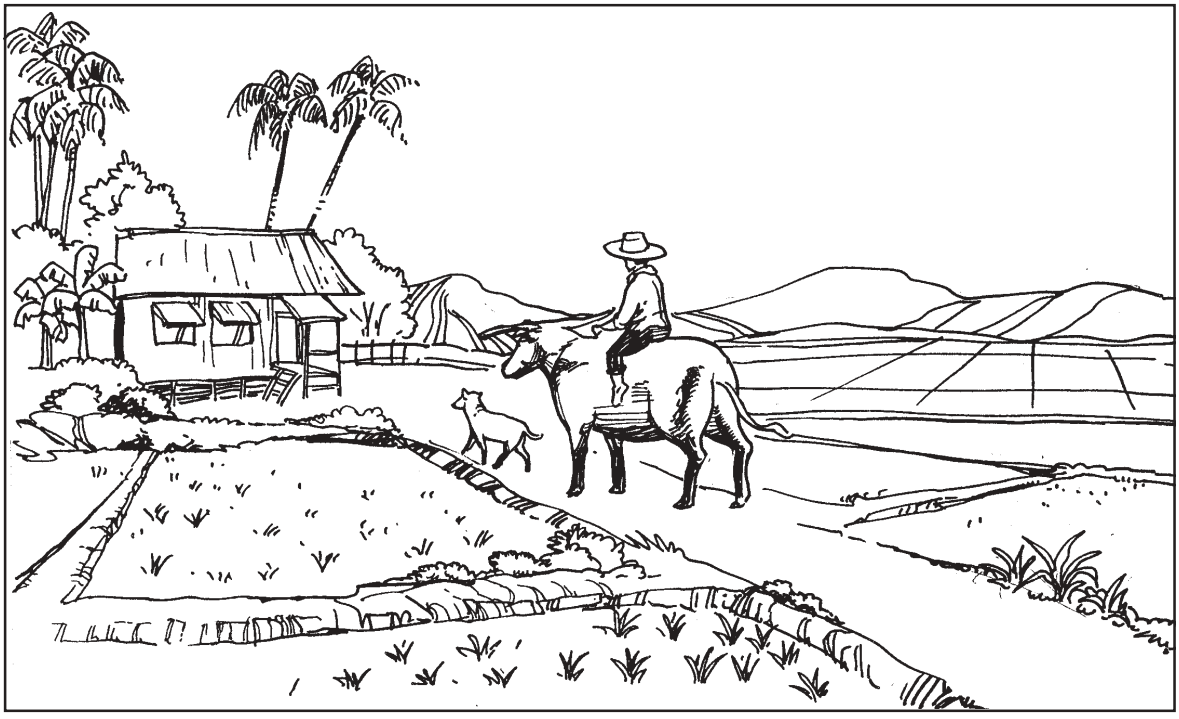
At the end of this lesson, you should be able to:

- define **crop rotation;**
- state the importance of crop rotation; and
- explain how crop rotation is done.



Let's Learn

Mang Gusting was very happy with his rice field. He applied the scientific method in choosing the seeds to plant and in irrigating the field. He was also able to choose an effective and economical fertilizer that is best suited to his plants.



While waiting for the rice plants to be harvested, Mang Gusting decided to raise vegetables in his backyard. His family invited Mr. Cruz again to help them in gardening. Aling Tinay, Mang Gusting's wife, was very eager and excited to start the project.

In this lesson, you will learn how to use the scientific method in getting the most from the soil's potential or farming through crop rotation. **Crop rotation** is a system of alternating the types of plants to be grown in a plot of land. This allows the soil to recover its lost nutrients. Crop rotation is the regular succession of planting crops for two or more years.

Let's Read

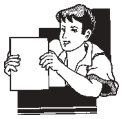
From Mr. Cruz's story, can you see how he used the scientific method in solving his problem with his garden?

Let's Try This

Fill up the following table.

Steps of the Scientific Method	What Mr. Cruz Did

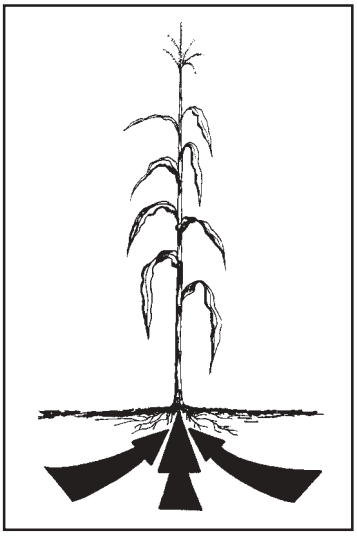
After answering, compare your answers with those found in the *Answer Key* on page 53.



