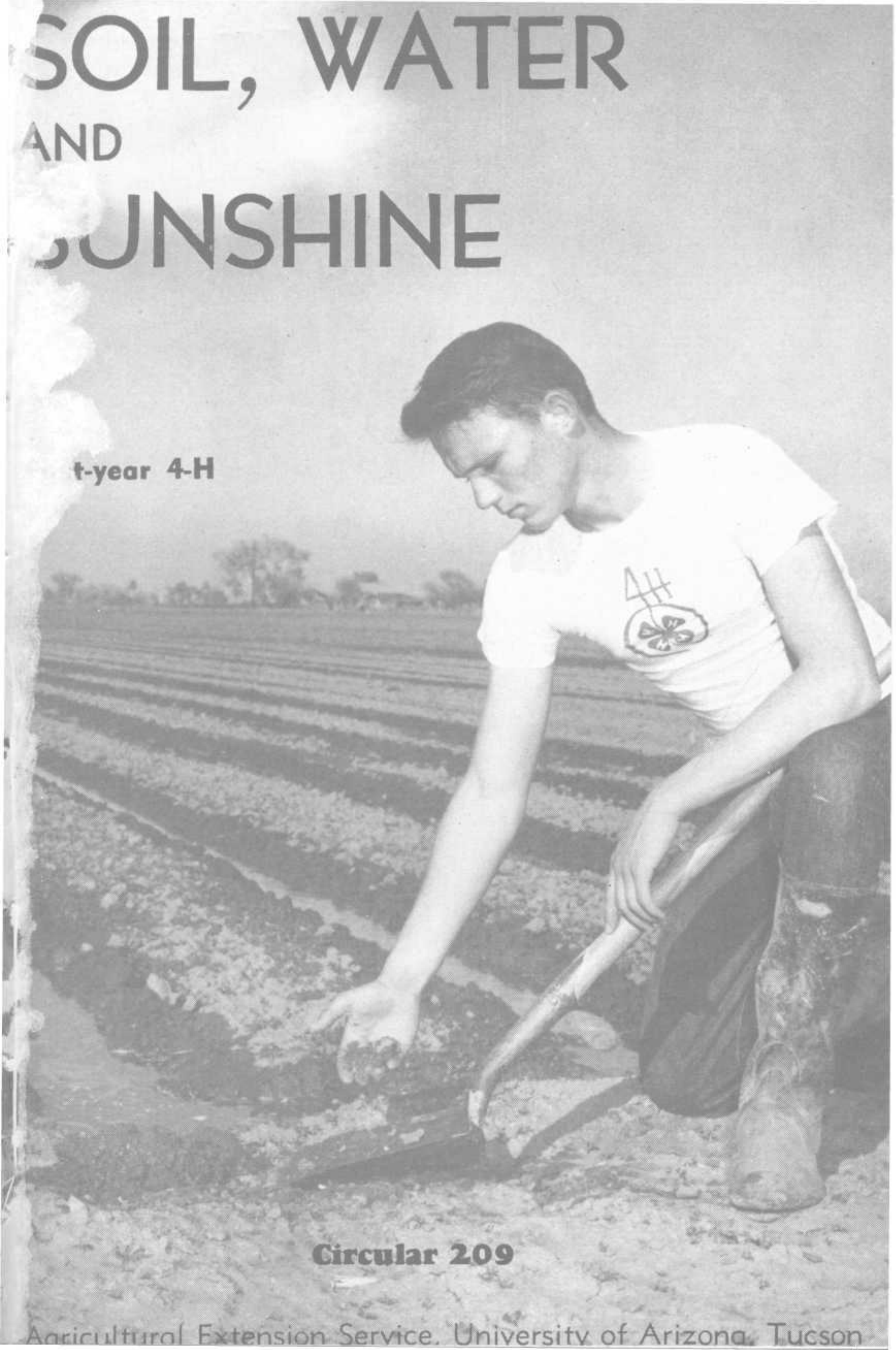
SOIL, WATER AND SUNSHINE

t-year 4-H



Circular 209

Agricultural Extension Service, University of Arizona, Tucson

To the 4-H Member:

You are taking part in one of the most important 4-H projects – Soil, Water and Sunshine. All other projects in livestock or crops are dependent upon what the 4-H member knows about soil and water. All feed or food crops need *Soil, Water,* and *Sunshine.*

You can make more profit from a beef calf if you raise your own feed. Raising feed successfully depends on what you know and learn about soil and water.

The success you have with a cotton project depends directly on how you work with soil and water and with the plants themselves. What you learn from your 4-H work in soil, water, and sunshine will be of help to you later if you intend to be a farmer or rancher.

We know that you will enjoy this project. There are county medals for those who do the best work, and trips to national 4-H events for state winners. These rewards are not as important to you, however, as what you learn about the relationships between soil, water, and crops.

Kenneth L. McKee
State Leader, 4-H Club Work

University of Arizona
College of Agriculture, Agricultural Extension Service
Chas. U. Pickrell, Director
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Three members of the Cartwright 4-H club check soil moisture and texture with the aid of a soil tube. Assistant County Agricultural Agent Richard Hoover (left) examines a core from the soil tube. Next, left to right, are Richard Sparks, John Sparks, and Larry Stallings.

ON THE COVER is John Sparks, Cartwright 4-H Club member of Maricopa County, who had completed his first-year Soil, Water and Sunshine project when this picture was taken.

SOIL, WATER

AND

SUNSHINE

By Howard E. Ray
Soils Specialist

and James E. Middleton
Irrigation Specialist

First-year 4-H

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Meeting No. 1

Soil, The Home of Plants

Soil is the Home of Plants

Soil is made up of fine pieces of rock (or mineral matter), tiny animals, and decaying remains of plants (organic matter). When you look closely at a handful of soil, you can see these small pieces of rock mixed in with old plant roots, bits of straw, and bits of old plant stalks.

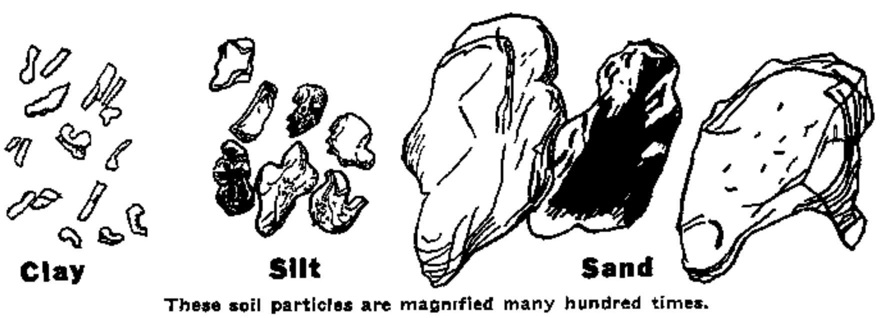
Our Soil Was Started from Rocks

Mother Nature worked thousands of years to make our soils. Freezing, thawing, running water, air, and sunshine caused large rocks to break up into small pieces. Then plants and animals made further changes to bring about our present soils.

This soil-forming process is taking place every day, but it is very slow. You have seen large rocks which cracked a long time ago and now have plants growing in the cracks. If you look more closely, you will see that there are many small pieces of rock down in the cracks that the roots of the plants are growing into. In these cases, the rock has broken down into smaller pieces and plants have started to grow and form some soil.

Soil Particles Come in Many Sizes

If you look closely, you'll see that soil is actually a network of various sized particles separated by tiny spaces. The larger particles of soil are called sand and



These soil particles are magnified many hundred times.

are coarse and grainy. The smallest particles are called clay. Clay is sticky when wet, but it cracks and forms hard clods when dry. The medium-sized particles, called silt, are like flour in the soil. Some soils also contain some gravel particles even larger than sand.

Soil Texture

The amounts of sand, silt, and clay in a soil determine its texture. Different soil textures may be determined as follows:

1. Sandy (coarse) — A soil containing nearly all sand. The soil particles very seldom hold together to form clods. When you moisten and rub them between the thumb and forefinger, they will feel gritty and will not hold together. Soils of this texture contain large pores which let water enter and drain through easily. They are very easy to plow and cultivate and for this reason are called "light" soils.

2. Loam (medium) — A soil containing a mixture of sand, silt, and clay. Particles of this soil form clods easily and feel a lot like flour when dry. When you moisten them and rub them between the thumb and forefinger, they will feel fairly smooth with not much grit, and will tend to hold together fairly well. Soils of this texture crack slightly upon drying, but do not allow water to enter or drain through as rapidly as do the sandy soils. They do, however, have the ability to hold more of the water in the soil.

