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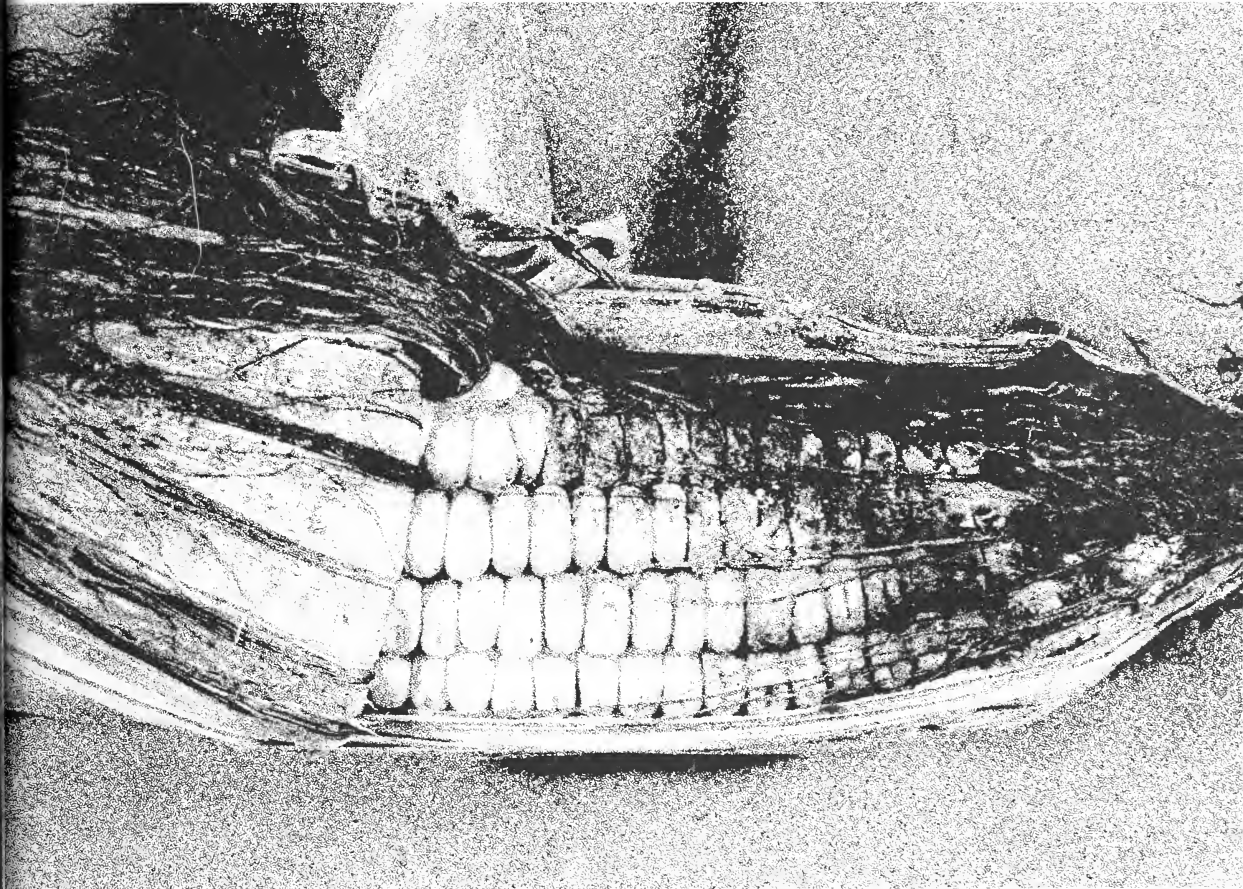

ILLINOIS AGRONOMY HANDBOOK 1971

The Cover. Two important facts were re-emphasized by the epidemic of Southern Corn Leaf Blight in 1970. The first is the hazard of "sameness," and the second is the value of research discoveries that have been stored on the shelf.

The danger of disease damage and a narrow genetic base has long been recognized and avoided because resistance to disease is normally genetically controlled. There had been no strong indication until 1970 that a broad source of cytoplasm was desirable for the same reason. The Texas source of male sterile cytoplasm has been used by the seed corn industry since the early 1950's to eliminate or reduce the cost and problems with detasseling the seed parent in seed production fields. The new race of Southern Corn Leaf Blight dramatically demonstrated that variation in cytoplasm is as important in disease control as is variation of genetic constitution.

Fortunately, USDA researcher Dr. J. B. Beckett, stationed at the University of Illinois several years ago, isolated several cytoplasms that controlled pollen shed. There was little interest in these new sources of male sterile cytoplasms at that time because the Texas source was widely used and there was no evidence of any problems unique to it. The new male sterile cytoplasms were put "on the shelf," but not forgotten.

As soon as the relationship between Texas male sterile cytoplasm and the new race of leaf blight was first suspicioned, Dr. A. H. Hooker of the Plant Pathology Department "dusted off" the cytoplasms discovered by Dr. Beckett and checked them for susceptibility to the new race of blight. Several were found to be resistant. It is probable that some seed corn will be produced within the next two or three years using one or more of these sources of male sterile cytoplasm.

CONTENTS

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THE 1970 CROP-GROWING YEAR

Floods, drouths, and southern corn leaf blight will make 1970 a year that most Illinois farmers won't soon forget.

Southern corn leaf blight will be blamed for almost everything that was wrong with the 1970 corn crop. And it probably does deserve most of the blame for low yields, poor quality corn, and harvest problems.

However, 1970 was never destined to be a bumper crop year. It started and finished wet over most of the state. The heavy rains in April, May, and early June delayed corn and soybean planting, and caused many farmers and fertilizer dealers to wonder whether most of the pre-plant nitrogen had been lost. Fortunately, much of the applied nitrogen likely had not been converted to nitrate, hence was not lost by either leaching or denitrification.

The heavy spring rains and the resulting flooding and ponding caused more than the usual amount of replanting.

Plowing for corn and soybeans was well ahead of normal in the fall of 1969. An estimated 55 percent of the land intended for these crops had been plowed by mid-December. There was practically no plowing in March, but it progressed rapidly in April. The heavy rains of late April and May delayed the finish of plowing until quite late.

April and May temperatures were ideal for rapid crop development. The first two weeks of June were warm and the last two weeks were cool. The first few days of July were hot, but the month averaged a little cooler than normal.

Drouth followed the heavy spring rains in some areas in northwestern, southeastern, and southwestern Illinois.

The new race "T" of southern corn leaf blight was first identified by plant pathologists as being present in Illinois in late June. By early August, the seriousness of the disease was readily apparent. It could be found in most Illinois corn fields by late August and in some the damage to the crop was already severe.

August temperatures were about average and so was rainfall except in western Illinois where it was above normal. September was both wet and warmer than usual.

By September the effects of southern corn leaf blight were evidenced by the earlier than normal maturity of infected corn. Five percent of the crop was harvested during the first two weeks of September and harvest would have progressed rapidly had the weather allowed.

The November 1 preliminary yield estimates for 1970 by the Cooperative Crop Reporting Service, compared with final estimates in 1968 and 1969, were:

	1968	1969	1970
Corn (bu./A)	89	98	75
Soybeans (bu./A)	31.5	33.5	31
Wheat (bu./A)	36	37	36
Oats (bu./A)	66	61	57
Hay (tons/A)	2.72	2.66	2.76

CORN

1970 Season

Early planting (April) was reported only in northwestern, central, and southwestern Illinois in 1970. Planting progressed slowly until after mid-May when the rains stopped long enough to allow planters in the field for more than one day at a time. Eighty-five percent of the intended acreage had been planted by June 1. This was a little above average for that date. However, some of the acreage remaining did not get planted until in July in southern Illinois.

The new race T of southern corn leaf blight was the most important single factor affecting the 1970 corn crop in Illinois. Fields which were severely infected by this disease produced exceptionally low yields. In addition, the corn harvested from these fields was low in quality. Weight per bushel was low and the presence of damaged kernels was usually high.

By mid-August the seriousness of this new race of southern corn leaf blight was no longer in question. It not only could cause lesions on the leaves, but it could also attack leaf sheaths, stalks, ear shanks, and penetrate husks to cause an ear rot. The damage caused by this disease, plus the other stalk rots such as Diplodia and Gibberella that were sure to infect the weakened plants, clearly pointed up the wisdom of early harvest as a means of avoiding excessive harvest losses.

Many farmers started harvesting as soon as their corn was mature. In some cases soybeans were left unharvested in preference to saving the corn crop.

The new race of southern corn leaf blight primarily attacks corn plants with the Texas male sterile type of cytoplasm. Plants with normal cytoplasm are resistant to the new race of the disease.

The corn plants' ability to shed pollen can be controlled by factors within the cytoplasm as well as in the genes. The Texas male sterile cytoplasm is one of the types that controls pollen shed and has been widely used by seed corn producers to reduce or eliminate the need to detassel the seed production rows in hybrid seed corn production fields.

Prior to the sudden appearance of "race T" the appearance and performance of plants with the TMS type of cytoplasm was identical, with the exception of pollen shed, to that of plants of the same variety with normal cytoplasm.

The supply of seed with normal cytoplasm which is resistant to "race T" will be limited in 1971. Seed corn producers will increase foundation seed of the normal cytoplasm version of their popular varieties during the 1970-71 winter and hopefully produce enough seed with normal cytoplasm in 1971 to eliminate the fear of an epidemic in 1972 such as occurred in 1970.

Meanwhile you may want to consider stretching your supply of seed with normal cytoplasm by reducing plant population. Experiments (see Tables 1, 2, and 3) indicate that the sacrifice for reducing population several thousand plants per acre under the optimum may be no greater than 8 to 10 percent.

Planting Date

Plant early if possible. Yields will be higher on the average. In addition the plants will be smaller, ears lower, and more uniform in height.

Start anytime after April 1 in southern Illinois, April 10 to 15 in central Illinois, and April 20 to 25 in northern Illinois. In central and northern Illinois the corn planted in April may yield no more than that planted during the first few days of May. However, starting in April improves your chance of finishing in early May.

The temperature of the soil may be used to help you decide whether to start planting in April — don't worry about soil temperature after May 1.

Here are two useful guides, though they may not be correct all the time.

1. Plant when the temperature at *7:00 a.m. reaches 50°F. at the 2-inch level.* This will assure a temperature favorable for growth during most of a 24-hour period if there is an appreciable amount of sunshine.

2. Plant when the temperature at *1:00 p.m. reaches 55° F. at the 4-inch level.* The 4-inch level is suggested for the 1:00 p.m. measurement because this level is not affected as much as the 2-inch level by a single day of bright sunshine. After May 1 in central Illinois and May 10 in northern counties, *plant if the soil is dry enough even though temperature is below* the suggested guidelines. Perhaps a simple way to say it is: early in the season plant according to soil temperature; later on plant by the calendar.

Incidentally, soil temperature data put out by the weather bureau are taken under sod where the midday temperature at 2 to 4 inches is often 8 to 12 degrees lower than under bare ground.

Degree Days and Corn Development

Temperature records can be used to predict the maturity development of corn. The greater the amount of solar energy received, the more rapid the development of corn toward maturity. Corn hybrids of differing maturities require differing amounts of solar energy to reach maturity.

The "degree day" is used to describe and record the solar energy received.

In 1970 the Illinois Cooperative Crop Reporting Service and the Weather Bureau calculated and reported the accumulation of growing degree days for the state during the period April 1 to November 1.

The formula used was:

$$\frac{\text{Maximum daily temperature} + \text{Minimum daily temperature}}{2} - 50 = \text{growing degree days}$$

Since corn grows little, if at all, at temperatures lower than 50° F., this temperature is substituted for the actual minimum whenever the daily minimum drops below 50° F. Eighty-six degrees is substituted for the maximum whenever the daily maximum exceeds 86° F. Therefore, 50° F. is the lower cutoff temperature and 86° F. the upper cutoff temperature. The estimated growing degree days and departure from average for 1970 are:

	Section of state				
	NW	NE	W	C	E
April 1-Oct. 1	3,305	3,295	3,610	3,684	3,574
Departure from average	− 42	− 32	− 25	+138	+118
	WSW	ESE	SW	SE	
April 1-Oct. 1	3,845	3,940	4,217	4,196	
Departure from average	−149	+ 45	−112	− 22	

Planting Rate

The optimum planting rate might be defined as the one that will result in the maximum population that can be supported with normal rainfall and distribution without excessive barren plants or pollination problems. This population will be slightly more than optimum in years with less than normal rainfall and probably less than optimum in years of higher but not excessive rainfall.

Many facts must be known before determining the optimum population for a particular field. These include:

1. The crowding tolerance of the variety. Varieties differ in their ability to tolerate high populations (Table 1).

2. The fertility level, especially nitrogen. Increase the amount of nitrogen applied as population increases (Table 2).

Table 1. — Effect of Crowding on Corn, Urbana, Illinois, 1966

Variety	Plants per acre planted in 30-inch rows		
	16,000	24,000	32,000
		Bushels per acre	
A	127	140	153
B	126	98	62

Table 2. — Effect of Nitrogen and Plant Population on Corn Yields, Northern Illinois Experiment Field

Nitrogen	Plants per acre		
	16,000	22,000	28,000
Pounds per acre		*Bushels per acre*	
0	88	83	76
240	139	148	158

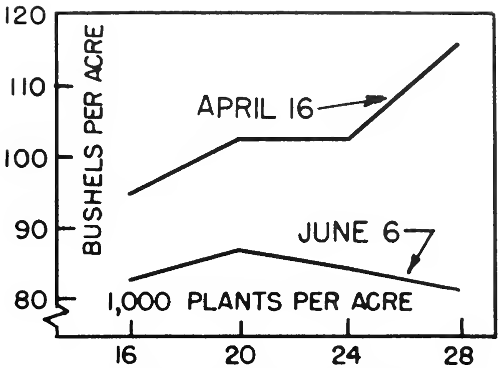
Table 3. — Effect of Row Width on Corn Yield, Urbana, Illinois, 1964-66

Plants per acre	Row width	
	40 inches	30 inches
	Bushels per acre	
16,000	127	132
24,000	133	144
32,000	126	138

3. Row width used. Population can usually be increased 2,000 to 4,000 plants per acre when rows are narrowed from 40 inches to 30 or 20 inches without any serious increase in barrenness or pollination problems. The result is an increase in yield (Table 3).

4. Planting date. Varieties that tolerate high plant populations may be planted at a higher population when planted early than when planted late (Fig. 1). There are several reasons for this. First, the early planted corn is shorter. Second, the early planted corn is more likely to pollinate during a period with favorable rainfall and temperature. Third, less of the subsoil moisture reserve has been used up. Moisture stress during the pollinating period is aggravated by high population.

In summary, a specific recommendation on planting rate is impossible unless such facts as the soil type, fertility level, date of planting, and so on, are known. If you are changing varieties or making a major change in some other practice, increase the population by 2,000 to 4,000 plants per acre over that which you normally use. Do this in two or three places in the field and check the effect of the increase in the fall.



Planting date and population, Dixon Springs, 1968. (Fig. 1)

Research in Progress

High-lysine corn made its commercial debut in 1969 and more seed will be available in 1971.

Lysine is one of the amino acids essential to animal life. Ruminants need not be concerned whether the protein they eat contains this amino acid because the microflora in their rumen can synthesize lysine from lysine-deficient protein. Non-ruminants cannot do this, so swine, poultry, and humans must have a source of protein that contains sufficient lysine to meet their needs.

Normal dent corn is deficient in lysine. The discovery in 1964 that the level of this essential amino acid was controlled genetically and could be increased by incorporating a gene named Opaque 2 was exciting news to the corn geneticist and the animal nutritionist.

The potential value of this discovery to the swine farmer was obvious when feeding trials demonstrated that growing swine needed very little additional protein when fed high-lysine corn.

Agronomic research work with high-lysine corn indicates that it is slightly lower in yield and higher in moisture than its normal counterpart. It also has a softer kernel which sometimes contributes to stand loss under adverse weather conditions.

Current research with more sophisticated hybrids indicates that the differentials in yield may be overcome. Continued work will probably solve the other problems in the future.

Swine growers should explore the possibility of growing high-lysine corn.

Liguleless or upright-leaved corn development and research indicates these types are more tolerant of high populations. One form of the upright leaf angle is controlled by a gene known as liguleless. Upright leaves in the upper part of the corn plant allow more light to penetrate deeper into the leaf canopy, providing more solar energy for leaves in the lower half of the plant at the ear-shoot level.

Illinois researchers have shown that as the corn leaf becomes more upright the amount of photosynthesis done by a given area of a leaf is slightly less. However, the upright leaves allow more light to penetrate into the canopy and enable the lower leaves to conduct photosynthesis at a greater rate than under heavily shaded conditions. Better distribution of light energy over the plant should return a higher yield.

High-oil corn. In the summer of 1896, Dr. C. G. Hopkins started breeding corn for high oil content. With the exception of three years during World War II, this has been a continuing research at the University of Illinois. The oil content of the material that has been under continuous selection has been increased to 17.5 percent as compared with 4 to 5 percent which is normal for dent corn.

Until recently efforts to develop varieties that were materially higher in oil than normal dent corn resulted in disappointing yield performance. Recent research results, which involve new gene pools of high-oil material unrelated to the original Illinois High Oil, indicate that varieties which contain 7 to 8 percent oil may be produced with little or no sacrifice in yield.

Commercial high-oil varieties will be available in 1971. The question of yield as compared with normal corn will be determined in the field. However, there will probably be little difference.

Since oil is higher in energy per pound than starch, a ration containing high-oil corn should have some advantage over one containing normal corn. However, only a few feeding trials involving high-oil corn have been conducted, so the merit of high-oil corn as a livestock feed has yet to be determined.

The corn-milling industry has indicated interest in high-oil corn. Whether this will continue will depend on the demand for corn oil. One of the reasons for the increased interest in corn oil is because of its high ratio of polyunsaturated fatty acids to saturated fatty acids. Corn oil is considered a desirable oil in the human diet because of this characteristic. The use of oils, which are high in unsaturated fatty acids, is believed to lessen the hazard of the accumulation of lipid or fat material in the arteries.

Nitrogen Applications for Corn

The most profitable rate for nitrogen depends not only on the cropping system and amount of manure applied, but also on the kind of job a farmer does in growing corn. Farmers who make better choices of planting date, hybrid, population, and weed-control practices may profitably apply far more nitrogen than their neighbors for the same kind of soil and cropping system.

Adjust rate for date of planting. Research at the Northern Illinois Research Station for several years showed that as planting was delayed, corn responded less to nitrogen fertilizer. Based upon that research, Illinois agronomists suggest that for each week of delay in planting after the optimum date for the area, the nitrogen rate may be reduced 20 pounds per acre down to 80 to 90 pounds per acre as the minimum for a corn-soybean cropping system for very late planting. Suggested reference dates are April 10 to 15 in southern Illinois, April 20 to May 1 in central Illinois, and May 1 to 10 in northern Illinois. Obviously the nitrogen is sidedressed.

Because of the importance of planting date, farmers are encouraged not to delay planting in order to apply fertilizer: plant, then sidedress.

Nitrogen-potassium balance. The idea is widespread that you should apply 1 pound of potassium for each pound of nitrogen. It is not based on any research or reliable farm comparisons.

Much has been made of the effect of nitrogen-potassium balance on stalk rot. Though research has clearly shown that the combination of high nitrogen and low potassium often accentuates stalk rot, there is no evidence that you can reduce stalk rot by adding potassium when the soil test is already high.

Situation 1. Corn in a continuous corn or corn-soybeans grain-farming system: use 125 to 250 pounds of nitrogen per acre.

The lower rate is suggested for fields where soil physical properties often limit yields to 100 bushels or less (sands and poorly drained, slowly and very slowly permeable soils). The higher rate is only for highly productive soils (150 bushels or more per acre in favorable years) on which excellent supporting practices are used and where the application is split between preplant and sidedress.

High rates of nitrogen increase the nitrogen content of residues returned to the soil, thus increasing the nitrogen the soil can supply for the next corn crop and reducing the fertilizer needed.

If you plan to apply more than 150 pounds, consider a split application: 125 to 150 pounds in the fall or in the spring before planting, and an additional amount as a sidedressing if warranted. When the corn is 12 to 18 inches tall, evaluate your crop prospects. Estimate how well your fall or early spring application has been preserved. If you planted early, and have 20,000 or more plants per acre, weeds under control, and a good supply of subsoil moisture, then sidedress with 75 to 100 pounds of nitrogen. If the crop outlook is not favorable, you may dispense with sidedressing unless you feel that nitrogen loss from your previous application was large.

Situation 2. Corn following soybeans, a small grain (no catch crop), or one year of corn in a farming system that includes a legume hay crop or catch crop once in 5 to 6 years: use 100 to 150 pounds of nitrogen per acre on dark-colored prairie soils and 125 to 150 pounds on light-colored timber soils.

Apply the lower rate in either case where soil physical properties limit yields to only 80 to 100 bushels with good management. The higher rate is suggested for superior management on soils with 5-year average yields in the 100- to 125-bushel range. These soils will produce 150 to 180 bushels in the best years without uneconomically heavy rates of fertilizers.

Situation 3. Corn following a good legume sod or 10 tons of manure per acre: use 75 to 150 pounds of nitrogen per acre.

Dark prairie soils with a good legume sod or 10 tons of manure will usually supply enough nitrogen for 100 bushels of corn per acre. Farmers who aim for 150 to 180 bushels will need to apply 100 to 150 pounds of nitrogen per acre.

For light-colored timber soils and the claypan soils in south central Illinois, 100 to 125 pounds of nitrogen are suggested. The top rate is less than for dark soils because yield potentials are less.

Which nitrogen fertilizer? Each nitrogen fertilizer has certain advantages and disadvantages over all others. For many uses on a wide variety of soils, all nitrogen fertilizers are likely to produce about the same yield increases.

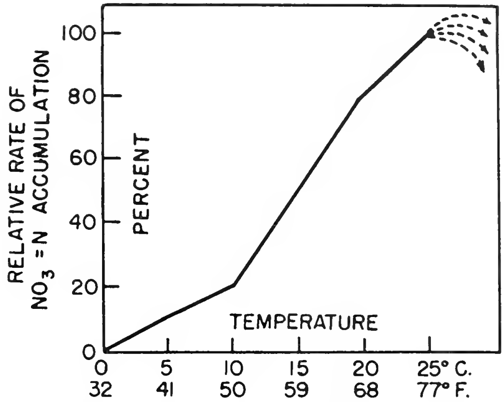
One exception is that fertilizers containing a considerable part of the nitrogen in nitrate form are not suitable for fall application on any soil or early spring application on sandy soils because of the likelihood of leaching. Nor are they suitable for soils that are often very wet in April and May because of possible loss by denitrification. Anhydrous ammonia probably has a slight advantage for fall application because the high NH_3 concentration delays nitrification and thus keeps more of the nitrogen in the ammonium form, so that it cannot be lost by leaching or denitrification.

Time of Nitrogen Application

Choosing the best time to apply nitrogen fertilizer requires an understanding of how nitrogen behaves in the soil. Key points to consider are the change from ammonium (NH_4^+) to nitrate (NO_3^-) and the movements and transformations of the nitrate.

Nearly all of the nitrogen applied in the Midwest is in the ammonium form or converts to ammonium (anhydrous ammonia and urea, for example) soon after application. Ammonium nitrogen is held by the soil clay and organic matter and cannot move very far until after it nitrifies (changes from ammonium to nitrate).

Whether the ammonium nitrifies in the fall depends



Influence of soil temperature on the relative rate of NO_3 accumulation in soils. (Fig. 2)

mainly on soil temperature after application (Fig. 2). Agronomists generally suggest that fall application be delayed until the soil temperature at 4 inches deep is 50° F. or less. The reason for this is that nitrification proceeds only one-half as rapidly at 50° F. as compared with 60° F., 1/10 as rapidly at 40° F., and stops completely at 32° F. *Average dates* on which these temperatures are reached are not satisfactory guides to use because of great variability from year to year. Local dealers and farmers can make good use of soil thermometers to guide fall nitrogen applications.

In Illinois most of the nitrogen applied in late fall or very early spring *will be converted to nitrate by corn-planting time.* Though the rate of nitrification is slow (Fig. 2), the period of time is long during which the soil temperature is between 32° F. and 40° to 45° F.

Nitrogen is lost by denitrification or leaching. *Only nitrogen in the nitrate form can be lost by either route.*

Denitrification. Denitrification is believed to be the main pathway of nitrate and nitrite nitrogen loss, except on sandy soils where leaching is more important. Denitrification involves only nitrogen that has already been converted from the ammonium form to either nitrate (NO_3^-) or nitrite (NO_2^-).

The amount of denitrification depends mainly on: (1) how long water stands on the soil surface or how long the surface is *completely saturated;* (2) the temperature of the soil and water; and (3) the pH of the soil.

When water stands on the soil or when the surface is completely saturated in fall or early spring, nitrogen loss is likely to be small because (a) much nitrogen is still in the ammonium rather than nitrate form and (b) the soil is cool and the denitrifying organisms are not very active.

Many fields in east central Illinois and to a lesser extent in other areas have low spots where surface water collects at some time during the spring or summer. The flat claypan soils also are likely to be saturated though not flooded. Sidedressing would avoid the risk of spring loss on these soils, but would not affect midseason loss. Unfortunately, these are the soils on which sidedressing is difficult in wet years.

The higher the pH the more rapid the denitrification loss, being almost twice as rapid at pH 6.8 as at 6.0.

Denitrification is difficult to measure in the field, but several laboratory studies show that it can happen very fast. At temperatures that are common in midsummer, most nitrate nitrogen can be lost within 3 to 5 days at pH 6.0 or above.

Leaching. One inch of rainfall moves down about one-half foot in silt loams and clay loams, though some of the water moves farther in large pores through the profile and carries nitrates with it.

In sandy soils each inch of rainfall moves nitrates down about one foot. If the total rainfall at one time was more than 6 inches, little nitrate will be left within rooting depth.

Between rains there is some upward movement of nitrates in moisture that moves toward the surface as the surface soil dries out.

Corn roots usually penetrate 5 to 6 feet in Illinois soils. Thus nitrates that leach 3 to 4 feet are well within normal rooting depth.

The fact that 6 or more inches of rain fell in some areas in a short time does not mean that 6 inches of water moved through the soil, thus flushing out nitrates. The infiltration capacity (rate at which water can enter the soil) of silty and clay soils is not high enough to allow all of the rain to enter the soil during high-intensity rainfalls. Most of the water runs off the surface either into low spots or into creeks and ditches.

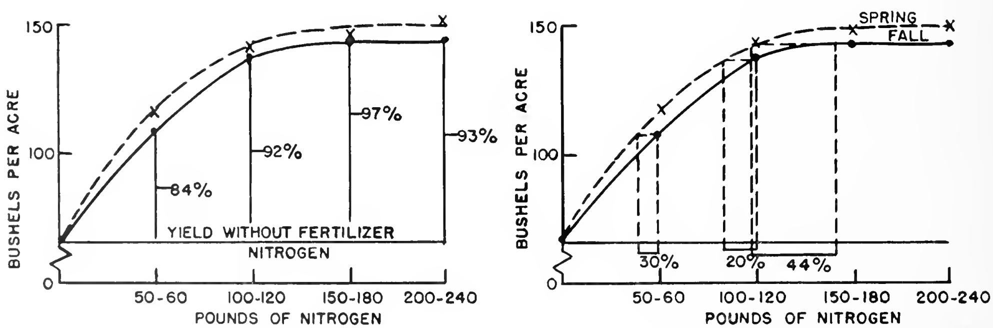
The soil is often already saturated during rainy periods, hence further rainfall either runs off or forms ponds on the surface in low spots. In either case, it does not simply move all of the nitrates down or out of the soil, except in low spots where one to two feet of water moves down to the tiles.

Nitrogen losses in 1970. Some areas in Illinois reported 20 inches or more of rainfall in April, May, and June. Much of the nitrogen that was in the nitrate form was undoubtedly lost either by leaching or denitrification. But the fact that many fields became wet soon after nitrogen application and stayed wet for several weeks probably kept the ammonium from nitrifying, hence the nitrogen was not susceptible to loss by either leaching or denitrification. Continued heavy rainfall beginning in late May or early June would have been much more serious because more nitrogen would have been in the nitrate form.

Fall, spring, or sidedressed nitrogen? In recent years farmers in central and northern Illinois have been encouraged to apply nitrogen in the fall in non-nitrate form, except on sandy, organic, or very poorly drained soils, any time after the soil temperature at 4 inches was below 50° F.

The 50° level for fall application is believed to be a realistic guideline for farmers. Applying nitrogen earlier involves risking too much loss. Later application involves risking wet or frozen fields, which would prevent application and fall plowing.

The results from 18 experiments in central and northern Illinois in four recent years (Fig. 3) show that fall-applied ammonium nitrate was less effective than spring-applied nitrogen. There are two ways to compare efficiency. For example, in Figure 3, left, 120 pounds of nitrogen applied in the fall produced 92 percent as much increase as the same amount applied in the spring. But looked at another way, it required 120 pounds to produce as much increase in the fall as was produced by 100 pounds in the spring (Fig. 3, right). At higher nitrogen rates the comparison becomes less favorable for fall ap-



Comparison of fall- and spring-applied ammonium nitrate, 18 experiments in central and northern Illinois, 1966-1969 (DeKalb, Carthage, Carlinville, and Hartsburg). Percentages in figure at left indicate increased yield resulting from use of fertilizer. Percentages in figure at right indicate how much more fertilizer you need to apply in the fall to obtain yields equal to those with spring applications. (Fig. 3)

plication because the yield leveled off 6 to 8 bushels below that from spring application.

No results are available to compare fall, spring, and sidedressed applications of a nitrogen source that is entirely in the ammonium form. Ammonium nitrate contains one-half of the nitrogen in nitrate form. The effectiveness of fall-applied nitrogen would likely have been greater if an all-ammonium form had been used. The failure of the highest rate to offset the lower efficiency from fall-applied ammonium nitrate remains a mystery.

In consideration of the date at which nitrates are formed and the conditions that prevail thereafter, *the difference between late-fall and early-spring applications of ammonium sources in susceptibility to denitrification and leaching loss is probably small.* Both are, however, more susceptible to loss than is nitrogen applied at planting time or as a sidedressing.

