LIMESTONE

HOW TO USE IT

WHEN TO USE IT

WHERE TO USE IT

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Illinois Farmers Have Used a Mountain of Limestone

In the last fifteen years, Illinois farmers have used more than 62 million tons of limestone. This mountain of limestone has meant millions of dollars in higher income for those farmers who used it, and for their communities. Did you get your share?

Limestone to sweeten acid or sour soils so that good crops of legumes can be grown has always been an important part of the Illinois System of Permanent Soil Fertility. With this system you can build up a strong, healthy soil and keep its fertility high. The system can be divided into five steps.

1. **Test the soil** for lime, phosphorus, potassium, and other plant food elements to find out what plant foods are needed and how much of each is needed.

2. **Apply the materials needed** — limestone, phosphate, potash, or other material — in the amounts called for by the soil tests.

3. **Grow heavy crops of legumes** at least once every four years and return them to the soil, either as legumes or as manure. They will supply nitrogen and organic matter to the soil, make its tilth better, and help control erosion. Rolling land needs legumes and grass more often to control erosion.

4. **Save the fertility in manure and in crop residues** such as straw and cornstalks and return them to the land. They also will supply organic matter and conserve nitrogen and other plant foods.

5. **Hold soil and fertility on the slopes**. Where soil treatment and a good rotation are not enough to control erosion, make use of terraces, contour farming, and grass waterways. Use rough land for hay, pasture, or timber.

In this circular we are concerned chiefly with the use of limestone. But in a system of permanent soil fertility, all five steps are essential.
Illinois farmers have used 4 to 5 million tons of limestone each year for the past several years. But in spite of this large tonnage, there is a big job ahead. We still have more than 10 million acres of crop and pasture land that need limestone for efficient and profitable farming. In addition, about 2½ million tons of lime are needed each year just for maintenance — to replace the lime removed by crops and lost by leaching.

Over fifty years ago, in 1902, the first limestone used on Illinois soils was applied to plots on the University soil-experiment fields. Four years later only a meager 122 tons were applied to Illinois farm land. From this small beginning, the use of limestone increased spectacularly — to almost 1 million tons in 1929 and then to a record of about 5,600,000 tons in 1946. For many years Illinois farmers used a fifth to a sixth of all the agricultural limestone used in the United States.

But the important thing to you individually is whether your own liming program is up to par. You cannot afford to farm without limestone if your land needs it. You will find yourself richer in both your soil-fertility bank account and your regular bank account if you use limestone and use it right.

Long-time experiments on twenty-one University soil-experiment fields show that limestone, when used along with legumes and other soil treatments, has meant $18.71 an acre in higher crop yields. This has meant a return at the rate of $63.36 per ton of limestone used. (These figures are based on crop yields and crop prices for the four-year period 1948 to 1951.)

The fifty years of research on the soil-experiment fields have shown that to be productive the land needs legumes. Legumes and legume-grass mixtures are the foundation of sound soil improvement and erosion control, as well as of efficient livestock feeding and management. Crop land should grow heavy crops of legumes at least every four years. If the land is subject to erosion, it may need to be in legume-grass a third of the time or even oftener.

Limestone is needed on acid land to grow legumes successfully. Where phosphate and potash are short, they must also be applied.

Limestone is stockpiled during periods when limestone spreaders cannot get on the fields.
Why Soils Need Limestone

Limestone’s job is to correct soil acidity and to supply the plant foods calcium and magnesium to the crops. Calcium (along with magnesium in some limestones) is the part of limestone that corrects soil acidity.

Soil is said to be “sweet” when it contains enough lime material (calcium, magnesium, and other acid-neutralizing or basic elements) to neutralize 80 percent or more of the acid in the soil. Such soil contains enough lime for maximum growth of legumes such as clover and alfalfa.