3. Clayey (fine) — A soil containing principally clay particles. Soils of this texture tend to crack, form very hard clods, and feel harsh when dry. When you moisten them, they are sticky and can be molded. They allow the water to enter and drain through very slowly. They are called "heavy" or fine-textured soils and require careful management to maintain them in a good condition.

Soil is Full of Life

You have seen many small animals such as earthworms, millipedes, and insects living in the soil. You have also seen the roots of plants growing in the soil. But many living bacteria and fungi in the soil are so tiny that you can see them only through a microscope. They might be called soil microbes.

Some of these tiny microbes digest (or rot) organic matter, such as straw in moist soils, so that it can be used by plants. Other soil microbes such as the legume bacteria are found on the living plants helping them to grow more vigorously.

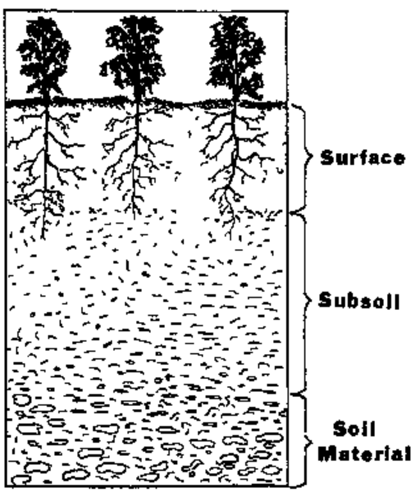
These are soil microbes greatly magnified.

Not all soil microbes are good, however. Some cause plant diseases just as other kinds of microbes cause animal and human diseases.

When you look in the soil for earthworms and other tiny animals, do you hunt for them in a dry soil, in a tight, hard clayey soil, or in a rich, moist loam soil? If you have looked very often, you probably have noticed that you nearly always find the most earthworms in a rich, moist loam soil. This soil usually has the most bacteria, fungi, and other soil microbes, too.

A Side View of the Soil

A side (vertical) view from the top of the soil down through the subsoil, and into the parent material (material from which soil is being formed) is called a soil profile. You can see such a side view in road banks or ditches. The topsoil usually has a richer color because more roots grow in the topsoil than in the subsoil.



Here is one type of soil profile.

Many of the soils in Arizona have been formed from material carried by water for long distances and then dropped. You often will see a soil profile with several layers which have been deposited in this manner. Different layers may have different textures and different colors.

Questions and Answers On Soils

Q. What is soil?

Ans. A mixture of mineral and organic matter on the surface of the earth which is the home of plants.

Q. What are the medium-sized particles in the soil called? The coarse particles? The fine particles?

Ans. Medium-sized — silt; coarse — sand; fine — clay.

Q. What is meant by soil texture?

Ans. The amounts of sand, silt, and clay present in a soil.

Q. What is a "loam" soil?

Ans. A soil which has the properties of sand, silt, and clay particles in about equal proportion.

Q. Why are sandy soils often called "light" soils?

Ans. Because they are easy to plow and cultivate.

Q. The soil microbes prefer what kind of soil?

Ans. Rich, moist, loam soil.

Q. Why are soil microbes important?

Ans. They digest the organic matter. Also, some cause plant diseases.

Q. What is a soil profile?

Ans. A side view of the soil from the surface down into the parent material.

Q. What is parent material?

Ans. The material from which new soil is being formed very, very slowly.

Q. Why do some soil profiles show several layers beside the topsoil and subsoil division?

Ans. Because many soils in Arizona are formed from material carried in water and then dropped in layers.

Assignments

1. Read instructions for soil profile record sheet.

2. Bring soil profile record sheet and instructions to field trip.

Field Trip No. 1

A Look at the Soil

On the field trip you will look at some of the things discussed at the first meeting, such as soil texture, soil profile, etc.

Assignments

1. Fill in soil profile record sheet and bring to next meeting.

2. Read section in manual entitled "Plants, How They Live and Grow."

3. Read instructions for the root record sheet.

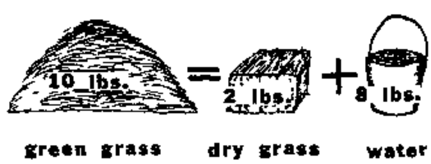
4. Bring the root record sheet and instructions to the meeting.

Meeting No. 2
Plants, How They Live and Grow

Our Lives Depend Upon the Soil

All animals (including people) depend upon plants for food. Minerals in soil, water, air, and sunshine, are needed to produce these plants. Man has invented many great things, but he still depends on plants growing in soil and water for food to supply energy.

Try to name a food which does not come directly or indirectly from the soil. (Beefsteak comes from an animal which must eat plants or parts of plants in order to grow.)



What's in a plant?

Plants Are Made Up of Dry Matter and Water

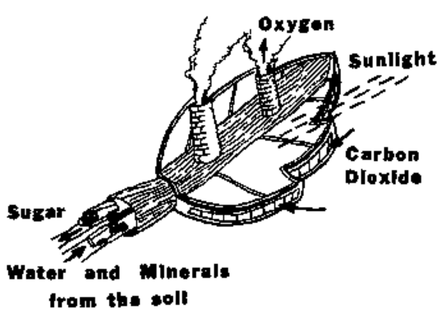
Green, living plants are more than three-fourths water and less than one-fourth dry matter. If you cut 10 pounds of green grass and take out the water, there will be only about 2 pounds of dry hay left.

About 5 percent of the dry matter in plants is mineral matter (phosphorus, potassium, sulfur, calcium, iron, etc.) and all the rest is organic matter (starch, sugar, proteins, fiber). Thus, 10 pounds of green grass contain only 1/10 pound of mineral matter.

If you burn a pile of grass, the ashes which are left will contain this mineral matter. The organic matter burns and disappears into the air principally as carbon dioxide and water vapor.

The World's Greatest Food Factory Is a Plant Leaf

The 5 percent of the plant dry matter that is mineral comes from the soil. The other 95 percent is manufactured by the plant in its leaves. This is food which may be changed by plants into grain, or by animals into pork or butter.



A leaf — the world's greatest food factory.

Plant leaves contain chlorophyll, a green substance that enables the leaves to combine carbon dioxide from the air (through the leaves) and water from the soil (through the roots) to manufacture sugar, a food. This sugar is later changed into starch or combined with nitrogen and phosphorus (from the soil) to make proteins. Other minerals besides phosphorus are used in plant growth, too.

Like other factories the plant leaf must have a source of power, and this power comes from sunlight.

Carbon dioxide and sunshine are plentiful, and water can be supplied by rain or irrigation. Once soil minerals have been taken up into the plant and the plant is harvested, they are lost forever from the soil. You can see why it is so important to turn under all crop residues, return all manure to the soil, and apply commercial fertilizers to provide these minerals.

Plants Can "Talk"

Plants can tell us when our soil is wearing out if we will learn to understand their sign language.

For example, if a plant is not getting enough nitrogen, its leaves will turn yellow or a light yellow-green down the center. On the other hand, healthy plants getting plenty of nitrogen have dark green, glossy leaves.

Plants also tell us, by signs, when they don't have enough phosphorus, potassium, calcium, and other elements. Good books have been written to help us understand these signs. "Hunger Signs in Crops" is one very good reference.

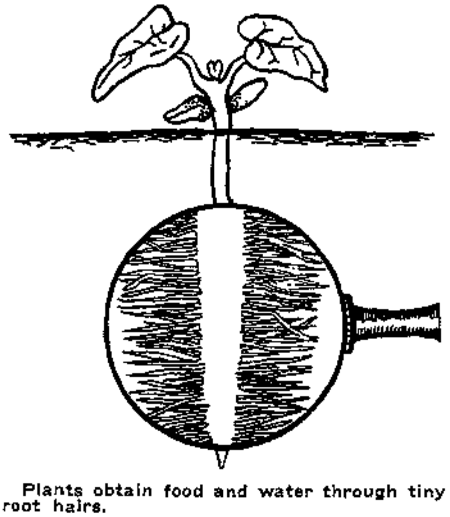
Plants Must Have Water

Because plants are not able to eat and chew their food, their roots must "drink" the soil water which contains mineral nutrients needed by the plants. When you examine a young, fast-growing root near the tip, you will find many tiny root hairs. It is through these root hairs that water and minerals enter the plant. Then the minerals are carried in the water to parts of the plant where they are needed.

