Understanding Your Soil Test Report

This publication is being sent with your *Soil Test Report* to help you understand the results of the soil analyses and the recommendations, and to help you supply profitable nutrient applications to each crop in your cropping system. The first section deals primarily with the analyses and recommendations. The "Profit Pointers" section gives more details about lime and fertilizer sources and time and method of application.

The *Soil Test Report* is a record of the analysis of the soil samples you sent earlier to the Iowa State University Soil Testing Laboratory. The upper left area of the report shows the laboratory analyses of organic matter (o.m.), phosphorus (P), potassium (K), zinc (Zn), sulfur (S), soil pH, and buffer pH. Each of these is discussed in this publication. The remainder of the report gives computerized nutrient recommendations for specific crops based on the soil analyses.

The nutrient rates recommended are for good management and favorable subsoil moisture and should give maximum net profit per acre. If management is average, crop outlook is poor (less than 100 bu. corn), or money is limiting, the nutrients can be applied at two-thirds the recommended rate for each nutrient.

For soils testing high in phosphorus and/or potassium, maintenance recommendations based on crop removal are made to maintain the soil test level. For soil testing very high in phosphorus and/or potassium, no fertilizer additions are suggested because increasing the test level is not economical and there is the possibility of creating other nutritional problems in crops.

Determining Nutrient Needs

The process of determining nutrient needs requires four parts:

1. a good soil sample representative of a given land area;
2. soil test procedures to measure nutrient availability;
3. interpretation of soil test results; and
4. fertilizer recommendations for different soil and environmental conditions.

Remember, any soil test results, however reported—pounds per acre (lb/A), parts per two million (pp2m), or parts per million (ppm)—are an index of nutrient availability and not the actual pounds per acre available to a given crop. Environment, the soil itself, and available nutrients in the subsoil will affect the amounts of nutrients taken up from the tillage zone.

Fertilizer recommendations are based on yield increases obtained from field experiments using various rates and combinations of nutrients under different soil, weather, and management conditions. Because of this, recommendations for a given crop will vary across Iowa according to soil test level, soil type, distribution of phosphorus and potassium in the subsoil, and the area within the state. Special considerations are made for poor internal drainage and physical conditions that limit crop growth.

Soil Analyses

Organic Matter (o.m.)

The chemically determined organic matter test is useful in determining herbicide rates. Organic matter content is a soil characteristic that greatly affects activity in the soil of many herbicides. It tends to attract and hold herbicide molecules (adsorption) and makes them less available in the soil solution for uptake by the weed seed or seedling, thus affecting the subsequent physiological action and hastening death of the weed.

Depending on the herbicide's chemical structure, the chemical may be strongly to weakly adsorbed to the organic matter and clay colloids of the soil. If strongly adsorbed, rate of chemical needed will be greatly influenced by the organic matter content. If weakly adsorbed, the rate of chemical needed will be less affected by organic matter levels.

Phosphorus (P)

The soil test for this nutrient uses a dilute acid extractant better known as the Bray P_1 test. This test measures a portion of readily available phosphorus. The results are reported in parts per 2 million (pp2m) of P, which is equal to pounds per acre in a plow furrow slice 6⅔ inches deep.

Soil test values above 40 pp2m are classified as high. This means no or very little yield increase is obtained from further additions of phosphorus to soils that test 40 pp2m or more. A maintenance recommendation for phosphorus fertilizer is given for soils testing 40 to 60 pp2m. This recommendation, based on crop removal for yields specified on the front of the *Soil Test Report*, is to maintain the current soil test level. Test values above 60 pp2m are classified as very high, and no phosphorus fertilizer is recommended, except that a small amount (no more

Prepared by Regis D. Voss and Randy Killorn, extension agronomists.

Cooperative Extension Service
Iowa State University
Ames, Iowa 50011

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than the quantity in 100 pounds of a common starter grade) could be applied to corn. A very high test value receives no recommendation because of the danger of creating other plant nutrition problems, and because increasing the test value further is simply uneconomical.

Potassium (K)

The soil test for this nutrient uses the normal neutral ammonium acetate extractant. This test measures the water-soluble and exchangeable potassium. Field-moist (undried) samples are tested by the Iowa State University Soil Testing Laboratory. Testing field-moist samples gives lower soil test values than those obtained from dried samples. ISU research has shown that this procedure gives a better measure of the potassium available to plants. The results are reported in parts per 2 million (pp2m) of K, which is equal to pounds per acre in a plow furrow slice 6⅔ inches deep.