Soil is “acid” when there is not enough calcium or other basic elements to neutralize 80 percent of the acid in the soil. Soil becomes acid because its calcium is used up by crops and carried away in drainage water. Unless limestone is added, sweet soil gradually becomes acid and acid soil becomes even more acid.

Soil contains very fine clay and organic matter, both of which can absorb and hold calcium, magnesium, and other basic elements. They can also hold hydrogen, which is an acid element. When calcium and magnesium are removed in the drainage water or are taken up by plants, their place is taken by hydrogen. The soil then becomes acid. Liming reverses this process. The calcium and magnesium that are released as the limestone dissolves replace the acid hydrogen and the soil becomes sweet. But the limestone must dissolve before it can change the acidity of the soil.

An acid soil will not grow the best crop. Soil acidity brings about a number of conditions that are unfavorable to crops and to soil bacteria.

When a soil becomes strongly acid, certain elements like manganese are dissolved in the soil solution and are taken up in amounts that are harmful to the plant. As soil becomes medium to strongly acid, the phosphorus in the soil is changed into forms that crops are less able to use.

Many desirable soil bacteria cannot grow well in an acid soil. For example, an acid soil discourages the growth and activity of bacteria that bring about the decay of organic matter. This is also true of other important bacteria such as the nitrogen-gathering bacteria which live on the roots of the legumes and the nitrogen-fixing bacteria which live independently in the soil. This means that a farmer on an acid soil is not getting his share of the free nitrogen that these nitrogen-fixing bacteria can take out of the air.

Much of the lime that grain crops use comes back to the soil because most of it is in the straw and stalks. A legume hay crop does remove a large amount of lime, but if the crop is fed, most of the lime is returned in the manure. Leaching losses will vary widely — from 100 pounds per acre per year for soils with tight subsoils to more than 300 pounds for those with open subsoils.
Test Your Soil for Lime

Our Illinois land varies from sweet to strongly acid. Land in southern Illinois does not vary as much in degree of acidity as that in central and northern Illinois.

Most of the naturally sweet land is in the central and northern parts of the state. Some of these areas of sweet soil are an acre or less in size; some cover several hundred acres. Some of the areas—such as "alkali" or "shelly" spots in northern Illinois—actually have too much lime material. If you put lime on naturally sweet areas, you may do more harm than good, because the extra limestone may reduce the availability of phosphorus and certain trace elements.

The only way you can know for sure how much lime to apply is to make a systematic test of each of your fields. Even within a single field, different parts will often vary in their need for lime. Your test may show that one area of several acres does not need limestone while other areas may need 2 to 4 tons an acre. Some land is slightly acid and needs only 2 tons of limestone to the acre to correct the acidity. Other land is medium acid and needs 3 tons. Still other areas are strongly acid and need 4 tons or more.

It's important to put on the correct amount of lime. If 3 or 4 tons are needed to correct acidity, 2 tons won't prevent legume failures. On the other hand, it is not good business to spread 4 tons where 2 tons will do the job.

What a pH reading means. In Illinois, farm land is tested for acidity and the need for limestone by the Comber test, but another method that is often used is known as the pH test. This test measures alkalinity also, which is the opposite of acidity. A soil that is neutral—neither acid nor alkaline—has a pH value of 7. Readings above 7, such as 7.5 or 8, indicate alkalinity. Readings below 7 indicate acidity, the degree of acidity increasing as the readings drop below 7.

Land that has been limed in amounts called for by the soil test and which tests sweet by the Comber test is actually slightly acid according to a pH test. A slight acidity as shown by the pH test, somewhere around 6.2 to 6.7, is considered the most favorable for the production of most crops. Soil with this slight acidity gives little or no color when tested by the Comber method and is considered to have plenty of limestone for the growth of legumes.

The drawing shows the pH readings that correspond to the different degrees of acidity and to the different limestone requirements indicated by the Comber test.
What Kind and What Size of Limestone

Several kinds of lime material can be used

Ground limestone makes up the bulk of the liming materials used by Illinois farmers. It is natural limestone that either has been crushed especially for use on land or is a byproduct in the production of building or road stone.