Plants also use water to keep themselves cool. To do this, large quantities of water transpire (evaporate) from the leaves. Perspiration evaporating from the surface of your skin cools you in the same manner.

For an idea of how much water a plant uses, consider some common crops. For instance, it takes about 1 barrel of water to produce an ear of corn and about 80 gallons of water to produce 1 pound of lint cotton.

Since plants need so much water, ou can see how important it is to store water in our soils. If you do not furnish plants with enough water, they will not produce good crops.



Plants obtain food and water through tiny root hairs.

Plant Roots "Go Underground"

Do you know that if all the roots of one mature plant were placed end to end they would stretch out for several hundred feet? In fact, the area of the roots underground, which we cannot see, is often greater than the area of the growth above ground which we can see.

In good soil with plenty of water, many roots of small grains and grasses can be found 4 or 5 feet beneath the surface of the ground. Alfalfa and cotton roots can be found even deeper.

Roots Aren't All Alike

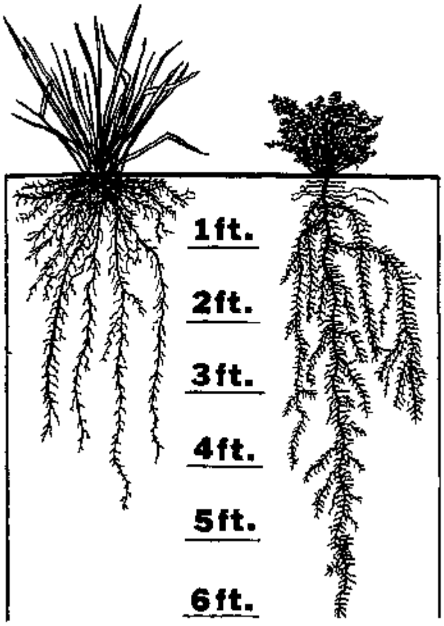
You have noticed that some plants (such as corn) have one main stem which grows straight up into the air while other plants (such as raspberry bushes) branch out into several smaller stems very close to the ground. If you will look at the roots of many different plants, you will find that there are different types of root systems, too.

Alfalfa and coton have one large, strong root (called a tap root) with smaller roots branching off from it.

Carefully dig up an alfalfa plant and you will see the tap root with its branches. Many plants have this kind of a root system.

Small grains and many other plants do not have a long tap root. Instead, they have a lot of smaller

TWO TYPES OF ROOT SYSTEMS.



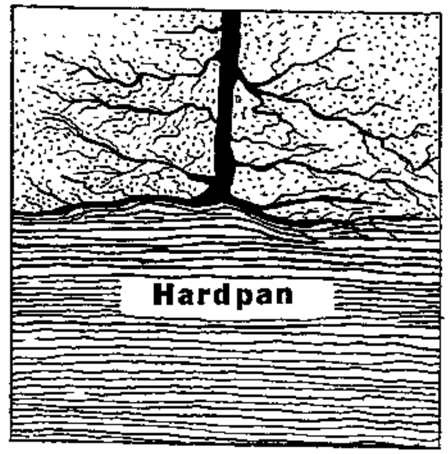
Fibrous root system of wheat — Tap root system of alfalfa

roots (fibrous roots) which spread out from the base of the stem to the plant. When you dig up a barley or wheat plant, you will see many roots which spread out through the soil in this manner.

Roots Are Tender

Roots will grow deep into a good, productive soil having plenty of moisture. They are rather tender, however, and cannot grow so deep into a hard soil. In fact, if there is a very hard layer (hardpan) somewhere in the soil, the roots may grow just along the top of this layer rather than push their way through it.

Try to find a place where there is a hardpan which not many roots will grow through.



Cotton roots refusing to grow through a hardpan.

Roots Like Water

Besides being tender, plant roots are thirsty all the time. This means that they will not grow into soil unless it has some water they can drink.

It is very important, then, to give the soil enough water to penetrate several feet down into the soil. Since small grains have roots which may grow down into the soil about 4 feet, the soil should be wet down to about that depth for them. Also, since alfalfa roots may grow even deeper, the soil should be wet down 6 feet or more where alfalfa is growing.

Roots Must Breathe

Although roots are always thirsty, and like to be near water, they also must have air to breathe. Therefore, you do not want to keep **all** of the pores in the soil full of water. If you did, the roots might drown just as you would drown if someone held your head under water long enough.

Sandy soils with large pores usually have space for plenty of air to reach the roots, but clayey soils have such small pores that sometimes the roots do not get enough air.

Sometimes water does not drain out of a soil, and does fill all the pores. This is known as a waterlogged soil. In some cases, the soil is filled nearly to the surface with water (waterlogged) all the time. This is called a high water table and roots grow down only to the top of the waterlogged portion.

Questions and Answers On Plants & Plant Roots

Q. How much of a green, living plant is water?

Ans. More than three-fourths (about 80%).

Q. If you burn some plant material, what is left in the ashes?

Ans. Mineral matter.

Q. What happens to the organic matter when a plant is burned?

Ans. It disappears into the air mainly as carbon dioxide and water vapor.

Q. Where does the plant manufacture its food?

Ans. In the leaves.

Q. What materials does the plant leaf use to form sugar?

Ans. Carbon dioxide and water.

Q. What does the plant leaf food factory use for power?

Ans. Sunshine.

Q. How do minerals get into a plant?

Ans. They are carried by the water through the root hairs into the plant.

Q. Why should you get the soil wet to a depth of several feet?

Ans. Because roots will not grow into dry soil.

Q. What is the plant saying when its leaves begin to turn a light yellow-green down the center?

Ans. It is probably begging for more nitrogen.

Q. Should you keep all of the pores of the soil filled with water?

Ans. No, because plant roots need air to breathe.

Assignments

1. Complete the root record sheet and bring it to the next meeting.

2. Read section in the manual entitled "Water, Its Place in the Soil."

3. Read instructions for water penetration record sheet.

4. Bring water penetration record sheet to next meeting.

Meeting No. 3

Water, Its Place in The Soil

The Soil is a Reservoir for Water

What happens to the water which disappears into the soil after a rain or an irrigation? Part of it sticks to the soil particles, at least temporarily, and the rest ("gravity water") flows deeper into the soil due to the force of gravity.

Dig a hole about 1½ feet deep into a well-drained loam soil immediately after an irrigation. The soil that you take out of the hole will, of course, be sloppy mud.

Wait about 2 or 3 days and then dig another hole close to the first one. The soil you take out of this hole will not be muddy because gravity has had time to pull part of the water deeper into the soil.

When all of the "gravity" water has drained from a soil, the soil is said to be at **field capacity.** More water remains in a clayey or loam soil at field capacity than in a sandy soil. For this reason, if the same amount of water is applied to a dry clayey soil and to a dry sandy soil, the sandy soil will be wet to a greater depth than will the clayey soil.

If too much water is applied to a soil, gravity will pull some of it so deep into that soil that plant roots cannot reach it. This water is wasted.

Plants Cannot Obtain All of the Soil Water

Only about half of the water which sticks to the soil particles at field capacity can be absorbed easily by plant roots. This portion of the water is the "plant-available" water. It is sometimes called "capillary" water because capillary action may cause it to move up, down, or in any direction toward drier soil. (Such movement is known as subbing.) Capillary action also causes ink to flow into a blotter, and oil to rise in a lampwick.

The rest of the water which sticks to the soil particles is held so tightly that plant roots cannot absorb it no matter how much they need it. This portion of the water can be removed from the soil particles only by heat or dry air, so it might be called "bound" water.

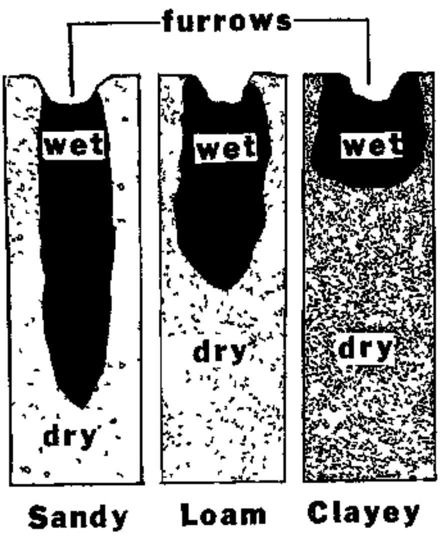
You can see, then, that even though some water is still present in the soil, more water must be applied as soon as the "plant-available" (capillary) water is nearly all gone. Otherwise the plants will wilt.