Five-year comparisons of spring and sidedressed nitrogen at DeKalb in northern Illinois show that spring and sidedressed applications were equal. In dry years spring application was better. In wet years, sidedressing was better.

Anhydrous ammonia nitrifies more slowly than other ammonium forms and, therefore, is slightly preferred for fall applications. It is well suited to early spring application, provided the soil is dry enough for good dispersion of ammonia and closure of the applicator silt.

The cost of nitrogen is now so low that even moderate loss is a relatively small factor in deciding when to apply nitrogen. Of more concern is the fact that increasing the rate has often not offset the lower efficiency of fall application (Fig. 3).

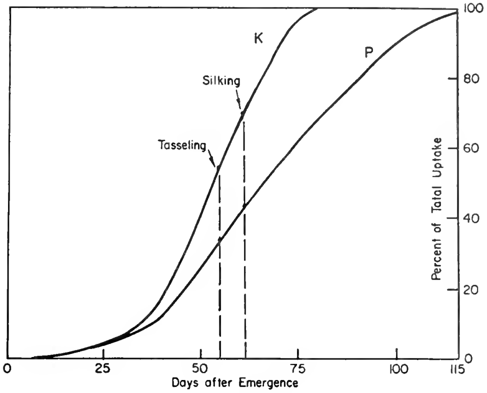
Another major concern is the fate of the nitrogen that is not used by the crop. Research is urgently needed to quantify the pathways of nitrogen losses under field conditions. If most of it returns to the air through denitrification, there is no problem. But if a substantial portion leaches into ground water, steps will likely be taken at some future date to restrict fall and early-spring application. Society is deeply concerned and will likely insist upon practices that minimize nitrates in water.

Secondary and Micronutrients

No deficiencies of secondary nutrients (calcium, magnesium, sulfur) have been identified on corn in Illinois where soil is pH 5.5 or above.

Illinois agronomists have not found any deficiencies of the micronutrients zinc, iron, manganese, copper, and boron. A few farmers and fertilizer dealers have reported suspected cases of deficiencies of one or more of these micronutrients, but none has been verified by research trials in Illinois.

The Department of Agronomy at the University of Illinois is continuing to run spectrographic analyses of plants from several research fields and has begun an important new project to learn the nutrient status of corn and soybeans in Illinois as described on page 36.



Uptake of phosphorus (P) and potassium (K) by corn through the growing season. (Hanway, Iowa State University) (Fig. 4)

Phosphorus and Potassium Uptake

Phosphorus continues to be taken up by corn until the grain is fully developed. Most of the potassium has been taken up soon after silking (Fig. 4). This indicates the need for different interpretations of phosphorus and potassium tests, based on characteristics of the subsoil.

Soil factors that influence the depth and extensiveness of rooting and the amount of available phosphorus in the *lower subsoil* are important in interpreting the phosphorus test (page 35). Subsoil phosphorus is especially important in drouth periods when roots cannot feed effectively near the surface.

In contrast with the situation for phosphorus, soil conditions in the *plow layer* and *upper subsoil* are more critical in interpreting the potassium test (page 38). Before the root system has reached maximum depth the plant has satisfied its need for potassium.

Phosphorus Applications for Corn

See page 35 for suggested P_1 soil test goals and page 37 for a discussion of soil tests that are very high. The amounts shown for broadcast applications in Table 4 at low P_1 test levels provide for considerable build-up, but the amounts shown for drill applications do not. Where there is a range in the amount suggested under the heading "Broadcast," the larger figure will give a quick increase in P_1 test, the smaller figure will give only a small increase.

Annual phosphorus removal by corn is about 36

Table 4. — Available Phosphorus to Apply for Corn and Soybeans, Based on P_1 Soil Tests

P_1 test, Soil region (see page 35): Low	Medium	High	Percent of possible yield	Pounds of P_2O_5 or P to add per acre based on the P_1 test: P_2O_5, Broadcast	P_2O_5, Through planter or drill	P, Broadcast	P, Through planter or drill
20	10	7	69	(a) 90 to 150 +	20 to 40[b]	(a) 39 to 65 +	9 to 17
25	15	10	83	or (b)	40 to 60[b]	or (b)	17 to 26
30	20	15	90	60 to 120 or	30 to 40[b]	26 to 52 or	13 to 17
38	30	20	97	60 or	20 to 30[b]	26 or	9 to 13
45[a]	40[a]	30[a]	98+	Phosphorus may be applied to maintain the soil test. Little or no response likely in the year of application.			

[a] See also tentative goals for the P_1 test on page 35.
[b] The highest drill rates are all that can profitably be placed in the band, but they will have little effect on the soil test in following years and hence do not substitute for larger amounts broadcast for rapid buildup.

pounds of P_2O_5 (16 pounds of P) in 100 bushels of grain. Fifty to 70 pounds of P_2O_5 will be needed just to maintain the P_1 test level. You may apply it each year, but proportionately larger amounts at two- to three-year intervals are equally good. Use these general guides only until the field is resampled and tested.

Harvesting the crop for silage increases removal to about 60 pounds of P_2O_5 (27 pounds of P), but 80 percent of this phosphorus is recovered in manure when silage is fed to animals and will usually be returned somewhere on the farm.

Several states have reported that unnecessarily high phosphorus levels have caused zinc deficiency, but this has not been identified in Illinois.

Potassium Applications for Corn

See Table 42, page 39.

Buildup and Maintenance

You may choose to build up your soils to the desired test levels (pages 35 and 39) in just a few years, or more gradually over a five- to ten-year period. If you choose the slower buildup, row fertilization will be helpful to obtain optimum yields.

There are several reasons why raising the soil tests for P and K with fertilizer is much slower than most people expect. First, the soil tests are in terms of the elements whereas fertilizer analyses are in the oxides P_2O_5 (43.6 percent P) and K_2O (83 percent K). Second, a crop often removes an amount equal to one-half to three-fourths of the amount applied. Third, phosphorus in fertilizers soon changes to forms that are only partly extracted by soil tests; some of the potassium moves back between the clay sheets and is not picked up by the test.

You may make buildup applications at any convenient point in the cropping system and at any time of year, except on bare, sloping, frozen fields.

After the desired soil-test levels have been reached, there is no reason to believe that continued annual broadcast applications are necessary. Larger applications every two or three years are more economical.

Some farmers are substituting chisels or field cultivators for moldboard plows, especially following soybeans. Chiseling and cultivating will mix the nutrients only 3 to 4 inches deep. On soils that test medium to high throughout the plow layer, it is doubtful that one could measure the difference in yield between having the most recently applied fertilizer 3 inches deep or 9 to 10 inches deep. Plowing once in four or five years will provide for adequate mixing.

On soils that are low enough in test and in supplying power to result in a large yield response to the fertilizer applied in the current year, there is likely to be a significant advantage for deeper placement, especially in dry seasons.

For more information on chiseling see page 39.

Row fertilization. Experimental results from row fertilization in central Illinois and farther south indicate that yield responses are rare on soils that have been built up to a high fertility level. But farmers in central and northern Illinois who plant very early may experience the cool, wet soil conditions typical of the usual planting dates in states farther north where row application is more popular and more effective.

Corn seedlings need a high concentration of available phosphorus. You can supply it either by raising the soil test of the whole plow layer to a high level or by adding a small amount near the seed where the soil test is medium or above (see also "Pop-up" fertilizers below). Phosphorus is the most important component of so-called "starter" fertilizers. Nitrogen in the fertilizer band enhances the uptake of phosphorus, so suggested ratios of N to P_2O_5 are from 1:2 to 1:4. Fifty percent water solubility of the phosphorus is adequate for the amounts applied in typical situations of soil test level and pH. On alkaline soils, higher water solubility is preferred.

Pop-up. Pop-up fertilizer will make corn look very good early in the season and may aid in early cultivation for weed control. But there is not likely to be a substantial difference in yield produced in most years by a so-called pop-up application or by fertilizer that is placed in a band to the side and below the seed. With these two placements there will seldom be a difference of more than a few days in the time the root systems intercept the fertilizer band.

"Pop-up" fertilization means placing 40 to 50 pounds of fertilizer in contact with the seed. Research in many states over a long period of time has shown that, for starter effect only, you should place fertilizer as close to the seed as safety permits. The old split-boot applicator gave more starter effect than the modern side placement equipment that places fertilizer 1½ inches to the side and 1½ inches below seed level.

Many farmers have built up the general fertility level of their soil to the point where they are interested in a small amount of fertilizer mainly for an early growth effect.

Farmer interest in pop-up fertilization in Illinois results from the fact that fewer stops are required at planting time because the application rate is cut in half.

Use a fertilizer with all three major nutrients in a ratio of about 1-4-2 of N-P_2O_5-K_2O (1-1.7-1.7 of N-P-K). The maximum safe amount of $N + K_2O$ for pop-up placement is about 10 to 12 pounds in 40-inch rows and correspondingly more in 30- and 20-inch rows. It is, in fact, necessary to apply more in narrow rows in order to have an equal amount per foot of corn row.

The term "pop-up" is a misnomer. The corn does not emerge sooner than without it, and it may come up one or two days later. It may, however, grow more rapidly during the first one to two weeks after emergence. Some people think that with pop-up applications the fertilizer is mixed with the seed. This is incorrect. The tube from the fertilizer hopper is repositioned to discharge the fertilizer in contact with the seed.

SOYBEANS

The 1970 Season

The 1970 Illinois soybean yield was estimated by the Cooperative Crop Reporting Service on November 1 as 31 bushels per acre. This is 2½ bushels under the record yield of 1969.

Planting was delayed by rain in May and June. At least half the crop was planted after June 1, and 20 percent was still to be planted on June 15. Many fields in low-lying areas were planted in July.

The crop was not able to overcome the combination of late planting and the cooler than normal temperatures in July. It was shorter than normal, and it bloomed and matured later than normal.

Green soybean fields next to blight-damaged, dry brown cornfields in September were common, but incongruous.

Later than normal maturity of soybeans, early harvesting of corn because of blight damage, and the wet fall weather all contributed to the late harvesting of soybeans. Soybean harvest which is normally complete by October 30 extended well into November in 1970.

Planting Date

Soybeans should be planted in May. The full-season varieties will yield best when planted in early May. Earlier varieties often yield more when planted in late May than in early May. The loss in yield of the full-season varieties when planting is delayed until late May is minor as compared with the penalty for planting corn late. Therefore, the practice of planting soybeans after the corn acreage has been planted is an accepted and wise practice.

The loss in yield of soybeans becomes more severe when planting is delayed past early June. However, the penalty for late-planted corn is proportionally greater and the danger of wet or soft corn becomes such a threat that soybeans are, under many conditions, a better crop for late planting than corn.

Planting Rate

A planting rate that results in 10 to 12 plants per foot of row at harvest in 40-inch rows, 6 to 8 plants in 30-inch rows, 4 to 6 plants in 20-inch rows, or 3 to 4 plants in 10-inch rows will provide maximum yield for May and very early June planting. Higher populations usually result in excessive lodging. Smaller populations often yield less, and the plants branch more and pod lower. This contributes to greater harvesting loss.

Populations should be increased by 50 to 100 percent for late June or early July plantings.

Table 5. — Yield of Soybeans Planted in Wheat Stubble When There Were 5, 8, 11, or 14 Plants per Foot of Row in 20-Inch Rows

	Plants per foot of row			
	5	8	11	14
	Bushels per acre			
1967	32	41	45	48
1968	26	32	29	..
1969	43	47	56	56

The results of double cropping wheat and soybeans at the Dixon Springs Experiment Station illustrate the need to increase population when planting late (Table 5).

Row Width

If weeds are controlled, soybeans will yield more in narrow rows than in the traditional 40-inch row (Table 6).

Table 6. — Soybean Yields for Different Row Spacings at DeKalb and Brownstown, 1959-1960

Variety	Location	40 inches	32 inches	24 inches
		Bushels per acre		
Chippewa	DeKalb	40.3	45.1	45.3
Shelby	Brownstown	29.0	31.0	35.0
Clark	Brownstown	31.2	33.5	35.8

When lodging is not severe, the advantage for narrow rows is also realized in widths less than 20 inches (Table 7).

Table 7. — Soybean Yields for Row Spacings of 10, 20, 30, and 40 Inches, Urbana, 1965-1966

Variety	40 inches	30 inches	20 inches	10 inches
	Bushels per acre			
Wayne	47.0	51.2	52.4	53.6
Harosoy	38.8	42.0	45.0	48.0

Since late-planted soybeans are not as tall as those planted in early May, the advantage for using narrow rows increases as planting is delayed past early June. Soybeans planted after the small-grain harvest should be planted in rows at least as narrow as 30 inches and 20-inch rows are better.

Seed Source

To insure growing a good crop you must do a good job of selecting seed. When evaluating seed quality, consider the percent germination, percent pure seed, percent inert matter, and percent weed seed for the presence of disease and damaged kernels.

Samples of soybean seed taken from the planter box as farmers were planting showed that home-grown seed was inferior to seed from other sources. (Tables 8 and 9).

Table 8. — Uncertified Soybean Seed Analysis by Seed Source

	Germination	Pure seed	Weed seed	Inert matter	Other crops
			Percentages		
Home grown.....	79.6	95.5	.02	2.29	2.27
Neighbor grown...	80.8	97.5	.01	2.06	.41
Seed dealer.......	81.2	97.8	.001	1.48	.77

Table 9. — Certified and Uncertified Soybean Seed Analysis

	Samples	Germination	Pure seed	Weed seed	Inert matter	Other crops
			Percentages			
Uncertified....	363	80.2	95.5	.02	2.6	2.0
Certified......	56	84.2	98.7	.001	1.2	.2

The germination and pure seed content of home-grown seeds were lower. Weed seed content, inert material (hulls, straw, dirt, and stones), and other crop seeds (particularly corn) in home-grown seed were higher.

Farmers who purchased certified seed obtained a higher quality seed on the average than farmers purchasing uncertified seed.

This evidence indicates the Illinois farmer could improve the potential of his soybean production by using higher quality seed. The home-grown seed is the basic problem. Few farmers are equipped to carefully harvest, dry, store, and clean seeds, and to perform laboratory tests adequately to assure themselves of high-quality seed. Agriculture today is a professional enterprise. If a farmer is not a professional seed producer and processor, he may be well advised to market his soybeans and obtain high-quality seed from a reputable professional seedsman.

The state seed tag is attached to each legal sale from a seed dealer. Read the analysis and consider if the seed being purchased has the desired germination, purity of seed, and freedom from weeds, inert material, and other crop seeds. The certified tag verifies that an unbiased non-profit organization (the Illinois Crop Improvement Association) has conducted inspections in the production field and in the processing plant. These inspections make certain the seeds are of a particular variety as named and have met certain minimum seed-quality standards. Some seedsmen may have a higher seed quality than others. It pays to read the tag.

Varieties

Soybean varieties are divided into maturity groups according to their relative time of maturity. Varieties of Maturity Group I are nearly full season in northern Illinois, but too early for good growth and yield farther south. In extreme southern Illinois the Maturity Group IV varieties range from early to midseason in maturity.

Maturity Group I

Chippewa 64 is an early variety adapted to the northern states and performs like its namesake Chippewa, except that it carries resistance to phytophthora root rot. Chippewa and Chippewa 64 account for about two-thirds of the soybean acreage in Wisconsin and Minnesota, but grow them only in northern Illinois and only when you want earliness, since the later varieties outyield them throughout Illinois.

Rampage was released in 1970. It matures 1 to 2 days earlier than Hark or 2 to 3 days later than Chippewa 64. It is 1 inch shorter than Chippewa 64 in height and slightly less lodging resistant. Rampage is susceptible to Phytophthora rot, but resistant to shattering.

Hark is a variety adapted to northern Illinois where it has yielded as well as most Group II varieties, but less than Amsoy. It has good height for an early variety, but has a tendency to shatter when grown in central Illinois where it ripens early while the weather is still warm. This variety, like Wayne, may show iron-deficiency chlorosis when planted on soils of high pH (7+).

A-100 is an early variety similar to Hark in maturity. It is a farmer selection from Minnesota. It is shorter than Hark but more resistant to shattering and has yielded about the same as Hark. Its tendency to lodge is slightly greater than Hark.

Maturity Group II

Harosoy and **Harosoy 63** are similar except that Harosoy 63 is resistant to phytophthora root rot. This can be of great importance on low ground or in wet springs when phytophthora can cause severe stunting and killing of susceptible Harosoy. The Harosoys were the top-yielding varieties in northern Illinois before the release of Amsoy. Continue to use Harosoy 63 on land subject to flooding or wherever phytophthora rot is a problem, since Amsoy is very susceptible. Both varieties have a tendency to shatter when conditions are overly dry at harvest time.

Corsoy was released in 1967. It is similar to Amsoy in growth habit, but averages 2 inches shorter. It is susceptible to phytophthora root rot, so grow it where this disease is not a problem. Corsoy has yielded 1 to 2 bushels per acre more than Amsoy and matured 3 to 4 days earlier. Lodging resistance of Corsoy was slightly less than Amsoy in 1969. Corsoy and Amsoy should replace much of the acreage of older Group II varieties except where phytophthora root rot is present.

Protana was released in 1970 as a high-protein variety resistant to phytophthora rot. It will range from 2 to 4 percent higher in protein than currently grown commercial soybean varieties. It matures about two days later

Table 10. — Characteristics and Parentage of Major Soybean Varieties in Illinois

Maturity group and variety	Parentage and year released[a]	Flower color	Pubescence color	Pod color	Seed luster	Hilum color[b]
0						
Grant	Lincoln X Seneca (1955)	white	lt. brown	brown	shiny	black
Traverse	Lincoln X Mandarin (Ottawa)(1965)	white	gray	brown	shiny	yellow
I						
Chippewa	Lincoln^2 X Richland (1954)	purple	brown	brown	shiny	black
Chippewa 64	Chippewa^8 X Blackhawk (1964)	purple	brown	brown	shiny	black
Rampage	Clark X Chippewa	purple	tawny	brown	shiny	black
Bombay	farmer selection (1966)	purple	gray	tan	shiny	yellow
Hark	Hawkeye X Harosoy (1966)	purple	gray	brown	dull	yellow
A-100	farmer selection (1959)	white	gray	brown	shiny	buff
SRF 100	Soybean Research Foundation (1971)	purple	tawny	brown	shiny	black
II						
Harosoy	Mandarin (Ottawa)^2 X AK (Harrow)(1951)	purple	gray	brown	dull	yellow
Harosoy 63	Harosoy^8 X Blackhawk (1963)	purple	gray	brown	dull	yellow
Carsoy	Harosoy X Capital (1967)	purple	gray	brown	dull	yellow
Lindarin 63	Lindarin^8 X Mukden (1963)	purple	gray	brown	dull	buff
Magna	[Mandarin (Ottawa) X Jogun] X	purple	gray	brown	dull	yellow
Prize	[Mandarin (Ottawa) X Kanro] (1967)	purple	gray	tan	dull	yellow
Provar	Harosoy X Clark (1969)	purple	tawny	brown	dull	brown
Protana	[CX291-42-1 (Mukden X C1069) X CX258-2-3-2(PI65,338 X C1079) (1970)]	purple	gray	brown	dull	imp. black
Amsoy	Adams X Harosoy (1965)	purple	gray	tan	shiny	yellow
Hawkeye 63	Hawkeye^7 X Blackhawk (1963)	purple	gray	brown	dull	imp. black
Beeson	(Blackhawk X Harosoy) X Kent (1968)	purple	gray	brown	shiny	imp. black
III						
Adams	Illini X Dunfield (1948)	white	gray	tan	shiny	buff
Shelby	Lincoln^2 X Richland (1958)	purple	brown	brown	dull	black
Wayne	(Lincoln, Richland, CNS) X Clark (1964)	white	tawny	brown	shiny	black
Calland	(Blackhawk X Harosoy) X Kent (1968)	purple	tawny	brown	dull	black
Adelphia	(Sib of Kent) X Adams (1966)	white	gray	tan	shiny	buff
SRF 300	Soybean Research Foundation Variety (1969)	white	brown	brown	shiny	black
SRF 307	Soybean Research Foundation (1971)	white	brown	brown	shiny	30% brown, 70% black
IV						
Clark	Lincoln^2 X Richland (1953)	purple	brown	brown	dull	black
Clark 63	(Clark^7 X CNS) X (Clark^6 X Blackhawk) (1963)	purple	brown	brown	dull	black
Bellatti L263	farmer selection (1965)	purple	brown	brown	dull	black
Patterson	introduced from Morocco (1965)	white	gray	tan	dull	yellow
Cutler	(Lincoln X Ogden) X Clark (1968)	purple	tawny	brown	shiny	black
Custer	(Peking X Scott) X Scott X Blackhawk (1967)	purple	gray	brown	shiny	imp. black
Kent	(Lincoln X Ogden) (1961)	purple	tawny	brown	intermed.	black
Delmar	(P.I.70218 X Lincoln X FC33,243 (1963)	white	gray	brown	dull	yellow
Scott	(Sib of Lee) (Lincoln X Richland) (1958)	purple	gray	brown	shiny	imp. black
SRF 400	Soybean Research Foundation (1971)	purple	tawny	brown	dull	black
V						
Dare	Hill X Roanoke X Ogden (1965)	white	gray	tan	shiny	buff
Dyer	Hill X (Lee^2 X Peking)^6 (1967)	purple	tawny	tawny	shiny	black
Hill	(Dunfield X Haberlandt) X Sib of Lee (1959)	white	brown	tan	shiny	brown
VI						
Ogden	Tokio X PI 54,610 (1942)	purple	gray	brown	dull[c]	imp. black
Hood	Roanoke X line from Ogden X CNS (1958)	purple	gray	tan	shiny	buff
Lee	S-100 X CNS (1954)	purple	brown	tan	shiny	black
Pickett	[(Sib of Lee)^6 X Dorman] X [Lee^4 X Peking] (1965)	purple	gray	tan	shiny	imp. black

[a] Superscript indicates the number of crosses in a backcrossing program.
[b] imp. = imperfect.
[c] Seed coat of Ogden is green. All others listed have yellow seed coat.

Table 11. — Soybean Variety Performance at Urbana, Illinois, 1967-1969

Maturity group and variety	Maturity date	Lodging	Plant height	Seed quality	Seeds per pound[a]	Seed content	
						Protein	Oil
		score[b]	inches	score[c]	number	percent	percent
I							
Chippewa 64	Sept. 4	1.2	32	2.1	2,900	40.9	22.2
Hark	Sept. 8	1.1	34	1.3	2,800	40.5	22.6
Rampage	Sept. 8	1.2	33	2.0	2,700	40.9	22.6
II							
Corsoy	Sept. 13	2.3	37	1.4	2,900	40.2	22.4
Amsoy	Sept. 14	1.8	40	1.6	2,600	39.0	22.6
Beeson	Sept. 16	1.3	38	2.1	2,400	39.6	21.9
III							
Wayne	Sept. 22	1.6	43	2.0	2,700	41.2	21.0
Calland	Sept. 24	1.5	45	2.1	2,600	38.9	20.7
IV							
Clark 63	Sept. 27	1.8	44	1.6	2,900	40.0	20.8
Cutler	Sept. 30	1.5	46	1.8	2,600	38.7	21.7
Kent	Oct. 5	1.6	43	1.8	2,600	39.3	21.4

[a] USDA Regional Uniform Test average.
[b] Lodging score: 1 = erect, 5 = prostrate.
[c] Seed quality score: 1 = excellent, 5 = very poor (wrinkled, shriveled, green, moldy, imperfect seed coat, or other defects).

Table 12. — Disease Resistance of Soybean Varieties

Maturity group and variety	Phytophthora root rot	Bacterial pustule	Bacterial blight	Downy mildew	Frogeye leaf spot	
					Race 1	Race 2
I						
Chippewa 64	++	–	+	–	–	–
Rampage	– –	–	–	–	–	–
Hark	– –	–	–	–	–	–
A-100	–	–	–	–	++	–
II						
Harosoy 63	++	–	–	+	++	–
Provar	– –	–	–	–		– –
Corsoy	– –	–	–	+		–
Amsoy	– –	–	–	+	++	–
Beeson	++	–	–	+		+
III						
Wayne	+	++	–	– –	++	+
Calland	++	–	–	+		–
IV						
Clark 63	++	++	–	– –	++	–
Cutler	+	–	–	–		+
Kent	–	–	–	+	++	++
V						
Dare	+	++				

++ = resistant; + = slightly susceptible; – = susceptible; – – = very susceptible.

than Amsoy and is comparable to Amsoy in lodging resistance and seed size. It is 3 to 4 inches shorter. Yield of Protana is slightly less than Amsoy and Corsoy.

Provar was released in 1969 as a special purpose high-protein variety. It will range from 2.5 to 4.5 percent higher in protein than most other soybean varieties. It matures one day later than Corsoy and two days earlier than Amsoy. It is comparable to Amsoy in lodging resistance, but is 3 to 4 inches shorter. It is susceptible to phytophthora rot and its yield is slightly less than Corsoy or Amsoy.

Amsoy is a high-yielding variety, second only to Corsoy among the Group II varieties, and is a very popular variety. It is very susceptible to phytophthora root rot and purple stain of the seed coat. Purple stain is occa-

Table 13. — Yields at Seven Test Locations, Average of Three Years, 1968-1970[a]

Maturity group and variety	DeKalb	Pontiac	Urbana	Girard	Edge-wood	Trenton	Eldorado
I							
Chippewa 64	43.0	32.0	....	....	....	....	....
Rampage	47.0	36.0	....	....	....	....	....
Hark	48.0	36.0	49.0	....	....	....	....
II							
Corsoy	57.0	46.0	53.0	51.0	40.0	48.0	49.0
Amsoy	53.0	43.0	52.0	51.0	44.0	49.0	50.0
Beeson	53.0	47.0	50.0	46.0	46.0	45.0	52.0
III							
Wayne	....	....	50.0	54.0	45.0	52.0	52.0
Calland	....	....	48.0	49.0	48.0	48.0	52.0
IV							
Cutler	....	....	47.0	46.0	44.0	50.0	52.0
Kent	....	....	47.0	41.0	46.0	51.0	51.0
Custer	....	....	....	....	....	42.0	47.0
Delmar	....	....	....	....	....	43.0	47.0

[a] USDA Regional Uniform Test.

sionally a problem, usually occurring in southern Illinois. The lodging resistance of Amsoy is superior to most other Group II varieties.

Beeson is resistant to phytophthora root rot. It was released by Purdue University in August, 1968. The variety has yielded nearly as well as Amsoy when root rot was not present. In the presence of root rot, Beeson has yielded much more than Amsoy or Corsoy. Beeson matures about 3 days later than Amsoy and 6 days later than Corsoy. Lodging resistance of Beeson is slightly greater than Amsoy or Corsoy. It is similar in height to Corsoy and 1 to 3 inches shorter than Amsoy. It has a spreading leaf canopy.

Maturity Group III

Wayne is a high-yielding variety in central and south central Illinois. It has some tendency to shatter and develops iron-deficiency chlorosis (yellowing of leaves) on high-lime soils (pH 7+). It is susceptible to pod and stem blight, so at times will have poor seed quality. Its chief advantages are resistance to bacterial pustule and high yields.

Calland has phytophthora root rot resistance and was released by Purdue University in August, 1968. It has yielded nearly as well as Wayne in the absence of phytophthora root rot. Where phytophthora root rot is severe, Calland has yielded much more than Wayne. Calland matures 1 to 2 days later than Wayne, averages about 1 inch taller, and has a little greater resistance to lodging.

Adelphia, released in New Jersey in 1966, showed resistance to a seed-quality problem similar to the one in southern Illinois. The yield of Adelphia has been lower than Wayne and other Group III varieties. The variety has a high seed quality. Interest is being maintained in Adelphia to test for resistance to the purple stain and other seed-quality problems that often occur in southern Illinois.

Maturity Group IV

Clark and **Clark 63** are similar, except Clark 63 is resistant to bacterial pustule leaf spot and phytophthora root rot. Bacterial pustule is a widespread leaf spot disease in southern Illinois, and in wet fields phytophthora rot can cause severe damage in that area. Neither disease will develop on Clark 63, so this is the preferred variety. The high yield and excellent lodging resistance of these two varieties have made them the leading varieties in southern Illinois.

Patterson was released by the High Plains Research Foundation of Plainview, Texas. It is as early as other Group IV varieties, and was tested at five locations in the state in 1966. It matured later than Clark 63 and earlier than Kent, but was distinctly lower in yield (5 to 40 percent below Clark 63) and had poor standability.

Cutler, a high-yielding variety, is moderately susceptible to phytophthora root rot. It was released in 1968 by Purdue University. In the absence of phytophthora root rot, Cutler yields 3 to 4 bushels more than Clark 63 and 1 bushel more than Kent. Cutler is 2 to 3 days later maturing than Clark 63 and 5 days earlier than Kent.

Custer variety is resistant to soybean cyst nematode and phytophthora root rot. It was released from the University of Missouri in 1967. Custer matures 7 days later than Clark 63, has less lodging resistance, grows about 4 inches taller, has lower oil and protein percentages, and has yielded 2 to 3 bushels per acre less than Clark 63 in the absence of the cyst nematode. Consider Custer only where the soybean cyst nematode is present.

Kent is a late variety over much of Illinois, but in the southern quarter of the state it ripens at the same time as earlier varieties do farther north. It has been a top-yielding variety in the southern quarter. It has excellent lodging resistance, but in some years it has a tendency to shatter when it is not harvested immediately after ripening.

Delmar was released in Delaware and Maryland. It is similar to Kent in maturity and shows some advantages in seed quality, but usually yields less than Clark 63 and Kent. It is resistant to root-knot nematode, which is a major problem in some states but has been of minor importance in Illinois.

Scott is recommended in southeastern Missouri and matures at about the same time as Kent. It has shown no advantage over Kent in Illinois tests.

Maturity Group V

Dare is a 1965 release and was increased by certified seed growers in Missouri, Oklahoma, Maryland, Virginia and North Carolina. It has had limited testing in the southern tip of Illinois and has performed very well. It is suggested for growing in that area whenever a late variety is desired because it has outyielded Hill, Ogden, and Lee, and it does not have the poor seed quality of the Group IV varieties. It has moderate resistance to phytophthora root rot.