Let's Learn

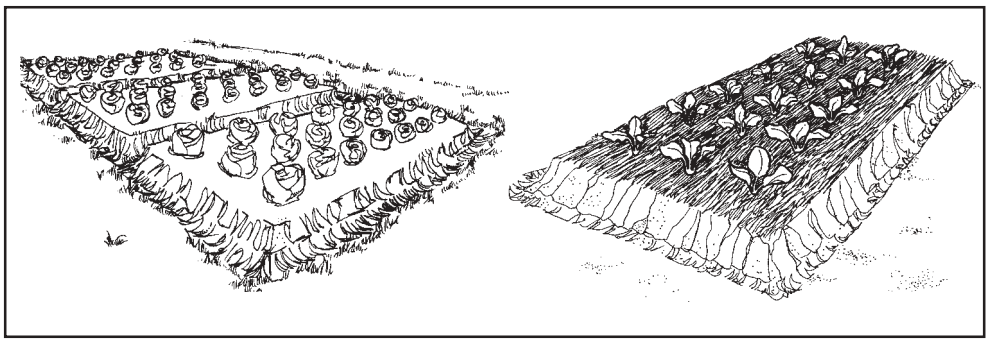
Mr. Cruz was able to discover crop rotation in his garden by using the scientific method. Let me tell you more about crop rotation.

Plants get their nutrients from the soil. Remember what you learned about fertilizers? Fertilizers are needed because the soil can lose its nutrients.

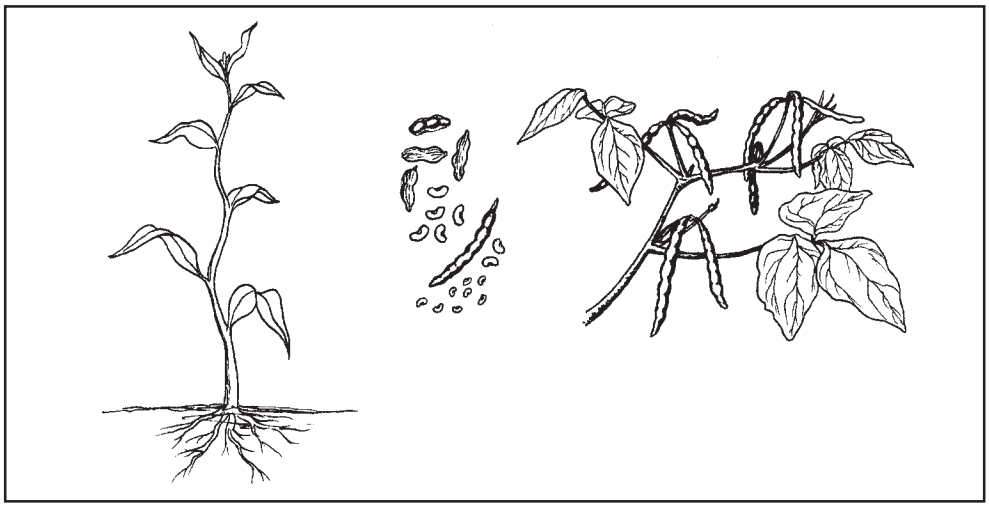


The soil loses its nutrients because of soil erosion. Another factor that can reduce soil fertility is the type of crops that are planted in the soil. Study the three types of vegetables on the next page.

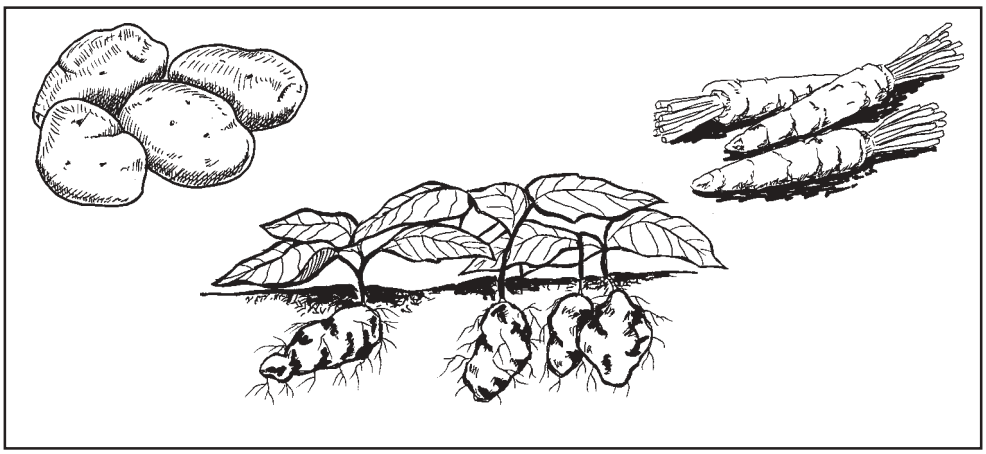
Leaf crops are "soil robbers." Vegetables with large leaves, such as mustard, cabbage, cauliflower and lettuce, take away a lot of nutrients from the soil.



Legumes are soil enhancers. Beans such as peas, peanuts and mungo give back to the soil the nutrients used up by other plants. The bacteria that infect the roots of these legumes fix nitrogen, that is, they convert nitrogen from the air into nitrogen compounds that can be used by plants. When the legume dies, it releases the stored nitrogen as it decomposes. Thus, the released nitrogen enriches the soil.