Soil test values above 200 pp2m are classified as high. This means no or little yield increase is obtained from further additions of potassium to soils that test 200 pp2m or above (field-moist samples). A maintenance recommendation for potassium fertilizer is given for soils testing 200 to 300 pp2m. This recommendation, based on crop removal for yields specified on the front of the *Soil Test Report,* is to maintain the current soil test level.

Test values above 300 pp2m are classified as very high, and no potassium fertilizer is recommended except that up to 100 pounds of a common starter grade could be applied to corn. A very high test value receives no recommendation because of the danger of creating other nutritional problems, and because increasing the test value further is simply uneconomical.

Zinc (Zn)

The soil test for this nutrient uses an organic chelate extractant, DTPA, and the results are reported in ppm of Zn. The soil test values have been divided into three categories: low (L), marginal (M), and adequate (H). The recommendations in pounds of zinc per acre for each category are 10 for L, 5 for M, and none for H. The most zinc sensitive crops grown in Iowa are corn and sorghum. Soybeans are somewhat sensitive.

The recommendation for zinc is based on the use of inorganic products such as zinc sulfate. Generally, broadcast and plowdown is the most effective method of application. Banding is also effective and may be preferred with shallow or minimum tillage. One application of 5 to 10 pounds of zinc per acre (15 to 30 lb. of zinc sulfate 36 percent Zn) to corn or sorghum should be sufficient for 2 to 4 years. This also will be sufficient for other crops in the cropping sequence.

Effective zinc chelates may be used at about one-third the rate of inorganic products and may be banded or broadcast. Applications should be repeated for each subsequent corn or sorghum crop.

Sulfur (S)

The soil test for this nutrient uses a calcium phosphate extractant that measures water-soluble and sorbed sulfate. The results are reported in ppm of S. The soil test values have been divided into three categories: low (L), marginal (M), and adequate (H). The most sulfur-sensitive crops grown in Iowa are alfalfa and clover. Corn is somewhat sensitive. The recommendations in pounds of sulfur per acre for each category for alfalfa and clovers are 30 for L, 20 for M, and none for H. Similarly, the recommendations for corn are 20 for L and none for M and H.

Scientists at Iowa State University have been unable to demonstrate a response to S fertilizer in over 20 years of experiments. Yield increases of corn or alfalfa may be obtained from sulfur application on coarse textured soils with low organic matter content. Application of sulfur to soils with medium to high organic matter and/or fine texture should be made on a trial basis only.

The recommended sulfur for forage legumes should be broadcast. It can be broadcast for corn. If the sulfur for corn is to be applied as a starter, apply no more than 10 pounds per acre (half the recommended rate). Some common sources of sulfur and sulfur contents are: elemental sulfur (85-99 percent S), gypsum or calcium sulfate (15-18 percent S), potassium sulfate (17-18 percent S), ammonium thiosulfate solution (20 percent S), and potassium magnesium sulfate (18 percent S).

Soil pH and Buffer pH

Soil pH and buffer pH are on the report form. These two measures of soil acidity mean different things.

Soil pH is a measure of the *degree* of soil acidity or of the *active hydrogen* in the soil solution. This hydrogen is present in the soil solution as positively charged particles or ions. It would take less than a pound of lime per acre to neutralize the acidity in the soil solution of a very acid soil.

Buffer pH is a measure of the *amount* of soil acidity or of the *potential acidity.* The potential acidity is due to the hydrogen held by the negatively charged soil particles of clay and humus. Hydrogen ions on the surface of these particles are known as exchangeable ions because they can be replaced by other positively charged ions such as calcium, magnesium, or potassium.

The buffer solution added to the soil replaces some of the hydrogen held by the clay and humus. The pH of this soil-buffer solution mixture is the buffer pH. The buffer pH of many Iowa soils has been calibrated with the amount of limestone (lb. of ECCE) needed to change the soil pH to 6.5 and 6.9, and the limestone recommendations are based on this calibration.

A Comparison

The degree of soil acidity (measured by soil pH) compares with the temperature of water, whereas the amount of acidity (measured by buffer pH) compares with the amount of water at a particular temperature. As an example, you may have either a cupful or a pailful of boiling water. The temperature of the water is the same in both containers, but the water in the pail has more total heat and more ice would be required to cool it to the same temperature. Thus, two soils may have the same soil pH, but the soil with the higher amount of clay and organic matter will have the lower buffer pH and thus the higher lime requirement.