Dyer is an early maturing variety in Group V that was released in 1967 by the USDA and agricultural experiment stations of Mississippi and Tennessee. It is resistant to soybean cyst nematode, two root-knot nematodes, bacterial pustule, wildfire, and target spot. It is more susceptible to phytophthora root rot than Hill, but less shatter resistant than Hill. Dyer has yielded slightly less than Hill in the absence of soybean cyst nematode.

Hill is a late-maturing variety that has been grown on a relatively small acreage in the bottomlands in extreme southern Illinois. It will probably be replaced by the more productive Dare. Other late-maturing varieties that should be replaced by Dare in this extreme southern tip of the state include extremely late-maturing varieties such is Ogden, Hood, and Lee.

Parentage, maturity comparisons, and characteristics of most of these varieties are shown in Tables 10, 11, and 12. Yield records of many of these varieties at various locations are shown in Table 13.

Private Varieties

Several soybean varieties developed by privately financed research programs have been released recently. These varieties are handled within the seed trade as proprietary items, i.e., the property of the developer.

Following are brief descriptions of several private varieties. These have met the National Certified Soybean Variety Review Board criteria of distinctiveness and as meriting certification.

SRF-100 is a narrow-leaf variety of Group I maturity developed by the Soybean Research Foundation. In plant type, oil and protein content, and maturity it is quite similar to Chippewa 64. It has purple flowers, tawny pubescence, brown pods, shiny yellow seed coat, and black hila. It is resistant to phytophthora rot. Unlike Chippewa 64 it has lanceolate-shaped leaves and bears a considerable number of four-seed pods. Seed size of SRF 100 is slightly smaller than Chippewa 64.

SRF-300 was developed by the Soybean Research Foundation, Mason City. The variety is similar to Wayne in maturity and lodging resistance. The leaves are narrow and lance shaped. It is susceptible to phytophthora root rot. SRF-300 grows about an inch taller than Wayne. The seed of SRF-300 is somewhat smaller than Wayne seed. Seed of SRF-300 is available only from member companies of the Soybean Research Foundation.

SRF-307 is a narrow-leaf variety of Group III maturity developed by the Soybean Research Foundation. This variety is a sister strain of SRF 300 and is very similar to SRF 300 in all aspects except that approximately 30 percent of seeds have brown hila (the remaining 70 percent are black), and the yield has been considerably higher than SRF 300.

SRF-400 is a narrow-leaf variety of Group IV maturity developed by the Soybean Research Foundation. In plant type, oil and protein content, and maturity it is quite similar to Clark 63. It has purple flowers, tawny pubescence, brown pods, black hila, and dull yellow seed coat, and is resistant to phytophthora rot. Unlike Clark 63, it has lanceolate-shaped leaves and bears many four-seeded pods. Seed size averages 14.3 grams per 100 seeds compared with 16.1 for Clark 63.

Bellatti L263 originated as a selection from Bavender Special. It is similar to Clark in yield, maturity, standability, and appearance. Bellatti L263 was released in 1965 by Mr. Louis Bellatti, Mt. Pulaski.

Fertilizing Soybeans

Farm magazines in recent years have reported some fantastic soybean yields from contest winners. Since most contestants fertilize their contest acres irrespective of soil test levels, it is easy to gain the impression that the high yields are a direct result of applying extra fertilizer. The Agronomy Department has conducted extensive research on very high rates of N, P, and K. Before examining some of the results, here is a review of current suggestions for liming and fertilizing soybeans.

Lime. Soybeans have the same pH requirements as corn. So a goal of 6.0 or slightly above is reasonable for a soybean-corn, cash-grain system and a goal of pH 6.5 is advised for a cropping system that includes alfalfa or clover.

Phosphorus and potassium. Soybeans give a large response to direct fertilization on soils that test low in phosphorus and potassium. Response to phosphorus on a very low-testing ($P_1 = 5$), dark prairie soil showed average 1967 to 1969 yields to be as follows: 25 bushels per acre with no fertilization; 52 bushels from 30 pounds of P_2O_5 (12 pounds of P); 54 bushels from 60 pounds of P_2O_5 (26 pounds of P); and 55 bushels from 90 pounds of P_2O_5 (39 pounds of P). These amounts of fertilizer were applied each year.

Broadcasting amounts indicated by soil tests is the preferred method in most cases. Row fertilizer is suggested where a farmer has a one-year lease or is extremely short on credit and must invest the minimum amount in fertilizer on a year-to-year basis.

Place row-applied fertilizer at least 1½ inches to the side and slightly below the seed level. "Pop-up" fertilizer, which involves a small amount in direct contact with corn seed, is unsafe for soybeans. In research plots at Dixon Springs, George McKibben cut the stand to one-half by applying 50 pounds of 7-28-14 and to one-fifth with 100 pounds.

Research has shown clearly that soybeans can feed efficiently on soil fertility that was built up for preceding crops and that they do not need direct fertilization where fertility is high.

Manganese. Manganese deficiency (stunted plants with green veins in yellow or whitish leaves) is common on high-pH (alkaline), sandy soils, especially during cool, wet weather in late May and June. Suggested treatment is to spray 10 pounds of manganese sulfate (containing 2.5 pounds of manganese) per acre in 25 gallons of water when the beans are 6 to 10 inches tall. If the spray is directed on the row the rate can be cut in half. Some fertilizer dealers have other manganese formulations that you can apply according to instructions. Broadcast application on the soil is ineffective because the manganese becomes unavailable in soils with high pH.

Iron. Wayne and Hark soybean varieties often show iron deficiency on soils with a very high pH (usually 7.4 to 8.0). The symptoms look like manganese deficiency. Most of the observed deficiencies have been on Harpster, a "shelly" soil that occurs in low spots in some fields in central and northern Illinois. This problem appeared on Illinois farms only since the Wayne variety was introduced in 1964.

Soybeans often outgrow the stunted, yellow appearance of iron shortage. As a result it has been difficult to measure yield losses or decide whether or how to treat affected areas. Sampling by U.S. Department of Agriculture scientists in 1967 indicated yield reductions of 30 to 50 percent in the center of severely affected spots. The yield loss may have been caused by other soil factors associated with very high pH and poor drainage rather than by iron deficiency itself. Several iron treatments were ineffective in trials near Champaign and DeKalb in 1968. Minnesota, which has had far more experience than Illinois with iron deficiencies, reports that "there is no known solution as yet."

In summary, the same pH, P_1, and K soil tests are suggested for corn and soybeans. Maintenance or build-up applications may be made ahead of either corn or soybeans. No nitrogen is recommended for soybeans. Sideband placement of fertilizer is suggested for certain situations, but "pop-up" applications are discouraged. Manganese should be applied on some high-pH sands. Iron treatment is not well worked out.

Results of extra high fertilization. Several experiments have been conducted in Illinois on extra heavy applications of fertilizer on soil that was already high according to soil tests.

Here are some typical results:

A. Direct fertilization (Table 14).

The differences are small and appear to be unrelated to fertilizer added, since the average of all treated plots is slightly below the untreated-plot yield.

Table 14. — Soybean Yields From Broadcast Applications of Fertilizer; Soil Tests Before Treatment Were: pH 5.9, P_1 90, and K 285; South Farm, Urbana, Illinois, 1965

N	P_2O_5 (P)	K_2O (K)	Bushels per acre
0	0	0	57.1
0	75(33)	75(60)	55.7
0	150(65)	150(120)	58.5
75	75(33)	75(60)	56.8
150	150(65)	150(120)	56.1
300	300(131)	300(240)	57.2

B. Combination of fresh and residual fertilizer and manure (Table 15).

There is no consistent effect of extra fertility. Treatment 4 appears to be slightly better than untreated plot No. 1, but this is offset by apparent reductions for treatments 2 and 3. This is typical variability encountered in field trials. The results are interpreted as no response to extra high fertility, either fresh or residual. Soil test on plots 2, 3, and 4 were extremely high, with P_1 testing from 225 to 408 and K testing from 558 to 1,086.

Table 15. — Soybean Yields From 7-Year Fertility Plots With and Without Fresh Application, South Farm, Urbana, Illinois, 1968

Treatment	Bushels per acre
None	56.4
40 tons of manure and 500 lb. N, 250 P_2O_5 (K_2O each year for 7 years)	54.3
Same as 2, plus 0-250-250 in 1968	52.6
Same as 2, plus 250-250-250 in 1968	57.8

C. Row fertilizer and localized lime (Table 16).

There was no increase from fertilizer or lime or a combination of the two. The apparent reductions for some treatments are probably normal field variations.

D. Other high-fertility treatments.

Many other experiments on heavy fertilization have been conducted by Illinois agronomists: nitrogen rates up to 1,400 pounds; nitrogen sidedressing up to 200 pounds at two growth stages; manure up to 80 tons per acre for six years with and without 160-60-60; and subirrigation with a nutrient solution each week.

The result of these experiments support the fertility suggestions for soybeans that were outlined at the beginning of this review.

Table 16. — Soybean Yields From Row Applications of Fertilizer and Lime; Phosphorus (P = 40) and Potassium (K = 300) Tests Were at Suggested Levels and pH Was Slightly Low (5.8); South Farm, Urbana, Illinois, 1965

Treatment	Bushels per acre
None	59.1
200 lb. 6-24-24 (2 in. side, 2 in. below)	56.3
250 lb. hydrated lime	56.9
200 lb. 6-24-24 and 250 lb. hydrated lime	58.1
200 lb. 6-24-24 and 250 lb. fine limestone	59.4

WHEAT

The 1969-70 Season

The Cooperative Crop Reporting Service estimated the state average yield to be 36 bushels. This is 5 bushels under the 1966 record of 41 bushels per acre.

Planting of the 1969-70 wheat crop started on schedule and about half of the intended acreage was in the ground by early October, which is normal. Then the rains came, planting was delayed, and was not completed until early November, which is a week or 10 days later than average.

There was very little winter damage even to the later planted wheat. Spring growth was good. There were reports that soil-borne mosaic caused discoloration and stunting in some fields in central Illinois, but the damage was minor. Just before harvest, scab was found to be prevalent throughout central and southern Illinois. This is a disease that infects during and just after pollination. The infected spikelets or "meshes" die prematurely. Commonly a part of a head or spike will appear bleached. A light pink or salmon color may often be found at the base of the infected spikelets or "mesh." Infected kernels are usually shrunken and wrinkled and often have a bleached or salmon or reddish color. The causal organism is *Gibberella zeae* which also causes Gibberella stalk and ear rot in corn. In fact, the fungus overwinters on corn stalks. There is no known resistance to the disease among wheat varieties, yet there are often great differences in the incidence of scab between varieties. This difference is believed to be caused by the fact that the wheat flower is susceptible to infection by scab spores for just a few days during and just after pollination. When this susceptible period coincides with warm moist weather, infection is highly probable. If the weather is dry during the susceptible period, infection does not occur. Therefore, differences among varieties in the amount of scab damage is believed to be primarily caused by differences between time of flowering.

Table 17. — Yield Record of Leading Wheat Varieties in Agronomy Department Tests at DeKalb, Urbana, and Brownstown

	DeKalb		Urbana		Brownstown	
	1970	1969–1970 average	1970	1969–1970 average	1970	1969–1970 average
	Bushels per acre					
Soft Wheat						
Arthur	58.8	65.4	63.4	66.5	53.4	57.5
Benhur	50.7	57.5	61.3	65.5	49.7	52.8
Blueboy	45.4	56.7	48.1	64.3	63.5	68.7
Knox 62	53.8	58.4	56.9	58.9	58.0	55.9
Logan	55.7		55.1	61.4		
Monon	50.0	58.9	55.8	60.9	50.1	50.4
Timwin	51.1	61.6	49.0	63.1	45.8	48.4
Hard Wheat						
Gage	52.8	57.3	46.1	53.8	49.3	45.1
Ottawa	45.2	54.9	32.5	45.7	46.5	
Parker	53.0	60.4	41.1	52.3	53.2	51.5
Pawnee	43.6	49.0	43.0	50.3		
Scout 66	51.6	55.3	45.0	56.1	46.9	
Triumph 64	51.0	52.9	53.2	57.8	58.5	53.6

Blueboy was damaged more by scab in 1970 than any other variety of wheat. This is probably caused by the fact that it was later in maturity and it reached the pollination stage when weather conditions were ideal for scab infection to occur.

Varieties: Hard Red Winter

Ottawa is a red chaff variety released in Kansas in 1960. It is similar to Pawnee in yield and maturity, but it has better grain quality and improved straw strength. It is resistant to stem rust but is susceptible to loose smut, which could become a problem. Ottawa has an excellent yield record in Illinois yield trials and on Illinois farms. Though its chaff color is principally red, it normally has a small number of white chaff heads and certain environmental conditions can increase this number.

Table 18. — 1970 Wheat Variety Demonstration Yields (Bushels per Acre), Hard Wheat Varieties

County or location	Gage		Ottawa		Parker		Pawnee		Scout		Triumph 64	
	Bu./A.[a]	T.W.[b]	Bu./A.	T.W.	Bu./A.	T.W.	Bu./A.	T.W.	Bu./A.	T.W.	Bu./A.	T.W.
Henderson	46.1	62.0	36.6	62.0	47.0	63.0	38.4	61.0	49.9	61.0	58.2	64.0
Macon	50.3	62.0	48.6	63.0	53.0	62.0	53.8	62.0	57.0	63.0	59.5	61.0
Madison	64.8	57.8	56.7	58.0	70.0	59.7	60.6	58.4	62.4	56.3	67.0	59.2
Mason	49.5		46.3		54.9		52.2		50.4		51.7	
Monroe	57.6	57.5	55.4	57.7	61.0	58.8	56.2	57.1	57.6	56.3	62.4	59.0
Randolph	26.7	52.5	30.2	55.0	43.4	58.2	24.5	55.0	29.3	52.5	37.3	56.8
St. Clair	48.7	54.3	48.7	56.3	48.8	56.0	46.2	56.1	50.3	55.3	64.1	58.0
Schuyler	39.7	59.0	40.5	60.5	51.7	62.0	28.9	58.0	40.9	61.2	40.7	61.8
Scott	54.3	61.5	56.0	62.5	65.5	63.0	51.8	61.0	59.7	60.5	65.3	62.5
Shelby	45.8	58.5	38.1	59.0	55.1	61.0	42.6	60.0	52.9	57.5	58.6	61.0
Carbondale	41.8	53.3	32.3	54.1	35.7	56.8	33.2	52.9	37.9	53.3	35.4	57.3
Dixon Springs	46.4	58.9	33.2	60.1	44.1	61.1	38.6	59.0	40.5	58.9	43.2	60.5
Belleville	42.7	54.4	42.4	56.9	45.1	56.1	46.2	55.3	46.0	53.5	52.5	57.3
Averages of 12 locations	47.9	57.5	43.7	58.6	51.9	59.6	45.3	57.9	49.5	57.1	54.6	59.7

[a] Bu./A. = bushels per acre.
[b] T.W. = test weight.

Gage, released by Nebraska in 1963, appears to be well adapted to Illinois. Similar to Pawnee in maturity and straw strength, it has improved resistance to rust, Hessian fly, and soil-borne mosaic. Gage has performed well in Illinois trials, generally outyielding both Pawnee and Ottawa by several bushels per acre. Its only weakness is poor straw strength. It is comparable to Pawnee in straw strength.

Scout, a 1964 release from Nebraska, has yielded well in Illinois trials. It is similar to Gage in maturity, straw height, and strength. It is susceptible to soil-borne mosaic and leaf rust.

Scout 66 is an improved version of Scout, being more uniform in height and maturity and higher in milling and baking qualities. Scout and Scout 66 are early maturing and are adapted to a wide climatic range.

Parker is a white chaff variety released in Kansas in 1966. It matures earlier than Gage or Pawnee but slightly later than Triumph. Parker has shorter straw than other hard wheat varieties grown in Illinois. Straw strength is excellent. It is resistant to leaf rust and Hessian fly. It is susceptible to soil-borne mosaic, stem rust, bunt, and loose smut. The kernel is mid-sized to small, but test weight is high.

Varieties: Soft Red Winter

Arthur is a 1967 release by the Purdue Agricultural Experiment Station and the USDA. It has been a high-yielding variety in Illinois tests with excellent test weight. It is as winter hardy as Monon, is beardless, white chaffed, and early maturing, and has a short, stiff straw. Arthur responds well to high fertility. It is moderately resistant to leaf rust, and has good resistance to stem rust, powdery mildew, loose smut, soil-borne mosaic, and race A of the Hessian fly.

Benhur looks very promising for the soft wheat growing section. It was released in 1966 by the USDA and was developed at Purdue University. It is a white chaff, beardless variety that matures 1 to 2 days earlier than Monon and under some conditions is as much as 3 inches shorter. It is superior to Monon in leaf and stem rust, Hessian fly, and lodging resistance. Yields of Benhur have been high in Illinois. Under some conditions the chaff and stems may turn dark in color. This tendency, which is inherited from one of its parents, does not affect its yield.

Monon, a beardless white chaff variety, was released by Purdue in 1959. It grows 2 or 3 inches shorter than Knox and matures about 1 day earlier. It has more lodging resistance than Knox and Vermillion and is equal to Vermillion and better than Knox in winter hardiness. Monon is resistant to soil-borne mosaic and moderately resistant to Hessian fly and leaf rust. It is susceptible to stem rust, loose smut, and bunt. In the mature-plant stage, it is moderately resistant to powdery mildew.

Riley is a white chaff, soft red wheat. It was released by Purdue in 1965. It is short, like Monon, and about 2 days later in maturity, but offers greater straw strength than Monon or Knox 62. Riley is resistant to the loose smut and soil-borne mosaic. It is moderately susceptible to powdery mildew, leaf rust, and Hessian fly.

Riley 67 was developed by Purdue and is comparable to Riley in all characteristics, except it is superior in leaf-rust resistance.

Table 19. — 1970 Wheat Variety DemonstrationYields (Bushels per Acre), Soft Wheat Varieties

County or location	Arthur		Benhur		Blueboy		Knox 62		Monon		Timwin	
	Bu./A.[a]	T.W.[b]	Bu./A.	T.W.	Bu./A.	T.W.	Bu./A.	T.W.	Bu./A.	T.W.	Bu./A.	T.W.
Franklin	62.6	58.0	54.4	58.0	58.6	54.0	53.6	59.0	46.0	57.0	34.0	56.0
Gallatin	51.0	58.0	41.9	58.0	45.1	55.0	47.2	59.0	39.3	58.0	29.4	58.0
Hamilton	32.7	58.0	50.4	58.0	60.2	52.0	62.1	59.0	50.4	57.0	57.3	55.0
Jackson	55.7	57.0	55.3	58.0	57.6	55.0	36.2	58.0	54.7	56.5		55.0
Jefferson	62.6	58.0	54.4	58.0	56.6	54.0	53.6	59.0	46.0	57.0	34.0	56.0
Macon	55.0	62.0	52.5	62.0	57.8	60.0	56.3	61.0	56.5	60.0	56.8	61.0
Madison	75.3	59.0	58.1	57.8	82.7	55.8	65.0	58.6	62.6	57.0	67.2	56.0
Massac	35.9	56.0	30.7	56.0	34.6	53.0	30.3	57.0	25.1	54.0	20.7	53.0
	28.6	56.0	26.8	56.0	40.0	54.0	35.0	56.0	28.2	53.0	22.3	55.0
Monroe	77.5	58.3	64.1	56.2	73.0	52.6	66.2	58.3	64.8	57.6	58.1	55.2
Randolph	53.0	57.5	34.2	57.0	41.6	48.0	38.0	52.0	34.6	55.0	33.3	54.5
St. Clair	73.8	57.5	56.4	57.0	58.2	51.0	63.2	57.0	66.0	56.3	53.6	53.9
	55.4	57.2	59.5	58.3	40.1	53.6	47.8	56.1	31.2	56.7		
Scott	77.2	61.5	63.7	62.0	79.7	60.0	66.2	62.0	68.7	61.5	67.5	60.0
White	56.1	60.0	50.8	59.0	64.3	55.0	53.6	60.0	40.3	58.0	44.0	55.0
Williamson	26.3		28.8		34.2		25.7		32.8		24.9	
Toledo	39.6	56.5	38.6	55.0	44.5	55.5	41.8	56.0	25.0	54.0	45.7	55.0
Carbondale	55.2	56.9	44.1	56.1	49.4	48.8	45.9	57.7	35.1	54.0	43.9	51.9
Dixon Springs	65.0	60.3	49.7	60.5	58.5	53.9	51.1	60.7	43.4	58.9	48.0	55.9
Belleville	55.1	55.8	52.7	56.2	51.2	52.7	48.4	56.9	47.4	55.4	45.0	52.1
Averages of 20 locations	54.7	58.1	48.3	57.8	54.4	53.9	49.4	58.1	44.9	56.7		

[a] Bu./A. = bushels per acre.
[b] T.W. = test weight.

Blueboy is a very short, stiff-strawed, white chaff beardless variety developed at North Carolina State University. It matures seven to eight days later than Monon and Benhur, weighs 3 to 4 pounds less per bushel than they do, and is susceptible to the rusts and Hessian fly. Blueboy has overwintered in 1968-69 and 1969-70 without noticeable cold damage. It is apparently more winter hardy than most varieties developed for the southeastern United States, but may be damaged under severe winter conditions.

Timwin is a soft red winter wheat variety released by the University of Wisconsin. It is a bearded white chaff variety which is very winter hardy. It is short-strawed, moderately resistant to lodging, and matures 3 to 5 days later than Monon. It has good tolerance to the rusts, but is susceptible to loose smut and Hessian fly.

Triumph is a bearded white chaff wheat developed in Oklahoma in 1940. It is shorter than Pawnee and matures three or four days earlier. It is susceptible to mosaic, leaf and stem rust, and bunt; however it has a good test weight and yield record in Illinois.

Varieties: Hard Red Spring

Pembina, released in Canada, is an early variety. It is beardless, has white chaff, and is rust resistant.

Chris is a beardless hard red spring wheat of medium height and maturity with moderately stiff straw. It is resistant to prevalent races of stem rust, leaf rust, and black chaff. It has good test weight and satisfactory milling and baking qualities. It was released by Minnesota in 1965.

Table 20. — Hard Red Spring Wheat Variety Yields at DeKalb, Illinois

	1970	1969–1970 average	1970	1969–1970 average
	Bushels per acre		*Pounds per acre*	
Chris	33	32	54	56
Crim	31	31	51	54
Justin	30	29	53	55
Lathrop	40	37	56	57
Pembina	34	34	53	55
Selkirk	35	33	50	52

Crim, released in Minnesota in 1963, is resistant to stem rust, but susceptible to leaf rust and loose smut. Its grain quality is satisfactory.

Justin, released in North Dakota in 1962, is a hard red spring wheat with good milling quality. It is resistant to strain 15B stem rust and to black chaff. Yields have been slightly lower than some of the other varieties.

Lathrop, a 1961 Wisconsin release, is similar to Henry, and also has fly resistance. *Lathrop is a feed wheat.*

Polk, released by the University of Minnesota in 1968, is a bearded variety of medium height and maturity. It has a moderately stiff straw, and good resistance to the common races of leaf and stem rust and to black chaff and bunt. Test weight is excellent.

Waldron was released by North Dakota in 1969. It is beardless with a trace of awned plants. It is earlier and has stronger straw than Chris and Polk. It is resistant to the common races of leaf rust and to stem rust.

Fortuna is an early, beardless variety released by North Dakota State University in 1966. It is resistant to the common races of stem and leaf rust. It is susceptible to lodging and black chaff.

Selkirk was released in Canada in 1953. It is a beardless, white chaff variety of medium height and maturity and good straw strength.

Fertilizing Wheat

Among Illinois field crops wheat is second only to corn in response to fertilizer.

Phosphorus. Wheat requires a large amount of *readily available phosphorus* in the fall. Phosphorus stimulates early growth, promotes winter survival, and helps make the young plant capable of high yield in the following year.

Suggested applications of phosphorus-supplying fertilizer for wheat in Illinois given in Table 21 are based on P_1 soil tests.

If you do not have the results of a P_1 soil test, apply 30 to 60 pounds of available P_2O_5 (13 to 26 pounds P) through the drill or broadcast about 60 to 120 pounds (26 to 53 pounds P). The lower figure in both cases is for fields on which considerable phosphorus has previously been added.

The Department of Agronomy at the University of Illinois has revised the interpretation of the P_1 test for corn based upon the available phosphorus in the subsoil, but the interpretation of the test for wheat will be the same for all soils until new data show that a change should be made.

Nitrogen. The nitrogen fertilizer program affects not only the profit from the wheat crop, but also the stand of alfalfa or clover that is seeded in the wheat (Table 22).

Wheat will usually respond to extra nitrogen up to the point where lodging begins. Greatest increases for nitrogen are on light-colored forest soils (formed under native cover of trees rather than prairie grasses). The light-colored prairie soils of south central Illinois are also relatively low in organic matter and thus respond well to nitrogen. Coarse-textured soils (sands, sandy loams, and gravelly loams) generally need extra nitrogen because nitrates leach readily from the root zone in these soils.

Fall application. The amount of nitrogen needed for good fall growth is not large because the total uptake in roots and tops is not likely to exceed 30 to 40 pounds per acre. The suggested rate for applying nitrogen in a mixed fertilizer through the drill on light-colored soils is therefore only 15 to 20 pounds. The safe upper limit for N plus K is about 40 pounds per acre.

On dark-colored soils nitrogen is not needed at planting time.

Potassium. Wheat is not very responsive to potassium unless the soil test is below 100. The potassium fertilizer applied before planting or at planting time is therefore aimed mainly at meeting the needs of the forage legume to be seeded in the wheat or as part of a general soil buildup or maintenance treatment.

Table 21. — Applications of Available Phosphorus for Wheat (P_2O_5 and Equivalent Pounds P)

P_1 test level	Percent of possible yield	Pounds of P_2O_5 or P to be added per acre based on the P_1 test					
		P_2O_5			P		
		Broadcast		Through planter or drill	Broadcast		Through planter or drill
10–15	Below 47	90[a] to 150[a]	+ or	30 or 90[a]	39[a] to 65[a]	+ or	13 or 39[a]
20	57	60 to 120[a]	+ or	30 or 80	26 to 53[a]	+ or	13 or 35
30	72	60 to 90[a]	or	60	26 to 39[a]	or	26
40	82	60	or	30 to 60	26 or 13 to 26		
60	92			30	13		

[a] The soil test will likely increase about 1 pound for every 9 pounds of P_2O_5 fertilizer (4 pounds of P) applied. Rates of 120 and 150 pounds are for those who desire a rapid buildup in available phosphorus and for all fields on which alfalfa, clover, or lespedeza will be seeded unless the P_1 test is already 50 or above.

Table 22. — Total Nitrogen Applications (Fall Plus Spring) for Different Soil Situations and Varieties

Soil situation	For fields with alfalfa or clover seedings (pounds)		For fields with no alfalfa or clover (pounds)	
	Benhur Riley	Other adapted varieties	Benhur Riley	Other adapted varieties
Soils **low** in capacity to supply nitrogen: inherently low in organic matter (light colored), no manure, alfalfa, or clover in the preceding year	50–70	40–60	70–90	50–70
Soils **medium** in capacity to supply nitrogen (compare situation to **low** above and **high** below)	30–50	20–40	50–70	30–50
Soils **high** in capacity to supply nitrogen (light-colored soils that regularly have legumes or manure and all deep, dark-colored soils)	20–30	0	40–50	20–30

BARLEY

Barley acreage in Illinois has been declining in recent years, including the 1970 crop (Table 23).

Barsoy and Schuyler have created the greatest interest recently. Barsoy is an early winter barley from Kentucky with good performance. The earliness of this variety has enhanced the opportunity for double-cropping soybeans after it.

Schuyler is an awned feed-type barley developed at Cornell University in New York. It is medium late, short, and stiff strawed. It has yielded well in limited testing in Illinois.

The performance of spring and winter barley varieties is shown in Tables 24 and 25.

Table 23. — Oats, Barley, and Rye Production in Illinois[a]

	1968	1969	1970
Spring Oats			
Acres	756,000	718,000	646,000
Bu./A.	66	61	57
Barley			
Acres	23,000	18,000	16,000
Bu./A.	44	40	42
Rye			
Acres	25,000	26,000	25,000
Bu./A.	21	23.5	22

[a] Illinois Cooperative Crop Reporting Service, July 1, 1970 report.

Table 24. — Spring Barley Performance at Urbana and DeKalb

Variety	Urbana		DeKalb	
	1970	1969-70	1970	1969-70
	Bushels per acre		*Bushels per acre*	
Traill	37	47	57	63
Larker	57	54	51	57
Dickson	40	46	56	55
Conquest	53	53	62	61
Paragon	52	52	65	60
Coho	53	52	63	62
Bonanza	44	47	58	60
Primus	46	54	58	63

Table 25. — Winter Barley Performance at Urbana and Brownstown

Variety	Urbana		Brownstown	
	1970	1969-70	1970	1969-70
	Bushels per acre		*Bushels per acre*	
Schuyler	75	83	53	59
Hudson	58	68	45	48
Knob	84	64	38	37
Lakeland	95	87	60	64
Harrison	90	74	72	66
Jefferson	92	74	54	44
Cass	60	53	43	47

SPRING OATS

The 1970 Season

The 1970 oat crop had a favorable year. Growth and production were better than in 1969 but slightly below that of 1968, a record-setting year. Planting, heading, and harvesting dates were about average. Some excess moisture in northern Illinois during May damaged small areas of oats. The temperatures were moderate, favoring this cool-season crop. Only in early July were temperatures high enough to create concern about oat yields and grain quality. Early planted oats had flowered by July 1, thus had advanced through their most sensitive heat stress period before the high temperatures occurred.

Oat acreage continues to decline and yield fluctuates with the condition of the growing season (Table 23).

Varieties

The variety usage in Illinois indicates Jaycee increasing in popularity, but Garland was the most popular in 1970 (Table 26).

Table 26. — Oat Variety Usage in Illinois[a]

Variety	Percent of acres planted			
	1967	1968	1969	1970
Garland	25	29	28	25
Jaycee	..	2	9	18
Newton	26	23	20	17
Clinton	4	4	4	5
Holden	..	..	1	4
Brave	4	5	4	3
Nemaha	6	7	4	3
Others	35	30	30	25

[a] Illinois Cooperative Crop Reporting Service.