Root crops are hardy plants. Tubers such as ube and cassava do not require many nutrients from the soil to survive. Carrots and turnips are root crops too. These are planted when the soil has not yet fully recovered its nutrients.



In crop rotation, the crops planted in a plot of land are alternated. Soil robbers are alternated with soil enhancers to allow the soil to recover its lost nutrients. This way, plants will grow healthier and yield more produce. Also, rotating crops will help control the pests and insects in the area since each one prefers a specific type of plant. Changing crops can limit the number of harmful organisms present in a farm or garden.

A typical crop rotation program would be:

First year

root crops → legumes → leaf crops

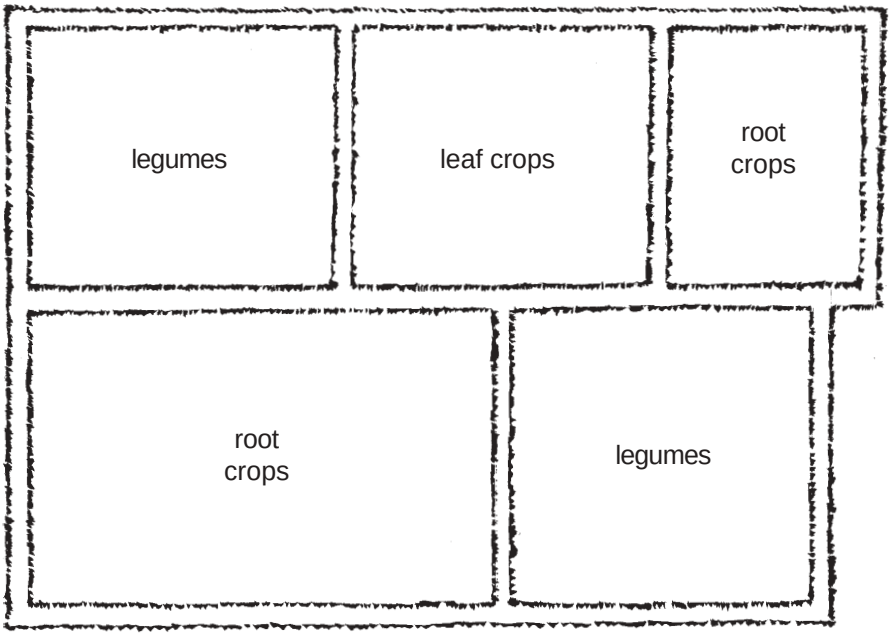
Second year

legumes → leaf crops → root crops

Let's Try This

Can you practice crop rotation in your own garden? If you have a vegetable garden, do the following activity. If you do not have a vegetable garden, you can look for one in your community.

Make a map of the vegetable garden. Based on what you have learned about the different types of vegetable crops, label each area according to the type of crops planted there. Below is a map of Mang Gusting and Aling Tinay's vegetable garden. Use this as reference.



Study the map of your own garden. Where are the roots crops located? Where can you find the legumes and the leafy crops? Based on these, determine the possible nutrient level in the soil where each type of plants is located. You can then plan your own crop rotation program based on the map.

Let's See What You Have Learned

Draw a line connecting the vegetable crop to its appropriate classification in terms of its effect on the soil. The first one has been done for you.

Vegetable Crop	Type
Carrot	
Cabbage	
Bean	Root crop
Camote	
Pechay	
Peanut	Legume
Onion	
Ampalaya	
Squash	Leaf crop
Pea	

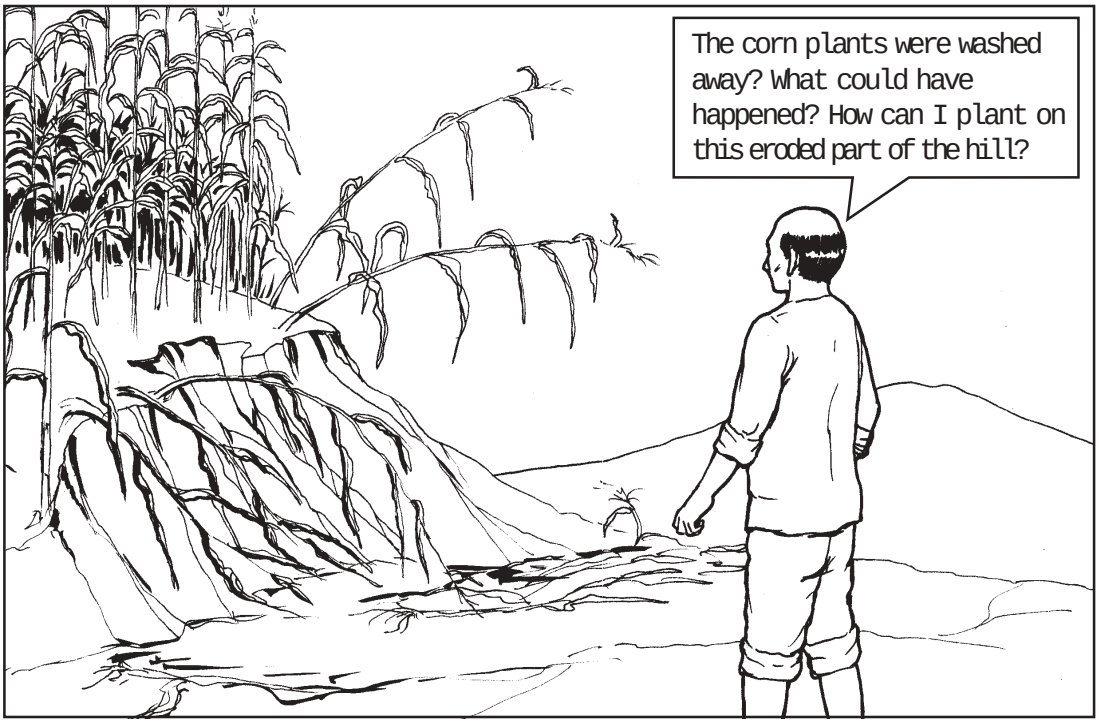
Compare your answers with those found in the *Answer Key* on page 53. Did you get a perfect score? If you did, that's very good! If not, that's okay. Just review tha parts of the lesson that you did not understand very well. Afterward, you may move on to Lesson 5.