Irrigation Water Refills Soil Reservoir

When water is applied to a furrow during an irrigation, it penetrates into the soil mainly because of the force of gravity. At the same time capillary action also pulls the water downward and outward toward drier soil. If the soil is uniform, water moves downward farther and at a more rapid rate than it moves (subs) outward or upward.

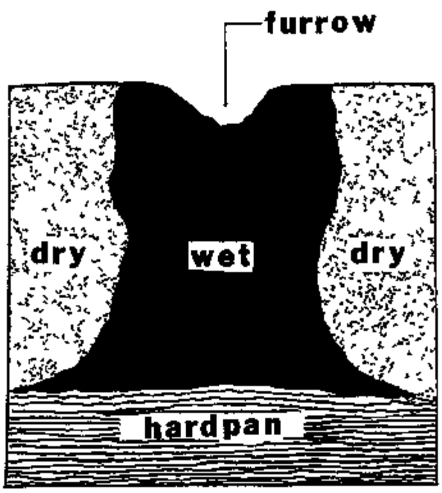
In a sandy soil there is much less outward and upward movement than in a loam or clayey soil, and the same amount of water penetrates much deeper.

If the soil is not uniform, water may move in a little different man-

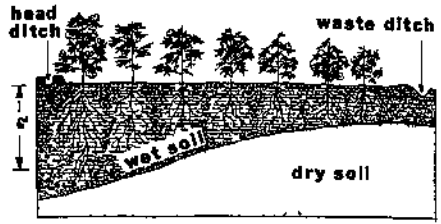


These are water penetration patterns below the furrow in uniform soils. All three soils received the same amount of water

ner. For example, if a hardpan is present in the soil, the irrigation water may penetrate only to the hardpan, and the water must then move outward. In such a case, too much water applied at one irrigation will fill all the pores in the soil, and plants may die from lack of air.



Here's a water peneration pattern where a hardpan exists



Long furrows result in uneven penetration

If you dig a trench across a furrow soon after an irrigation, you can see the pattern formed by the irrigation water which entered the soil.

Longer Irrigation Gives Deeper Penetration Of Water

The depth to which water penetrates into any uniform soil depends upon the length of time the water is on the soil. Running water penetrates at the same rate as still water.

Long runs on land with a uniform slope have water for a longer time on the upper end of the field near the ditch than on the lower end. Therefore, if an irrigation run is too long, some water may penetrate so deeply near the head ditch that roots cannot reach it, while on the lower end of the same run, the water may not penetrate deeply enough to provide sufficient water for the roots.

Use a moisture probe or a soil tube in a recently irrigated field to find out how deep the water has penetrated at the upper and lower ends of a furrow or border.

Water Doesn't Always Remain in the Soil

Water would be of very little value in farming if it remained in the soil permanently after being applied by either irrigation or rainfall. Plants need to remove large quantities of water from the soil in order to grow and produce a crop.

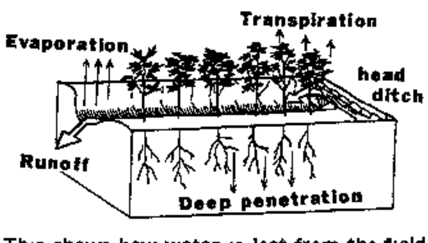
Most of this water passes up through the plant and is lost into the air by transpiration(evaporation from the leaves). This kind of water loss from the soil is useful unless weeds are allowed to grow and use water which is needed by crop plants.

Another kind of water loss which is **not** useful to the farmer is runoff. This is water which runs off over the surface of the ground after a rain or which runs off as tailwater from an irrigation. Runoff water is lost to the crop and also carries with it valuable plant nutrients, organic matter, and very fine particles of soil.

Water which penetrates so deeply into the soil that roots cannot reach it will not help to produce a crop in most cases. There are places, however, where a heavy irrigation is needed from time to time to wash harmful salts down below the reach of plant roots.

Some water is also lost by evaporation directly from the soil. Nearly all of this evaporation takes place in the top 8 or 10 inches of soil.

It is easy to see how important it is to do a good job of irrigating so that as much of the water as possible will be placed where it can be used by the plants. You will learn more about how to irrigate properly later on in your project.



This shows how water is lost from the field by evaporation, transpiration, runoff, and deep penetration.

Questions and Answers On Water in the Soil

Q. What is "gravity" water?

Ans. Water which flows down through the soil due to the force of gravity.

Q. What is meant by field capacity?

Ans. The amount of water remaining in the soil after the "gravity" water has all drained out.

Q. Do all soils contain the same amount of water when they are at field capacity?

Ans. No, clayey soils hold more water than sandy soils.

Q. What is capillary action?

Ans. The force which causes oil to rise in a lampwick. This force also causes soil water to move in any direction toward drier soil.

Q. How much of the water which remains in the soil at field capacity can be used by plants?

Ans. About one-half.

Q. Will water which is standing still penetrate into a soil faster or slower than water which is running over the surface of the same soil?

Ans. The same rate.

Q. How is water removed from a field?

Ans. By transpiration from the leaves of plants, evaporation from the soil, surface runoff, and deep percolàtion (below the root zone).

Q. Are any of the above water losses of any benefit to the farmer?

Ans. Yes. Growing crop plants lose much water by transpiration from their leaves. As these plants later produce a crop, this kind of water loss might be called a use which benefits the farmer. Also in some cases, deep penetration at intervals may be necessary to wash harmful salts below the reach of plant roots.

Assignments

1. Complete water penetration record sheet and bring to the next meeting.
2. Read section in manual entitled "Irrigation, Why and How."
3. The club members assigned to discuss the methods used to irrigate crops grown on the farm on which they have their project, and the source of the water, should have their talks outlined before the meeting.

Meeting No. 4

Irrigation, Why and How

What is Irrigation ?

Irrigation is the name given to any artificial method man uses to put water on his land to wet it so plants will grow.

Why Irrigate?

The natural rainfall in this state does not keep the soils wet enough to satisfy the water needs of crops during the growing season. Irrigation is used to replace the water drawn out of the soil by (1) growing crops and weeds, and (2) evaporation.

Irrigation should replace all water used from the soil with the smallest amount of waste in water, soil, and labor, so that the soil will have proper moisture content for the best plant growth at all times. The soil should not be allowed to stay either too wet or too dry.

A heavy application of irrigation water also can be used to wash out any harmful salts that are in the soil by carrying them down below the root zone.

Source of Irrigation Water

A small amount of water is stored in the soils of the irrigated valleys from rainfall and snow, but not enough to grow our crops. The water needed for irrigation must come from the mountain country where the rainfall and snowfall is greater than can be stored in the soil and used by mountain plants.

The extra water from the mountains reaches the valley by flowing in open streams, trickling slowly underground until it reaches the surface as springs or seeps, or fills the open underground reservoirs of the valleys. The flow of rivers or springs can be stored for use in reservoirs behind man-made dams or can be turned directly into canals by small diversion dams for delivery to farms.

The water stored underground in the valleys can be brought to the surface and used on farms by drilling wells and pumping.

Moving Water To the Farm

The water stored in dams or diverted from a flowing stream is turned into canals that usually carry it by natural gravity flow to the farms. The water is then turned into the farmers' ditches.

Usually farmers using underground water have their own wells, pumps and canal systems. Sometimes they organize and form a company which drills the wells, pumps the water, and delivers it to each farm.

Types of Canals, Ditches and Pipe Lines

Open channels that carry a large supply of water, usually to many farmers, are commonly called canals. The smaller channels are called ditches. Water flows through them by the force of gravity, as in rivers. In many cases rivers are used below dams to act as canals when the dams are a long distance from the farm land that is to be irrigated.

Open canals can be cuts in and banks built from natural earth, or the inside of the canal can be lined with special clays, concrete or asphalt products. Concrete may be sprayed on, hand plastered, poured in forms or applied with a slip form.

Canals are lined to stop water from seeping out of the canal through the natural soil, especially sandy soil.

When water must be pumped uphill because of the way the land lies, when water losses in ditches are high, or when ditches interfere with farm operation, the water may be put under pressure by pump or gravity into pipe lines. These lines are usually concrete pipe.

Methods of Releasing Irrigation Water From Farm Ditch to Fields

Many methods are used to release the water from the ditches to the land. Any method that gives complete control and eliminates loss of water is good management.

The oldest method of releasing water to the field is by cutting holes in the bank for each border or several rows. Control is not very good since the cuts wash out unevenly and more water is applied to one part of the land than to the rest. This causes runoff losses or deep-penetration losses.