Chats, a byproduct of lead mining, are frequently used in the southern Illinois area near the lead-mining district of Missouri. Chats from this district are dolomitic limestone (containing both calcium and magnesium) and seem to equal ordinary ground limestone for correcting soil acidity.

Lime sludge, a byproduct of city and railroad water-softening plants, is used for liming farms near these plants. On the dry basis, this material usually tests 82 to 92 percent as effective as pure calcium limestone. Lime sludge is difficult to spread and the manure spreader seems to be the most satisfactory implement for handling it.

As it is found in the pile, lime sludge is usually high in moisture. This moisture can be considered an impurity since it adds to the cost of handling, hauling, and spreading. If you don’t know what the water content of the sludge is, you can pay for the material and the trucking by the cubic yard to avoid paying for the water.

Neutralizing power differs

Most of the limestone sold in Illinois is of good quality, but some has a rather low value because of its coarseness or its low neutralizing power. Your county farm adviser or county PMA (Production and Marketing Administration) office can give you detailed information on the quality of limestone from the various quarries serving your area.

Pound for pound some limestone has a greater neutralizing power than others. Neutralizing power is usually expressed in terms of calcium carbonate although it is determined by the amounts of calcium carbonate and of magnesium carbonate which the limestone contains. Limestone from some quarries contains only calcium carbonate and is known as calcium limestone. That from other quarries contains both calcium carbonate and magnesium carbonate and is known as dolomite or dolomitic limestone.

You can compare the neutralizing ability of different limestones by comparing their “calcium carbonate equivalent” (c.c.e.). This is the usual measure of neutralizing ability. Pure calcium limestone contains 100 percent calcium carbonate and its neutralizing value is expressed as 100 percent. Calcium limestone that contains 90 percent calcium carbonate and 10 percent impurity has a value of 90 percent c.c.e.

Magnesium carbonate has a greater neutralizing ability than calcium carbonate. Eighty-four pounds of magnesium carbonate is equal in this respect to 100 pounds of calcium carbonate. Limestone that contains magnesium carbonate may therefore have a neutralizing value of more than 100 percent.

8-mesh limestone is fine enough

Finely ground limestone will correct acidity faster than the coarsely ground. The finer limestone has
mixing there seems to be no great advantage in grinding finer than 8-mesh. This means the material will pass through an 8-mesh screen (8 openings to the inch each way; each particle would be less than \( \frac{1}{16} \) inch in diameter). Such material contains considerable fine dust and will correct acidity fast enough for all practical purposes. On the other hand, the coarser particles in the 8-mesh limestone not only have some immediate value but they make the effect of the limestone last longer.

If it were possible to get perfect distribution throughout the soil, an extra-fine grade of limestone might correct acidity considerably faster than 8-mesh material, but the distribution of limestone particles in the soil is usually far from perfect, so there is no great advantage to an extra-fine grind. Any advantages of grinding finer than 8-mesh are not great enough to justify paying the higher price for the finer material.

**How Limestone Works**

Limestone works slowly and may need four or five years to finish the job.

When limestone is first applied, diskimg and harrowing scatter the particles rather unevenly through the top 2 or 3 inches of the surface soil. Each particle begins to dissolve and to correct the acidity of the soil around it.

During the first year, each particle may neutralize an area an inch in diameter or less. In between these areas of sweet soil will still be zones of acid soil. During the first few years, the acid zones are still considerably larger than the nonacid areas around the limestone particles. This means that if you test your soil again within a few years after you limed it, you are likely to get many of the samples from the larger acid areas and the tests will show the soil apparently to be as acid as before liming.