Let's Remember

- Crop rotation is a system of alternating the types of plants to be planted in a plot of land. This is done to allow the soil to recover its nutrients after a planting season.
- There are three main types of vegetable crops based on their effects on the soil. These are the leafy crops (soil robbers), root crops (hardy plants) and legumes (soil enhancers).

Applying the Scientific Method in Contour Planting

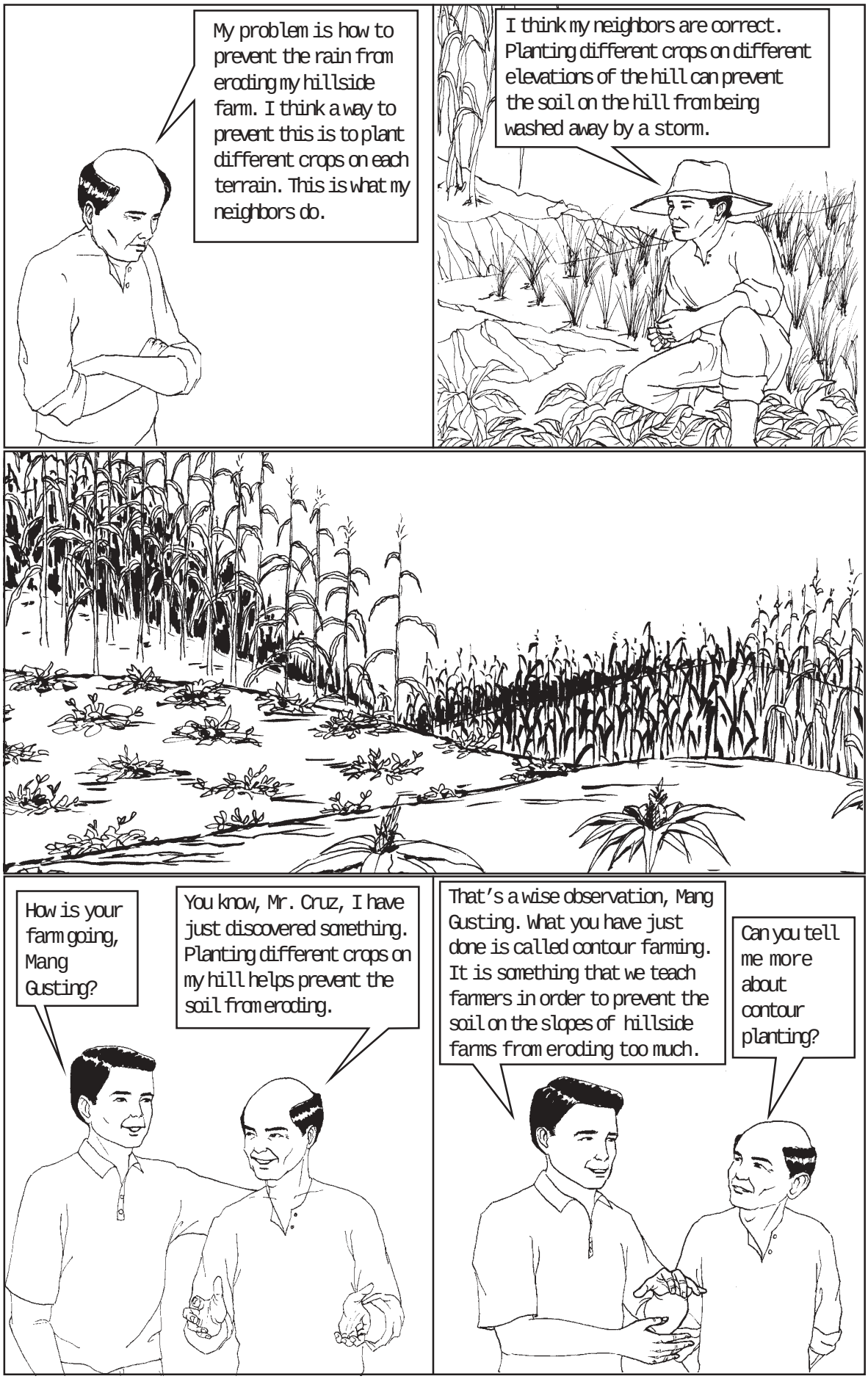
Six months have passed. Mang Gusting was able to get a good harvest because he applied what he learned about choosing seeds, fertilizers, irrigation and crop rotation. Because of his earnings, he was able to buy the hill next to his field. He planted corn on that hill. Sadly, a part of the hill was washed away when a strong typhoon came.