Kota was developed by South Dakota State University. It is similar to Portal in height, heading date, maturity date, test weight, and kernel size. It is moderately resistant to lodging and to stem and crown rust. It is resistant to smut and has some tolerance to the barley yellow dwarf disease (BYDV).

Jaycee is an early maturing, high-yielding variety developed at the University of Illinois. The grain color is light brownish to yellowish white. It produces fairly large, plump kernels with groat percentage and test weight similar to Newton. Jaycee is very short strawed (1 to 3 inches shorter than Goodfield), and has stood well under Illinois conditions until maturity. Jaycee loses its strength rapidly after maturity. Harvest Jaycee as soon after maturity as is possible to avoid high field losses. It has barley yellow dwarf virus tolerance that is superior to any variety now available for growing in Illinois. It is resistant to some, but not all, races of leaf and stem rust. Jaycee is resistant to races of smut that have occurred in Illinois.

Tyler, developed at Purdue, is similar to Goodfield and Tippecanoe in height and standing ability, but has been superior to both in yield. Tyler matures approximately 2 days earlier than Clintland 60. The grain is a light brownish white (or light yellow in some seasons), plump, and medium in test weight.

Clintford also was developed at Purdue from the cross of a Clintland type with Milford. Milford was introduced from Wales for its excellent straw strength. Clintford is the first variety in the United States to use this source of straw strength. The grain is a light brownish white (or light yellowish white in some seasons), large, plump, and very high in test weight. Clintford has very

Table 27. — 1970 County Oat Variety Demonstration Yields (Bushels per Acre)

County	Brave	Clint-ford	Clint-land 64	Garland	Holden	Jaycee	Kota	Newton	Orbit	Portal	Tyler
Boone	90	85	101	86	..	75	101	88	101	75	81
Bureau	80	85	100	92	92	95	76	94	92	94	86
Ford	50	34	39	31	34	38	49	36	51	58	48
Henry	82	83	83	58	78	85	92	58	63	83	58
Henderson	78	84	94	81	88	76	96	88	93	88	79
Knox	67	60	77	68	73	60	78	58	71	59	60
Lee No. 1	86	98	93	91	104	102	99	89	101	77	108
Lee No. 2	65	107	91	72	83	79	67	88	99	106	72
Mercer	74	84	92	74	84	74	92	81	80	81	78
McDonough	51	43	40	38	44	43	50	50	57	40	34
Stark	72	64	69	54	61	72	81	59	66	90	66
Winnebago	82	85	83	76	57	65	50	71	82	66	62
Whiteside	102	95	101	105	101	109	..	101	112	107	96
Woodford	100	94	84	95	93	94	104	99	86	96	90
Warren No. 1	88	81	93	74	83	80	80	70	60	76	76
Warren No. 2	70	74	88	73	70	74	90	70	88	74	64
Average 16 locations	77	78	83	73	76[a]	76	80[a]	75	81	79	72

[a] 15 locations average not directly comparable to other averages.

Table 28. — University of Illinois Oat Variety Yields

	DeKalb			Urbana			Brownstown		
	1970	1970	1968–1970 average	1970	1970	1968–1970 average	1970	1970	1968–1970 average
	Bu./A.[a]	T.W.[b]	Bu./A.	Bu./A.	T.W.	Bu./A.	Bu./A.	T.W.	Bu./A.
Brave	93.6	30.5	94	104.4	29.8	92	71.0	33.0	82
Clintford	96.4	36.0	84[c]	94.5	30.2	74[c]	...	...	..
Clintland 64	96.1	34.5	94	78.9	27.0	78	45.0	33.0	50[c]
Diana	89.2	32.0	..	91.2	29.8	..	64.4	34.5	..
Froker	133.7	30.0	..	56.7	23.5	..	...	...	..
Garland	93.8	31.5	99	92.8	29.5	85	53.0	35.0	65
Holden	103.1	31.0	103	85.2	28.2	87	51.7	35.0	68
Jaycee	84.6	32.5	99	107.6	32.0	99	57.2	33.5	75
Kota	84.7	32.5	86[c]	105.3	30.0	92[c]	...	...	..
Newton	104.3	33.0	100	91.7	31.0	92	73.1	35.5	75
Nodaway 70	86.7	31.5	..	97.2	32.0	..	50.9	33.5	..
Orbit	110.6	31.0	107	111.4	28.8	98	64.6	33.5	77
Otter	107.4	30.0	102[c]	121.5	30.2	100[c]	57.1	34.0	60[c]
Pettis	...	...	102[c]	105.5	33.5	93	...	...	..
Portal	95.0	33.0	101	74.7	27.2	77	57.5	35.5	67
Tyler	87.7	30.5	94	94.6	30.2	87	60.6	36.0	66

[a] Bu./A = bushels per acre.
[b] T.W. = test weight.
[c] Average of 2 years. Not directly comparable to other averages.

short, stiff straw with large-diameter stems. It matures about 2 days earlier than Clintland. Clintford has a compact panicle that distinguishes it from other varieties grown in Illinois.

Brave is a high-yielding variety from Illinois. It has excellent smut resistance, some tolerance to Septoria, and tolerance to BYDV. Its test weight is adequate, quality good, and seed color yellow. Brave has fair straw strength but is not quite equal to Newton in this respect. Generally an early variety, Brave appears to be well adapted throughout Illinois.

Clintland 64 was released by the Indiana Agricultural Experiment Station and is very similar to Clintland 60, except for improved leaf-rust resistance. Clintland 64 is one of the most leaf-rust-resistant varieties currently available. The variety is not resistant to BYDV.

Orbit is a recent white-oat release from Cornell University. It is short-strawed, lodging resistant, and matures three to five days later than Newton. It is resistant to smut, stem rusts, and some of the leaf rusts. Orbit has about the thickest hull among current varieties. The heavy hulls lower the groat-to-hull percentage.

Garland, released by Wisconsin, performs very well in northern and central Illinois. A sister selection of Dodge and Goodfield, Garland has shown top performance both in Urbana and DeKalb yield trials and in county demonstrations. It has good test weight, stands well, and has resistance to some races of smut.

Newton was released by Indiana in 1955. This variety has both Nemaha and Clinton in its parentage, and combines the best characteristics of each. Generally, it has large, plump kernels and good straw strength. Newton shows some tolerance to yellow dwarf and has some rust resistance, but it is susceptible to several of the newer races of rust. It is also susceptible to Septoria.

Holden was released by the Wisconsin Agricultural Experiment Station in 1967. The variety matures slightly later than Garland. Its yield has been 5 to 8 percent greater per acre than Garland. The grain of Holden has a yellow hull, a well-filled kernel, and a good test weight that is equal to Garland. Holden is resistant to older races of leaf rust and intermediate-to-susceptible to newer races. It has resistance to smut and some races of stem rust.

Portal was released by the Wisconsin Agricultural Experiment Station in 1967, and is a variety that matures in midseason in Illinois. Portal is similar to Garland in most characteristics but has yielded 5 to 10 percent more than Garland. The test weight and straw strength of Portal are slightly less than Garland. It is taller than Garland and matures a little later than Garland. The variety has a yellow hull and resistance to smut and most races of stem rust. Portal has more resistance to leaf rust than most varieties available at present, equaling Clintland 64.

Pettis was released by the Missouri Agricultural Experiment Station in 1967. The variety is early maturing in Illinois, and has a high test weight and high groat percentage. Pettis has excellent tolerance to BYDV and some races of stem rust. The seeds of the variety are red and moderately small. The straw is 1 inch shorter and slightly weaker than the variety Mo. 0-205. It has weaker straw than most varieties currently grown in Illinois.

New Varieties

Four new varieties were tested in Illinois in 1970. Seeds are being increased and will likely be available for farm planting in 1972.

Diana is a yellow oat released by Purdue University in 1966. It matures about the same time as Garland, yields above Clintland 64, and possesses good test weight and straw strength. Diana is medium in height, has good resistance to leaf rusts, and is resistant to most races of stem rust. It has been in University of Illinois tests only one year.

Froker is a yellow oat released by the University of Wisconsin in 1970. It is late maturing, similar to Lodi. Froker has improved leaf rust resistance, resistance to most races of stem rust, and good resistance to smut. Straw height is similar to Portal but with greater strength. Yields were high in northern Illinois but only mediocre in central Illinois, indicating the influence of the lateness on adaptation of the variety.

Otter is a white oat released by the University of Minnesota in 1970. It matures about the same time as Garland and is of similar height. Straw strength is a little weak. Otter is resistant to smut. It has fair to good resistance for leaf and stem rusts. The yields of Otter have been high and its test weight slightly below most varieties, but the great percentage has been high.

Nodaway 70 was a University of Missouri release in 1970. It is a single plant selection from the older variety Nodaway which was not widely grown in Illinois. Nodaway 70 has greater uniformity in height and maturity than Nodaway, has a higher yield, is one day earlier maturing, is one inch shorter, and has a heavier test weight. Nodaway 70 has not been high yielding in Illinois tests.

Winter Oats

Winter oats may be grown in southern Illinois. Norline from New Jersey and Compact from Kentucky are suggested varieties.

Fertilizing Oats

Since an oat field usually has a forage seeding in it, the fertilizer application must be planned to meet the needs of both crops. Both have high phosphorus requirements. Suggested treatments are slightly lower than for wheat (Table 21, page 20), because oats are less valuable than wheat.

Oats have a relatively low potassium requirement, so plan the application to meet the needs of the legume seeding or to build up the soil-test level (Table 42, page 39), or both.

A large proportion of Illinois oat fields would benefit from nitrogen fertilizers. Varieties have become progressively shorter, with stiffer straw, so they resist lodging and give a yield increase with higher rates of nitrogen.

On highly fertile, dark-colored soils in livestock systems of farming where lodging is still likely, no extra nitrogen is suggested. In typical situations in central and northern Illinois, use 40 to 60 pounds. On light-colored soils that have not regularly had either legume crops or manure, 80 pounds of nitrogen is about right.

In all fields where you make a legume seeding, apply slightly less nitrogen than is normally recommended for the oats. This will improve the seeding more than enough to offset the reduction in oat yield.

CROPS FOR LATE PLANTING

In most years flooding or some other disaster makes replanting of corn and soybeans necessary somewhere in Illinois.

When this happens the most common questions are: Is it too late to replant with corn or soybeans? If it is not too late, how early a variety should be used? If it is too late for corn or soybeans is there any other crop that can be substituted for feed grain or cash-grain production.

Any answer to these questions assumes that (1) weather conditions following replanting will favor immediate germination and emergence, (2) that rainfall and temperatures will favor normal growth and development, and (3) that the first killing frost in the fall will be as late or later than average.

The following are estimates of how late corn and soybeans may be planted in Illinois when favorable weather and growing conditions follow replanting.

Starting in the northwestern corner of the state where the first killing frost can be expected before October 5, June 15 is the latest date that early varieties of corn can be planted with reasonable assurance that they will be mature (30 to 35 percent moisture) before the first frost. Make the shift to early varieties in late May.

As the average date of the first killing frost moves later into October the latest date for planting corn for grain moves later into June.

In the northern third of the state you can move the planting date later into June about the same number of days that the first frost falls after October 5.

In the southern two-thirds of the state (this is especially true of the southern one-third) you can move the planting date proportionally later into June because of the higher temperatures during the remainder of the growing season. In central Illinois where the average killing frost occurs on October 15, corn planted as late as July 5 has a 50-percent chance of maturing before frost.

Unless the need for grain or silage is especially great, planting corn later than July 5 to 10 is of questionable merit because yields are likely to be low.

Soybeans have the ability to greatly shorten their vegetative period and may be planted later than corn with reasonable assurance that they will mature before frost. In northern Illinois, where the first killing frost is expected about October 5, early varieties such as Chippewa 64 and Hark may be expected to mature when planted as late as the last of June. The later varieties, such as Harosoy 63 and Corsoy, may be used until the middle of June.

In north central Illinois you can plant Harosoy 63 and Corsoy until early July and you can use varieties of the maturity of Amsoy until mid-June.

In central Illinois Wayne and varieties of similar maturity may be expected to mature when planted by mid-June. Use Amsoy, Harosoy 63, and Corsoy until July 5 to 10.

The growing season in southern Illinois is long enough that most of the varieties normally grown in the area will mature when planted as late as July 5 to 10.

When you must plant soybeans late, use the tallest variety that has a reasonable chance to mature. One of the problems with late-planted soybeans is short plant height and low podding. Dry weather aggravates this.

Other grain crops that mature in a short time and may be used in an emergency are sorghum and buckwheat.

Varieties of sorghum that will mature in 90 to 100 days are sometimes used for late planting. The penalty for planting sorghum late is often not so great as it is for corn and other crops. If the crop is being grown as a cash crop, arrangements for a market should be made ahead of planting. Some elevators prefer not to handle sorghum. Local livestock feeders or feed mills may be interested in the crop.

Another problem usually associated with sorghum is that of drying the grain. The grain should be harvested as soon as it is mature. Often this will be before the plant is dry and the grain will be too wet to store without drying.

Buckwheat may mature in 75 to 90 days. It can be planted as late as July 10 to 15 in the northern part of the state and late July in southern Illinois.

The crop is sensitive to both cold weather and hot weather. It will be killed by the first frost in the fall. Yields will be disappointingly low if it blooms during hot weather.

The market for buckwheat is limited unless you plan to use it for livestock feed. Be sure of a market before you plant it.

HAY, SILAGE, PASTURE, AND SEED PRODUCTION

The 1970 Season

Seeding alfalfa in the spring without a companion crop of oats or wheat increased. Early planting was possible in northern and central Illinois, but very difficult in southern Illinois because of wetter soils and prolonged periods of rainy weather. Some late spring seedings were tried in southern Illinois with marginal success.

Weed control in spring seedings in northern Illinois was inadequate for some preemergence herbicides. Rains and wet soils prevented some farmers from making postemergence herbicide applications. Therefore, some spring-seeded alfalfa in northern Illinois was very weedy at the first cutting.

Central Illinois had good weather conditions for effective herbicide weed control in spring-seeded alfalfa.

Southern Illinois weather conditions did not favor spring seedings. Late seedings had grassy weed problems.

Winter survival of forages was good throughout the state. Heaving of alfalfa and clover was less severe than in most years.

Spring growth of established hay and pasture was excellent. First cutting yields nearing three tons of dry hay per acre were reported in northern and central Illinois. Rainy weather made haymaking difficult in southern Illinois and some first cuttings were made very late. Excessive alfalfa weevil damage occurred on some fields where harvests were delayed.

Alfalfa Weevil

Damage from alfalfa weevil ranged from slight to severe in the southern one-third of the state. Little or no damage occurred in central or northern areas. Parasites and diseases of the weevil have resulted in reducing the weevil population.

Leafhoppers

This small green angular insect becomes a serious problem for alfalfa in early June and persists throughout the summer. Leafhoppers are particularly damaging to new growth, either new seedings or recovery growth. An early symptom of feeding is a V-shaped yellow area at the tip of alfalfa leaflets. Both carbaryl and methoxychlor are effective insecticides for leafhopper control.

Illinois Hay Acreage

Hay production in Illinois increased by 11,000 acres in 1970 over the 1969 acreage. Alfalfa increased 8,000 acres and clover-timothy increased 4,000 acres. There was little change among the other classes of hay. This is the first year since 1964 that hay acreage has *increased* over the previous year.

Table 29. — Hay Acreage and Yields in Illinois[a]

Year	Alfalfa (thousands of acres)	Alfalfa yield (tons per acre)	All hay (thousands of acres)	Hay yields (tons per acre)
1964	1,128	2.75	1,896	2.28
1965	1,064	2.90	1,744	2.44
1966	939	2.80	1,552	2.38
1967	869	3.20	1,409	2.70
1968	782	3.25	1,305	2.73
1969	766	3.20	1,281	2.64
1970[b]	774	3.30	1,292	2.76

[a] Bul. 70-1, Illinois Cooperative Crop Reporting Service.
[b] Preliminary estimate, July 1, 1970.

High Hay Yields

Yields of 2 to 2½ tons of dry hay per acre are usually needed to make a profit. High yields may cost more to produce, but the value of product received will usually be greater than the additional costs of production. Yields of six to over ten tons of dry matter should be the goal of most Illinois farmers.

Select suitable soils for high hay yields. Soils should have good internal drainage and water-holding capacity. Rolling topography is not essential, though surface drainage is desirable. Soils with slope may be better suited for hay production than for row crops, thus reducing the problem of erosion and sedimentation of streams, rivers, and reservoirs. Nearly level soils will usually benefit from some surface drainage. Poorly drained, level soils should definitely have surface drainage provisions made for alfalfa and clover production.

Fertilize the crop according to yield expectations, nutrient-supplying capacity of the soil, and soil test values. Fertilization is essential for high yields and longevity of stand.

Select varieties of high yield potential that have suitable disease resistance. Stands that will last two years may call for more disease susceptible varieties than if the stand will last three to ten years. Rapid recovery after harvesting seems to be closely related to high yield potential.

Establish dense uniform stands. Highly productive stands should have about 30 plants per square foot at the first harvest in the seeding year, 10 the second year and 5 the succeeding years. Uniform stands of optimum population rarely can be established with a companion crop of oats, wheat, barley, or weeds. Spring seedings without a companion crop or late-summer seedings seem to be a key step to dense uniform stands of hay crop species. Spring seedings of alfalfa and alfalfa-grass mixtures have been very successful in northern, central and south central Illinois. Spring seedings have been less successful in southern Illinois, but late-summer seedings have usually been good. Red clover and grasses seeded alone can also be established in the spring without a companion crop in the northern two-thirds of the state. However, the seeding year yields are about 50 percent less than alfalfa.

Table 30. — Acceptable Fall Harvesting Dates for Alfalfa in Illinois by Regions

	Northern	Central	Southern
		Harvest dates	
September	1	10	20
October	No	25	30

Maximum dry-matter yield from alfalfa and most forages is obtained by harvesting the first cutting at nearly full bloom and each succeeding harvest every 40 to 42 days thereafter until September. This management produces a forage that is relatively low in digestibility. It is suitable for livestock on maintenance, will produce slow weight gain, and can be used in low-production feeding programs. High performance feeding programs need a highly digestible forage. The optimum compromise between high digestibility and dry-matter yield of alfalfa is to harvest the first cutting at the late-bud-to-first-flower stage and to make subsequent cuttings at 35-day intervals.

Winter survival and vigor of spring growth are greatly affected by the time of the fall harvest. A high level of root reserves (sugars and starches) is needed. Root reserves decline following a harvest as new growth begins. About three weeks after harvesting, root reserves are depleted to a low level and the top growth is adequate for the photosynthesis to support the plant's needs for sugars. Root reserves are replenished gradually from this point until harvested or until the plant becomes dormant in early winter. Harvests made in September and October affect late-fall root reserves of alfalfa more than do harvests made in the summer. A recovery growth period from early September to late October is needed to store a high level of root reserves. A harvest may be taken late in October after the plants are dormant in central and southern Illinois. See Table 30 for fall management suggestions.

Alfalfa

Low yields are major problems with the hay crops, including alfalfa. The potential yield of the crop is three or more times greater than the state average of 3.2 tons per acre. Some soil and climatic situations reduce the potential somewhat. Even on the lower potential soils, yields are one-third to one-half of easily reached potential.

Some major barriers to higher alfalfa yields are poor drainage, inadequate stands, low fertilization, late harvests, and long periods of time between harvests.

Soils with good internal drainage and slope enough for surface drainage are ideal. Poorly drained soils should be tiled if feasible and provisions should be made for surface drainage. Alfalfa stands that have surface water on them for extended periods in winter and early spring have more winter killing and winter damage, such as heaving, than where surface water is removed.

Varieties

Alfalfa variety development is largely in the hands of private seed companies. A few excellent varieties from public research programs are available along with the good varieties from private research.

Bacterial wilt is a major disease of alfalfa. Bacterial wilt is a root and crown disease that lives indefinitely in the soil. Susceptible varieties live through two to three production years in infected soil.

Adding stress with intensive harvesting schedules increases the rate at which bacterial wilt infects and destroys susceptible plants. Susceptible varieties should not be expected to be highly productive beyond two harvest seasons. Moderately resistant varieties may last four to five harvest seasons. Only resistant varieties should be used if alfalfa stands are expected to remain productive five or more harvest years.

In Illinois use varieties that are resistant to leafspot diseases, anthracnose, alfalfa weevil, leafhopper, and pea aphids. No variety has a high level of resistance to all these problems.

Varieties of varying maturities may be needed on a farm to spread the optimum harvesting period.

Extreme cold hardiness is not necessary in Illinois. Moderately cold-hardy varieties seem to perform well throughout the state. Varieties with early fall dormancy tend to be more winter hardy and lower yielding than late fall dormancy varieties.

Lodging resistance is important in alfalfa as in other crops. An erect plant is more completely harvested, has less shading of the lower stem area, and consequently less leaf loss from shading.

Information concerning these characteristics should be available from seed dealers. Information on comparative yield performance and bacterial wilt resistance is presented in Table 31.

Flemish and non-Flemish designations for alfalfa varieties are less meaningful today than five to ten years ago.

Table 31. — The Yields of Leading Alfalfa Varieties Given as Percentages of Certain Check Varieties Tested Two Years or More in Illinois[a]

Variety	Flemish or non-Flemish	Bacterial wilt	Nor. Ill.	Cen. Ill.	So. Ill.
A-24	F	S[b]	105	101	. . .
Alfa	F	S	97	103	104
Apex	F	MR[c]	107	103	. . .
Arnim	F	S	96	103	104
ATRA 55	NF	R[d]	105	102	. . .
Cardinal	F	S	96	98	107
Cayuga	NF	R	105	104	99
Cherokee	NF	S	104	103	107
Cody	NF	R	96	102	101
Dawson	NF	R	101	102	. . .
Dominor	NF	R	113	105	116
DuPuits	F	S	101	99	102
Europa	F	S	95	100	104
Flamande SC118	F	S	102	100	104
Flandria	F	S	102	109	105
Franck's Langmeiler	NF	U[e]	97	100	106
Glacier	F	S	97	101	106
Haymor	F	S	99	103	106
Iroquois	NF	R	105	96	. . .
Milfeuil	F	S	93	101	108
Mustang	NF	R	101	103	. . .
Narragansett	NF	S	103	98	. . .
Orchies	F	S	98	106	106
Pat 30	F	S	100	103	98
Progress	NF	R	98	102	101
Saranac	F	MR	107	104	108
Socheville	F	S	. . .	111	103
Team	NF	S	104	99	. . .
Tempo	NF	R	105	102	115
Titan	NF	R	104	101	98
Thor	F	R	114	102	110
Warrior	F	MR	100	99	103
Weevlchek	NF	R	114	101	. . .
WL 202	NF	R	103	103	109
WL 210	NF	R	110	103	114
WL 300	NF	R	102	. . .	105
WL 303	NF	MR	109	106	109
WL 305	NF	MR	111	106	110
WL 306	NF	R	112	106	. . .
123	NF	R	104	101	111
153	NF	S	101	105	97
235	NF	R	106	. . .	. . .
520	NF	R	104	101	. . .
522	NF	R	102	98	102
525	NF	R	106	104	110

[a] The check varieties were Vernal, Ranger, Atlantic, and Buffalo. The performance of the other varieties was tested against these varieties.
[b] S = susceptible.
[c] MR = moderate resistance.
[d] R = resistant.
[e] U = information not available.

Flemish varieties usually mature early, recover rapidly after harvesting, and are moderately winter hardy and susceptible to bacterial wilt. Recent varieties have been developed with similar and improved attributes of the Flemish, but may not have any Flemish material in the breeding background. Improved Flemish varieties have also been developed with more winter hardiness and bacterial wilt resistance than the older Flemish varieties. The Flemish and non-Flemish designations are provided in Table 31 for whatever value they may have.

Red Clover

There are fewer varieties of red clover than alfalfa. There has been some interest in mammoth red clover, particularly Altaswede. Mammoth red clovers make one large crop and have little or no regrowth, resulting in a lower seasonal yield. Mammoth red clover is a good plow-down crop, but is usually inferior as a hay crop compared with medium red clover (Table 32). Use northern-anthracnose-resistant varieties in the northern one-third of the state and southern-anthracnose-resistant varieties in the southern two-thirds of the state.

Table 32. — Red Clover Variety Yields, Urbana, 1968-1969

Variety	Anthracnose resistance	Tons dry matter per acre
Chesapeake	Southern	3.56
Kenland	Southern	3.24
Pennscott	Southern	3.18
Dollard	Northern	3.60
Lakeland	Northern	3.78
LaSalle	Northern	3.40
Mammoth	. . . .	3.42
Altaswede	. . . .	2.96

Other Hay and Pasture Crops

There are fewer varieties of other forage crops than alfalfa. Variety development work continues for most of these crops. Table 33 lists several varieties that have been grown in Illinois tests and are adapted to Illinois. Some varieties are higher yielding than others (Tables 34 and 35).

Fertilization of Hay and Pasture

Fertilization suggestions at time of seeding are determined from information supplied by soil tests and by the nutrient-supplying capacity of the soil (Tables 36 and 37). Maintenance fertilization suggestions are determined from nutrient-supplying capacity of the soil and by nutrients removed by harvesting or grazing. On some soils as little as 50 percent of the nutrients phosphorus and potassium will need to be replaced. Other soils may require 100 percent replacement of one or both of these nutrients (Table 38).

At or Before Seeding

Lime. Apply lime at the rates suggested in Figure 6, page 33. If rate requirements are in excess of 5 tons, apply half before the primary tillage (in most cases, plowing) and half before the secondary tillage (harrowing, disking). Apply rates of less than 5 tons at one time, preferably after plowing, but either before or after is acceptable.

Nitrogen. Up to 20 pounds per acre may help assure rapid seedling growth on soils with less than 2½ percent organic matter. If you band-seed, apply nitrogen with the grain drill with phosphorus. For broadcast seeding, apply broadcast with phosphorus and potassium.

Table 33. — Other Hay, Pasture, and Silage Crop Varieties

Crop	Variety	Origin	Use	Relative maturity (days)[a]
Ladino clover	Merit	Iowa	Pasture	
Birdsfoot trefoil	Empire	New York	Pasture	
	Dawn	Missouri	Pasture	
	Viking	New York	Hay and pasture	
	Leo	Canada	Hay and pasture	
Crownvetch	Penngift	Pennsylvania	Erosion and pasture	
	Chemung	New York	Erosion and pasture	
	Emerald	Iowa	Erosion and pasture	
Smooth bromegrass	Achenbach	Kansas	Hay and pasture	
	Baylor	Rudy Patrick Co.	Hay and pasture	
	Blair	Rudy Patrick Co.	Hay and pasture	
	Lincoln	Nebraska	Hay and pasture	
	Saratoga	New York	Hay and pasture	
	Sac	Wisconsin	Hay and pasture	
	Southland	Oklahoma	Hay and pasture	
Orchardgrass	Boone	Kentucky	Hay and pasture	0
	Danish	Denmark	Hay and pasture	+10
	Napier	Rudy Patrick Co.	Hay and pasture	0
	Pennlate	Pennsylvania	Hay and pasture	+10
	Pennmead	Pennsylvania	Hay and pasture	+5
	Potomac	Maryland	Hay and pasture	0
	Sterling	Iowa	Hay and pasture	+3
	S-37	Wales	Hay and pasture	+11
Tall fescue	Alta	Oregon	Pasture	
	Kenmont	Kentucky	Pasture	
	Kenwell	Kentucky	Pasture (more palatable)	
	Ky-31	Kentucky	Pasture	
Timothy	Clair	Kentucky	Hay	0
	Verdant	Wisconsin	Hay	+20

[a] Maturity relative to a popular variety within the species.

Table 34. — Smooth Bromegrass Varieties

Variety	Urbana 1967–1969	DeKalb 1967–1969
	Tons per acre	
Achenbach	4.09	..
Baylor	4.06	..
Carlton	3.05	3.32
Lancaster	3.70	3.64
Manchar	3.28	3.62
Red Patch	3.56	3.69
Sac	3.78	..
Saratoga	3.50	..
Southland	3.83	..

Table 35. — Orchardgrass Variety Yields, 1967-1969

Variety	Tons dry matter per acre	
	DeKalb	Urbana
Akaroa	3.36	2.65
Boone	..	3.53
Common	3.30	3.28
Danish	3.38	2.91
Latar	3.31	2.64
Masshardy	3.44	2.41
Napier	3.50	3.32
Pennlate	3.58	2.81
Potomac	..	3.35
Sterling	..	3.31

Phosphorus. Apply all phosphorus at seeding time (Table 36) or broadcast part of it with potassium. For band seeding, reserve a minimum of 30 pounds of P_2O_5 per acre for this purpose. For broadcast seeding, broadcast all the phosphorus with potassium after primary tillage and before secondary tillage.

Potassium. Broadcast potassium before or after primary tillage (Table 37). For band seeding you can apply a maximum of 30 to 40 pounds K_2O per acre in the band. For broadcast seeding, apply all the potassium after the primary tillage. You can apply a maximum of 300 pounds of K_2O per acre in the seedbed.

Maintenance Fertilization

Make maintenance application (Table 38) annually after the first or second year. Maintenance applications are based on percent of nutrient removal, soil nutrient-supplying power, and whether K was applied for 1 or 2 years (see Table 37). Approximate nutrient removals by alfalfa per ton of dry matter are: phosphorus, 11 pounds of P_2O_5, and potassium, 50 pounds of K_2O.

Nitrogen. The most profitable nitrogen program for legume-grass mixtures is determined by the percent of legume in the stand. When the alfalfa or other legumes stand is *30 percent or more* of the mixture, the main objective in fertilizing is to *maintain the legume.* If heavy applications of nitrogen are made when the legume stand is still excellent, the grass is given a competitive advantage and tends to crowd out the legume.

After the legume has declined to *less than 30 percent* of the mixture, the objective in fertilizing is to *increase the yield of grass.*

The suggested rate of nitrogen is about 50 pounds per acre when the legume makes up 20 to 30 percent of the mixture, and 100 pounds when the legume is 0 to 20 percent. Of this 100 pounds, it is best to apply one-half in late winter to early spring and one-half after the first cutting.

Farmers who maintain pure grass probably will find it profitable to apply 80 to 100 pounds early in the spring, 50 pounds after the first cutting, and 50 pounds about September 1 to 15 if they need extra fall feed.