The dirt plugs often break and over-irrigate portions of the field. Also, much labor is required.

Spiles or tubes of rubber, wood or metal have been used for many years and usually give very good control with very little loss or leakage. Siphons of metal, plastic or rubber have been in use for several years, and give the best control when the ditch is built right and the water is clean with an even flow.

Both of these methods work very well with row irrigation, and large siphons can be used with borders, but are hard to start and handle. The spiles work best with an extra field ditch in which the water can be held at a constant level.

Siphons work very well in lined ditches since the ditch bank can be made narrow. This also allows the ditches to be built without turnouts which reduces the possibility of leakage.

Mechanical gates of many types have been used. If properly installed in concrete or masonry, the gates have given good control with low losses. This works very well on the border method of irrigation, but some further means must be used to distribute the water to furrows or rows.

Tile turnouts with metal slide gates are used extensively, but leakage losses are usually high since it is hard to obtain and hold a perfect fit so they will not leak. Some type of screw valve is usually used on pipe lines.

Methods of Irrigation

The two major methods of irrigation in Arizona are flooding and row or furrow irrigation. There are many variations and combinations of these two methods.

Row Irrigation

Corrugations are small furrows, usually placed close together. The method is useful where the irrigation stream is too small for effective flooding. When the soil crusts or bakes over from flooding, corrugations allow wetting of the soil without crusting. They also help give control on steep or rolling land used for close growing crops, but should be used with borders to control any runoff from side slopes.

Furrows are usually wider spaced and larger than corrugations for use with crops that are planted in rows and cultivated. This method wets only part of the surface and reduces evaporation losses and lessens the puddling effect of the water on heavy soils. It is adaptable to great variations in slope and can be used to follow contours on steep slopes.

The use of furrows down steep slopes cause high soil losses through erosion. Water losses are high from runoff and deep penetration below the root zone unless the water application is handled carefully according to the soil and slope.

Beds are usually used for vegetable crops, with the plants on each side just above the water line. This allows greater dry soil surface for the crop, with a furrow for irrigation.

Broad base furrows are essentially bordered areas and are used where deep penetration is desired or where the soil is slow in taking water. They are mainly used in orchards.

Flood Irrigation

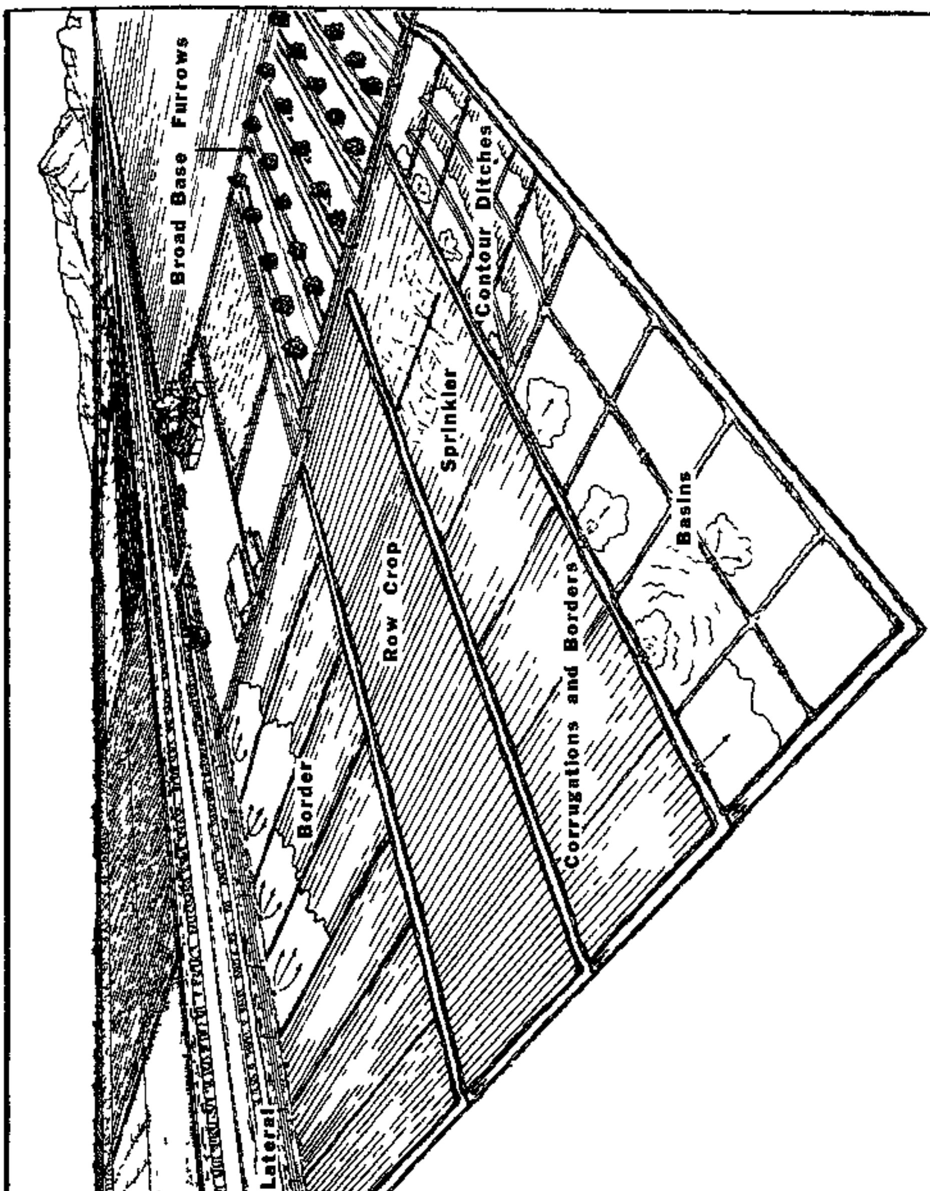
Flood irrigation is accomplished by advancing a sheet of water across the land. This means that the land should be leveled according to the soil intake rate in the direction of irrigation without any side slope. The soil should be deep enough to allow for making cuts for leveling.

Borders or ridges should be built to control the water. They should be spaced to give complete coverage of the strip between them with the water available. This strip is often called a land. The method is called border irrigation. The borders should be rounded so that crops may be planted across them to save waste of land and allow farm machinery to cross.

This method gives excellent control of water with a small amount of labor, since several borders can be irrigated at one time with a large head of water by one irrigator, if the land and irrigation system is properly prepared. It is adapted to any cover crop such as hay, grain, or pasture, or any crop that can be wet for a short time without damage.

Borders on contours, with the lands between leveled, are often used when the land is too steep for leveling with either slope. Benches also are used.

Basin or border check method of irrigation is done by making small level plots and flooding quickly with a large head of water to a depth that will fill the soil with water to the desired depth.



Some of the various methods of irrigation used in Arizona.

The method gives even penetration and works very well on heavy soils, with a slow penetration rate or on sandy soils that would allow over penetration with a continued application.

Controlled flooding between properly contoured and spaced ditches on steep land gives the operator fair control but corrugations and borders will aid in control of the water. Wild flooding from the highest point should never be used.

Sprinkler Irrigation

Sprinkler irrigation is comparatively new and can be used where it is impossible to level the land for any other method of irrigating. The following are a few advantages and disadvantages:

Advantages

1. Even distribution of water with proper design and weather conditions.
2. Low cost of land preparation.
3. Adapted to hilly or unlevel land.
4. Adapted to very porous soil types.
5. Ability to irrigate rolling land without erosion.
6. Can be used where it is impossible to level because of shallow soil.

Disadvantages

1. High initial cost of installation.
2. Cost of power to maintain pressure.
3. Labor involved in moving most types of portable equipment.
4. The rain effect may crust over certain soil which decreases water penetration.
5. High evaporation losses from high temperatures and wind velocities.
6. Water supply systems of projects and water companies are not designed for sprinkler supply.

Checking on Moisture in the Soil

The best method of finding out how much water a soil needs before irrigation is to dig down and check the amount of moisture in the soil. This can be done with a shovel, but a soil tube or auger is easier to use below the one-foot depth.

An inspection of the soil profiles will often show whether the soil texture, structure or some special condition such as a cemented layer, has any relation to the water penetration and movement in the soil. Also, roots of plants which can often be seen in the soil indicate how the plant roots are growing.

Checking the water penetration after irrigation, in this manner, is the only sure way of determining if the soil has been wet to the depth of the root zone.

(See Extension Circular No. 205, "Water Management," for further information.)