In this lesson, you will learn contour planting. Like what you learned in the previous lesson, the scientific method can also be applied to address Mang Gusting's problem.

Let's Read

If you were Mang Gusting, how would you use the scientific method in solving the problem of erosion on his hill? Recall the steps of the scientific method and study the story on the next page.


My problem is how to prevent the rain from eroding my hillside farm. I think a way to prevent this is to plant different crops on each terrain. This is what my neighbors do.
I think my neighbors are correct. Planting different crops on different elevations of the hill can prevent the soil on the hill from being washed away by a storm.
How is your farm going, Mang Gusting?
You know, Mr. Cruz, I have just discovered something. Planting different crops on my hill helps prevent the soil from eroding.
That's a wise observation, Mang Gusting. What you have just done is called contour farming. It is something that we teach farmers in order to prevent the soil on the slopes of hillside farms from eroding too much.
Can you tell me more about contour planting?

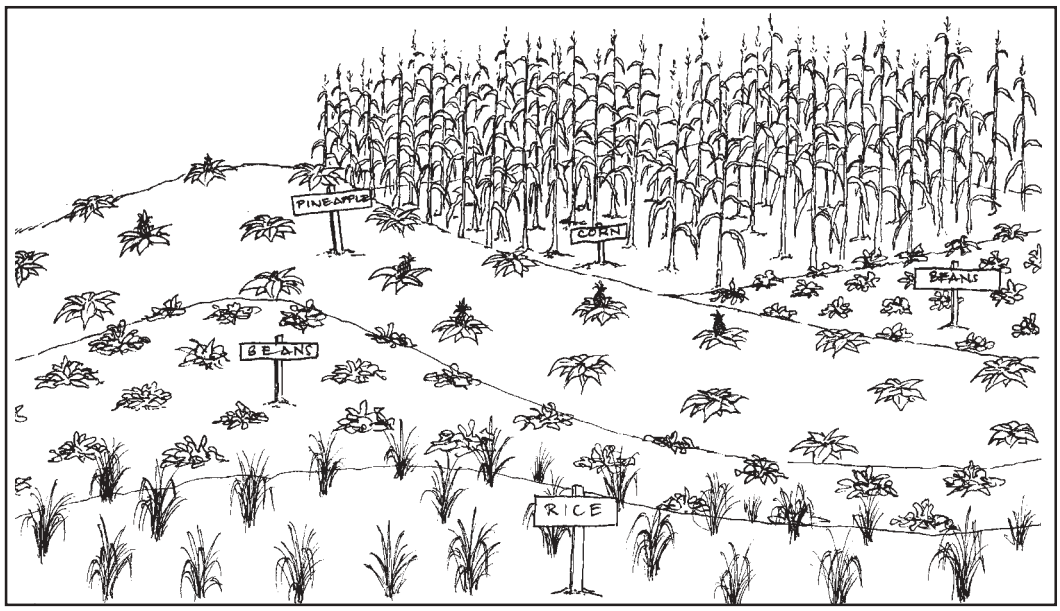
Let's Learn

This is what Mr. Cruz told Mang Gusting:

Farmers usually plant on terrain that is not flat like rice fields. However, when farmers plant on hillsides where the terrain slopes (slants upward and downward), contour farming is recommended.

Contour farming is a farming technique applied on sloping land. It is very useful for farms on the sides of a hill or a mountain. Contours are areas in the field having the same elevation. Study the diagram below. The different contours are marked.

Trace the contours with your finger. Did you notice that the hill has different contours? Different contours make elevated farms more prone to erosion. To solve this problem, planting a row of crops on a contour and planting a different crop on another can be done. Study the picture below. Notice how the different contours are planted with different crops.