Rock Phosphate. Each 1,000 pounds of rock phosphate per acre supplies 13 pounds of immediately available P (30 pounds of P_2O_5), plus some available P each year as the rock reacts with soil acids. This is adequate for establishment on soils that test medium by the P_1 test and medium to low by the P_2 test. For soils that test very low by both tests, use either 1,500 pounds of rock or the amount of available P in Table 35. A liberal treatment *before planting* is adequate for three to four years.

Boron. Boron deficiency symptoms appear on second- and third-cutting alfalfa in drouth periods in many areas of Illinois. But in 15 trials boron fertilizer increased the forage yield in only one field on the second cutting.

There is no recommendation for general application of boron in Illinois. If you suspect there is a boron deficiency, topdress strips in your alfalfa fields with 30 pounds of household borax per acre (3.3 pounds of actual boron).

Table 36. — Suggested Rates for Phosphorus Applied Before Seeding, Based on Expected Yield in Seeding Year for Alfalfa and Alfalfa-Grass Mixtures

P_1 test: Soil region (see map, page 35)			Broadcast seeding: Expected yield per acre		Band seeding: Expected yield per acre	
low	*med.*	*high*	2-3 tons	3-5 tons	2-3 tons	3-5 tons
			Pounds of P_2O_5 per acre			
25	15	10	120	180	60	90
30	20	15	90	150	50	80
38	30	20	60	90	30	60
45	40	30	60	60	30	40
60	50	40	..	..	30	30

Table 37. — Suggested Rates for Potassium Applied Before Seeding, Based on Indicated Expected Yield in Seeding Year of Alfalfa and Alfalfa-Grass Mixtures

K test level	Soils low in potassium-supplying power: Expected yield: tons per acre				Soils medium to high in potassium-supplying power: Expected yield: tons per acre			
	2-3	3-5	2-3	3-5	2-3	3-5	2-3	3-5
	For 1 year		For 2 years		For 1 year		For 2 years	
	Pounds of K_2O to apply per acre							
90 or less	150	225	300	450[a]	These soils seldom if			
91–120	135	200	270	400[a]	ever test below 121			
121–150	120	180	240	360[a]	110	160	220	320[a]
151–180	105	160	210	320[a]	90	135	180	270
181–210	90	135	180	270	75	115	150	230
211–240	75	115	150	230	60	90	120	180
241–300	60	90	120	180	..	70	..	135
Above 300	Test every 4 years and adjust annual rates to maintain the test level							

[a] May cause seedling injury. To avoid risk, incorporate before plowing or by deep disking, or apply the rate suggested for 1 year.

Table 38. — Suggested Annual Maintenance Fertilization for Alfalfa and Alfalfa-Grass Mixtures After Soil Tests Are Built to High Levels

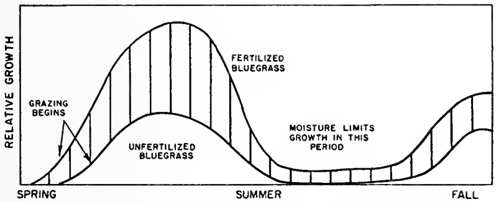
Nutrient-supplying power rating of soil[a]	Approximate percent of nutrients removed to be supplied by annual fertilization: Phosphorus	Potassium
Low	100	100
Low to medium	80	90
Medium	70	80
Medium to high	60	70
High to medium	50	60
High	50	50

[a] See pages 35 and 38.

Fertilizing Permanent Pasture

Two adjustments are made from the usual sampling and liming procedures: soil samples are taken from the surface 3 inches, and the rate of liming is reduced about one-third to one-half because (a) the lime is mixed with less soil and therefore it has less soil with which to react and (b) the species in permanent pastures have a lower lime requirement than alfalfa.

Nitrogen applied in the late fall or very early spring can advance grazing at least a week and greatly increase early carrying capacity (Fig. 5).



Relative growth of nitrogen-fertilized and unfertilized bluegrass pasture during the grazing season. (Fig. 5)

Each application of nitrogen (50 to 60 pounds) will last about 6 weeks. Repeated applications will be effective as long as moisture is adequate (usually from May 15 to June 1 in southern Illinois and June 1 to 15 in northern Illinois). Nitrogen will become effective again after fall rains begin.

Forage Mixtures

Mixtures of legumes and grasses are usually desired. Yields tend to be greater with mixtures than either the legume or the grass alone. Grasses are desirable additions to legume seedings to fill in where the legume ceases to grow, to reduce the bloat hazard with ruminant animals, to reduce late winter heaving damage, to increase drying rate, and perhaps to improve animal acceptance. Mixtures of two or three well-chosen species are usually higher yielding than mixtures of five or six species of which some are often not particularly well suited.

You may use the forage seed mixture recommendations in the column at right for rotation and permanent pastures, hay crops, hog pastures, and horse pastures.

For Rotation and Permanent Pastures

Central and Northern Illinois

Well-drained soils	*Pounds per acre*
Alfalfa Bromegrass Timothy	6 lb. 5 lb. 2 lb.
Alfalfa Orchardgrass	6 lb. 4 lb.
Alfalfa Orchardgrass Timothy	6 lb. 4 lb. 2 lb.
Orchardgrass Ladino clover	6 lb. ½ lb.
Red clover Ladino clover Orchardgrass	8 lb. ½ lb. 6 lb.
Red clover Ladino clover Tall fescue	8 lb. ½ lb. 6-8 lb.
Birdsfoot trefoil Timothy	5 lb. 2 lb.
Bromegrass Ladino clover	8 lb. ½ lb.
Tall fescue	10 lb.
Orchardgrass	8 lb.
Poorly drained soils	
Alsike clover Ladino clover Timothy	3 lb. ¼ lb. 4 lb.
Birdsfoot trefoil Timothy	5 lb. 2 lb.
Reed canarygrass Alsike clover Ladino clover	8 lb. 3 lb. ¼-½ lb.
Alsike clover Tall fescue Ladino clover	2 lb. 8 lb. ½ lb.
Drouthy soils	
Alfalfa Bromegrass	6 lb. 5 lb.
Alfalfa Orchardgrass	6-8 lb. 4 lb.
Alfalfa Tall fescue	6-8 lb. 6 lb.
Red clover Ladino clover Orchardgrass	8 lb. ½ lb. 6 lb.
Red clover Ladino clover Tall fescue	8 lb. ½ lb. 6-8 lb.

Southern Illinois

Well-drained soils	*Pounds per acre*
Alfalfa Orchardgrass	8 lb. 4 lb.
Alfalfa Tall fescue	8 lb. 6 lb.
Tall fescue Ladino clover	8 lb. ½ lb.
Alfalfa Bromegrass Timothy	8 lb. 6 lb. 2 lb.
Orchardgrass Ladino clover	6 lb. ½ lb.
Tall fescue	10 lb.
Orchardgrass	8 lb.
Red clover Ladino clover Orchardgrass	8 lb. ½ lb. 6 lb.
Red clover Ladino clover Tall fescue	8 lb. ½ lb. 6-8 lb.
Poorly drained soils	
Alsike clover Tall fescue Ladino clover	2 lb. 8 lb. ½ lb.
Reed canarygrass Alsike clover Ladino clover	8 lb. 3 lb. ½ lb.
Drouthy soils	
Alfalfa Orchardgrass	8 lb. 4 lb.
Alfalfa Tall fescue	8 lb. 6 lb.
Red clover Ladino clover Orchardgrass	8 lb. ½ lb. 6 lb.
Red clover Ladino clover Tall fescue	8 lb. ½ lb. 6-8 lb.

For Hay Crops

Central and Northern Illinois

Well-drained soils	*Pounds per acre*
Alfalfa	12 lb.
Alfalfa Bromegrass	8 lb. 6 lb.
Alfalfa Bromegrass Timothy	8 lb. 4 lb. 2 lb.
Alfalfa Timothy	8 lb. 4 lb.
Poorly drained soils	
Alsike clover Timothy	5 lb. 4 lb.
Reed canarygrass Alsike clover	8 lb. 3 lb.
Birdsfoot trefoil Timothy	5 lb. 2 lb.
Drouthy soils	
Alfalfa Bromegrass	8 lb. 6 lb.
Alfalfa Tall fescue (south and central Illinois only)	8 lb. 6 lb.

Southern Illinois

Well-drained soils	*Pounds per acre*
Alfalfa Orchardgrass	8 lb. 6 lb.
Alfalfa Tall fescue	8 lb. 6 lb.
Poorly drained soils	
Reed canarygrass Alsike clover	8 lb. 4 lb.
Tall fescue Alsike clover	6 lb. 4 lb.
Redtop Alsike clover	4 lb. 4 lb.
Drouthy soils	
Alfalfa Orchardgrass	8 lb. 4 lb.
Alfalfa Tall fescue	8 lb. 6 lb.
Alfalfa Bromegrass	8 lb. 6 lb.

For Hog Pastures

(for anywhere in Illinois)

Alfalfa	6 lb.
Ladino	2 lb.

For Horse Pastures

(for anywhere in Illinois)

Alfalfa	6 lb.
Bromegrass	6 lb.
Kentucky bluegrass	5 lb.

Pollination of Legume Seeds

Illinois has always been an important producer of legume seeds, particularly red clover. From 1967 to 1969 both yields and acreage of red clover have dropped noticeably. During the same period, honey bee numbers (hives) have also decreased to a new estimated low of 76,000 colonies for 1969. As recently as 1958 there were 140,000 colonies in the state, yet an insufficient number of bees were present at that time near most red clover fields. Honey bees visit medium red clover well during second bloom and pollinate it as they collect pollen and some nectar. A colony on the Agronomy Farm at Urbana in 1967 collected from 54 to 99 percent of its daily pollen intake from red clover between July 12 and August 3. Prior to that time they were more interested in the other clovers.

If you produce red clover seed, do so on the second crop and use at least two colonies of honey bees per acre within or beside the field. On large fields place them in two or more groups. Research has shown a decrease in pollination and seed set if the bees are more than about 800 feet from the plants requiring pollination. Bring the hives to the field as soon as it comes into bloom. There are not sufficient bumble bees to provide pollination, and seed yields may continue to drop as honey bees become even more scarce in the state. Proper use of honey bees for pollination has the potential of doubling or tripling red clover seed yields.

White and yellow sweetclovers are highly attractive to bees and other insects. However, probably because of their large number of blossoms, their seed yields increase when colonies of honey bees are placed nearby. Yields of up to 1,400 pounds per acre have been produced in the Midwest by using six colonies of bees per acre. One to two hives per acre will provide reasonably good pollination.

Crownvetch is not attractive to bees and requires special techniques to produce a commercial crop of seed. Best yields have been obtained by bringing strong, new hives of bees to the fields every eight to ten days. In place of such special provisions, one or more hives of honey bees per acre of crownvetch are of value.

The effects of insect pollination on annual lespedeza, such as Korean, have not been investigated. However, the perennial lespedezas require insect pollination to produce a crop of seed and honey bees can be used for this purpose.

Many legumes grown in Illinois for pasture or for purposes other than seed production are visited by honey bees and other insects. Alfalfa, birdsfoot trefoil, and alsike, white, and Ladino clovers all provide some pollen and nectar and, in turn, are pollinated to varying degrees. Soybeans are visited by honey bees, especially in late July and early August. Unfortunately, the bee visits do not have any effect on yields of soybeans.

SOIL TESTING AND FERTILITY

Soil Testing

Soil testing is the most important single guide to the profitable application of fertilizer and lime. When soil test results are combined with information about the nutrients that are available to the various crops from the subsoil, the farmer has a reliable basis for planning his fertility program on each field.

Sampling every 4 years is strongly suggested. Sampling instructions are available from soil testing laboratories.

The most common mistake is to take too few samples to represent the field adequately. Following shortcuts in sampling may produce unreliable results and lead to higher fertilizer costs or lower returns or both.

What tests to have made. Illinois soil testing laboratories are equipped to test soils for pH (soil acidity), P_1 (available phophorus), P_2 (reserve phosphorus), and K (potassium). No test for nitrogen has proved successful enough to justify a recommendation by University of Illinois agronomists that laboratories provide the test.

Soil tests for certain secondary and micronutrients may warrant consideration under particular circumstances. Tests may be made for most of them but the tests are costly and the interpretation is less reliable than the tests for lime, phosphorus, and potassium. Complete field history and soil information are therefore important in interpreting the tests for treatments. Crops differ in their nutrient requirements and this affects the choice and usefulness of special tests. The boron test, for example, is useful for alfalfa and the manganese test is useful for soybeans.

Secondary and micronutrient tests may be useful for:

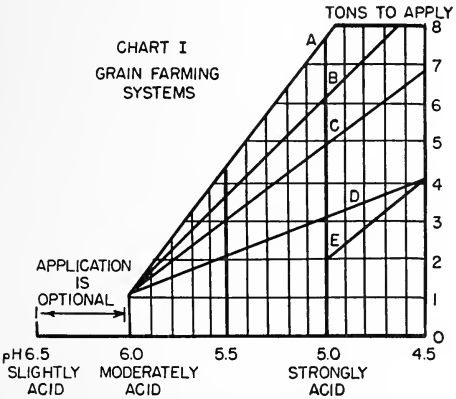
1. Trouble shooting — diagnosing symptoms of abnormal growth. Paired samples representing areas of good and poor growth are needed for analyses.
2. "Hidden-hunger checkup" — identifying deficiencies before symptoms appear. Soil tests have little value in indicating marginal levels of secondary and micronutrients when crop growth is apparently normal. For this purpose plant analysis may yield more useful information.

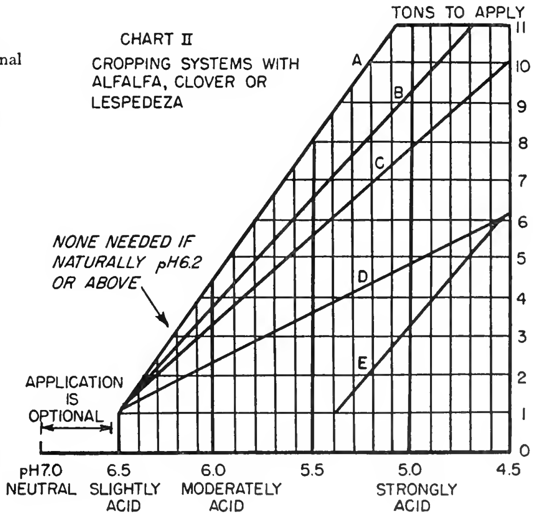
For a more complete discussion of secondary nutrients, micronutrients, and plant analysis, refer to page 36.

Suggested limestone rates based on soil type, pH, and cropping system. (Fig. 6)

STEPS TO FOLLOW

1. **Use Chart I for grain systems, Chart II for alfalfa, clover, or lespedeza.**
2. **Decide which soil class fits your soil:**
   - **A.** Silty clays and silty clay loams (dark).
   - **B.** Silty clays and silty clay loams (light and medium). Silt and clay loams (dark).
   - **C.** Silt and clay loams (light and medium). Sandy loams (dark). Loams (dark and medium).
   - **D.** Loams (light). Sandy loams (light and medium). All sands.
   - **E.** Muck and peat.
3. **Find your soil's pH along the bottom of the chart.**
4. **Follow up the vertical line until it intersects the diagonal line A, B, C, D, or E that fits your soil.**
5. **Read the suggested rate of limestone along the right side.**





Lime

The liming program is being slighted on many Illinois farms. A random sampling of 1,706 fields in 74 counties from 1967 to 1969 showed that 34 percent were too acid for top yields of corn and soybeans and 64 percent were too acid for alfalfa. Soil test results indicate that a substantial number of farmers have built their soil test levels for phosphorus and potassium unnecessarily high but have neglected limestone.

Farmers who regularly apply 150 to 200 pounds or more of nitrogen in an intensive corn cropping system are advised to test their soil every four years and apply limestone if needed. Even lower nitrogen rates will cause sandy soils to become acid rapidly.

The tonnage of limestone in Illinois had been holding steady since 1963, but dropped sharply in 1968, caused partly by an unfavorable fall for spreading.

Suggested pH goals. For cropping systems with alfalfa and clover, maintain a pH of 6.5 or above. But if the soils are pH 6.2 or above without ever having been limed, neutral soil is just below plow depth and it will probably not be necessary to apply limestone.

For cash-grain systems (no alfalfa or clover), maintaining a pH of at least 6.0 is a realistic goal. If the soil test shows that the pH is 6.0, apply limestone to prevent a drop in pH below 6.0. Farmers may choose to raise the pH to still higher levels. After the initial investment, it costs little more to maintain a pH of 6.5 than 6.0. The profit over a 10-year period will be affected very little, since the increased yield will about offset the original cost of the extra limestone (2 or 3 tons per acre) plus interest.

Research indicates that a profitable yield response from raising the pH above 6.5 in cash-grain systems is unlikely, and the risk of nitrogen loss through denitrification is increased unnecessarily.

Liming treatments based on soil tests. The limestone requirements in Fig. 6 are based on these assumptions:

1. A 9-inch plowing depth. If plowing is less than 9 inches deep, reduce the amount of limestone; if more than 9 inches, increase the lime rate proportionately.

2. Typical fineness of limestone: 90 percent through 8-mesh; 60 percent through 30-mesh; 30 percent through 60-mesh. If the limestone is not as fine as indicated above and if a quick effect is desired, apply more limestone than indicated in the charts.

3. A calcium carbonate equivalent (total neutralizing power) of 90 percent. The range in neutralizing power of standard agricultural limestone in Illinois is about 80 to 105. The rate of application may be adjusted according to the deviation from 90.

Information on the neutralizing power and fineness of limestone is sent regularly to county extension advisers.

If high initial cost is not a deterrent, you may apply the entire amount at one time. If cost is a factor and the amount of limestone is 6 tons or more, apply it in split applications of about two-thirds the first time and the remainder three or four years later.

Calcium-Magnesium Balance in Illinois Soils

Soils in northern Illinois contain more magnesium than those in central and southern sections because of the high magnesium content in the rock from which the soils developed. This has caused some to wonder whether the magnesium was too high. There have been reports of suggestions from some laboratories located outside Illinois that either gypsum or low-magnesium limestone from southern Illinois quarries should be applied. At the other extreme some laboratories have told southern Illinois farmers to buy high-magnesium limestone from northern quarries.

The following is a quotation from a report on research conducted at the University of Illinois:

"Varying the calcium to magnesium (Ca:Mg) ratio had no significant effect on the yield of either corn or soybeans, provided the amount of calcium was equal to, or greater than, the amount of magnesium in the culture, and provided sufficient quantities of the two ions were present. When . . . magnesium exceeded calcium . . . yields were greatly decreased. From these data indications are that Ca:Mg ratios do not play an important role . . . as long as calcium exceeds the exchangeable magnesium. . . .

"In these experiments, when the Ca:Mg ratio was less than 1:1, there may have been an actual shortage of calcium. That would not be the case under field conditions in any soil limed to the suggested pH goal."

A study of northern Illinois soils showed that in no case did calcium to magnesium approach the 1:1 ratio reported to be critical in the research studies.

Adding high-magnesium limestone can never raise magnesium above calcium, because pure dolomite contains 55 percent calcium carbonate to 45 percent magnesium carbonate and thus adds more calcium than magnesium.

No one operating a soil-testing laboratory or selling fertilizer in Illinois has put forth any research to justify concern over the calcium:magnesium ratio.

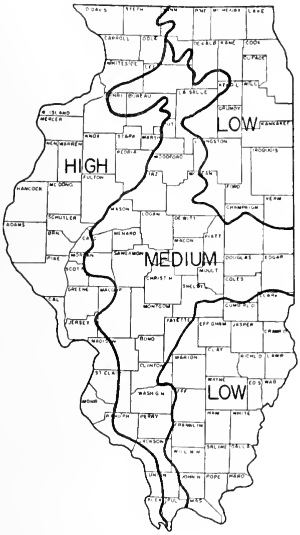
Based upon a study of the available information on (a) the calcium:magnesium ratio in Illinois soils, and (b) the tolerance of field crops to a wide range in Ca:Mg ratios, *there is no agronomic reason to recommend* either that farmers in northern Illinois bypass local sources which are medium to high in magnesium and pay a premium for low-magnesium limestones from southern Illinois, or that farmers in southern Illinois order limestone from northern Illinois quarries because of magnesium content.

Phosphorus

Illinois has been divided into four regions in terms of inherent phosphorus-supplying power of the soil below the plow layer in dominant soil types (Fig. 7).

High phosphorus-supplying power means:

1. The amount of available phosphorus (P_1 test) is relatively high.



Phosphorous-supplying power. (Fig. 7)

2. The conditions are favorable for good root penetration and branching in the subsoil.

Low phosphorus-supplying power may be caused by one or more of these factors:

1. A low supply of available phosphorus in the subsoil because (a) the parent material was low in P; (b) phosphorus was lost in the soil-forming process; or (c) the phosphorus is made unavailable by high pH (calcareous) material.
2. Poor internal drainage that restricts root growth.
3. A dense, compact layer that inhibits root penetration or spreading.
4. Shallowness to bedrock, sand, or gravel.
5. Drouthiness, strong acidity, or other conditions that restrict crop growth and reduce rooting depth.

Regional differences in P-supplying power are shown in Fig. 7. Parent material and degree of weathering were the primary factors considered in determining the various regions.

The "High" region occurs in western Illinois. The primary parent material was more than 4 to 5 feet of loess. The soils are leached of carbonates to depths of more than 3½ feet. Roots can easily spread in the moderately permeable profiles. The loess was high in phophorus.

The "Medium" region occurs in central Illinois with an arm extending into northern Illinois and a second arm extending into southern Illinois. The primary parent material was more than three feet of loess over glacial till, glacial drift, or outwash. Some sandy areas with low "P" supplying power occur in the region. Compared to the high region, more of the soils are poorly drained and have less available phosphorus in the subsoil and substratum horizons. Carbonates are likely to occur at shallower depths than in the high region. The soils in the northern and central areas are generally free of root restrictions. Soils in the southern arm are more likely to have root restricting layers within the profile. "P" supplying power of soils of the region is likely to vary with natural soil drainage. Soils with good internal drainage are likely to have high available P levels in the subsoil and substratum. If internal drainage is fair or poor, P levels in the subsoil and substratum are likely to be low or medium.

In the "Low" region in southeastern Illinois, the soils were formed from 2½ to 7 feet of loess over weathered Illinoian till. The profiles are more highly weathered than in the other regions and are slowly or very slowly permeable. Root development is more restricted than in the "High" and "Medium" regions. Subsoil phosphorus levels may be rather high by soil test in some soils of the region, but this is partially offset by conditions that restrict rooting.

In the "Low" region in northeastern Illinois, the soils were formed from thin (less than 3 feet) loess over glacial till. The glacial till ranges in texture from gravelly loam to clay in various soil associations of the region. The tills are generally low in available phosphorus. In addition, shallow carbonates further reduce the P-supplying power of the soils of the region. High bulk density and slow permeability in the subsoil and substratum restrict rooting on many soils of the region.

The three regions are separated to show broad differences between them. Parent material, degree of weathering, native vegetation, and natural drainage vary within a region and cause variation in P-supplying power. It appears, for example, that soils developed under forest cover have more available subsoil phosphorus than those developed under grass. Whether this is offset by a lower amount of phosphorus in organic matter in the surface has not been determined.

The importance of subsoil phosphorus may be different for corn, soybeans, small grains, and deep-rooted perennial legumes. The significance of subsoil phosphorus is likely to depend on the depth of rooting at the time during the growing season when phosphorus is most needed. This point is discussed in connection with fertilizer suggestions for each crop.

Additional research is needed to refine the differences within and among regions in P-supplying power in Illinois soils.

Goals for the P_1 test. The following goals are suggested for 1971, but they may be adjusted when additional data are obtained.

Phosphorus-supplying power	*P_1 test goal*
Low	40–50
Medium	35–45
High	30–40

Specific suggestions for the application of phosphorus to each crop are on pages 7, 8, 16, 20, 21, and 30.

Illinois farmers still use large amounts of rock phosphate.

Rock phosphate contains about 3 percent citrate soluble P_2O_5 and this portion (about 1/10 of the total) is as available as that in other phosphorus-supplying fertilizers.

The remainder of the phosphorus is in the apatite form and depends upon the action of soil acids to make it available. Hence, the most economic use of rock phosphate is related to soil pH.

pH 6.5 or above. Rock phosphate is not likely to be as economical a source of phosphorus as phosphates derived from treating rock with acid or heat.

pH 6.0 to 6.5. This is a transition range. Rock phosphate and more readily available forms may be equally profitable up to pH 6.5 if: (1) alfalfa, clover, lespedeza, or birdsfoot trefoil are an important part of the cropping system; (2) the soil is inherently moderately acid; and (3) ACP cost-sharing assistance is available. Otherwise forms other than rock are likely to have an advantage.

pH 6.0 or below. There is enough soil acidity to provide for reaction with phosphate rock and thus rock is likely to be a satisfactory source of phosphorus when large amounts are broadcast in a soil-buildup program.

Applications of rock phosphate are based upon a test that involves a stronger acid extractant (P_2 test) than that used to measure available phosphorus (P_1 test).

Fertility of Corn and Soybean Fields

A survey of 1,706 fields in corn and soybeans in 74 counties from 1967 to 1969 produced the data in Tables 39, 40, and 41.

Table 39. — pH of Surface Soils in 1,706 Fields Sampled in 1967 to 1969

pH	Percent of fields	Evaluation
Below 5.0	2	Manganese toxicity is common below 5.0. Needs lime for all crops. Unsuited without liming to grow alfalfa or clover. pH 5.6–6.0 is slightly low for corn and soybeans.
5.1–5.5	11	
5.6–6.0	21	
	(34)	
6.1–6.5	30	Optimum pH.
6.6–7.0	22	
	(52)	
7.1–7.5	11	Alkaline. Watch for manganese deficiencies in soybeans and oats, and iron deficiencies in Wayne soybeans.
Above 7.5	3	
	(14)	

Table 40. — P_1 Soil Tests on Surface Soils of 1,706 Fields Sampled in 1967 to 1969

P_1 test	Percent of fields	Evaluation
Below 11	3.2	Low for all crops and soils. Buildup application suggested.
11–20	12.2	
21–30	16.9	
	(32.3)	
31–40	15.2	Reasonable goals for corn and soybeans depending somewhat on phosphorus-supplying power of subsoil (Fig. 7, page 35). Phosphorus should be applied for wheat, alfalfa, and clover.
41–50	11.6	
	(26.8)	
51–100	25.1	Very high. Maintenance amounts or less needed.
101–200	11.5	Unrealistically high. No application needed.
Above 200	4.3	
	(15.8)	

Phosphorus. About one-third of the fields are definitely low in available phosphorus (Table 40, one-fourth are near suggested levels or somewhat above, 41 percent are above suggested levels and, of those, 16 percent are unrealistically high. Some of the very high tests may represent only the small area in the field that was sampled rather than the entire field. Extremely high tests may be caused by an old manure pile or burning of brush or corncobs.

Potassium. About 16 percent of the fields are low to very low in potassium for all crops, 18 percent slightly low, and nearly 20 percent are unnecessarily high (Table 41). Some of the highest test results for potassium may have been found on small areas where some residue had been burned.

Research at a few locations shows responses of corn to potassium at soil tests above 241. At present fertilizer prices farmers may choose to aim for a test of 300 rather than 241.

Some interesting relationships showed up among soil tests and plant analyses.

Table 41. — Potassium Tests on Surface Soils of 1,706 Fields Sampled in 1967 to 1969

K test	Percent of fields	Evaluation
Below 121	3.4	Very low; soils need broadcast applications for buildup.
121–180	13.0	
	16.4	
181–240	18.1	Slightly low.
	18.1	
241–300	21.9	Optimum to slightly too high. Maintenance applications only needed.
301–400	24.0	
	45.9	
401–800	14.4	Unrealistically high. No K needed for at least 2 years where test is 400 or above.
801–1,100	2.6	
Above 1,100	3.4	
	19.6	

Zinc increased in corn with increasing P. This was unexpected, but can readily be explained if it turns out that the highest P tests are on livestock farms where manure would add both P and zinc or where top farmers had applied some micronutrients including zinc.

Zinc and manganese in both corn and soybeans decreased at both sampling stages as pH of the soil increased.

Magnesium decreased in both crops and at both dates when potassium increased either in the soil or in the plant. This suggests that magnesium deficiencies may be caused by heavy K applications on soils that are borderline in magnesium supply.

Within the next year many more relationships will be studied, including effects of subsoil fertility.

How to Handle Very High Soil Tests

A 1968 study in one Illinois county showed that farmers who already had the highest P_1 soil tests were still applying the most phosphorus in fertilizer. In other words, they were ignoring the results of their soil tests.

What advice should dealers, extension advisers, soil testers, and others give to farmers whose soil test reports are *very high* in P and K? In order to earn and keep the respect and confidence of top farmers, sooner or later all who advise farmers must face up to that question. It won't go away. It will arise even more frequently in the future.

Improved practices that continuously raise yield goals call for higher nitrogen levels. A practice that raises the potential yield by 10 percent may, in fact, justify 20 percent more nitrogen.

Not so with phosphorus and potassium. As yield levels rise, more P and K will be needed to *replace the nutrients removed* in the harvested crop. But that is a relatively small amount, 9 pounds extra P_2O_5 and 6 pounds K_2O for example, for 175 bushels of corn compared with 150 bushels.

Both theory and field research show that a soil test level for P or K that produces 99 percent of maximum yield at the 100-bushel level will also produce about 99 percent yield at the 175-bushel yield level. This is because the feeder roots of crops actually contact only 5 to 10 percent of the available phosphorus and potassium in the soil volume occupied by the roots. The higher the crop yield, the larger the root system and thus the more of the available P and K that are reached. It seems likely that there will be *little upward adjustment in the suggested goals* for soil test levels over the next five to ten years.

This is how the situation is handled in the soil test report forms from the University of Illinois. The person reporting the test chooses one of the following that best describes the soil test level:

1. Phosphorus is below the most profitable level. Phosphorus applications should, therefore, be large enough not only to meet the needs of the next crop but to raise the soil test level.