Assignments

1. Read instructions for soil moisture profile. (Attached to record sheet.)
2. Each member should bring a pencil and his sheet of field notes on soil moisture profiles. The record sheet is to be filled out as the information is taken in the field.

Field Trip No. 2

Checking Water in the Soil

On this field trip you will see some of the things discussed in Meeting No. 4, "Irrigation, Why and How."

Assignments

1. Complete record sheet on the soil moisture profile and bring to the next meeting.

2. Each member is to bring to the meeting the legal description and location of the land on which he has his project. This legal description will be placed on the record sheet and the farm located on the drawing of a section. This record sheet will be a part of the project records.

3. Read section in manual entitled, "Legal Description For Your Farm."

Meeting No. 5

Legal Description For Your Farm

Why Have a Legal Description?

We are all proud of ownership of anything, and among farmers the ownership of land is the proudest possession of all. To say we own a certain piece of land or farm is not enough. We must be able to describe it so that anyone can tell exactly where it is in relation to other pieces of land and other farms.

Also, we must have permanent records proving ownership of that land against all claims. Without these permanent records, there would be no positive method of knowing the size, position or ownership of the land.

Describing Lands and Keeping Records

The need for records led to surveying, marking and writing down a description of land boundaries. These descriptions and ownerships are then filed in the county and state records. They are called deeds. Each change of ownership of any land parcel is described and recorded in the county records to give a permanent record of ownership.

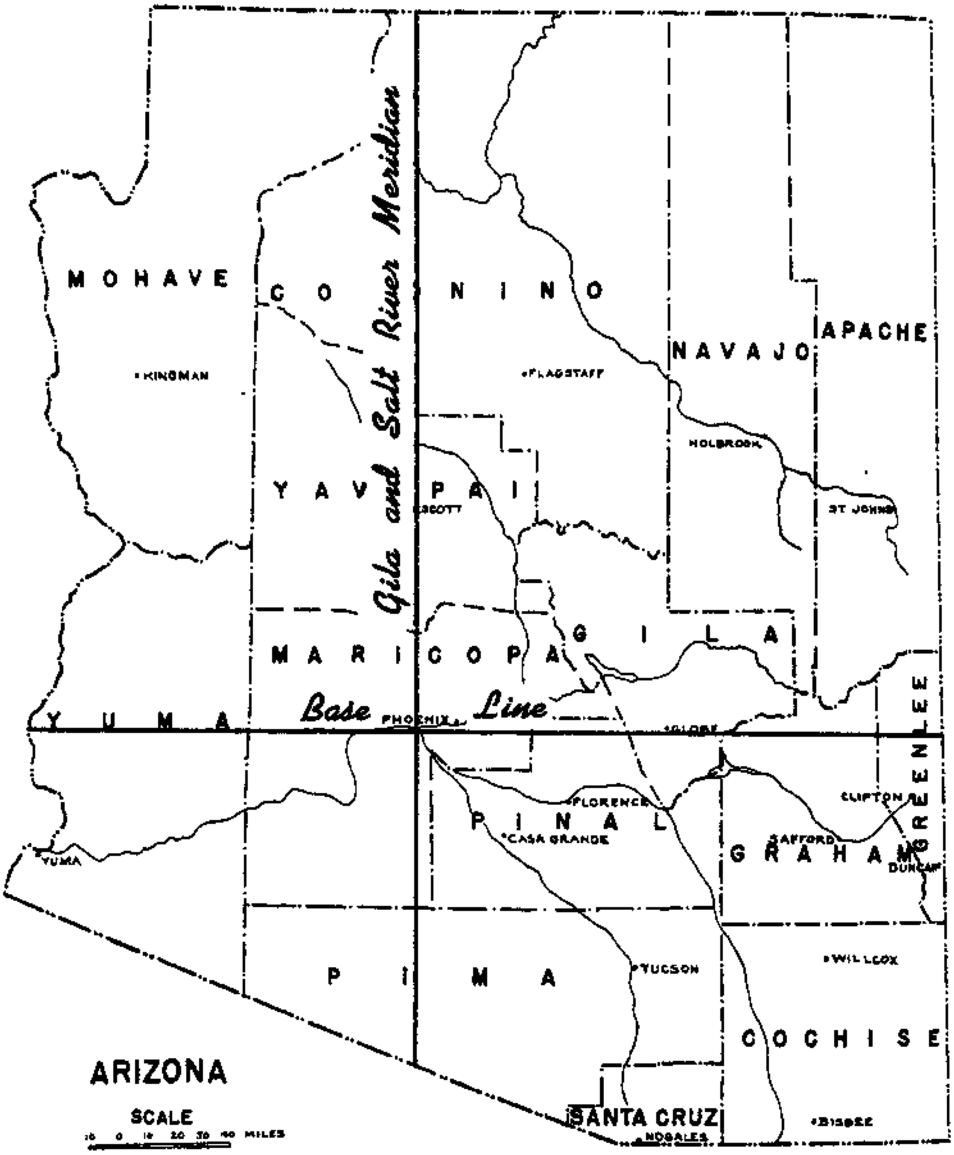
How the Present Land Description Was Started

The United States Government established a rectangular system of surveying, marking and describing land about 1875. This law required that the land should be divided by a system of parallel lines.

The Starting Point For All Surveys And Legal Descriptions

One or more points, called initial points, were established in each state. From these points, lines were surveyed running north and south and east and west, intersecting at right angles on the initial point.

The north and south line is called the principal meridian. The east and west line is called the base line. All survey lines and legal descriptions are located from these lines.



This map of the State of Arizona shows the initial point, the base line, and principal meridian.

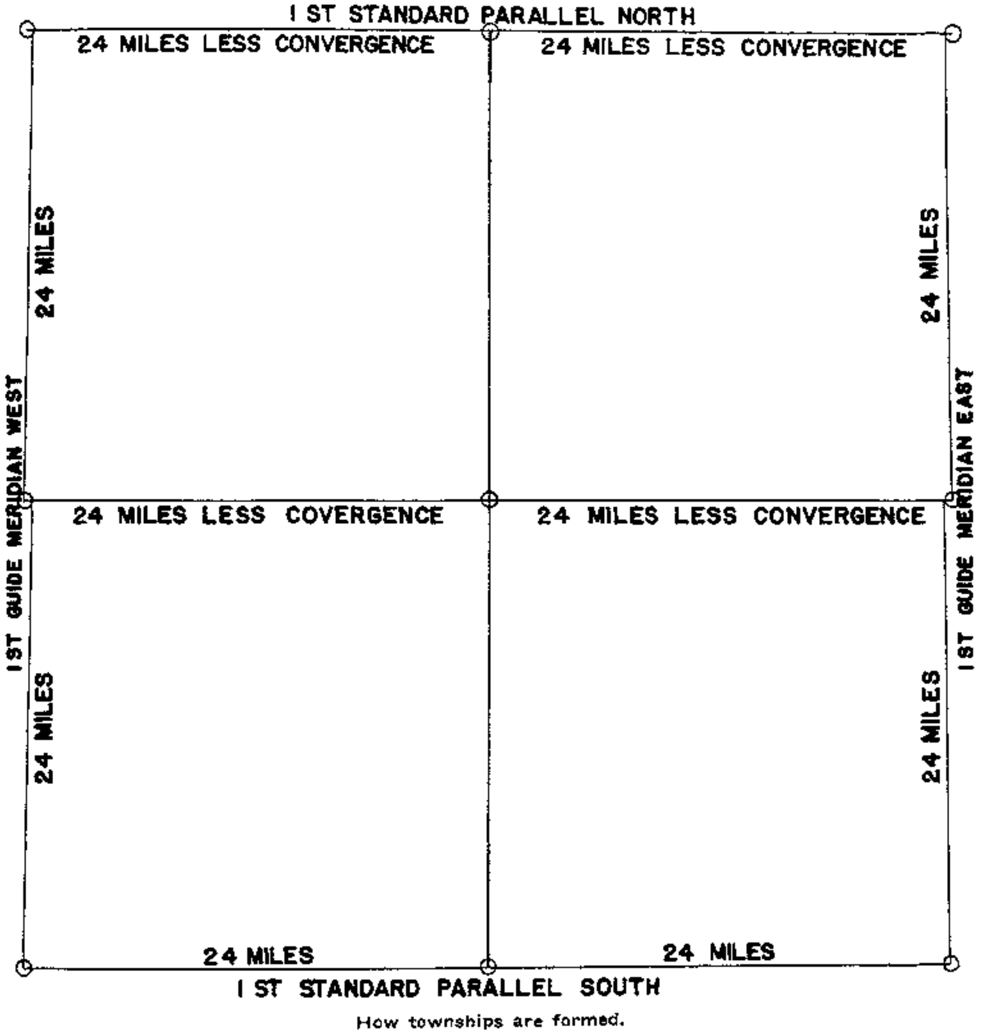
The Initial Point In Arizona

The principal meridian used in Arizona is the Gila and Salt River Meridian. The initial point is located south of the junction of these two rivers as shown on the map at left (page 24.) All of the land surveyed is based on these two lines, except a small part of the Navajo Indian Reservation.