Whatever such a test shows, if you have done the job right, your legumes will be able to get enough lime from the sweet areas around the scattered limestone particles, and after all, you are applying the limestone primarily for the legumes. Doing the job right means applying the amounts called for by the soil test, mixing the limestone thoroughly with the soil, and allowing several months for the particles to establish areas of sweet soil.

The slow results from coarse limestone are due to the small number of particles per ton, which are able to establish only thinly scattered areas of sweet soil.
When and How to Apply Limestone

Apply limestone at least 6 months or, better yet, a year before seeding legumes. This is especially important when you are liming a field for the first time. Limestone often fails to do the job expected because not enough time is allowed for the particles to establish areas of sweet soil, from which young legume plants get the lime they need.

Work the limestone into the seedbed. Disking and harrowing will distribute the limestone particles throughout the top 2 or 3 inches of soil, where they will be within easy reach of the young legume roots. Where liming a field for the first time, don’t plow the lime under directly ahead of the legume seeding. Plowing turns the acid soil up and turns the limed layer down where it is out of reach of the young legume seedling.

If you are reliming a field, it does not matter if you plow the limestone under. There should still be enough limestone left from the previous application to take care of the needs of the young legume plants. Also in reliming it is not necessary that the lime go on at least 6 months ahead of the legumes.

Be sure the lime is spread evenly. This means that you have to be willing to pay enough to get a good job done. If the trucker does a poor job, it will show when the legumes come up. If he fails to lap enough, you are likely to find regularly spaced strips with little or no legumes, as happened in the field shown below. These strips didn’t get enough limestone to correct the acidity. These bare strips will often add up to a fifth or more of a field that is seeded in legumes. For a 40-acre field this means clover or alfalfa failure on 8 acres. This could easily amount to a loss of 15 to 25 tons of legume hay and pasture, or about $300 to $500 for the legume crop alone. The legume failure would also mean a loss in yield of corn and other crops grown later on these 8 acres.
Where to Apply Limestone

You can apply limestone at a number of places in the rotation.

On land plowed for corn or soybeans. You can apply the limestone in the spring on the land for corn or beans where spring grain and legumes are to follow. This is an ideal place in the rotation.

On land plowed for winter grain where legumes are to follow. This method permits you to work the limestone thoroughly into the surface soil about 6 months before you seed the legume. Don’t wait until after the grain is sown because then you cannot work the limestone into the soil.

On soybean stubble. Another good place for limestone (if there is no danger of loss by erosion) is on soybean stubble where small grains and legumes are to follow. Apply the limestone as soon as you can after combining the soybeans so the limestone will have more time to correct acidity before the legumes are seeded. Disk in the limestone soon after applying in order to mix it with the soil.

On cornstalk ground. You can apply limestone to cornstalk ground where you are going to seed small grain and legumes without plowing. In central and northern Illinois, however, cornstalks should be plowed down for corn-borer control. If your corn is harvested in time for fall-plowing, limestone can go on anytime after you plow. Fall-plowed fields, however, are usually rather rough for the lime truck.

On permanent pastures. Limestone can be put on permanent pastures where legumes are to be seeded as part of a pasture-improvement program. If you are going to plow up the pastures to prepare a seedbed, put the limestone on after plowing and work it in. Apply the limestone at least 6 months ahead of the time you are going to seed the legumes.

Other places. If you are reliming a field before it has become very acid, the limestone can go on at almost any place in the rotation. It can even be plowed under, if that is more convenient. You can put it on legume seedings after the small grain is combined, on legume sod, or on cornstalks.
How Long Will Lime Last?

You will probably not need to relime for ten or fifteen years if you applied the amount of lime called for by your soil test. Just how long it will last depends on the subsoil drainage, the acidity of the soil, the amount you put on, the fineness of the material, and your cropping system.

Many farmers make the mistake of applying limestone too often. They may use 4 tons of limestone to the acre and then when legumes do not do well, they assume that the soil needs more limestone, so they put on another 3 or 4 tons without considering that something else may be causing the legumes to fail. On many of these farms, soil tests have later shown that the failures were due either to a lack of phosphorus or of potassium or both. The $10 to $15 an acre spent for the limestone that the soil did not need should have been spent for phosphate or potash.