2. Phosphorus is at the suggested goal. You may broadcast phosphorus this year and thereafter at the rate of 50 pounds of P_2O_5 per year (100 for 2 years, 150 for 3 years) to at least maintain the test level until the field is sampled again.

3. Phosphorus is well above the level believed to be needed. Hence no yield increase is likely from an application of phosphorus this year.

4. Phosphorus is so high that you run the risk of creating problems with other nutrients.

A similar set of choices is given on the potassium report.

Polyphosphates

Polyphosphates are becoming important sources of phosphorus in fertilizers. Here is a brief explanation of how polyphosphates differ from ordinary phosphates.

Except for a small amount of metaphosphate, phosphorus has been supplied until recently in the orthophosphate form. It is the form believed to be used by plants. Polyphosphates are formed when a water molecule H_2O is split off and two or more of the remaining units hook up together into a larger molecule. In simple terms then polyphosphates are mixtures of these "waterless" phosphate units linked together in groups of two up to ten. Actually the superphosphoric acid used to manufacture fertilizers is about one-half orthophosphate and one-half a mixture of polyphosphates.

In order for the phosphorus in polyphosphate to become usable by crops, it must add water and convert to orthophosphate. This likely presents few problems because one-half of the phosphorus is already the ortho form and thus usable, and polyphosphates soon convert to orthophosphate in soils. The conversion is rapid in acid soils and slower where the pH is neutral or above.

Polyphosphates have three properties not already mentioned that differ from orthophosphates:

1. They form complexes in liquid fertilizers that prevent the precipitation of impurities found in wet-process (green) phosphoric acid.

2. They permit higher analysis in fertilizers.

3. They may somewhat increase the availability of certain micronutrients.

Based on the fact that half the phosphorus is already in ortho form and the remainder will likely convert within a few weeks at most, and because of the general scarcity of micronutrient problems, Illinois agronomists feel that fertilizers with polyphosphates are as good as, but not superior to, the usual phosphorus sources.

High Water Solubility of Phosphorus

The purposes of this statement are to list the factors that influence the relationship between yield and degree of water solubility, and to arrive at guides for working under practical field conditions.

pH. As pH increases to the neutral point or above, water solubility becomes increasingly important. The vast majority of soils in Illinois are in the range of pH 5.6 to 7.0 where water solubility is least critical. There are, of course, local exceptions in whole regions or in small areas within fields.

Placement. The degree of water solubility is relatively more important in banded fertilizer than in fertilizer that is broadcast. Of the total amount of phosphorus applied in Illinois, most is broadcast and mixed thoroughly with the soil.

Granule size. To improve effectiveness within the year of application, fertilizers containing phosphorus with relatively *low water solubility* should be supplied *as small granules.*

To reduce the "fixation" and consequent loss in short-term availability of sources that are *high in water solubility,* large granules are preferred on soils that have a high "fixing capacity" (strongly acid soils, for example).

Soil-test P and rate of application. As the total supply of phosphorus (soil-available phosphorus plus newly applied phosphorus fertilizer) increases, the importance of water solubility decreases. In other words, water solubility is of little importance in fields that have already been raised to the desired soil-test goal.

Time interval between application and plant utilization. The rate of chemical change in the phosphorus compounds contained in the fertilizer to other reaction compounds (depending on the fertilizer, soil pH, and other soil factors) was until recent years grossly underestimated. Probably at least three-fourths of the phosphorus is changed chemically by the time the seed germinates and the seedling roots penetrate the fertilizer band. The new compounds *are not water soluble.* They continue, of course, to be important sources of phosphorus, though less readily available than before undergoing change.

In a typical situation only 10 to 20 percent of the phosphorus in fertilizer that is applied for a crop is taken up in the first year. The major supply for the crop comes from the large soil reserve. In other words, the water-solubility principle of the fertilizer applies to only a small, though important, segment of the total available supply.

Summary. The degree of water solubility of the portion that is listed as available P_2O_5 on the label is of little importance for typical field crop and soil conditions of medium to high levels of available phosphorus in the soil, typical rates of application on good farms, and broadcast placement. There are exceptions.

For band placement of a small amount of fertilizer that is designed to produce early growth stimulation, at least 40 percent of the phosphorus should be water soluble for application to acid soils and preferably 80 percent for calcareous soils. The phosphorus in nearly all fertilizers sold in Illinois is at least 50 percent water soluble.

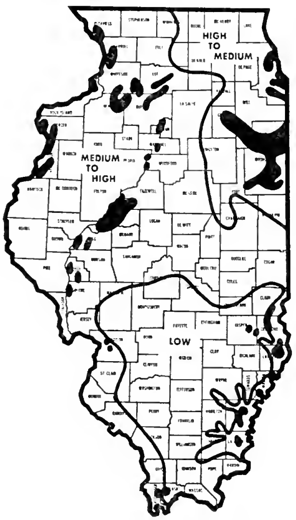
For broadcast application on soils that are below pH 7.0, water solubility is not important; for calcareous soils, a high degree of water solubility is desirable, especially on soils that are shown by soil test to be low in available phosphorus.

Potassium

Illinois is divided into four general regions based on potassium-supplying power (Fig. 8). There are, of course, important differences among soils within these general regions because of differences in the seven factors listed below.

Inherent potassium-supplying power depends mainly on:

1. The amount of clay and organic matter. This influences the exchange capacity of the soil.
2. The degree of weathering of the soil material. This affects the amount of potassium that has been leached out.
3. The kind of clay mineral.
4. Drainage and aeration. These influence K uptake.
5. pH (very high calcium and magnesium reduce K uptake).



Potassium-supplying power. The black areas are sands with low potassium-supplying power. (Fig. 8)

6. The parent material from which the soil formed.

7. Compactness or other conditions that influence root growth.

Sandy soils are low in potassium-supplying power because they are low in exchange capacity and cannot hold much reserve K. In addition, minerals from which sandy soils develop are low in K.

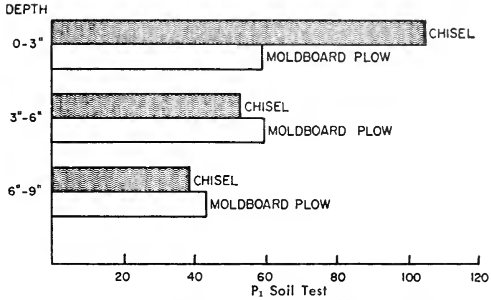
The silt loams in the "Low" area in southern Illinois (claypans) are relatively older soils in terms of soil development and consequently much more of the potassium has been leached out of the root zone. Furthermore, wetness and a platy structure in the upper subsoil may interfere with rooting and with K uptake early in the growing period even though roots are present.

Soils in northeastern Illinois that were formed from medium- to fine-textured till are quite high in potassium by soil test, but restricted drainage may reduce potassium uptake during the early part of the growing season. As a result, those soils with wetness problems have only a medium rating in the ability to supply potassium to crops.

A soil-test goal of 241 to 300 is suggested for all the regions. Research at a few locations shows responses of corn to potassium at soil tests above 241. At present fertilizer prices farmers may choose to aim for a test of 300 rather than 241. Rates of potassium suggested in the buildup period and for maintenance on soils that are classified low or medium in supplying power are larger than on those soils that are classified high (Table 42).

Tests on soil samples that are taken *before May 1* or *after September 30* should be adjusted downward as follows: subtract 30 for dark-colored soils in central Illinois; subtract 45 for light-colored soils in central and northern Illinois; subtract 60 for medium- and light-colored soils in southern Illinois; subtract 45 for fine-textured bottomland soils.

On soils that have a very low potassium test, you may apply the suggested initial applications (even up to 300



Accumulation of phosphorus after three years at various soil depths in a chisel system compared with moldboard plowing. 140 pounds P_2O_5 (61 lb. P) applied. Agricultural Engineering, University of Illinois. (Fig. 9)

pounds of K_2O per acre) at one time or you may apply two-thirds the first year and one-third the second year. Approximate maintenance amounts are suggested (60 pounds of K_2O per year or 120 pounds to last two years) for the third and fourth year or until the field is resampled. Specific suggestions for potassium applications for individual crops are given in other sections.

Phosphorus, Potassium, and Lime Applications in No-Plow Systems

A small but growing number of farmers are substituting chisels or zero-tillage systems for the conventional moldboard plow. Since phosphorus and potassium move very little except on extremely sandy soils, zero tillage leaves P and K on the surface, chisels mix a small portion to or slightly below plow depth, but leave most in the surface 2 or 3 inches, and disks or field cultivators mix 3 to 6 inches deep (Fig. 9). None of these mix P and K uniformly to normal plow depth.

What is the significance of shallow placement? Nitrogen presents no problem because as soon as the ammo-

Table 42. — Potassium Application Rates Based on Tests on Samples Taken Between May 1 and September 30[a]

Soil test range, lb.	Estimated percent of maximum possible yield		Potassium rates for first application to last 2 years			
			Soils **low** in potassium–supplying power		Soils **medium** to **high** in potassium–supplying power	
	Corn, soybeans, alfalfa, clover	Wheat, oats	K_2O, lb.	K, lb.	K_2O, lb.	K, lb.
90 or less	75 or less	90 or less	300	250	These soils are seldom this low.	
91–120	76 to 81	91 to 94	270	225		
121–150	82 to 90	95 to 98	240	200		
151–180	91 to 93	98 or more	210	175	180	150
181–210	94 to 95	98 or more	180	150	150	125
211–240	96 to 97	98 or more	150	125	120	100
241–300	98 or more	98 or more	120	100	Test every 4 years and apply enough to maintain the test.	
Above 300	98 or more	98 or more				

[a] An adjustment is suggested for samples taken earlier or later (see text).

nium forms nitrify they move down into the soil readily after rainfall. To answer the question for phosphorus and potassium you must consider two factors:

A. What is the present soil test level?

B. Are plant residues left on the surface?

If the soil test level is high throughout the plow layer you are not likely to see any marked effect of leaving fertilizers P and K near the surface. In a moderate drouth, plant roots can get nutrients from the fertile lower part of the old plow layer and from the subsoil.

If the soil tests for P and K are low you will not likely see any ill effect of shallow placement in wet seasons because roots will spread and feed effectively near or at the surface.

But in dry periods P and K near the surface simply are not positionally available to feeding roots when the soil dries out. If the major supplies of nutrients, especially phosphorus, are in the surface few inches the crop will suffer more than if they are mixed to a depth of 8 to 10 inches.

The influence of amount of residues on the surface is indirect through the effect on moisture. Heavy residue serves as a mulch and keeps the surface moist more of the time, hence shallow roots can feed for a longer time into a drouth period. But the total root system may be less deep and therefore the crop may not feed as effectively on subsoil P and K in a severe drouth. Researchers in Ohio report no loss of fertilizer efficiency in six years of no-plow tillage. McKibben at Dixon Springs in southern Illinois has not observed any problem in three years. Both in Ohio and at Dixon Springs the soils normally do not permit deep rooting. Results on the deep, dark Illinois soils may therefore be different. Farmers who adopt the chisel system probably can mount applicator equipment to place fertilizer to chisel depth. All farmers who shift to no-plow systems may find it advisable to plow once in 5 or 6 years to mix in fertilizer that has concentrated near the surface.

What about a liming program? If anhydrous ammonia, aqua, nitrogen solutions, or dry nitrogen fertilizers are placed 8 to 10 inches deep, zones of soil acidity will develop. Since the neutralizing effect of limestone moves down rather slowly, there is a possibility that soil acidity will become at least a short-term problem below the depth that limestone is mixed in chisel or zero-tillage systems.

Is Nitrogen Fertilizer a Threat to Environmental Quality?

The growing concern for environmental quality has raised important questions about the use of nitrogen fertilizers:

1. Have nitrogen fertilizers already polluted surface water or groundwater or will present trends in fertilizer usage, if continued, pose a future threat to the quality of environment or to health?

2. Can the food needs of society be met by alternative ways to supply plant nutrients that will have less undesirable effects on the environment?

3. Will failure to apply adequate nitrogen fertilizer jeopardize future productivity of soils?

Contrary to the impression left by statements in many news stories, the influence of fertilizer nitrogen on nitrates in water has not yet been established. Several studies in low-rainfall regions where irrigation was practiced showed little or no relationship between fertilizer and nitrates in water.

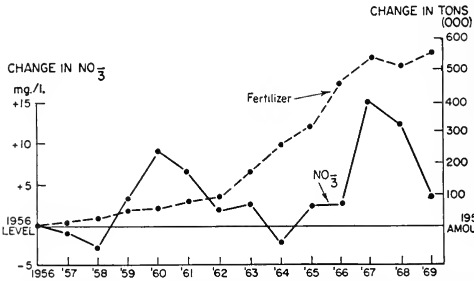
In humid regions the situation may be different though; that is yet to be established.

Much has been written about nitrates in Illinois rivers, including the statement that rivers were "killed" by farmers who poured on nitrogen fertilizer. In the Illinois River (Fig. 10), except for high levels in 1967 and 1968 (which were reversed in 1969) there is only a slight indication of an upward trend over a recent 14-year period (1956 to 1969). Nitrate concentration in the Illinois River appears to be related little, if any, to the amount of nitrogen fertilizer applied to soils.

The nitrate concentration in the Mississippi River at Chester, Illinois, has not increased since 1960. Most of the increase in nitrogen fertilizer in the states that contribute water to the Mississippi above Chester has occurred since 1960. The possibility exists, of course, that algae and other plants have stripped nitrates out of the water.

The Kaskaskia River at New Athens shows no significant change in nitrates since 1946.

The Kaskaskia River at Shelbyville presents a different picture. Nitrate concentration showed no clear trend from 1958 to 1964, but in 1965 there was a sudden increase. Fertilizer nitrogen may have contributed to it



Change in nitrate concentration in the Illinois River at Meredosia, Illinois, and in nitrogen fertilizer used in Illinois, 1956 to 1969. Long-term fertilizer data are not available for the watershed alone. (Fig. 10)

but other factors obviously were important because fertilizer had been increasing steadily rather than in spurts.

Short-term records are available for several other rivers, but they are inadequate to establish trends.

The data from these rivers show that it is premature to blame fertilizer nitrogen for high nitrates in some years in the Illinois, Mississippi, and Kaskaskia rivers.

The amount of nitrogen in fertilizer, though small in total, provides the margin between adequate food and widespread shortages in the United States with the present population. Nitrogen fertilizer greatly increases the yields of corn, wheat, rice, vegetables, fruits, and hay and pasture for livestock. If less nitrogen fertilizer were used, the effects of higher food costs would be catastrophic to low-income people, and problems of the inner cities would probably be increased.

Some ecologists suggest less use of nitrogen fertilizer and greater reliance on nitrogen from nitrogen-fixing legumes, composting of plant residues, and animal manure.

Substituting nitrogen fixed from the air by bacteria on the roots of leguminous plants for fertilizer nitrogen appears attractive to people who are unfamiliar with agriculture and with soil reactions. *But there is little, if any, reason to believe that the amount of nitrates that gets into water would be less if supplied by legumes or manure rather than by nitrogen fertilizer to produce an equal crop yield.*

Most ecologists overlook the unexpected side effects from attempting to meet nitrogen needs with leguminous crops. In Illinois, 50 percent more crop acres would be needed to grow the legumes and small grains in which they would be seeded, and to make up for lower acre yields. The additional acres would be on less productive soils than are now farmed. Many of these acres would be on steep slopes, hence plowing them up would increase water runoff and floods downstream. The water would carry topsoil, thus filling up reservoirs and diminishing water storage capacity. Wind erosion and dust storms would increase. Millions of acres of wildlife habitat would be destroyed.

The ultimate reason for using nitrogen fertilizer is to maintain the productive capacity of the soil for future generations. If organic matter is allowed to decline because of inadequate nitrogen, as it has over the past 100 to 200 years, future generations will have increasing difficulty with floods, erosion, and sediment pollution.

No drastic changes should be made in the amount of nitrogen fertilizer used unless new research clearly shows a greater danger than seems likely from available information. The wisest course is to initiate needed research at once to answer certain key questions about the fate of applied nitrogen and to continue to follow sound agronomic practices on time and rate of application and form of nitrogen fertilizer adapted to individual crops and soils.

Fertility "Quacks" Continue in Business

It seems hard to believe that in this day of better informed farmers the number of letters, calls, and promotional leaflets about completely unproven products is increasing.

The claim is usually that Product X either: replaces fertilizers and costs less; makes nutrients in the soil more available; supplies micronutrients; or is a natural product that doesn't contain strong acids that kill soil bacteria and earthworms.

Research is such a magic word that people are conditioned to expect miraculous new products and thus the door is opened for the fertility quack.

The strongest position that legitimate fertilizer dealers, extension advisers, and agronomists can take is to *challenge these peddlers to produce unbiased research results to support their claims.* Farmer testimonials are no substitute for research! Incidentally, when a legitimate fertilizer company depends heavily upon farmer testimonials in its advertising, then this makes the selling job easier for the quack.

Agronomists can refute the specific claims of the quacks, except when they come up with new claims or fall back on the old cliche, "We don't know why it works, but it does." No one can effectively argue with the farmer who says "It works on *my* farm." Dozens of research trials on the same kind of soil are no match for the simple statement, "It works for me." That is what is so frustrating to dealers, agronomists, and extension advisers and so dangerous to farmers about farmer testimonials.

Extension specialists at the University of Illinois are ready to give unbiased advice when asked either about purchasing new products or accepting a sales agency for them.

Gypsum Not Needed on Illinois Soils

In spite of repeated statements from agronomists at the University of Illinois that gypsum is not effective under practical conditions, sales promotion appears to be increasing. The number of letters and phone calls from dealers, extension advisers, and farmers grows each year.

Three claims are made for gypsum. First, that it improves soil structure; second, that it is a good source of calcium; third, that it supplies sulfur.

Gypsum improves alkali soils in desert and semi-desert areas of the western United States. Alkali soils contain too much sodium. The calcium in gypsum replaces the sodium which then leaches out of the root zone; the pH declines and the soil structure improves. The high pH soils in central and northern Illinois do not contain large amounts of sodium. They are already high in calcium and magnesium. Adding more calcium can't improve them.

Illinois is now testing gypsum on high-sodium "slick-spot" soils (locally called scalds, hardpans, and deer licks) that occur throughout much of southern and part of western Illinois. Measurable improvement was obtained only where 27.8 tons of gypsum was mixed thoroughly to a depth of three feet. Illinois agronomists tried gypsum on poorly-drained clay soils to learn whether structure and internal drainage could be improved. No improvement was found.

Salt-saturated areas around oil wells are also high in sodium and *may* respond to gypsum, provided the subsoil is permeable enough to allow rainwater to flush the displaced sodium down and out of the root zone. In most cases the subsoil unfortunately is compact and impermeable, and no one has yet found that treatment with gypsum improves this situation.

Gypsum is an effective source of calcium where calcium is deficient as a plant nutrient. But calcium is not deficient in Illinois soils that are raised to the desired pH with limestone. There is no evidence that the calcium: magnesium balance is a problem, hence there is no basis for applying gypsum in place of limestone (see page 34).

Gypsum supplies sulfur, but all Illinois soils appear to be well supplied with sulfur for field crops.

Gypsum is not a substitute for limestone on acid soils. It does not raise the pH.

In summary, there is no known need for gypsum treatment of Illinois soils. The price of products composed mainly of gypsum now being promoted to Illinois farmers is $150 to $165 per ton. Anyone who wants gypsum for trial can find plenty of sources within the state where it can be purchased for $10 to $20 per ton or in some areas just for the cost of hauling.

SOIL MANAGEMENT AND TILLAGE SYSTEMS

The 1970 Season

Wet soils resulted in delayed planting in many areas of Illinois. Ponded areas were evident during much of the growing season in many fields in northern and central Illinois. Early in the season, the ponds were water filled. If they dried out early enough, replanted corn or soybeans (or soybeans in small areas within corn fields) provided vivid reminders of earlier wet conditions.

Wet soil conditions provided evidence of the need for drainage improvement and also demonstrated the value of drainage improvement projects that had been completed before 1970. The intense rain that fell in some areas also provided evidence of the need for and benefits of erosion control practices such as terracing, contouring, and strip cropping. The effect of conservation tillage in reducing soil and water losses was again evident in many areas.

The delay in planting, caused by wet soil conditions, was much less of a problem with zero-tillage systems, especially in southern Illinois. In White County, for example, the firm soil surface with zero tillage permitted planting three to four weeks earlier than was possible on the same farm with spring plowing. Weed, insect, and disease problems appeared to be more severe with tillage systems that maintained a heavy mulch of crop residues on the soil surface. Phosphorus and potassium response in chisel and zero-till systems appeared to be as good as that in a moldboard plow system at Urbana. Surface-applied phosphorus that was chiseled into the soil gave excellent response at DeKalb.

Water Erosion Control

Bare soils with long slopes have a high potential for water erosion with the rainfall patterns that occur in Illinois. The damage of erosion depends upon soil characteristics. If a soil has horizons in the profile that are unfavorable for root development, water erosion can cause permanent soil damage even though the nutrients lost through erosion can be replaced through liming and fertilization. On soils that are free of root restricting horizons, water erosion damage is the result of nutrient removal to a large extent. The nutrients can be replaced through application of limestone and fertilizers, but result in added production costs. Soil particles that are eroded must be deposited eventually. Part of the deposition is in streams, lakes, or reservoirs, so water resource quality is lowered.

Effective erosion control systems usually include one or more of three features. First, the soil is protected with a cover of vegetation, such as a mulch of crop residues, as much of the time as possible. Second, the soil is tilled so that a maximum amount of water is absorbed with a minimum amount of runoff. Third, long slopes are divided into a series of short slopes so that the water cannot get "running room." Conservation tillage systems, discussed on pages 45 to 46, utilize one or both of the first two features. Terraces are effective because they divide long slopes into several short slopes. Strip cropping provides season-long vegetative cover on half or more of a slope and also divides a slope into shorter slope lengths.

Effective erosion-control systems must be designed for a particular situation. Contact your district conservationist with the Soil Conservation Service for technical assistance on erosion-control systems.

Fall Tillage

Get a head start on next year's corn and soybean crops through fall tillage. Chopping stalks, disking, plowing, or chiseling in the fall may help you get off to an early start the following spring. Fall tillage may also present problems if the hazards of wind and water erosion are not considered.

The kind and amount of fall tillage that is needed or desirable depends on the soil, slope, and previous crop, as well as on the seasonal demand for labor and machinery. Of course, weather conditions will have a major role in determining how much tillage is possible before freeze up late this fall or early winter.

The Previous Crop

The previous crop influences the kind and amount of residues that are left after harvest.

Corn residues are the heaviest in terms of tonnage and probably present the greatest problems. Shredding the stalks, or disking followed by fall plowing, or both operations, provide a bare soil surface over winter that may dry earlier in the spring. If the corn stover is not plowed in the fall, leaving the stalks standing without chopping or disking them may provide more wind erosion control than if stalks are shredded. Shredding may protect more of the soil surface against the beating action of rain and thus reduce water erosion. However, the shredded corn residues may mat down and result in wetter soils that dry more slowly in the spring.

Soybean residues are light in tonnage and present essentially no problem in handling. *Fall plowing of soybeans will increase the potential for severe wind erosion. Disking soybean fields in the fall will also create a severe wind-erosion problem.* The surface soil is loose following soybeans and this, combined with the small amount of residues, results in a potentially severe wind-erosion hazard if the soybean field is disked or plowed, or both, in the fall. Fall chiseling following soybeans results in a rougher surface and helps lessen the wind-erosion hazard. Following soybeans, crop yields with spring tillage (plow, disk, chisel, or no-till) have been as good as those with fall plowing in tests in Illinois and Iowa. These tests showed greatly reduced wind-erosion.

Small-grain residues may be plowed in late summer or early fall in preparation for fall seedings of wheat or alfalfa-grass mixtures or for corn or soybeans the following year. Plowing under weeds in the stubble will help reduce weed populations if stubble is plowed before weed seeds mature.

If legume seedings (for green manure) are made in the small grain, more nitrogen will be added by the legume if fall plowing is delayed until late fall (October 15 in northern Illinois, November 15 in southern Illinois). Late fall plowing of meadow crops will also provide additional time for nitrogen fixation by the legume. Grass, grass-legume, or legume meadows that are fall-plowed are less erosive than fall-plowed corn, small grain, or soybeans.

The Soil

Fall plowing decreases tillage problems on poorly drained soils that have high organic matter and silty clay or silty clay loam surface layers. These soils are usually wet in the spring and will develop poor physical conditions if tilled when too wet. If such soils are fall-plowed, large clods will slake down over winter so that spring seedbed preparation is much easier. *However, avoid fall plowing after soybeans on these soils because of the wind-erosion hazard.*

Dark-colored silt loam soils that are nearly level and have good to fair drainage present fewer tillage problems than the finer textured silty clay loams or silty clay soils. Fall plowing may be desirable to help spread the labor load or because these soils occur in an intricate pattern with soils that are directly benefited by fall plowing.

Silt loam soils that have less than 2½ percent organic matter are likely to crust during the winter. (The publication "Color Chart for Estimating Organic Matter in Mineral Soils in Illinois," AG-1941, can be used to estimate organic matter content of the surface soils.) Spring tillage with moldboard plow, chisel plow, or disk, or zero tillage provide alternatives to fall plowing on low organic matter soils.

Sandy soils are subject to severe wind erosion if they are fall-plowed, and should be left with a vegetative cover as much of the time as possible.

Slope

The erosion hazard from fall plowing increases with percent and length of slope. Slopes of less than 2 percent can be safely fall-plowed, although soil erosion can be severe if they are more than 300 feet long and if spring rainfall is above normal in quantity and intensity. Soils with favorable subsoils on slopes of 2 to 4 percent can be fall-plowed on the contour if slope length is less than 150 feet. Longer slopes can be divided into a series of short slopes by leaving an unplowed strip a few feet wide every 150 feet. Severe erosion can occur on soils with unfavorable subsoils even on slopes of 2 to 4 percent.

Fall Disking

Disking cornstalks may aid fall plowing or chiseling. On soils that are too sloping for safe fall plowing, disking in the fall will incorporate part of the residues, loosen the soil, and result in earlier drying in the spring. Earlier seeding of oats or corn may be possible. Wind erosion will be slightly worse if cornstalks are disked in the fall. *Avoid disking in the fall following soybeans because of the danger of wind erosion.*

Fall Chiseling

Fall chiseling is a practice used by many farm operators who have developed tillage systems built around the chisel plow. Fall chiseling of cornstalks leaves part of the residue on the surface for wind and water erosion control. The soil is loosened so it dries earlier in the spring than if the field was untilled over the winter. Fall chiseling is especially important where the chisel plow system is used on dark-colored, poorly drained soils. Delays in spring operations or excessive drying often result if all chiseling is delayed until spring. The rough surface left after chiseling of soybean fields in the fall provides a barrier to soil blowing and reduces the hazard of wind erosion. The rough, chiseled surface is most effective if the chisel operation is carried out perpendicular to the prevailing wind.

Fall-Seeded Cover Crops

Fall seedings of spring oats provide effective control of wind and water erosion if they can be made early enough in the fall for the seeding to be established. The oats should germinate and make sufficient growth for soil protection if seeded by October 1 in the northern one-third of Illinois, by October 15 in the central one-third of Illinois, and by November 1 in the southern one-third of Illinois. Seed directly on fall-plowed fields or on soybean stubble at a rate of 1 to 1½ bushels per acre. The oats will be winter-killed. Seedbeds can be prepared with disk and harrow in the spring. Fall-seeded rye can also be used as a winter cover and may provide some spring pasture. It may be necessary to use a contact herbicide such as Paraquat to kill the rye in the spring before planting corn or soybeans.

Summary

Fall tillage can help you get the jump on spring field work if you fit it to your cropping situation and your soil and slope conditions. By using fall tillage where it will benefit you and by avoiding fall tillage where wind and water erosion may be severe, you will have a good foundation on which to develop your overall tillage program.

Tillage Systems

Tillage operations are carried out to prepare a seedbed for planting and a root bed for the development of roots. Tillage is used to loosen or compact the soil, to handle crop residues, to control weeds, and to control or manage water. A variety of tillage systems can be used in crop production. These include conventional, reduced, mulch, and zero-tillage systems. Each has unique advantages and each has limitations.

Conventional Tillage

Conventional tillage uses a moldboard plow followed by liberal use of a disk, harrow, hoe, and cultivator. It is the standard of comparison for other systems.

Advantages:

1. Results in a uniformly fine seedbed for ease of planting.
2. Insecticides and herbicides may be incorporated as needed.
3. Flexible and adaptable to a wide range of soil, crop, and weather conditions.
4. Provides for efficient distribution of labor and machinery.
5. The necessary equipment is readily available on most farms.
6. Results in yields that are as high as or higher than other systems over a wide range of soil and climatic conditions.

Limitations:

1. Highest cost because of the large number of operations (Table 43).
2. Often results in excessive tillage so that soil crusting and compaction may be problems.
3. Results in small aggregates (clods) so that water-intake rate is reduced.
4. Provides few surface depressions for temporary storage of rainfall.
5. Exposes bare, fine, or compact soil that is subject to wind and water erosion.

Reduced-Tillage Systems

Reduced-tillage systems also use the moldboard plow, but with reduction or elimination of secondary tillage with the disk, harrow, hoe, and cultivator. Plow-plant, wheel-track-plant, and cultivator-plant systems are examples. These systems are designed to provide good contact between seeds and moist soil in the seedling environment (row zone), and a rough, porous area between the rows (water management zone).

Advantages:

1. Reduces costs through elimination of some tillage operations (Table 43).
2. Less chance of forming surface crust.
3. Less compaction.
4. Faster initial intake of water and more water absorption before runoff begins.
5. A rough, porous area between the rows provides temporary storage for rainfall.
6. Reduction in runoff and water erosion.
7. Provides for built-in weed control in rough, porous area between the rows.
8. Cultivator-plant system has flexibility and can be used with fall or spring plowing over a wide range of soil conditions.

Limitations:

1. The rough, porous surface may make planting operations more difficult.
2. Plow-plant and wheeltrack systems require special adaptation to large planters.
3. Plow-plant and wheeltrack systems "bunch" plowing and planting operations into a short period of time. This may be a problem with large acreages or in wet springs.
4. It is difficult to obtain good contact between seed and moist soil in silty clay loam and finer textured soils ("gumbo" soils).
5. Soil is bare and more subject to wind and water erosion than with mulch or zero tillage.