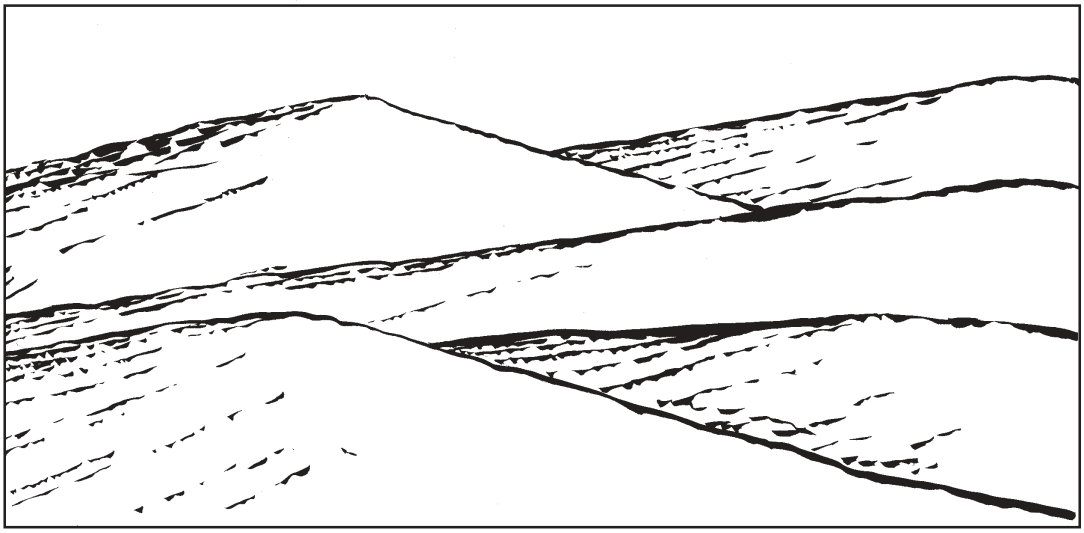


To enhance contour planting, one or two cultivated contours can be followed by strips of cover crops. This practice is called **contour strip cropping.** Cover crops are creeping, bushy plants with thick growth and expansive root systems. Cover crops include species of grass such as *centrosema* and *crotolaria.* You can inquire from the Bureau of Soil Management office in your area about these grasses and where to get them. Legumes such as peanuts and peas are also good cover crops. Study the picture below showing contour strip cropping.

Cover crops have wide root systems and are usually not tall. They reduce erosion by holding the soil in place especially during heavy rainfall. Aside from this, they cover the soil from the heavy impact of rainfall. They slow water down as it goes down the sides of a hill. Their roots bind the soil together and when they decompose, they add nutrients to the soil. Study the picture of a cover crop below and imagine how it protects the soil from erosion.

Let's See What You Have Learned

Below is a picture of a hillside farm. Practice contour farming by assigning what plants are to be planted on each contour.



Compare your answers with those in the *Answer Key* on page 54.

Let's Remember

- Contour farming or planting is a technique wherein different contours of land are planted with different crops. This prevents erosion.
- Cover crops are low-lying plants that have expansive root systems. They prevent erosion by holding soil in place, shielding it from rainfall and lessening the impact of water as it flows down the slopes from an elevated field like a hill.

Well, this is the end of the module. Congratulations for finishing it! Did you enjoy studying this module? Did you learn a lot from it? Below is a summary of its main points to help you remember them better.

Let's Sum Up

This module tells us that:

- The scientific method is a series of steps that one follows when solving a problem or making a decision. These steps are:
  a. Identifying the problem
  b. Making a hypothesis
  c. Gathering data
  d. Analyzing the data
  e. Making a conclusion
  f. Making and implementing recommendations
- The scientific method can be used in solving problems in agriculture, such as:
  a. Choosing seeds for planting
  b. Irrigation
  c. Deciding whether to use natural or commercial fertilizers
  d. Using farming techniques such as crop rotation and contour planting

What Have You Learned?

It's harvest time on Mang Gusting and Aling Tinay's farm and the rice is ready for harvesting. They have to decide what is the better method for harvesting their crop in terms of cost effectivity. Should they use a harvesting machine or hire people to harvest the rice by hand? Help the couple decide by using the scientific method.

In the blank spaces in the table below, write the steps of the scientific method in correct order. In the space opposite that step, write what the couple should do. The first item has been done for you.

Steps of the Scientific Method	What Mang Gusting and Aling Tinay Can Do
1. Identifying the problem	What is the more cost-effective method of harvesting rice, by machine or by hand?
2.	
3.	
4.	
5.	
6.	

Compare your answers with those found in the *Answer Key* on page 54. If you got 5 or 6 items right, congratulations! You are now ready to use the scientific method in solving problems not only related to agriculture but to other situations as well.

If you got a lower score, that's okay. You should just study this module again more carefully.

Answer Key

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

1. a. Identifying the problem
   b. Making a hypothesis
   c. Gathering data
   d. Analyzing the data
   e. Making a conclusion
   f. Making and implementing recommendations
2. a. It is a logical and organized way of solving problems.
   b. Usually, the best solutions are arrived at if the scientific method is used.
3. a. Must be from good parent plants
   b. Plump, smooth and without scars
4. a. Irrigation provides adequate water supply to the plants.
   b. Proper irrigation increases a field's productivity.
5. A fertilizer is a mixture of chemicals added to the soil to provide additional nutrients such as sodium, potassium and phosphorus that plants need.
6. a. Crop rotation restores nutrients to the soil.
   b. Crop rotation limits the number of pests in a farm by varying the availability of food for these organisms.

B. Lesson 1

Let's Try This (page 6)

1. He thought that maybe his corn seeds lacked sunlight and this prevented them from growing.
2. He made two setups of corn seeds inside jars. He placed one under sunlight and the other inside his room.
3. He observed the growth of the seeds and analyzed his observations.
4. Jose concluded that his seeds did not grow because they lacked sunlight.