An example:	Soil A	Soil B
Soil pH	6.0	6.0
Texture of soil	Sandy loam	Clay loam
Buffer pH	6.6	6.2
Lime requirement to raise soil pH to 6.5 (lb. ECCE per A)	2100	5000

Profit Pointers

Liming

The limestone recommendation is expressed as pounds of 100 percent effective calcium carbonate required to neutralize soil acidity in the plow depth specified on your *Soil and Cropping Information Sheet* and repeated on your *Soil Test Report*. If no plow depth was given, the liming rate recommended on the *Soil Test Report* is for a depth of 6 inches for forage legumes and 8 inches for cultivated row crops.

Which Rate

Two rates of calcium carbonate are shown for each sample on your *Soil Test Report*. Liming to pH 6.5 is sufficient for corn, soybeans, grass, and establishment of legume seedlings. Liming to near neutrality (pH 6.9) will give maximum yields of forage legumes and will not limit yields of other crops.

Pounds of Calcium Carbonate

Your liming recommendation is given in pounds of pure calcium carbonate. The amount of agricultural limestone required to fulfill the calcium carbonate recommendation depends on the quality (effectiveness) of the limestone. Effectiveness is determined by the purity or composition and the fineness of the limestone material in comparison with pure, fine calcium carbonate. This measure is called Effective Calcium Carbonate Equivalent (ECCE). The ECCE must be provided for limestone sold in Iowa according to the Iowa Agricultural Limestone Law.

Example: Recommended rate of calcium carbonate: 4,500 pounds
ECCE of limestone: 60 percent
Required amount of limestone: 4,500 divided by .60 equals 7,500 pounds.

Previous Applications

Applications of lime within the past 2 years may affect the amount now required. This amount will depend on uniformity of spreading, how well it was worked into the soil, and the year of application. If good practices have been used for previously applied limestone, the following allowances may be made:

1. Within 6 months after application, deduct the full amount applied from the recommended rate.

2. One year after application, deduct half the amount applied from the recommended rate.

3. Two years after application, deduct one-fourth of the limestone previously applied from the recommended rate.

4. More than 2 years after application, use the recommended rate.

Application of Limestone

Since lime reacts slowly in the soil, it should be applied 6 months to 1 year ahead of the legume seeding. Then soil acidity will be reduced by the time the seeding is made. However, crops grown after the lime application and prior to the seeding will also benefit. For any cropping system, apply limestone before tilling the soil.

Uniform spreading on the land surface and mixing into the plow layer are assumed when making a limestone recommendation. Because lime moves very slowly in the soil and since uniform mixing is difficult to attain, it may be several years before the lime can be completely effective in neutralizing soil acidity in the plow layer. Spreader passes should be lapped to avoid alternate good and poor crop strips in following years. Do not allow limestone spreading trucks on the field when the soil is too wet in the spring.

Different soil types within one field may require more or less limestone than the major part of the field. Heavier additions may be applied either by double treatment or by a heavier initial rate.

More complete and basic information on liming recommendations, tests for limestone needs, and an explanation of the calcium carbonate basis are given in Pm-812, *Lime for Iowa Soils and Crops*. This publication is available through your county or area extension office.

Changing Nutrient Recommendation into Amounts of a Fertilizer Grade

The percent of nutrients in a fertilizer is called the fertilizer grade analysis. Fertilizer analysis is commonly expressed in the elemental form for nitrogen (N) and the oxide form for phosphorus (P_2O_5) and potassium (K_2O). This is the way it is currently marketed.

If your *Soil Test Report* indicates a need for 80 pounds of P_2O_5 and you wish to use 0-46-0 as the fertilizer to supply this need, divide the 80 pounds by the 46 percent P_2O_5 written as a decimal, 0.46, to obtain the pounds of 0-46-0 needed. The answer is

$$\frac{80}{0.46} = 174 \text{ pounds of 0-46-0 per acre.}$$

Choosing Fertilizers to Fill Nutrient Needs

Be sure to take into account the N contributions from legumes and the N, P_2O_5, and K_2O contributions from manures (See *Animal Manure: A Source of Crop Nutrients,* Pm-1164). Suggested values are given in tables 1, 2, and 4. Assume a recommendation of 190 + 70 + 70 for corn that is to follow soybeans. What fertilizers or nutrient sources would you use to fill this need? This can be set up as a subtraction problem as follows:

	N	P_2O_5	K_2O	
	190	+70	+70	fertilizer recommendation
−	40			N from soybeans (table 1)
	150	+70	+70	adjusted fertilizer requirement
	150	+70	+70	adjusted fertilizer requirement
−	6	−24	−24	row application of 6:24:24
	144	+46	+46	adjusted fertilizer requirement
	144	+46	+46	adjusted fertilizer requirement
−	144			N preplant or sidedress
	0	+46	+46	fertilizer to be plowed down

We may choose a need of 6-24-24 to be supplied by a row fertilizer. You could use 100 pounds of the common starter grade 6-24-24, which is a 1:4:4 ratio. Another choice would be a 1:2:2 ratio, which could be either 240 pounds of liquid 5-10-10, 120 pounds of solid 10-20-20, or suspension 10-20-20. This latter ratio would supply more nitrogen than the 1:4:4 ratio but this can be adjusted by reducing the amount of N applied preplant, plowdown, or sidedress.

There are several approaches to fill the 144 + 46 + 46 nutrient needs:

1. You could plow down a bulk blend or liquid mix of the P and K need and preplant or sidedress the remaining N need.

2. You could plow down a bulk blended material formulated to supply the entire nutrient.

3. You could plow down any liquid, suspension, or dry material with a 1 to 1 ratio of P_2O_5 to K_2O fulfilling the P_2O_5 and K_2O needs and preplant or sidedress the remaining N needs.

There may be economic advantages in one of the alternatives, either from a labor and service standpoint or from the cost of the fertilizer. Check your crop production and economic situation, and use your pencil to determine which approach is best for you.

Fertilizing Corn or Grain Sorghum

The fertilizer needs for corn can be applied by any one or combination of methods and times of application and fertilizer materials. The most popular approach is to broadcast a bulk blend or liquid mix of phosphorus and potassium sources, preplant or sidedress the nitrogen, and in some areas of the state use a row fertilizer at planting time to complement the total fertilizer program. Suggestions for various approaches are made in the following section.

Methods and Time of Applying Phosphorus (P) and Potassium (K)

Amounts of P_2O_5 and K_2O greater than 40 pounds should be broadcast and tilled into soils testing low to very low. For clean tillage systems, plowing down these nutrients is better than disking them in because deeper placement is achieved. Deep placement keeps the P and K, which move very slowly in the soil, in contact with moist soil longer during dry weather. Thus, plants are able to take up plowed-under P and K over a longer period of time compared to disk-in. Deep placement is not as important in conservation tillage because surface crop residue and less tillage help retain a moist soil condition. Where no-plow tillage is practiced, knifing in of P and K at usual plow depth may be considered. In addition, depth of placement is less important on high testing soils.

Optional maintenance applications of P and K on high testing soils for continuous row crop (for example, corn-soybean sequence) may be made every other year. Remember, a maintenance application is for soils already testing high and thus little or no yield increase will occur. Since P and K are essentially nonleachable, time of application is not critical.

Winter Application

Winter application of P and K fertilizer is feasible in areas of traditional fall plowing. Whether fertilizer is applied in winter depends on slope of fields, crop residue or crop cover, conservation practices, and snow cover.

The major considerations are having fertilizer in contact with the soil surface, moving the fertilizer into the soil, and not losing it through sheet erosion. Because most fertilizer materials are water soluble, loss can occur in snow melt runoff if the fertilizer does not come in contact with the soil surface. Fertilizer can be applied on fields that are level to nearly level, with or without snow cover. Some snow melt runoff would be expected because fertilizer spread on snow must melt through the snow to contact the soil.

Fertilizer can be winter-spread on fields with slopes not exceeding 5 percent if crop residue, contour rows, or other conservation practices are there to slow runoff. The fertilizer can be spread on a light snow cover if the fertilizer can melt through the snow. Do not spread fertilizer on fields in winter where sheet erosion is likely to occur.

Fields with predominant slopes greater than 5 percent should be carefully judged before winter application of fertilizer. Do not apply fertilizer in winter on such fields if runoff will be rapid, or if sheet erosion probably will occur.