Table 43. — Tillage Costs per Acre for Alternative Tillage Systems (Corn Following Corn)[a]

Operation	Cost for tillage operations with:				
	Conventional	Plow-plant or wheel-track plant	Cultivator-plant	Chisel-plow	Zero-tillage
Shred stalks	$ 2.00	$2.00	$ 2.00	$2.00	$2.00
Disk	1.50	....	....	....	....
Plow	5.00	5.00	5.00	....	....
Chisel	....	....	....	4.00[b]	....
Disk	4.00(twice)	....	....	....	....
Harrow	1.00	....	....	1.00	....
Plant[c]	3.00	3.00	4.00[d]	3.00	3.00
Harrow	1.00	....	....	....	....
Hoe	1.00	....	....	1.00	....
Sweep	3.00(twice)	1.50	1.50	1.50	....
Spray	....	....	....	....	1.50
Total tillage costs	$21.50	$11.50	$12.50	$12.50	$6.50[e]

[a] Costs in this table are based on data in Illinois Extension Circular 1003.
[b] Many corn producers chisel in fall and again in spring. In these cases chisel charge should be $8 per acre.
[c] Includes applying chemicals with planter attachment.
[d] Cultivate and plant and apply chemicals in one trip over the field.
[e] Cost of chemicals ($5 to $10 per acre) must be added for comparison with other systems.

Mulch Tillage

Mulch-tillage systems use chisel, disk, or rotary tillage equipment so that the soil is not turned over as with a moldboard plow. Significant portions of the residues from the previous crop are left on the surface. With the chisel-plow system some secondary tillage with disk or harrow is usually used to prevent an excessively loose seedbed.

Advantages:

1. Lower cost than conventional tillage (Table 43) because there are fewer tillage operations and lower draft requirements.
2. Rough, porous surface (especially with chisel plow and disk) aids rapid water absorption.
3. More water can be absorbed before runoff and erosion begin.
4. Mulch protects soil from raindrop impact and reduces crusting and surface sealing.
5. Mulch slows velocity of runoff and lowers its capacity to carry soil.
6. Mulch protects soil from wind erosion.
7. Fall chiseling or disking of cornstalks will help speed drying of soil in spring so that planting can be done earlier than with moldboard plow systems used in spring.
8. Fall chiseling of soybean fields may reduce wind erosion. *Avoid fall disking following soybeans.*
9. Deep tillage with a chisel plow (deeper than moldboard plow depth) may shatter the plow or traffic pan if it is chiseled when dry.

Limitations:

1. Planters must be equipped to plant in crop residues.
2. Loose, trashy seedbeds may result in uneven emergence. (Use a disk or harrow after chiseling to firm the seedbed.)
3. Soil temperatures may be reduced, resulting in slow early growth of corn in the northern two-thirds of Illinois.
4. Crop residues may interfere with herbicides or cultivation, resulting in a more severe weed problem.
5. Crop residues may harbor corn insect pests.
6. Lime and fertilizer may be concentrated near the surface.

Zero Tillage

Zero-tillage systems consist of planting in an otherwise undisturbed seedbed. Herbicides are used to control weeds and other undesirable vegetation. Zero-tillage has been used for corn following corn, soybeans, small grain, and sod crops (grass or legume). Soybeans and wheat, as well as corn, have been grown in zero- or no-tillage systems.

Advantages:

1. Lower tillage costs since planting and spraying are the only tillage operations (Table 43).
2. Provides the maximum control of wind and water erosion that is possible through tillage alone.
3. Provides a firm seedbed and earlier planting when compared with the spring moldboard plow system, especially in the southern one-third of Illinois.
4. Reduces compaction.
5. Conserves soil moisture.

Limitations:

1. Requires special planting equipment.
2. Results in low soil temperatures and slow early growth of corn in the northern two-thirds of Illinois.
3. Weeds, especially grass weeds, may be a severe problem because of the interference of crop residues with herbicides.
4. Poor stand may limit yields more frequently than with other systems.
5. Residues may harbor insects and rodents.

Strip Tillage

With strip tillage, a strip up to 16 inches wide is tilled in the row area with the area between the rows left untilled. The tillage may be done with a rotary tillage machine, chisels, or a till-planter such as the Buffalo-till planter.

Advantages:

1. Can be adapted to ridge planting to gain additional erosion control and to lessen soil temperature reduction.
2. Other advantages are similar to those listed for mulch and zero tillage.

Limitations:

1. Requires special equipment.
2. Other limitations are similar to those listed for mulch and zero tillage.

Tillage System Combinations

Tillage systems must be designed for a particular situation if they are to be most effective. A system that combines features of one or more of the systems described above may be the best bet to cope with the varying soil and crop-residue situations that exist on most farms. For example, a chisel plow, disk, or zero tillage may be used following soybeans to control wind erosion. If the soils are level and poorly drained, fall plowing with a moldboard plow may be used to minimize early growth problems with corn following corn. Use of the moldboard plow every 3 to 4 years will help provide better distribution of limestone and broadcast phosphorus and potassium applications (see pages 39 and 40).

Careful attention to weed and insect problems may help lessen the limitations of mulch and zero tillage. This is discussed in the next two sections.

Tillage System and Weed-Control Interactions

During 1970 weed problems were severe in many fields. Mulch-tillage and zero-tillage systems seemed to be especially plagued by severe weed problems. The problems were acute where heavy corn residues were left on the surface. Several factors contributed to the problem.

First, the weed seeds are left on or near the surface with mulch and zero-tillage. With conventional tillage, the weed seeds are incorporated so that many are too deep for germination and emergence. They may eventually rot.

Second, the corn residues intercept the herbicides and prevent them from reaching the soil where they are most effective.

Third, the corn residues serve as a mulch and reduce evaporation. The soil at or near the surface has sufficient moisture for weed-seed germination. With conventional tillage the soil at the surface may be dry a higher percentage of the time so that the shallower weed seeds do not have sufficient moisture for germination.

With mulch and zero tillage it is especially important to select herbicides on the basis of the type of vegetation which is or will be present. The following suggestions may help you solve a weed problem with mulch or zero tillage. For rates and use suggestion, see pages 48 to 59.

For existing grass-sod vegetation, perennial grasses, and early emerging annual weeds, apply Paraquat at 1 quart per acre for a quick kill at planting time.

For corn Atrazine plus Ramrod, Atrazine plus Lorox (Lorox may damage corn), or Atrazine alone have been used preemergence for weed control. Atrazine plus oil is used for preemergence application to corn, but is used postemergence for weeds.

For corn following alfalfa Paraquat has not always given effective control of the alfalfa. Banvel has given effective control but should not be used if soybeans have already been planted nearby and have emerged. 2,4-D or Banvel plus 2,4-D is also a possibility for killing legumes. If perennial grass is growing with the alfalfa, Paraquat can be used to control the grass.

For broadleaf weeds that escape the initial treatment in corn, 2,4-D postemergence can be effective as a follow-up application.

For grass weeds in corn, a directed spray of Dowpon or Lorox may be helpful for postemergence control if there is sufficient height difference between corn and the weeds (see page 54).

For soybeans, Lorox plus Surfactant WK or Amiben along with Paraquat (1 quart per acre) have looked promising with zero-tillage planting in wheat stubble (double cropping).

The most effective weed control is achieved when the control measures are adapted for each situation. Watch for developing weed problems and be prepared to take corrective action as needed. Postemergence application of herbicides and row cultivation where feasible may mean the difference between success and failure of the tillage system.

Tillage and Insect Control

Some damage from cornborer, common stalk borer, and other insects appeared to be associated with cornstalk residues or grassy weed infestations, or both, in mulch-tilled and zero-tilled corn. In general, control measures with these tillage systems have not differed from those used with conventional tillage. Careful attention to the developing crop may help you recognize a potential insect problem soon enough for effective control. Specific recommendations are available in Illinois Extension Circular 899, "Insecticide Recommendations for Field Crops."

1971 WEED CONTROL GUIDE

This guide for using weed control chemicals is based on research results at the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture. Although not all herbicides commercially available are mentioned, an attempt has been made to include materials that were tested and showed promise for controlling weeds in Illinois. Consideration was given to the soils, crops, and weed problems of the state.

The field of chemical weed control is still relatively new. The herbicides now available are not perfect. Factors such as rainfall, soil type, and method of application influence herbicide effectiveness. Under certain conditions some herbicides may damage crops to which they are applied. In some cases chemical residues in the soil may damage crops grown later.

When deciding whether to use a herbicide, consider both the risk involved in using the herbicide and the yield losses caused by weeds. If you do not have much of a weed problem and if cultivation and other good cultural practices are adequate for control, do not use herbicides. Much of the risk can be decreased by following these precautions:

- Use herbicides only on those crops for which they are specifically approved and recommended.
- Use no more than recommended amounts. Applying too much herbicide may damage crops and may be unsafe if a crop is to be used for food or feed, and is costly.
- Apply herbicides only at times specified on the label. Observe the recommended intervals between treatment and pasturing or harvesting of crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label. Some individuals are more sensitive than others to certain herbicides.
- Guard against possible injury to nearby susceptible plants. Droplets of 2,4-D, MCPA, 2,4,5-T, and dicamba sprays may drift for several hundred yards. Take care to prevent damage to such susceptible crops as soybeans, grapes, and tomatoes. If it is necessary to spray in the vicinity of such crops, the amine form of 2,4-D is safer to use than the volatile ester form, but even with the amine form, spray may drift to susceptible crops. To reduce the chance of damage, operate sprayers at low pressure with tips that deliver large droplets and high gallonage output. Spray only on a calm day or make sure air is not moving toward susceptible crop plants and ornamentals. Some farm liability insurance policies do not cover crop damage caused by the ester form of 2,4-D.
- Apply herbicides only when all animals and persons not directly involved in the application have been removed. Avoid unnecessary exposure.
- Return unused herbicides to a safe storage place promptly. Store them in original containers, away from unauthorized persons, particularly children.
- Since manufacturers' formulations and labels are sometimes changed and government regulations modified, always refer to the most recent product label.

Where trade names are used in this publication, rates refer to the amount of commercial product. Where common or generic names are used, rates refer to the amount of active ingredient. Unless otherwise stated, rates are given on a broadcast basis. Proportionately less should be used for band applications.

This guide is for your information. The University of Illinois and its agents assume no responsibility for results from using herbicides, whether or not they are used according to the suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Names of Some Herbicides

Trade	Common (generic)
AAtrex	atrazine
Amiben	chloramben
Amino triazole, Weedazol	amitrole
Amitrol-T, Cytrol	amitrole-T
Banvel	dicamba
Bladex	SD15418
Butoxone, Butyrac, and others	2,4-DB
Chloro IPC	chlorpropham
Dacthal	DCPA
Dowpon, Basfapon	dalapon
Eptam	EPTC
Knoxweed	EPTC plus 2,4-D
Lasso	alachlor
Londax	propachlor plus linuron
Lorox	linuron
Milogard	propazine
Planavin	nitralin
Preforan	C6989
Princep	simazine
Ramrod	propachlor
(Several)	dinoseb
(Several)	MCPA
(Several)	sodium chlorate
(Several)	2,4-D
(Several)	2,4,5-T
Solo	naptalam plus chlorpropham
Sutan	butylate
Tenoran	chloroxuron
Treflan	trifluralin
Vernam	vernolate

For clarity, trade names have been used frequently. This is not intended to discriminate against similar products not mentioned by trade names.

Herbicide Application Rates

The performance of some herbicides is influenced considerably by the organic-matter content of soil. You can estimate the organic-matter content of most Illinois soils by using the "Color Chart for Estimating Organic Matter in Mineral Soils in Illinois" (AG-1941), available from your county extension adviser or the Publications Office, College of Agriculture, University of Illinois, Urbana, Illinois 61801. For a more precise determination of organic matter, obtain a laboratory analysis.

After you know the approximate organic-matter content of soil, Table 44 can be used for selecting herbicide rates. Using this guide should help you select rates to provide adequate weed control and minimize herbicide residue.

Table 44. — Suggested Herbicide Rates for Illinois Soils

Percent organic matter	Pounds of active ingredient per acre on a broadcast basis				
	atrazine	trifluralin	linuron	nitralin	alachlor
1	.8[d]	½	½	¾	1½
2	1.6[d]	⅔	1	1	2
3	2.4	¾	1½	1⅛	2½
4	3.2[a]	1	2	1½[b]	2½
5+	4.0[a, c]	1	3[c]	. . .[b]	2½
	Commercial formulation per acre on a broadcast basis				
	AAtrex 80% wettable powder	Treflan liquid (4 lb./gal.)	Lorox 50% wettable powder	Planavin liquid (4 lb./gal.)	Lasso liquid (4 lb./gal.)
	pounds	*quarts*	*pounds*	*quarts*	*quarts*
1	1[d]	½	1	¾	1½
2	2[d]	⅔	2	1	2
3	3	¾	3	1⅛	2½
4	4[a]	1	4	1½[b]	2½
5+	5[a, c]	1	6[c]	. . .[b]	2½

[a] If you use more than 3 pounds per acre of active atrazine, do not follow with any crop except corn or sorghum the next growing season.
[b] Adapted mainly to soils with less than 4 percent organic matter.
[c] Since results are variable on soils with 5 percent or more organic matter, consider another herbicide or a herbicide combination. Rates indicated for 5 percent or more organic matter are the maximum rates cleared.
[d] On soils with 1 to 2 percent organic matter it may sometimes be preferable to increase the rate of atrazine above that indicated. A slightly higher rate may be desirable where atrazine is incorporated, under unfavorable weather, or for improved control of some weeds.

Corn

For most effective weed control in corn, well in advance of planting plan a program that includes both cultural practices and herbicide applications. If weeds are not serious, cultural practices alone are sometimes adequate. Prepare seedbeds to kill existing weed growth and provide favorable conditions for germination and early growth of corn. Working the soil several times is not essential if weeds can be destroyed during final seedbed preparation. Working the seedbed excessively may intensify the weed problem and contribute to crusting. A relatively high plant population and perhaps narrow rows provide enough shading to discourage weed growth.

Early cultivations are very effective for killing weeds. The rotary hoe or harrow works best if you use it after weed seeds have germinated and before or as soon as the weeds appear above the soil surface. Use row cultivators while the weeds are still very small. Set the shovels for shallow cultivation to prevent root pruning and to bring fewer weed seeds to the surface. Throwing soil into the row can help smother weeds in the row. However, if a herbicide has given good control in the row, it is sometimes best not to move soil or weeds from the middles into the row. Where you use a preemergence herbicide, if it is not sufficiently effective, cultivate with the rotary hoe or row cultivator while the weeds are still small enough to control.

Even where herbicides are used, most farmers still use a rotary hoe or harrow for an early cultivation, followed by one or two row cultivations as needed. Some farmers, especially those with narrow rows, high populations, and large acreages, broadcast herbicides and sometimes eliminate cultivation if control is adequate.

Weigh the added expense of broadcasting herbicides against other factors, such as time saved at a critical season. Research indicates that *if weed control is adequate* and the soil is not crusted because of excessive seedbed preparation or other factors, there often is little or no yield increase from cultivation on most Illinois soils. One or two cultivations are, however, often beneficial for controlling certain weed species that are not controlled by the herbicide.

The popularity of preemergence herbicides is partly caused by the need for improved control of weeds, especially annual grasses which became more severe as farmers switched from checking to drilling and hill-dropping corn. Preemergence herbicides also offer a relatively convenient and economical means of providing early weed control and they allow faster cultivation.

You can mix some herbicides with other agricultural chemicals for application. You can apply some to the surface, but must incorporate others into the soil. You can apply some either way. Time of application depends partly on what herbicide you use.

Plan well in advance to select a weed-control program that is most appropriate for your soil, crops, weed problems, farming operations, and personal desires. Be prepared to modify your plans as required during the season.

Preplant Herbicides for Corn

Some herbicides may be applied before planting where you wish to commit yourself to broadcast application.

Preplant applications offer an opportunity to make some herbicide application before the busy planting season. This can be particularly advantageous for custom applicators and for farmers with large acreages. Preplant allows fewer attachments on the planter. The weather will often dictate the actual time for application, so where preplant applications are planned, you should also have an alternate plan in case preplant applications are not possible.

Preplant-incorporated applications offer an opportunity for applying herbicide, insecticide, and fertilizer at the same time if the chemicals are compatible and if the incorporation gives the proper placement for each chemical.

AAtrex (atrazine) can be applied within 2 weeks before planting corn. Although early spring and even fall applications have been tried, research indicates that the closer to corn planting time you apply AAtrex, the more successful the application is likely to be.

Apply AAtrex to the soil surface or incorporate it lightly with a shallow disking or similar operation. The field cultivator has been successfully used for incorporation, but results have not always been quite as good as with a disk. Depth and thoroughness of incorporation will depend on many factors, such as type of equipment, depth of operation and other adjustments, speed, soil texture, and soil physical condition when incorporating.

With so many factors involved, exact specifications for incorporation cannot be given. However, one principle to keep in mind is that the deeper the herbicide is incorporated and the more soil it is mixed with, the more diluted it will be. With excessive incorporation and dilution the effectiveness of the herbicide may be decreased. As a rule of thumb, incorporation devices such as a disk usually move the herbicide only to about half the depth at which the implement is operated.

The major reason for incorporating some herbicides is to reduce loss of herbicide from the soil surface. Since loss of AAtrex is not very rapid, incorporation is not essential. Moving herbicide into soil where there is sufficient moisture for weeds to absorb the chemical may be another advantage for incorporating some herbicides.

AAtrex is very effective for control of many broad-leaved weeds and is often quite satisfactory for control of annual grass weeds. However, under unfavorable conditions it may not adequately control some annual grasses such as giant foxtail, crabgrass, and panicum. Considerable research has been done attempting to find another herbicide that could be combined with AAtrex to improve grass control.

Sutan (butylate) plus atrazine has been successfully used as a preplant-incorporated treatment. This combination has its greatest adaptation to soils above 3 percent organic matter. Sutan can often improve the control of annual grass weeds and the combination gives much better control of broad-leaved weeds than Sutan alone.

For the "tank mix" combination, ½ gallon of Sutan plus 1¼ to 2 pounds of AAtrex 80W per acre broadcast is suggested. Injury to corn from this combination has not been a serious problem thus far, but occasionally injury may occur.

Sutan (butylate) may be used alone as a preplant incorporated treatment at a rate of ⅔ gallon per acre broadcast. Sutan is primarily for control of grass seedlings and may be helpful for control of fall panicum, Johnsongrass from seed, wild cane, and nutsedge. Although it has not been a serious problem thus far, corn may occasionally be injured by Sutan. *It is important to apply Sutan accurately and uniformly to avoid injury.* If you use Sutan alone or in combination with AAtrex, incorporate it immediately after application.

Sutan is cleared for field corn, sweet corn, and silage corn, but not for hybrid corn grown for seed.

Lasso or **Lasso plus atrazine** may be used as a preplant treatment within 7 days before planting corn. Either treatment can be applied to the surface or incorporated. If the major problem is annual grass weeds, a surface application rather than incorporation of Lasso is usually preferred. However, incorporation of Lasso may improve nutsedge control. If Lasso is to be incorporated, consider using the higher rates indicated on the label. See further details under preemergence section.

Preemergence Herbicides Applied at Planting (Preferred)

AAtrex (atrazine) is one of the most popular herbicides for corn. It controls both broad-leaved and grass weeds, but is particularly effective on many broadleaves such as smartweed. Corn has very good tolerance to preemergence applications of AAtrex. It is most effective on the light soils that are relatively low in organic matter, but is also effective on soils with more organic matter if you increase the rate. Do not exceed the rates specified on the label. For help in selecting AAtrex rates on the basis of organic-matter content of the soil refer to Table 44.

AAtrex will often persist long enough to give weed control for most of the season. Unless you take proper precautions, enough AAtrex may remain in the soil to damage some crops the following season. Where you apply AAtrex in the spring, do not follow that fall or the next spring with small grains, small seeded legumes, or vegetables. If you use AAtrex 80W at a broadcast rate above 3¾ pounds per acre (or comparable rates in a band) do not plant any crop except corn or sorghum the next growing season.

Soybeans planted where AAtrex was used the previous year may show some effect, especially if you used more than the recommended amount or on ends of fields where some areas received excessive amounts. Applying AAtrex relatively late the previous year and planting soybeans early allows less time for loss of AAtrex residue and increases the possibility of injury to soybeans. Minimizing tillage before planting soybeans also increases the possibility of AAtrex residue affecting soybeans.

You can use AAtrex on most types of corn, including field corn, silage corn, seed-production fields, sweet corn, and popcorn. AAtrex is available as a wettable powder or as a liquid suspension. Both forms appear to perform equally well. Mix adequately, provide adequate agitation, and follow other precautions on the label to assure uniform application.

Ramrod (propachlor) has given very good control of annual grass weeds on soils above 3 percent organic matter. On soils with less than 3 percent organic matter, Lasso would be more appropriate than Ramrod. In addition to annual grasses, Ramrod usually controls pigweed and may give some control of lambsquarter.

Most of the commonly grown corn hybrids have good tolerance to Ramrod. It is cleared for field corn, silage corn, hybrid-seed-production fields, and sweet corn.

Ramrod is available as a 65-percent wettable powder and as 20-percent granules. Either formulation of Ramrod can be irritating to skin and eyes. Some individuals are more sensitive than others. Twenty pounds of the granules or 6 pounds of the wettable powder are equivalent to 4 pounds of active ingredient, which is the recommended rate per acre on a broadcast basis. Use proportionately less for band applications.

A good program is to use Ramrod either as a spray or as granules at planting time to control annual grass weeds and follow with an early postemergence application of 2,4-D to control broad-leaved weeds.

Ramrod plus atrazine, each at a reduced rate, has generally given good control of both annual broad-leaved and grass weeds. This combination is best adapted to soils with over 3 percent organic matter. For "tank-mixing" this combination, 4½ pounds of Ramrod 65-percent wettable powder plus 2 pounds of AAtrex 80W wettable powder is the suggested amount for soils with over 3 percent organic matter.

A prepackaged wettable powder combination of Ramrod plus atrazine is available. Use it at a rate of 6 to 8 pounds per acre.

The reduced rate of AAtrex will control many broad-leaved weeds, such as smartweed, but may give marginal control of velvetleaf. The reduced rate of Ramrod in the mixture is adequate for control of most annual grasses. The mixture controls broad-leaved weeds better than Ramrod alone and often controls annual grass weeds better than AAtrex alone. It reduces the AAtrex residue problem, and gives more consistent control on the darker soils or with limited rainfall than AAtrex alone.

Lasso (alachlor) is similar to Ramrod in some respects. Although Lasso has performed well on soils with more than 3 percent organic matter, it is not likely that it will entirely replace Ramrod for corn on these soils in the immediate future. Being less soluble than Ramrod, Lasso may require slightly more moisture initially, but weed control may last a little longer. Lasso performs better than Ramrod on soils with less than 3 percent organic matter. Like Ramrod, Lasso is intended primarily for control of annual grass weeds. Following Lasso with a postemergence application of 2,4-D to control broad-leaves gives more complete weed control. Lasso is helpful for control of nutsedge.

Corn tolerance to Lasso has usually appeared to be relatively good. However, occasional corn injury has occurred, particularly to certain hybrids. Check with your seed corn dealer and chemical dealer to avoid using Lasso on the more susceptible hybrids.

Lasso is available as a 4-pound-per-gallon liquid concentrate and as 10-percent granules. Lasso may be used for field corn, hybrid seed corn, and silage corn. At least 12 weeks must elapse following treatment with Lasso before immature corn forage can be harvested or fed to cattle. Refer to Tables 44 and 45 and to the product labels for suggested rates.

Although Lasso is less irritating than Ramrod, the precautions listed on the label should be taken when handling Lasso.

Lasso plus atrazine may be used preemergence in a similar way to Ramrod plus atrazine. The Ramrod-atrazine combination has performed quite well on the darker soils, but the Lasso-atrazine combination is less irritating to handle and means less wettable powder to handle than with Ramrod-atrazine. Degree of weed control with either of these combinations has been somewhat comparable. The Lasso-atrazine combination is preferable to Ramrod-atrazine on soils with less than 3 percent organic matter and may improve control of some grasses such as panicum. Precautions should be taken to avoid using the Lasso-atrazine combination on corn hybrids that may be susceptible to Lasso. Suggested rates for tank-mixing Lasso-atrazine are 1½ quarts of Lasso and 1½ pounds AAtrex 80W per acre broadcast for soils with less than 3 percent organic matter or 2 quarts Lasso and 2 pounds AAtrex 80W per acre for soils with more than 3 percent organic matter.

Princep (simazine) usage for corn has been largely replaced by AAtrex. However, Princep, used alone or in combination with AAtrex may give more control of fall panicum than AAtrex alone. Princep may also give some control of wild cane. Being less soluble than AAtrex, Princep may have more residual activity. The major use for Princep would be on soils with less than 3 or 4 percent organic matter.

Bladex (SD15418) is a new triazine corn herbicide which is similar in some respects to atrazine. Clearance for corn is anticipated in 1971. The product will probably be formulated as an 80 percent wettable powder.

Research thus far suggests that corn has relatively good tolerance to Bladex. Rates of Bladex may sometimes need to be higher than with AAtrex for comparable control. Bladex may sometimes give slightly better control of some annual grasses but less control of some broad-leaved weeds than AAtrex. Length of control and residual activity will be less than with equal rates of AAtrex.

Bladex will probably be for preemergence use only for surface application. Combinations of Bladex with other corn herbicides may offer some potential for the future.

Preemergence Herbicides Applied at Planting (Less Preferred)

Because of greater possibility of crop injury or less weed control, the following preemergence herbicides for corn are not considered as satisfactory as those discussed above.

Knoxweed is a combination of Eptam (EPTC) and 2,4-D. It is cleared for use on field corn, sweet corn, and silage corn. Do not use it on seed production fields. Knoxweed has given rather erratic weed control, depending on rainfall and soil moisture. More consistent weed control is likely when rain occurs soon after application. The possibility of corn injury from Knoxweed has not been a serious problem but does exist. Knoxweed has presented no hazard to crops the next season. It is available in both liquid and granular forms. Do not use on peats, mucks, or sands.

2,4-D ester preemergence for corn controls broad-leaved weeds and gives some control of grass weeds. Weed control is rather erratic. There is some chance of injury to the corn. Use only the ester form for preemergence, since the amine form is more subject to leaching. 2,4-D ester is available in both liquid and granular forms.

A combination of **Lorox (linuron) plus atrazine** has been available as a prepackaged, wettable-powder mixture or you can "tank-mix" it on the farm for preemergence use on field corn. Especially on the relatively light-colored soils with low organic matter this combination has often given satisfactory weed control. Using a reduced rate of Lorox in the combination reduces, *but does not eliminate,* the possibility of corn injury. Do not use the combination containing Lorox on sandy soils or injury may result. This combination may give more control of panicum than atrazine alone.

Londax, a combination of Lorox and Ramrod, has clearance for use on field corn for grain or silage. It contains linuron and propachlor in a ratio of 1 to 2 parts respectively of active ingredient. The 45-percent wettable powder formulation contains 15 percent linuron and 30 percent propachlor. The 15-percent granular formulation contains 5 percent linuron and 10 percent propachlor. Rates should be very carefully selected on the basis of soil texture and organic-matter content. Maximum rates are 1½ pounds of linuron plus 3 pounds of propachlor per acre on a broadcast basis. This combination has given relatively good weed control. Control of broad-leaved weeds is better than with Ramrod alone. However, the addition of Lorox *increases the chance of crop injury.* Applications should be made very accurately and uniformly to help avoid crop injury.

Amiben (chloramben) and **Lorox (linuron)** each have label clearance for preemergence use on corn, but the risk of corn injury is considered too great to recommend their use for this purpose in Illinois.

Postemergence Herbicides for Corn

2,4-D provides one of the most economical and effective treatments for many broad-leaved weeds in corn.

For greatest effectiveness, apply 2,4-D when weeds are small and easiest to kill. You can apply the spray broadcast over the top of the corn and weeds until corn is about 8 inches high. After that height, use drop extensions from the boom down to the nozzles. These "drop nozzles" help keep the 2,4-D off the top of the corn and decrease the possibility of injury. You can direct the nozzles toward the row where most of the weeds will be. However, if you direct the nozzles toward the row, adjust the concentration of the spray so that excessive amounts are not applied to the corn.

Each year some corn is damaged by 2,4-D. It is virtually impossible to eliminate all cases of 2,4-D damage. The chemical usually makes corn brittle for a week or ten days. If struck by a strong wind or by the cultivator, some corn may be broken off. Some stalks may "elbow" or bend near the base. Other symptoms of 2,4-D injury are abnormal brace roots and "onion-leafing," a condition in which the upper leaves remain tightly rolled and may delay tassel emergence.

Spraying 2,4-D during very cool, wet weather when corn plants are under stress, or spraying during very hot, humid weather may increase the possibility of corn injury from 2,4-D.

Some inbreds and some hybrids are more easily injured by 2,4-D than others. It is usually best not to use 2,4-D on inbreds unless you are certain they have a high tolerance. Single crosses may or may not be more sensitive than double crosses, depending on the sensitivity of the inbred parents. Doublecross hybrids and three-way crosses also vary in their sensitivity depending on their genetic makeup.

To help avoid damage to corn, be sure to apply 2,4-D at no more than the recommended rate. The suggested rates per acre for broadcasting are: 1/6 pound of low-volatile ester; 1/4 pound of high-volatile ester; or 1/2 pound of amine.

The ester forms of 2,4-D can volatilize and the vapors move to nearby susceptible plants to cause injury. Since the amines are not so volatile they are less likely to injure nearby desirable plants. However, when spraying either the ester or amine forms, spray particles can drift to nearby susceptible plants.

Here is an easy way to calculate the amount of 2,4-D needed. If using a formulation with 4 pounds of 2,4-D per gallon, each quart will contain 1 pound; each pint 1/2 pound; and each half-pint 1/4 pound. It would take 1 pint of amine formulation to get 1/2 pound of 2,4-D. A gallon of 2,4-D amine (with 4 pounds of 2,4-D per gallon) would be enough to broadcast 8 acres (4 lb./gal. ÷ 1/2 lb./A. = 8 acres). A gallon of 2,4-D containing 4 pounds of 2,4-D high-volatile ester would be enough to broadcast 16 acres (4 lb./gal. ÷ 1/4 lb./a. = 16 acres).