How Townships Are Formed

Lines parallel to the base line were established at 24-mile intervals on the principal meridian, both north and south. Points at 24-mile intervals were then established on the base line and the lines parallel to the base line.

The points are shown as circles in the drawing on this page. The



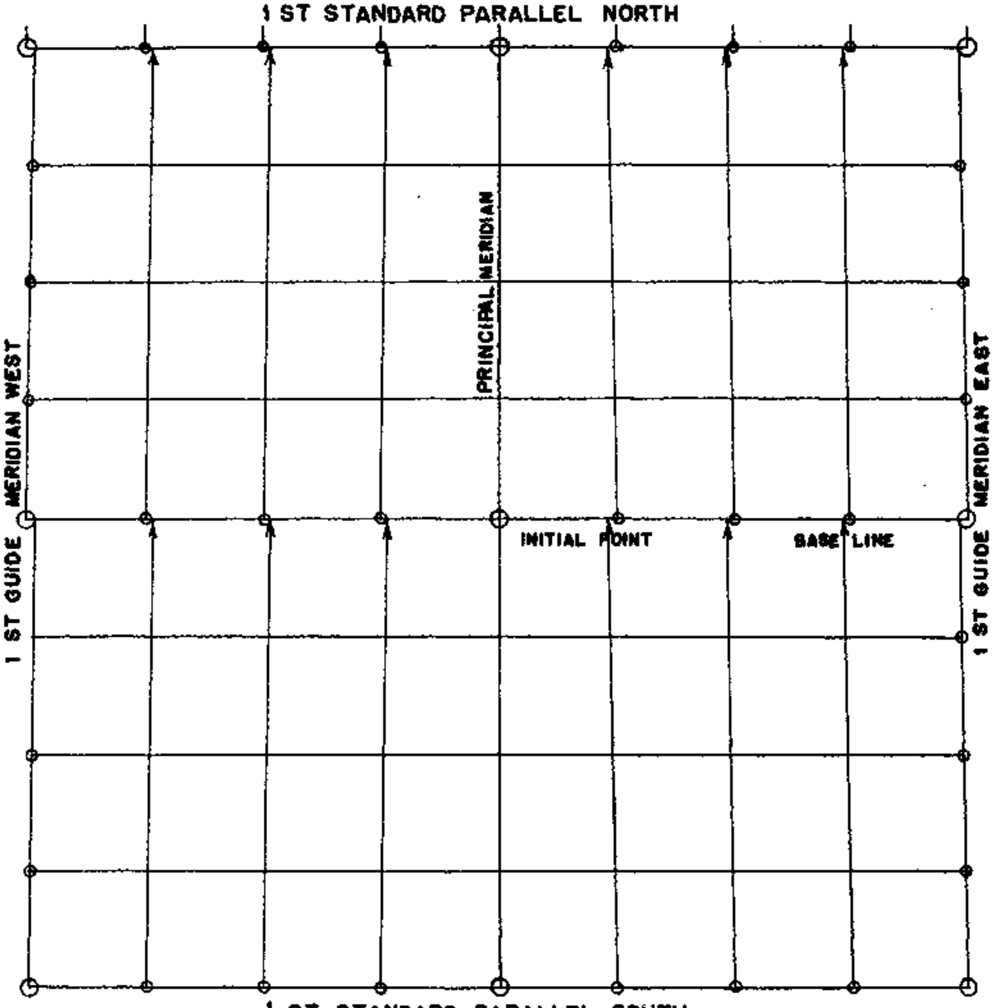
How townships are formed.

parellel lines are called standard parallels and are numbered according to their position north or south of the base line.

From the points, true meridians, called guide meridians, are run true north as shown in the drawing, page 25. They are numbered according to their position east or west of the principal meridian.

Points were established at 6-mile intervals on the base line, the standard parallels, the principal meridian and the guide meridians as shown by circles in drawing on this page. These points are then connected by true meridians and parallels to form areas called townships.

Townships are not true squares since lines drawn to a pole of a round object, such as the earth, come together or converge as they go in the direction of a pole. This



How townships are laid out using 24-mile parallel lines.

can be seen in the way the lines running to the north converge towards the principal meridian in drawing on page 26.

Many variations from this standard division of land will be found on maps due to errors in surveying and the impossibility of meeting these standards in rough country.

How Townships Are Described

A method was needed to show the position of each township in relation to the initial point, the principal meridian, and the base line. Therefore, townships are numbered from the base line to give the north or south position, and the name "Range" is used and numbered from the principal meridian to give the east or west position.

This gives each township two descriptions to place it in relation to the initial point. For example, the first township north and east of the initial point would be: Township 1 North, Range 1 East, or usually abbreviated to T1N; R1E.

All other townships surveyed from this initial point in Arizona can be described in the same way. (See drawing "a" below.)

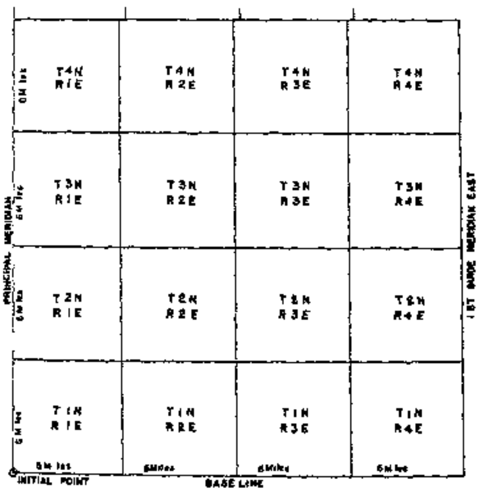
How Sections Are Formed And Described

The townships are divided into 36 areas approximately one mile square which contain approximately 640 acres. These areas are called sections. They are numbered consecutively, starting west from the northeast corner.

The first section north and east of the initial point would be Section 31. The complete description of this section would be: Section 31; Township 1 North; Range 1 East, or Sec. 31: T 1 N; R 1 E. (See drawing "b" below.)

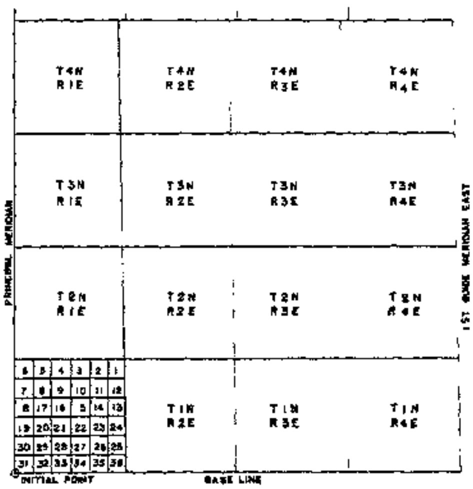
All other surveyed sections in Arizona can be described in the same way. All surveyed sections and some divisions of sections were originally marked by brass, wood,

a



How townships are numbered.

b



How a township is divided into numbered sections.

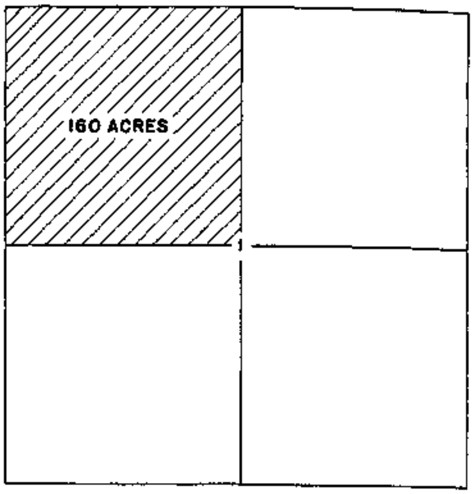
or stone markers which are still there unless they have been destroyed. These original corners always control all future surveys and cannot be changed regardless of error.

Parcels of Land Smaller Than Sections

The sections are usually divided by breaking them down by halves and quarters. These divisions are described by naming the direction from the center of the section in which the area lies. The acreages of different divisions of a section, and the description of each are shown in the series of drawings C, D, E, F, G, H, & I, pages 28 & 29.