Sometimes farmers test their soil within a few years after they first put on the limestone and because soil often will still test acid within so short a time, they believe they need more limestone. A test for acidity within four or five years after liming is not, however, likely to be satisfactory, for reasons explained on page 7.

After you have applied as much limestone as your soil test calls for, you do not need to test again for about eight years.

Of course it is even worse to wait too long to retest and relime, and then to lose a legume stand because your previous application of limestone was used up.
Phosphate and Potash Also Needed

Often legumes will fail or produce only a poor crop even though the land has had plenty of lime. Usually the trouble is that the land lacks phosphorus or potassium or both.

More than 60 percent of the farm land in the state needs phosphorus and about 40 percent needs potassium for high yields of legumes and other crops. The need for potassium is especially critical in southern Illinois. In central and northern Illinois its lack is not as severe or as widespread. But on many farms the need for potassium is causing serious losses in crop yields. Your soil tests will tell you if you need phosphorus and potassium as well as limestone.

Boron is another plant food that seems to be needed for alfalfa in many areas of Illinois. The shortage of boron is most serious in southern Illinois, but shortages are sometimes found in central and northern Illinois. A testing service for boron has been started by the University. If you suspect a shortage of boron, see your farm adviser about having tests made at the University's Soil Testing Laboratory.

Magnesium does not as yet seem to be short in Illinois soils, although some areas may be approaching a shortage. The University is continuing to study the magnesium question in the field and in the laboratory. A test for magnesium is now being developed.

Lime and Rock Phosphate Can Be Applied Together

Farmers often wonder whether they can apply limestone and rock phosphate together. The answer is yes. If your soil tests show that both are needed, then go ahead and put them on together. The important thing is to get these materials on the land especially for the legume seeding.

The question comes from the belief that limestone will more or less permanently tie up the phosphorus in rock phosphate. Actually there is a temporary tie-up of the phosphorus, which shows up especially when wheat follows immediately after the application of limestone and rock phosphate. Even this tie-up is not very important, for you are applying the rock phosphate mainly for the legume that is seeded in the wheat. The phosphorus needs of wheat can be taken care of by drilling a small amount of superphosphate in addition to the rock phosphate.

Rock phosphate can be applied before or after planting corn or soybeans. The picture shows application after planting corn.
Limestone Can’t Do the Job Alone

Limestone is only one member of your soil-fertility team. Another very important member, and the one for whom you apply the limestone, is legumes. You can think of the legume as your nitrogen fertilizer factory. An acre of a heavy crop of legumes can take from 150 to 200 pounds of nitrogen from the unlimited supply in the air. They also improve the tilth by manufacturing three to five tons an acre of valuable organic matter.

Legumes and legume-grass mixtures have a double-barreled effect in protecting sloping land. The thick cover that they form protects the soil against beating rains and holds it against washing. The organic matter that they add makes the soil better able to absorb rainfall, and so cuts down erosion, even when corn and other crops are growing on the land.

Some farmers have not grown legumes often enough—maybe they have planted them only once every eight or ten years when they were needed every four years. They forget that although the limestone may be good for ten to fifteen years, the legumes for which the limestone is applied are needed by the soil much oftener than that.

Try to keep the whole fertility team in balance—limestone, legumes, and all the other members. The limestone and legumes will not be able to do the job they should if your land also needs phosphorus and potassium. Nor can you afford to improve your soil, and then let the fertility wash away with every rain that comes. You need a good well-balanced coordinated team with each member doing his part.

The soil tests offer a practical guide in organizing a balanced soil-fertility team. As we have already pointed out, these tests will tell you where limestone, phosphate, and potassium are needed and how much of each is needed. See your farm adviser about having these tests made.