It is important to spray weeds when they are small and easiest to kill and before they have competed seriously with the crop. However, you can use high-clearance equipment relatively late in the season if you wish, especially for control of late-germinating weeds. Many of the weeds that germinate late are not very competitive with corn, but control would decrease production of weed seeds. Do not apply 2,4-D to corn from tasseling to dough stage.

Amines are salts that are dissolved to prepare liquid formulations and when mixed with water they form clear solutions. Esters of 2,4-D are formulated in oil and when mixed with water they form milky emulsions.

Dacamine and Emulsamine are amine forms of 2,4-D that are formulated in oil and are called oil-soluble amines. Since they are formulated in oil like the esters they are said to have the effectiveness of the esters, but to retain the low-volatile safety features of the amines.

The active ingredient in the various formulations of 2,4-D is still 2,4-D and when you adjust rates appropriately to provide both weed control and crop safety the various formulations are usually similar in their effectiveness.

Banvel (dicamba) is suggested only for emergency use. You can use it as a postemergence spray over the top of field corn until corn is 3 feet high. Rates are 1/4 to 1/2 pint (1/8 to 1/4 pound active ingredient) per acre on a broadcast basis. Use proportionately less if placed only over the row.

Banvel is similar to 2,4-D in some respects, but controls smartweed better than does 2,4-D. Corn injury can occur with either Banvel or 2,4-D. *Banvel has often affected soybeans in the vicinity of treated cornfields and has presented a much more serious problem than 2,4-D.* Although soybean yields may not always be reduced, they can be if injury is severe enough. Banvel can also affect other susceptible broad-leaved plants, such as vegetables and ornamentals.

Do not make more than one postemergence application of Banvel per season. You can use Banvel on field corn for grain or silage, but do not graze or harvest for dairy feed before the ensilage stage (milk stage). Use extreme care not to allow Banvel onto desirable plants either by direct application, from contaminated sprayers, or by movement through the air from treated areas.

Because of the limited advantage of Banvel over 2,4-D and the greater risk of injury to other crops in the vicinity, Banvel is usually not recommended. If you anticipate a smartweed problem in corn, AAtrex preemergence or very early postemergence usually gives good control with much less risk of injury to other nearby plants.

AAtrex (atrazine) can be applied as an early postemergence spray to corn up to 3 weeks after planting, but before weed seedlings are more than 1½ inches high. Most annual broad-leaved weeds are more susceptible than grass weeds. The addition of 1 gallon of oil formulated especially for this purpose has generally increased the effectiveness of early postemergence applications of AAtrex. *On the relatively light-colored soils of Illinois, a regular preemergence application of AAtrex will likely remain more popular than postemergence AAtrex* because AAtrex preemergence applications usually give better control with less herbicide on such soils.

On the relatively dark soils of the state there is some interest in the AAtrex-oil treatment. Research and field experience suggest that for those relatively dark soils, 2½ pounds of AAtrex 80W plus 1 gallon of oil may sometimes be just as effective, and sometimes more effective, than a preemergence application of 3¾ pounds of AAtrex 80W. However, a preemergence application is usually preferred.

As with many herbicide applications, the results with AAtrex and oil will be influenced by many factors, and results are not always consistent. For control of annual grasses, it is especially important to apply early when grasses are small.

The early postemergence application with AAtrex and oil may be of particular help where rainfall is less certain, on the darker soils, and where soil conditions are too wet for cultivation.

Although corn has displayed excellent tolerance to AAtrex alone, corn has sometimes shown a general stunting where oil was added. There have been a few cases of fairly severe injury to corn where AAtrex and oil have been used. Weather conditions, stage of growth, rate of growth, genetic differences, and rate of herbicide used with oil seem to be some of the factors involved. Refer to the label for other precautions and for special instructions for aerial applications.

Certain other additives might be used instead of oil to enhance the postemergence activity of AAtrex. One of these is Tronic. Although results with Tronic have not been quite as consistent as with oil, results were often quite similar. An advantage for Tronic would be the need for handling less volume — 1 pint of Tronic per 25 gallons of spray solution.

Directed Postemergence Applications for Corn

Directed sprays are sometimes considered for emergency situations when grass weeds become too tall for control with cultivation. By the time help is sought, the weeds are often too large for directed sprays to be very practical or successful. Since present directed sprays cannot be used on small corn, some other means of control must be used early. Early control with only preemergence herbicides and cultivation is often quite adequate, leaving no need for the directed sprays. Since weeds begin competing with corn quite early, place primary emphasis on early control measures, such as use of preemergence herbicides, rotary hoeing, and timely cultivation.

Directed postemergence may have some potential for controlling some relatively late-germinating grasses, such as fall panicum.

Dowpon (dalapon) may be applied as a directed spray when corn is 8 to 20 inches tall from ground to whorl. Direct Dowpon toward the row using the equivalent of 2 pounds of product on a broadcast basis (⅔ pound in a 14-inch band over 40-inch rows). Dowpon is primarily for control of grass weeds, but 2,4-D can be added for control of broad-leaved weeds. With this treatment, use extreme caution to keep the Dowpon off the corn plant as much as possible to avoid injury. Do not let spray contact more than the lower half of the stalk and do not direct the spray more than 7 inches above the ground. Use "leaf lifters." Other precautions are given on the label. Dowpon does not give a quick kill, but can stunt the grass and reduce formation of weed seeds. Do not use Dowpon on corn grown for seed.

If excessive amounts of Dowpon contact the corn leaves, the chemical can be translocated (moved) inside the plant and may cause stunted and deformed plants, twisted leaves, short ear husks, and abnormal ears. Because of the risk of injury, Dowpon is not usually recommended in Illinois for application to corn.

Lorox (linuron) may be applied as a directed spray after corn is at least 15 inches high (to top of free-standing plant), but before weeds are 8 inches tall (preferably not over 5 inches). This height difference may not occur in some fields and when it does it will usually last for only a few days so the application needs to be very timely. Lorox can control both grass and broad-leaved weeds. Cover the weeds with the spray, but keep it off the corn as much as possible. Corn leaves that are contacted can be killed and injury may be sufficient to affect yields.

Consider this an emergency treatment. Refer to the label for further information and other precautions. A rate of 4 pounds of Lorox 50W on a broadcast basis or proportionately less in a directed band is suggested, but less Lorox may sometimes be adequate, especially for small weeds. Surfactant WK should be added at the rate of 1 pint per 25 gallons of spray mixture.

Soybeans

For soybeans Illinois farmers usually plow the seedbed and use a disk, field cultivator, or similar implement at least once to destroy weed growth and prepare a relatively uniform seedbed for planting. Planting in relatively warm soils helps soybeans begin rapid growth and compete better with weeds. Good weed control during the first three to five weeks is extremely important. If weed control is adequate during that early period, soybeans usually compete quite well with most of the weeds that begin growth later.

Rotary hoeing is very popular for soybeans. It not only helps control early weeds, but it aids emergence if the soil is crusted. To be most effective, use the rotary hoe after weed seeds have germinated, but before the majority of weeds have emerged. Operate the rotary hoe at 8 to 12 miles per hour and weight it enough to stir the ground properly. The soil must be moved sufficiently to kill the tiny weeds.

Following one or two rotary hoeings, use the row cultivator one or two times. Adjust the row cultivator properly and operate it fast enough to move soil into the row to smother small weeds. Avoid excessive ridging which would make harvesting difficult.

It is often said that soybeans in narrow rows provide more shade and compete better with weeds. However, with narrow rows there is more row area where weeds are difficult to control. So a good weed-control program is just as important for narrow-row beans.

There is some interest in "solid drilling" of sobyeans in 7- to 10-inch rows. However, you cannot expect present herbicides to control weeds adequately 100 percent of the time. For most situations it is preferable to keep the rows wide enough so you can use cultivation as required.

Use of preemergence herbicides for soybeans has increased rapidly. Nearly three-fourths of the soybean acreage in Illinois is treated with a preemergence herbicide. Whether you should use herbicides for soybeans will depend on the seriousness and nature of your weed problem, as well as your preference for various alternative methods of weed control. Preemergence herbicides are often extremely helpful in obtaining the necessary early control in the row. They can allow a reduction in the number of cultivations, allow faster cultivation, and reduce the amount of ridging needed to smother weeds in the row.

Even though you have used a preemergence herbicide, if it appears doubtful that it will give adequate control, use the rotary hoe while weeds are still small enough to be controlled. Use row cultivation as needed before weeds in the row become too large to be smothered.

When selecting a preemergence herbicide for soybeans, consider the kind of weeds likely to be present. Many of the preemergence herbicides for soybeans are particularly effective for controlling annual grasses. The majority give good control of pigweed, and many will also control lambsquarter. Most do not give good control of annual morningglory, and control of velvetleaf, jimsonweed, and cocklebur is rather erratic.

Many of the preemergence herbicides for soybeans may occasionally cause injury to the soybean plants. Fortunately, soybeans usually have the ability to outgrow modest amounts of early injury, and usually the benefits from weed control provided by the herbicide are much greater than any adverse effects from the herbicides. There may occasionally be exceptions and anyone using herbicides should realize there are some risks involved.

Where you use herbicides for soybeans, it is particularly important to use high-quality seed of disease-resistant varieties. Soybeans that are under stress and do not begin vigorous growth appear to be more subject to herbicide injury. And soybeans that are injured by a herbicide are likely to be more subject to disease. Any one of these factors alone may not be too serious, but several of them acting together could be.

Preplant Herbicides for Soybeans

Treflan (trifluralin) is one of the most effective herbicides for controlling annual grasses such as foxtail. It is also the major soybean herbicide suggested for controlling wild cane and Johnsongrass seedlings. Treflan may also control pigweed and lambsquarter, but does not give good control of most other broad-leaved weeds commonly found in Illinois soybean fields.

Treflan has given satisfactory control of susceptible weeds a high percentage of the time. Soybean injury is possible with Treflan. It may cause tops to be stunted and may cause a reduction in the number of lateral roots in the treated zone. Compared with the advantages of Treflan for controlling annual grasses, the injury from Treflan on a statewide basis is not considered a serious problem. However, in some individual fields where the stand of soybeans is reduced and plants are injured, the problem may be considered significant. Following instructions for rate and method of application is very important in reducing the possibility of injury.

You can apply Treflan just before planting or anytime during 10 weeks before planting. Incorporate it into the soil immediately after application, by using a disk or similar implement to reduce loss from the soil surface. Cross-disk a second time at right angles to the first disking to obtain more uniform distribution. This will help give more uniform weed control and reduce possibility of soybean injury. You can delay the second disking until anytime before planting, and using it for final seedbed preparation just before planting usually improves control.

The disk probably will incorporate the chemical to only about ½ the depth of operation. Disking about 4 inches deep to mix the majority of the chemical into about the top 2 inches usually works best. Having a harrow attached behind the disk is often helpful.

You can use implements other than the disk if they adequately mix the chemical into the top 2 inches. The field cultivator is usually not recommended for incorporating Treflan. Results with the field cultivator sometimes have been acceptable, but are usually not as good as with the disk. The degree of incorporation may vary considerably depending on type of implement, adjustment, speed, soil moisture, soil texture, and other soil physical conditions.

The rate of Treflan is between ½ and 1 quart liquid (½ to 1 pound of active ingredient) per acre on a broadcast basis. Select the rate on the basis of soil type as indicated on the label. After determining the organic-matter content of your soil by estimation or by laboratory analysis you can also use Table 44 as a guide for selecting appropriate rates for most Illinois soils. For most of the light-colored silt loams in Illinois use ½ to ¾ quart per acre; for the dark-colored silty clay loams, and clay loams with over 3 percent organic matter use ¾ to 1 quart per acre.

Treflan is also available in granular form. The granules have not been as popular as the liquid, but appear to be comparable in performance.

In a few cases Treflan residue has carried over to injure corn the following year. In many of these fields the soybean stubble had not been plowed with a moldboard plow. Some areas apparently had excessive applications.

Research also suggests some possibility of Treflan residue affecting small grain. Using no more than recommended rates and making careful applications no later than early June should reduce, but may not eliminate, the possibility of injury to subsequent crops.

Planavin (nitralin) is similar to Treflan in the kinds of weeds controlled. However, research indicates that in Illinois higher rates of Planavin are usually needed to provide about the same control obtained with Treflan.

On some of the light-colored silt loams of the southern part of Illinois, ¾ pound per acre of active ingredient of Planavin (¾ quart of liquid or 1 pound of 75-percent wettable powder) appears to be appropriate. Higher rates are needed as organic matter increases (see Table 44).

Planavin is cleared up to 1½ pounds per acre of active ingredient, but it is not well adapted to the darker soils of the northern part of Illinois. Planavin can be applied within 6 weeks before planting. Incorporate soon after application into the top 1 to 1½ inches of soil with a disk operated shallow or with similar equipment.

Lasso (alachlor) may be applied as a preplant incorporated treatment within 7 days of planting. Incorporation is usually helpful for controlling nutsedge.

Preemergence Herbicides Applied at Planting Time (Preferred)

Amiben (chloramben) has been one of the most popular herbicides for soybeans. It controls the majority of annual grass and broad-leaved weeds in soybeans most of the season. The major exception is annual morningglory. Control of velvetleaf, jimsonweed, and cocklebur is somewhat erratic. Amiben occasionally injures soybeans, but damage is usually not very severe. When it occurs, injury appears as malformed roots and stunting of the tops.

Amiben is adapted to a wide range of soil types. The manufacturer recommends 1 to 1½ gallons or 20 to 30 pounds of granules (2 to 3 pounds active ingredient) on a broadcast basis per acre or proportionately less for band application. University trials have shown best weed control with 1½ gallons or 30 pounds of granules per acre. If you reduce the rate, weed control may be reduced. Consider the degree of control desired, as well as the cost.

You can make a comparison of 1, 1¼, and 1½ gallons (20, 25, and 30 pounds of granules) per acre on a field and use it as a basis for selecting rates for that field in the future. Granules and liquid perform about equally well. Amiben is easy to handle and is usually applied to the soil surface at planting time.

Ramrod (propachlor) is cleared only for soybeans grown for seed and not for soybeans that will be harvested for food, feed, or edible oil purposes. Most of the comments on page 51 regarding Ramrod for corn apply for soybeans. Lasso is somewhat similar to Ramrod and has broader clearance for soybeans, so Lasso is usually used.

Lasso is intended primarily for control of annual grass weeds, but may also control pigweed and lambsquarter. Lasso is also helpful for control of nutsedge. Soybeans appear to have relatively good tolerance to Lasso although slight distortion of the leaves may appear early.

Lasso is less soluble than Ramrod and may require slightly more moisture initially, but can provide control a little longer than Ramrod. Lasso is not as irritating as Ramrod, but follow precautions listed on the label.

Lasso is available as a liquid with 4 pounds active ingredient per gallon and as 10-percent granules. Lasso has generally performed well on the darker soils and performs better than Ramrod on the lighter soils. A rate of 2 to 2½ quarts of liquid or 20 to 25 pounds of 10-percent granules (broadcast basis) is suggested for most Illinois soils. Use proportionately less for band applications.

Lasso plus Lorox in combination has given good weed control, primarily on the silt loam soils with less than 3 percent organic matter. On these soils, 1 to 1½ quarts of Lasso and 1 to 1½ pounds of Lorox 50W is suggested on a broadcast basis or proportionately less in a band. Do not use more than 1 pound of Lorox for each 1 percent organic matter. Lasso improves grass control and Lorox improves control of broadleaves such as velvetleaf, cocklebur, jimsonweed, and smartweed.

Lorox (linuron) has given relatively good weed control in soybeans, particularly on the light-colored silt loams. However, ***the margin of selectivity between dependable weed control and crop damage is rather narrow.*** Lorox performance is affected considerably by organic-matter content of the soil. For suggested rates see Table 44.

Selecting rates on the basis of organic matter and making careful applications will reduce, ***but may not eliminate, the possibility of crop injury.*** Do not use Lorox on sandy soils because of the risk of crop injury.

Chloro IPC (chlorpropham) has not commonly been used in Illinois, except in combination with other herbicides. When tested alone rates of Chloro IPC sufficient to give adequate control of most weeds have sometimes caused soybean injury. However, smartweed is particularly sensitive to Chloro IPC. For controlling smartweed in soybeans, use 2 to 3 pounds per acre of Chloro IPC active ingredient on a broadcast basis. You can use this reduced rate of Chloro IPC alone or in combination with some other herbicides that are weak on smartweed. Treflan may be incorporated preplant and Chloro IPC applied to the surface at planting or soon after.

Preforan (C-6989) is cleared for use on soybeans raised for seed. Broader clearance *may* be obtained for 1971. Preforan has been formulated as a 3 lb. per gallon liquid for use at 5 to 6 quarts per acre. Preforan should be applied to the soil surface at or near planting time. It controls annual grasses such as foxtails, and broadleaves including pigweed, lambsquarter, and smartweed. Lack of velvetleaf control is quite evident. Soybean tolerance with Preforan seems to be fair to good. As with most soybean herbicides, a little early injury may sometimes be noticed but soybeans usually outgrow any early injury rather well.

Preemergence Herbicides Applied at Planting Time (Less Preferred)

Because of the greater possibility of crop injury or less weed control, the following preemergence herbicides for soybeans are not considered as satisfactory as those previously discussed.

Solo (naptalam plus chlorpropham) sometimes gives satisfactory weed control but has been rather erratic. Crop injury can sometimes occur. Under favorable conditions, Solo can control annual grasses, smartweed, ragweed, velvetleaf, and jimsonweed. Solo is usually used at the rate of 1 to 1½ gallons of liquid or 20 to 30 pounds of granules per acre on a broadcast basis, or proportionately less when banded. This is equivalent to 2 to 3 pounds of naptalam and 2 to 3 pounds of chlorpropham active ingredient broadcast per acre.

Vernam (vernolate) has given good control of annual grass weeds in Illinois trials, *but some injury to soybeans may occur.* In addition to annual grasses, Vernam controls pigweed, lambsquarter, and may give some control of annual morningglory. Vernam might be considered for serious infestations of wild cane and for control of Johnsongrass seedlings where some soybean injury from the herbicide might be tolerated. Vernam may also be helpful for controlling nutsedge.

It would usually be preferable to incorporate Vernam before planting. However, granules are often banded on the surface at planting. Incorporation of granules is not essential but usually improves control, especially if rainfall is delayed. Rates of active ingredient suggested vary from 2 to 3 pounds per acre depending on soil type, formulation, and method of application.

Postemergence Applications for Soybeans

Tenoran (chloroxuron). Tenoran may be applied at the rate of 2 to 3 pounds of the 50-percent wettable powder in 25 to 40 gallons of water per acre with 1 pint of Adjuvan T surfactant added per 25 gallons of spray solution. This is the broadcast rate, but you can use proportionately less for directed or semi-directed band spraying. Apply from the time trifoliolate soybean leaves form and when broad-leaved weeds are less than 1 to 2 inches high.

Some non-phytotoxic oils may be substituted for Adjuvan T, using 1 gallon of oil in 25 gallons of spray solution for a directed or semi-directed spray.

Under favorable conditions Tenoran may give fairly good control of pigweed, lambsquarter, smartweed, jimsonweed, morningglory, and cocklebur. Velvetleaf is more difficult to control and should be not over 1 inch when you treat it. Although intended primarily for control of broad-leaved weeds, Tenoran may give some control of grass if you apply it under favorable conditions when grass weeds are less than ½ inch.

The major interest in Tenoran would be as a possible control for some of the broad-leaved weeds where a preemergence herbicide such as Treflan or Lasso had been used preemergence. Control with Tenoran has been somewhat erratic and soybeans usually show some injury at rates required for weed control. This early season injury to soybeans by Tenoran may not necessarily reduce final yields.

2,4-DB can be considered for emergency situations where cocklebur is quite serious (as in some bottomland areas). 2,4-DB is sold under several trade names including Butoxone SB and Butyrac 175. This herbicide may be broadcast from 10 days before soybeans begin to bloom until midbloom or as a postemergence directed spray when soybeans are 8 to 12 inches tall and cockleburs are 3 inches tall, if this height difference exists.

2,4-DB may also give fairly good control of annual morningglory and giant ragweed. But do not expect good control of most other weeds found in Illinois soybean fields. Soybeans may show early wilting followed by later curving of the stems. Some cracking of stems and some proliferated growth may occur at the base of the plants. Lodging may be increased and if excessive rates are applied or unfavorable conditions exist near time of treatment, yields may be lowered. Carefully follow application rates specified on the label.

Fencerow Control

If the vegetation in fencerows consists primarily of broad-leaved weeds, use 2,4-D at the rate of ½ to 1 pound applied in 10 or more gallons of water per acre. Two miles of fencerow, 4 feet wide equals about an acre.

Make the first application of 2,4-D in May or early June to control early weeds, and make another application in July or early August to control late weeds.

If there are grass weeds such as Johnsongrass or foxtail in the fencerow, you may mix Dowpon (dalapon) with 2,4-D for control of both broad-leaved weeds and grasses. Spray grasses before seed heads form. Use only 2,4-D where the fencerow vegetation consists primarily of broad-leaved weeds and desirable grasses. Use care to avoid injury to nearby desirable plants.

Additional Information

Readers who want additional information on weed control may obtain single copies of the following publications from the Office of Publications, College of Agriculture, University of Illinois, Urbana, Illinois 61801, or from a county extension adviser.

Weeds of the North Central States. Circular 718. ($1.00)

Prevent 2,4-D Injury to Crops and Ornamental Plants. Circular 808.

Controlling Johnsongrass in Illinois. Circular 827.

Controlling Giant Foxtail in Illinois. Circular 828.

Controlling Quackgrass in Illinois. Circular 892.

Calibrating and Maintaining Spray Equipment. Circular 837.

Calibrating and Adjusting Granular Row Applicators. Circular 1008.

Controlling Poison Ivy. Circular 850.

Using Preemergence Herbicides. Circular 932.

Color Chart for Estimating Organic Matter in Mineral Soils in Illinois. AG-1941.

Wild Hemp (Marijuana): How to Control It. USDA PA-959.

Eradicating Marihuana Plants.

The following publication may be obtained from the Division of Plant Industry, Illinois Department of Agriculture, Emmerson Building, State Fairgrounds, Springfield, Ill. 62706.

Noxious Weeds in Illinois.

Herbicide Application Rates

Table 45 lists the amount of commercial herbicides to apply per acre for liquids or granules, either broadcast or banded.

Here is a guide for calculating the amount of herbicide needed for spraying bands for various row spacings:

Row spacing (inches)	Width of band (inches)	Percent of total area covered
20	12	60
20	14	70
24	12	50
28	14	50
30	12	40
30	15	50
36	12	33
38–40	13	33
42	14	33

Formula for other situations: band width ÷ row spacing = percent of area covered.

Example: 12 inches ÷ 36 inches = ⅓ or 33 percent.

By operating your equipment over 1 acre of land you can determine how much spray is used. Do this by starting with a full tank of water and after operating on 1 acre measure the amount of water needed to refill the tank. Multiply the percentage figure from the guide above for your situation times the amount of herbicide recommended for broadcasting. The answer is the amount of herbicide to add with enough water to equal the spray volume you used per acre.

Example: 28-inch rows with 14-inch band; 1 gallon per acre of herbicide recommended if broadcast; 50 percent (from table) × 1 gallon = ½ gallon per acre needed for 14-inch bands on 28-inch rows; if you used 10 gallons per acre of spray, add ½ gallon of herbicide to each 9½ gallons of water to make 10 gallons of spray solution.

When using band treatments the amount of active chemical per row doesn't change with row spacings, but the amount of chemical applied per acre does. Table 46 shows the liquid and granular band rates for 13-inch bands on various row widths.

Table 45. — Amount of Commercial Product To Apply per Acre

Herbicide	12- to 14-inch bands over 40-inch rows		Broadcast	
	Liquid[a]	Granules[b]	Liquid[a]	Granules[b]
		Corn		
AAtrex	⅚ to 1¼ lb.	....	2½-3¾ lb.	....
Ramrod	2 lb.	7 lb. (20%)	6 lb.	20 lb.
Lasso	½-⅚ qt.	5-8 lb. (10%)	1½-2½ qt.	15-25 lb.
Knoxweed	1⅓ pt.	7 lb. (14%)	2 qt.	20 lb.
2,4-D ester	1 pt.[c]	3⅓ lb. (20%)	1½ qt.[c]	10 lb.
Eptam	1⅓ pt.	10 lb. (10%)	2 qt.	30 lb.
Sutan	....	....	⅔ gal.	40 lb. (10%)
		Soybeans		
Amiben	2 qt.	10 lb. (10%)	1½ gal.	30 lb.
Treflan	....	....	½-1 qt.	10-20 lb. (5%)
Lasso	½-⅚ qt.	5-8 lb. (10%)	1½-2½ qt.	15-25 lb.
Solo	⅓-½ gal.	7-10 lb. (20%)	1-1½ gal.	20-30 lb.
Lorox[d]	⅓-⅔ lb.	....	1-2 lb.	....
Vernam	....	7-10 lb. (10%)	1⅓-2 qt.	20-30 lb.
Planavin[d]	¼-⅓ qt.	....	¾-1 qt.	....
Preforan	2 qt.	....	6 qt.	....

[a] For broadcasting use 10 to 30 gallons of spray solution per acre for liquid formulations. For wettable powders use 20 to 30 gallons of spray per acre.

[b] The amount of granules listed is for material with the indicated amount of active ingredients.

[c] For a 2,4-D formulation containing 4 pounds acid equivalent per gallon.

[d] Amount for light-colored silt loam. See label for rates on other soils.

Table 46. — Liquid and Granular Band Rates for 13-Inch Bands on Various Row Widths

Broadcast rate (gallons per acre)	40-inch rows	38-inch rows	36-inch rows	30-inch rows	20-inch rows
			Liquid (gallons per acre)		
15	4.9	5.1	5.4	6.5	9.8
20	6.5	6.8	7.2	8.7	13.0
25	8.1	8.5	9.0	10.8	16.2
30	9.8	10.3	10.8	13.0	19.5
			Granular (pounds per acre)		
	1	1.1	1.1	1.3	2.0
	2	2.1	2.2	2.7	4.0
	3	3.2	3.3	4.0	6.0
	4	4.2	4.4	5.3	8.0
	5	5.3	5.5	6.7	10.0
	6	6.3	6.7	8.0	12.0
	7	7.4	7.8	9.3	14.0
	8	8.4	8.9	10.7	16.0
	9	9.5	10.0	12.0	18.0
	10	10.5	11.1	13.3	20.0
	11	11.6	12.2	14.7	22.0
	12	12.6	13.3	16.0	24.0
	13	13.7	14.4	17.3	26.0
	14	14.8	15.5	18.7	28.0
	15	15.8	16.7	20.0	30.0
	16	16.9	17.8	21.3	32.0

Control of Major Weed Species With Herbicides

(This chart gives a general comparative rating. Under unfavorable conditions some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions control may be better than indicated. Type of soil is also a very important factor to consider when selecting herbicides. Rate of herbicide used will also influence results. G = good, F = fair or variable, and P = poor.)

Control for Soybeans

	PREEMERGENCE								POSTEMERGENCE	
	Amiben	Lasso	Treflan	Planavin	Lorox	Solo	Vernam	Preforan	2,4-DB	Tenoran
Grasses										
Giant foxtail	G	G	G	G	G	F	G	G	P	P
Green foxtail	G	G	G	G	G	F	G	G	P	P
Yellow foxtail	G	G	G	G	G	F	G	G	P	P
Barnyard grass	G	G	G	G	G	F	G	F	P	P
Crabgrass	G	G	G	G	G	F	G	G	P	P
Johnsongrass from seed	F	P	G	G	P	P	G	P	P	P
Wild cane	F	P	G	G	P	P	G	P	P	P
Yellow nutsedge	P	F	P	P	P	P	F	P	P	P
Broadleaves										
Pigweed	G	G	G	G	G	G	G	G	P	G
Lambsquarter	G	F	G	G	G	F	F	F	P	F
Velvetleaf	F	P	P	P	G	F	F	P	P	P
Jimsonweed	F	P	P	P	F	F	P	F	P	F
Cocklebur	F	P	P	P	F	F	P	P	G	F
Annual morningglory	P	P	F	F	P	F	F	P	F	F
Ragweed	G	P	P	P	G	G	P	G	F	F
Smartweed	F	P	P	P	G	G	P	G	P	F
Soybean tolerance	F	G	F	F	F	F	F	F	F	F

Control for Corn

	PREEMERGENCE										POSTEMERGENCE	
	AAtrex	Ramrod	Lasso	Ramrod+atrazine	Sutan+atrazine	Knoxweed	2,4-D ester	Londax	Sutan	Eptam	2,4-D	Atrazine and oil
Grasses												
Giant foxtail	F	G	G	G	G	F	F	G	G	G	P	F
Green foxtail	G	G	G	G	G	F	F	G	G	G	P	G
Yellow foxtail	G	G	G	G	G	F	F	G	G	G	P	G
Barnyard grass	G	G	G	G	G	F	F	G	G	G	P	G
Crabgrass	F	G	G	G	G	F	P	G	G	G	P	P
Johnsongrass from seed	P	P	P	P	F	P	P	P	F	G	P	P
Wild cane	P	P	P	P	F	P	P	P	F	G	P	P
Yellow nutsedge	F	F	F	F	F	P	P	P	F	F	P	F
Panicum	F	F	G	F	G	F	P	F	G	G	P	P
Broadleaves												
Pigweed	G	G	G	G	G	G	G	G	G	G	G	G
Lambsquarter	G	F	F	G	G	G	G	G	P	F	G	G
Velvetleaf	F	P	P	F	G	F	F	F	F	F	F	F
Jimsonweed	G	P	P	G	G	F	F	F	P	P	F	G
Cocklebur	G	P	P	G	G	F	G	F	P	P	G	G
Annual morningglory	G	P	P	G	G	F	G	P	P	P	G	G
Ragweed	G	P	P	G	G	F	F	G	P	P	G	G
Smartweed	G	P	P	G	G	F	F	G	P	P	F	G
Corn tolerance	G	G	G	G	F	F	F	F	F	F	F	F

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