Let's See What You Have Learned (page 9)

1. Identifying the problem
2. Gathering data (through experimentation)
3. Making a conclusion
4. Making and applying recommendations
5. Making a hypothesis
6. Making a hypothesis
7. Gathering data (through experimentation)
8. Making a conclusion
9. Identifying the problem
10. Gathering data (through experimentation)

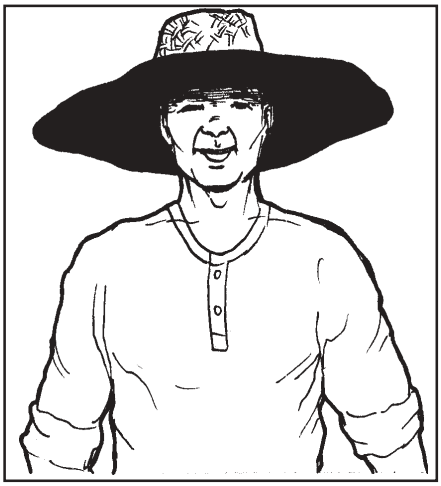
C. Lesson 2

Let's Try This (page 15)

(Answers will vary. The following are sample answers.)

1. Identifying the problem: Mang Gusting has to choose which rice variety from among the six will grow best in his field.
2. Making a hypothesis: One of the six rice varieties will grow faster than the rest.
3. Gathering data: Mang Gusting can divide his plot of land into six areas for planting the six rice varieties. He can visit the field every day after planting the rice varieties and note his observations.
4. Analyzing data: Mang Gusting can now carefully study his observations.
5. Making a conclusion: The C-4 rice variety grew the fastest and yielded the most rice. Therefore, Mang Gusting can say that this rice variety will grow best in his field.
6. Making and implementing recommendations: Mang Gusting can now start planting the C-4 variety on his rice field.

Let's Try This (pages 18–19)



Comes from a healthy plant
Well stored
Discolored
With scars from insect infestation
Easily germinates
Wrinkled
Smaller than usual size
Evenly colored

Let's Review (pages 22–23)

1. Seed germination is the process in which the embryo inside the seed sprouts or develops.
2. You can tell that the seeds have germinated if the seeds swell and you can see small plants starting to develop from the seeds.
3. You can add more layers of moist cloth to cover the seeds. This increases the heat which is needed for germination.

Let's See What You Have Learned (page 27)

1. Water is important to plants because water is required for the plants' vital functions needed for growth and survival.
2. Irrigation is the technique by which plants are artificially supplied with water.
3. Plants need different amounts of water because they have different structures and functions. For example, cacti in deserts have less need for water because they have thicker coverings that prevent water from evaporating in warm conditions.

D. Lesson 3

Let's See What You Have Learned (pages 34–35)

1. d
2. d
3. a
4. c
5. b
6. a
7. b
8. c

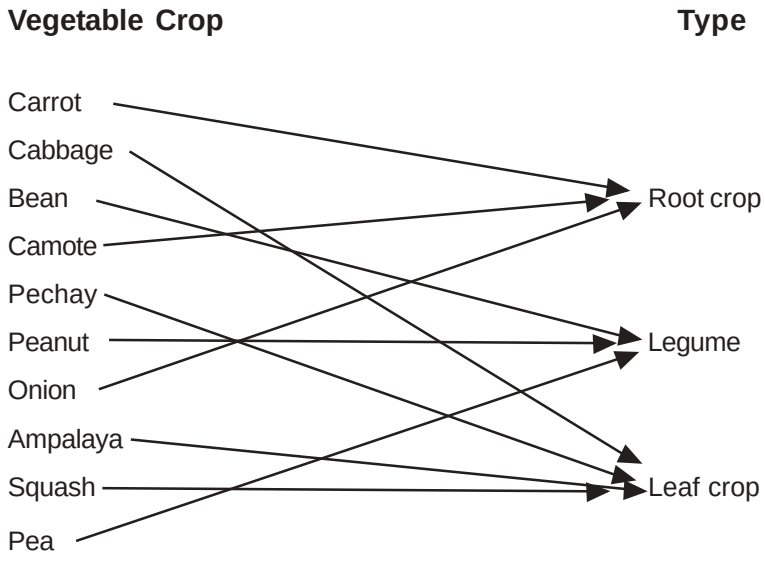
E. Lesson 4

Let's Try This (page 39)

Other answers are possible. Below are some suggested answers.