Method and Time of Applying Nitrogen (N)

Sources

All N sources will give comparable yield results if applied properly and if applied at the same rate of actual N. Anhydrous ammonia is 82 percent N. The low-pressure solutions also contain ammonia and can range from 20 to 40 percent N. The no-pressure 28 to 32 percent N solutions are a combination of ammonium nitrate and urea. Some 19 percent N no-pressure solutions containing only ammonium nitrate are occasionally marketed. The solid sources of nitrogen are: ammonium nitrate, 33.5 percent N; urea, 45 percent N; and ammonium sulfate, 21 percent N.

Preplant Application—This may be done before or after plowing. Before plowing, solid or no-pressure solutions may be broadcast and plowed under. Anhydrous ammonia and the low-pressure solutions applied before plowing should be injected 2 inches below the plow layer if you plow 6 inches deep or less. For plow depths greater than 6 inches, inject the N about half the plow depth, but be sure a good seal can be obtained. Proper depth of application will help prevent opening up the center of the injection zone when plowing and help prevent loss of ammonia to the atmosphere.

After plowing, preplant applications can be made in a variety of ways. Broadcast applications of solid sources and no-pressure solutions can be made. Solid urea or that contained in no-pressure solutions applied to high-lime (calcareous) soils should be incorporated shortly after application to minimize volatilization losses. The incorporation of ammonium nitrate into the soil is less important on high-lime soils. Always remember that surface application of N will stimulate weed growth, but use of herbicides makes the practice feasible.

Anhydrous ammonia applied preplant should be injected 6 to 8 inches—deep enough to get a good seal. Low-pressure N solutions should be injected at least 4 inches deep, or deeper if necessary to obtain a good seal. Insist on a good seal of the knife opening regardless of the pressure material or the depth of application. When the soil is in good condition to till, a good seal is easy to obtain. Covering devices should be used regardless of soil condition to help insure a good seal over the knife openings.

If free ammonia comes in contact with the seed, the seed may not germinate or germination and growth may be slowed. To reduce or eliminate this risk from knifed-in ammonia or banded urea, get a soil separation between the seed and the N source. Placing the fertilizer 6 to 8 inches deep combined with planting at a depth not to exceed 2 inches should give this soil separation. Time, moisture, temperature, and concentration of the N source influence the potential effect of shallow-placed ammonia sources on germination. Delaying planting 3 to 5 days after shallow preplant application is helpful, but this doesn't guarantee elimination of damage.

Sidedress Application—Sidedressing N is still a sound practice. It can be done any time after planting but preferably before the corn is 10 to 14 inches tall. With row spacing of 30 inches or less and/or contour rows, application knives may damage the corn. When sidedressing anhydrous ammonia or low-pressure solutions, inject deep enough to obtain a good seal. Broadcast applications of no-pressure N solutions on emerged corn may produce a burning effect on the corn leaves similar to a frost. Usually this is not a lasting effect.

Fall Application—Fall application of nitrogen is a management decision.

The concept of fall N application is to apply an immobile form (ammonium) of nitrogen and to minimize the conversion to a mobile form (nitrate). This conversion is made by bacteria and is most rapid in moist soils at temperatures above 50 degrees F.

If you want to apply an immobile or nonleachable ammonium nitrogen—which is held by the clay and organic matter—use sources containing primarily ammonia, ammonium, or urea. For most of the N to remain as ammonium, the soil temperature must be 50 degrees F or lower and getting colder. These temperatures occur, on the average, after October 15 in northern Iowa, after October 25 in central Iowa, and after November 1 in southern Iowa. Some conversion to nitrate will occur at all temperatures above 32 degrees F.

Nitrogen in the nitrate form is free to move as water moves in the soils. If soils are at or near saturation in the fall, the probability of significant N loss is high. Fall applications should be avoided under such conditions. If nitrate nitrogen moves below the root zone, do not expect fall application to be as effective as spring preplant or sidedressing applications. Losses of nitrate nitrogen can also occur due to denitrification in very wet soils.

Split Applications—Splitting the fertilizer recommendation between sidedress and fall or early spring applications is a management decision. Sidedressing part of the nitrogen may insure the proper amount of N for the stand level and weather. But this possible gain should be weighed against the extra cost and labor of application and the risk of not getting it applied.

Split application allows more flexibility of the N rate and tends to insure available N throughout the rooting zone. Consider all factors for your corn production system.

Row Fertilizer

A row application should complement your total fertilizer program. It can be used for starter effect only or to supply the total P_2O_5 or K_2O needs if they are less than 40 pounds and the proper method of application is used. The starter effect will be greatest in a wet, cool spring. On well-drained soils, particularly in western and northwestern Iowa, row application gives little or no advantage over broadcast application.