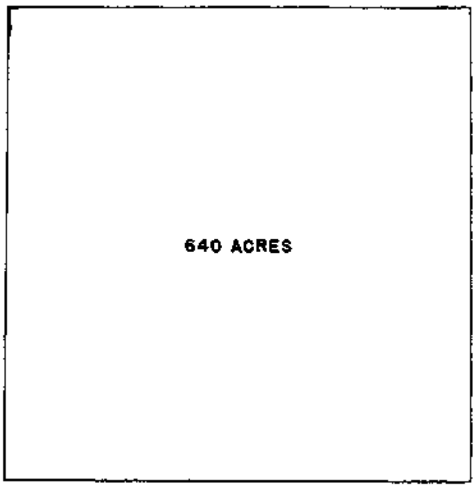
Divisions, not by quarters or halves, may be described as lots. These usually are odd-shaped areas or combinations of such areas.

d



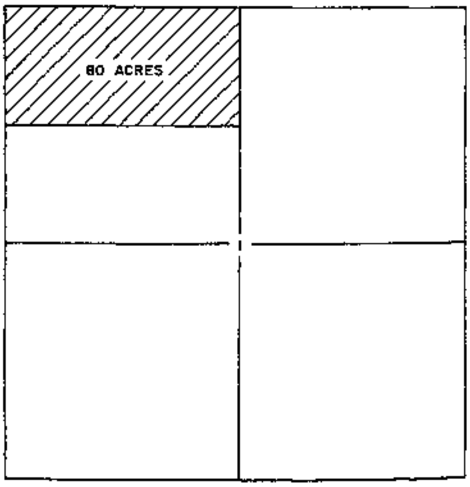
A section divided into quarters. The shaded quarter is described as the Northwest Quarter, Section 1, Township 1 North, Range 1 East. (Or NW ¼ Sec. 1, T 1 N, R 1 E)

c

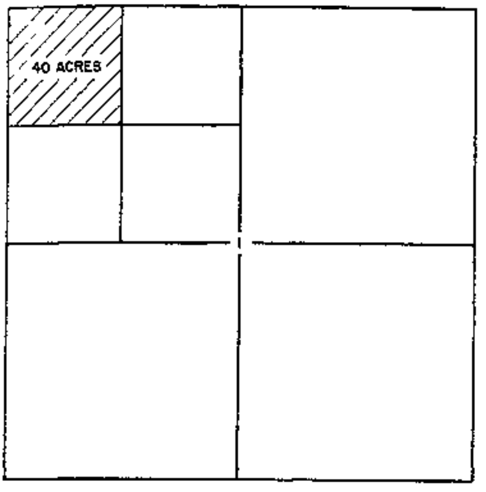


A standard section. Its description is Section 1; Township 1 North; Range 1 East. (Or Sec. 1; T 1 N; R 1 E)

e

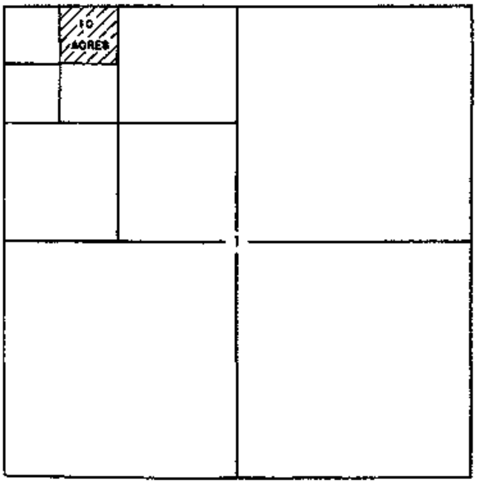


A quartersection divided into halves. The shaded area is described as the North Half of the Northwest Quarter; Section 1; Township 1 North; Range 1 East (Or N ½, NW ¼; Sec. 1; T 1 N; R 1 E) *f*



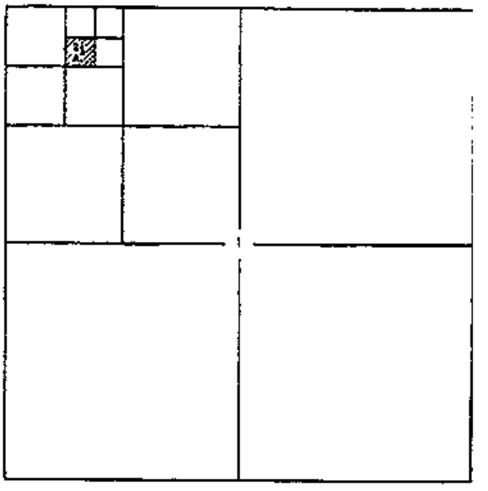
A quartersection divided into quarters. The shaded quarter is described as the Northwest Quarter of the Northwest Quarter of Section 1; Township 1 North; Range 1 East. (Or NW¼ NW ¼ Sec. 1; T 1 N; R 1 E)

g



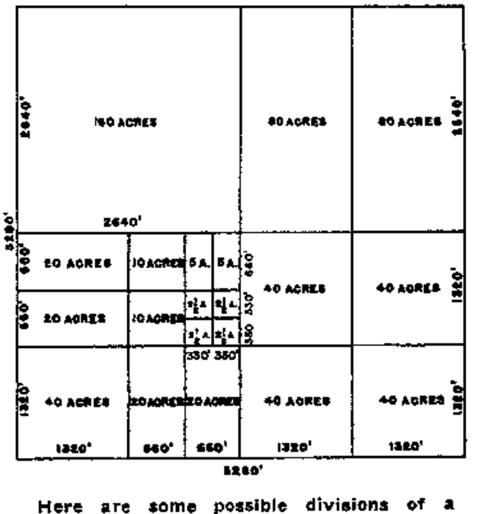
A quarter of a quarter of a quartersection. The shaded area is described as the Northeast Quarter of the Northwest Quarter of the Northwest Quarter of Section 1; Township 1 North; Range 1 East. (Or NE ¼ NW ¼ NW ¼; Sec. 1; T 1 N; R 1 E)

h



A quarter of a quarter of a quarter of a quartersection. The shaded area is described as the Southwest Quarter of the Northeast Quarter of the Northwest Quarter of the Northwest Quarter of Section 1; Township 1 North, Range 1 East. (Or SW ¼ NE ¼ NW ¼ NW ¼ Sec. 1; T 1 N; R 1 E.)

i



Here are some possible divisions of a standard section.

Assignments

1. Complete record sheet on Legal Description and Location of Farm.

2. Read section in manual entitled, "Farm Map For Your Farm."

3. The members should bring the following information and materials with them:

A. Size and shape of the farm — this information should already have been obtained from plotting the farm on a section.

B. Dimensions and locations of each field.

C. Acreage of each field.

D. Source of water for irrigation and the location of the source — well or canal.

E. Location of the canal system on the farm and the direction of water flow.

F. Direction of irrigation on each field.

G. The dimensions and location of the farmstead.

H. A scale or ruler to use in laying out the farm.

I. Pencils—black and colored.

The location of each object or field should be made by measuring the distance from a particular place, such as corner of the farm, as the purpose is to place them on a map with a known scale.

Meeting No. 6

Farm Map For Your Farm

Why Have a Farm Map?

A map of the farm will make the keeping of records and planning for changes in farming practices, crop rotations, and irrigation practices much easier. Many records for the three years of this project will be based on the farm map.

Changes in the farm during the project can be placed on a new map and a "before-and-after" demonstration made of the maps.

What the Farm Map Should Contain

The farm map should include:

1. Your name.

2. Scale of measurement used so that the map can be checked for accuracy.

3. Dimensions of the field.

4. Acreage of each field so that amounts of yield per acre, amount of water used, and other computations can be easily made.

5. Source of water showing whether the water comes from a well or canal so that any planning of irrigation on the different fields can be made easily.

6. Canal system on the farm and direction of flow so that it can easily be seen how the water reaches each field.

7. Direction of irrigation on each field so that the layout of the field can be more easily understood.

8. Type of ditch, whether lined or unlined, open or covered. This

could determine the methods of irrigation.

9. Number the fields for ease in keeping records of work done and crop yields on each field.

10. The area covered by the farmstead and any non-cultivated land with reasons for non-use.

Assignment
For Next Meeting

All records should be completed and neatly placed in the record book so that it will be ready to turn in, since the next meeting is the last one for the first year of the project.