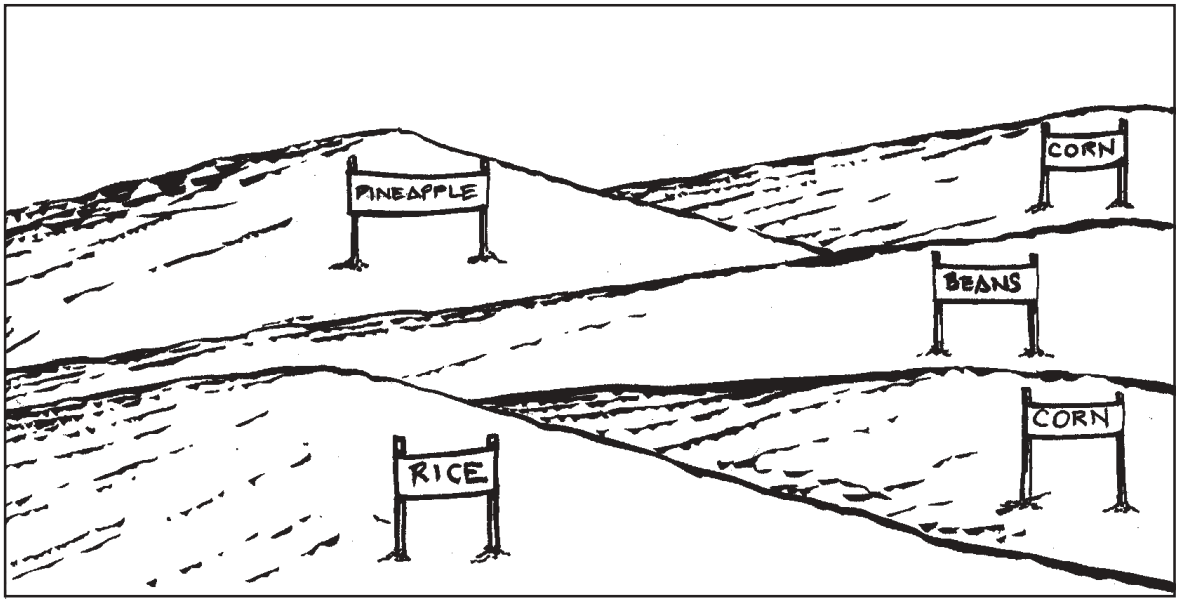
Steps of the Scientific Method	What Mr. Cruz Did
1. Identifying the problem	He noticed that the vegetables were not as healthy as when he first planted them.
2. Making a hypothesis	He thought that maybe the soil had lost its nutrients.
3. Gathering data	He planted mungo before planting eggplants. He then observed the rate of growth of the eggplants.
4. Analyzing data	He then compared the growth rates of eggplants.
5. Making a conclusion	He then concluded that eggplants tend to use up the nutrients in the soil but mungo plants restore these nutrients.
6. Making and implementing recommendations	He decided that planting mungo every now and then can help maintain the fertility of the soil.

Let's See What You Have Learned (page 42)



F. Lesson 5

Let's See What You Have Learned (page 47)



G. What Have You Learned? *(page 49)*

(Answers will vary. Below are sample answers.)

Steps of the Scientific Method	What Mang Gusting and Aling Tinay Can Do
1. Identifying the problem	What is the more cost-effective method of harvesting rice, by machine or by hand?
2. Making a hypothesis	Their hypothesis could be harvesting by machine will save more money than harvesting by hand.
3. Gathering data	Two rice fields of equal areas will be chosen. The rice in one field is to be harvested by machine and the other, by hand.
4. Analyzing data	Mang Gusting and Aling Tinay can tabulate the cost of harvest and the amount earned from selling the harvested rice. They can then compare the profit with the cost of harvesting per rice field.
5. Making conclusion	They conclude that harvesting by machine is cheaper.
6. Making and implementing recommendations	They can now harvest rice by using machines.

Glossary

Agriculture The study and discipline of cultivating plants for human use and consumption.

Biology Study of life and living things.

Commercial fertilizers Fertilizers made and sold by chemical companies.

Compost Layered heap of decayed organic matter that can be used as a fertilizer.

Conclusion A reasoned judgment based on data gathered and analyzed.

Contour farming Farming technique used for sloping land; involves planting different types of crops for each contour to prevent erosion.

Contours Areas in a field that have the same elevation.

Contour strip farming Alternating cover crops between contours.

Cover crops Low-lying plants such as grasses and legumes, with wide extensive root systems that protect the soil from erosion.

Crop rotation A system of alternating the types of plants to be grown in a plot of land.

Data Facts; information.

Decomposition Process of breaking down plants and animals.

Experimentation The process of gathering and analyzing data based on observations.

Fertilizers Substances that, when added to soil, provide additional nutrients that plants need.

Furrows Small canals.

Germination Development of the embryo inside a seed.

Hypothesis A tentative solution to a problem.

Irrigation A man-made system of providing adequate and regulated water supply to plants.

Leaf crops Plants that are leafy and rob the soil of nutrients.

Legumes Beans and related plants that give back nutrients to the soil.

Method A way of doing things.

Natural fertilizers Fertilizers derived from plants and animals.

Photosynthesis Process by which plants make food using sunlight.

Root crops Tubers and hardy plants that do not require much nutrient from the soil.

Scalding Pouring hot water over something.

Science Systematized body of knowledge.

Scientific method A series of steps used in solving problems and coming up with decisions.

Tubers Plants whose roots are used as food, such as camote and cassava.

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