Two ways to place row fertilizer include sideband and with the seed (pop-up). Both should use a complete fertilizer containing N, P, and K.

Banding versus Broadcast

As more acres are converted to some form of conservation tillage, there is increasing interest in banding P and K fertilizers as a way to increase their efficiency of use by growing crops. This is an important consideration since broadcast applications are not incorporated into the root zone, and hence P and K tend to become concentrated in the upper few inches of the soil profile.

The decision whether to band or broadcast P and K fertilizer should be based on a knowledge of soil test levels of the nutrients. An abundance of evidence indicates better uptake of banded P and K, and hence higher yields, when soil tests are low. If the soil tests are in the medium to high range for P and K, banding or broadcasting of P and K fertilizers produces equivalent results.

Sidebanding should place the fertilizer to the side and slightly below the seed. There is no particular limit to the rate as long as the fertilizer is placed below the seed. Sideband placement is preferred for heavy row applications. However, large amounts are more efficiently broadcast and plowed under.

Placement with the seed (pop-up) is in the seed furrow. The fertilizer ratio should be a 1:4:1 or 1:4:2 to help avoid salt damage to the seed from N and K_2O. The rate per acre should be limited to about 12 pounds of N plus K_2O for 40-inch rows, 18 pounds for 30-inch rows, and 24 pounds for 20-inch rows. Phosphorus need not be limited as long as these ratios are maintained. Use of greater amounts increases risk of salt damage. This method promotes early starter effect but may delay emergence.

More information can be found in Pm 361, *Three Ways to Place Row Fertilizer.*

Water-Soluble Phosphorus

Fertilizers to be used in a starter application should contain at least 50 percent of the phosphorus fraction in water-soluble form. A solubility of 80 percent may increase corn yield 1 to 2 bushels over 50 percent solubility. A solubility of 100 percent will not generally be better than 80 percent, according to Iowa tests. The percent of water-soluble P is much less important at high soil test values. On acid soils there is essentially no difference due to water solubility of manufactured fertilizers. On high-lime soils, there is a trend in favor of the more soluble phosphorus in the year it is applied broadcast. The N and K in mixed fertilizers are not of concern because water-insoluble N sources are too expensive to put into farm fertilizers, and K must be water-soluble by law.

Fertilizing Soybeans

Soybean yield response to P and K may generally be expected if soils test low or very low in phosphorus, potassium, or both. Fertilizer for soybeans can either be sidebanded near the row at planting time or broadcast and plowed under before planting. A consistent advantage for any one application method has not been observed. Direct application of nitrogen is generally not needed for soybeans.

Phosphorus source comparisons have not been made in Iowa with soybeans. All common phosphorus fertilizers, except rock phosphate, should be equally effective. Sources high in water-soluble phosphorus may have a slight advantage on high-lime soils.

All potassium sources should be equally effective.

Fertilizing Small Grains (Seeded)

The objective in fertilizing small grain (seeded) is to obtain a good yield of grain and at the same time allow establishment of a good legume, legume-grass, or grass seeding. The fertilizer needs shown on your *Soil Test Report* are designed to meet this objective and to furnish the necessary nutrients for the small grain and seeding establishment. The effectiveness of the fertilizer is governed by the method of application and the nutrient sources used.

Time and Method of Application

Fertilizers for oats, barley, wheat, and flax are usually applied at planting time in the spring, except for winter wheat. Regardless of when small grain is planted, however, the fertilizer can either be drilled with the seed or broadcast and disked in ahead of planting. Drilling the recommended fertilizer rate with the seed offers some yield advantage over broadcasting and disking in both seed and fertilizer.

Winter application of fertilizer on frozen ground or on top of light snow for next spring's small grain crop is satisfactory if fertilizer is applied on level land. Applications on rolling land farmed on the contour may be satisfactory if water runoff is not a problem. Winter applications should be avoided on rolling land that is not contoured because fertilizer loss and pollution could occur due to water runoff or soil erosion.

If fertilizer cannot be applied at time of planting, it may be topdressed after planting up to one week after emergence.

Fertilizer Sources

All common dry or liquid fertilizers are acceptable for small grains and seedings.

If low-pressure N solutions or anhydrous ammonia are to be used as sources of N, inject them 4 to 6 inches deep, respectively. Space knives about 10 inches apart for uniform results.

Fertilizing Established Legume-Grass Meadows

The fertilizer recommendations given in your *Soil Test Report* for established legume-grass meadows are intended to maintain good legume stands and produce high total yields of the mixture over a period of years. Since the legumes are emphasized, the fertilizer recommendations are almost always for P and K. If you wish to stimulate the grass, apply N up to the rate recommended for grass pastures.

Methods and Sources

Topdress in the fall or as early as possible in the spring. If topdressing is not possible in the spring because of wet ground, topdress after the first crop of hay has been removed. Do not disk in fertilizer.

All common dry or nonpressure liquid single-nutrient or mixed fertilizer sources are equally effective for topdressing. To avoid streaked growth in the field, apply nutrients uniformly.

Fertilizing Grass Pastures

Nitrogen most frequently limits the yield obtained from grass pastures. Phosphorus and potassium needs are not as critical with pasture grasses as with other crops, but these nutrients may be important in specific instances. Topdress all required P and K along with one of the nitrogen applications before growth begins in the spring. If nitrogen is applied separately, it might be more convenient to double the P and K rate, apply it in early spring or fall, and let it last for 2 years.

If the growth of one of the tall grasses is in excess of that needed for pasture, you may wish to make one cutting of hay. In this case you should request a recommendation for tall grass—hay and pasture—because the P and K needs are higher than for pasture only, because of removal.

Methods and Sources

Bluegrass, should be fertilized with N early in the spring. For stimulation of fall growth, apply N about the middle of August before expected late summer rains.

Orchardgrass, bromegrass, and reed canarygrass should be fertilized once early in the spring for N rates less than 120 pounds. For N rates above 120 pounds, a split application between early spring and mid-June would be desirable for these tall grasses. If N is reapplied, a proportionate amount of the recommended P_2O_5 and K_2O should be reapplied. If "stockpiling" of these tall grasses for fall and winter grazing is the goal, a single application in the spring may be made with any rate of N.

All N sources are equally acceptable if properly applied. Topdress dry and liquid N, and any P and K needed, when there is a minimum of leaf surface exposed. Because of the low cost of anhydrous ammonia there is interest in using it on pastures. This material must be knifed in and sealed, which presents problems on grass sods. More study is needed before it can be generally suggested. However, if you do use it, follow these guidelines: Inject low-pressure nitrogen solutions 4 inches deep with knives spaced 10 inches apart. Use the same spacing for anhydrous ammonia, but apply it 6 inches deep.

Fertilizing Sorghum-Sudan Pastures

The nutrient requirements of sudangrass are high, especially for nitrogen and phosphorus. Seedbed preparation and fertilizer applications should be made in much the same way as for a crop of corn. Additional N, such as 40 pounds per acre, can be topdressed after each grazing period. See comments in the section "Fertilizing Grass Pastures" on methods and sources of fertilizer.

Table 1. N contribution to first- and second-year corn following legume.

	1st-year corn following:					2nd-year corn following:	
	50-100% legume meadow	20-50% legume meadow	0-20% legume meadow	Legume green-manure	Soybeans for grain	2 years 50-100% legume meadow	1 year 50-100% legume meadow
Pounds of N Contribution	140	100	20	100	1 lb N/bu beans produced	30	20

Table 2. Suggested average N, P_2O_5 and K_2O content for barnyard manure with some bedding in year applied.

	Nutrients, lb per ton		
Kind of manure	N	P_2O_5	K_2O
Cattle or hogs	5	5	10
Sheep	10	10	20
Poultry	20	45	12

Table 3. Estimated tonnage capacity for various manure spreader sizes.

Spreader size		Tons of manure
Bushels	Cubic feet	
60- 80	75-100	1.2
90-110	112-137	1.7
120-140	149-174	2.2
150-170	187-211	2.7

Table 4. Approximate nutrient content of various manure forms.

	N		P_2O_5		K_2O	
Type of manure	lb/1,000 gal.	lb/T (wet basis)	lb/100 gal.	lb/T (wet basis)	lb/1,000 gal	lb/T (wet basis)
Liquid, beef	26.6	—	19.1	—	30.0	—
Liquid, swine	55.0	—	27.0	—	34.0	—
Open feedlot runoff, beef	1.8	—	0.6	—	2.7	—
Open feedlot solids, beef	—	10.0	—	9.2	—	13.3

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