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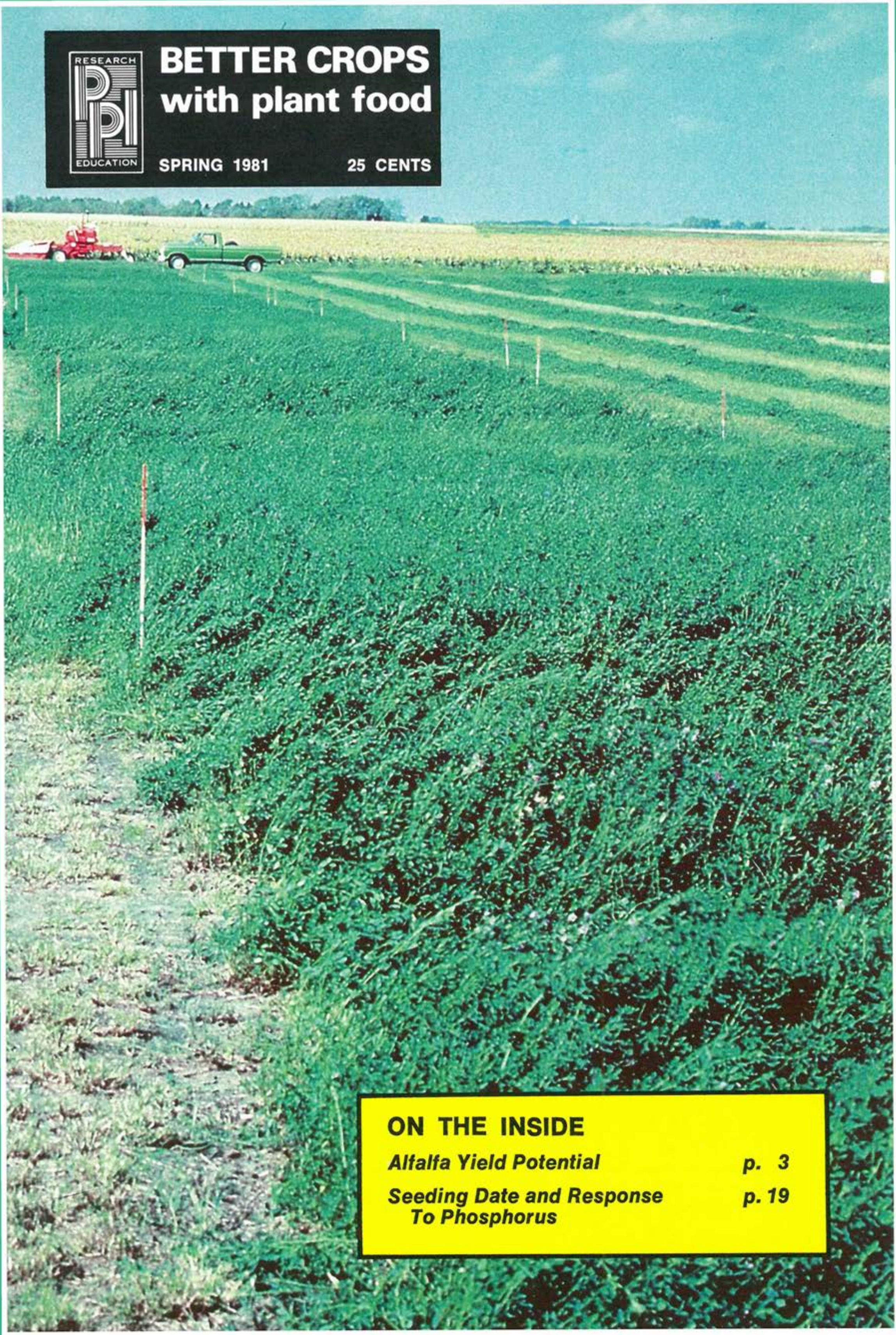
BETTER CROPS with plant food

SPRING 1981 25 CENTS



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BETTER CROPS with plant food

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Alfalfa Yield Potential In The Southeast

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North Carolina State University

RESEARCHERS AND FARMERS in the Midwest and Northeast have reported non-irrigated alfalfa yields of over 8 tons hay equivalent per acre.

Reports indicate alfalfa production in these areas has been significantly enhanced.

Are these high yields primarily the result of new cultivars, improved harvest procedures, intensified fertilizer use, more efficient pest control, a more favorable weather cycle, or a combination of these factors?

Alfalfa acreage in the Southeastern United States has never been as large as the major alfalfa producing regions. Considerable potential for expansion exists.

It would seem the Southeast, with its long growing season, moderate winter temperatures, and ample precipitation could produce very high alfalfa yields. But yields of 8 tons dry forage have not been reported.

There are many possible reasons for limited yield response from alfalfa in the Southeast.

1. SOILS. The soils in the Southeast are relatively acid and infertile. Cation exchange capacity generally ranges between two and eight meq/100 g of soil. Typically, most soils require one to three tons of lime per acre to raise the pH to 6.5 to 6.8.

Even on the most productive alfalfa soils, subsoil concentrations of soluble aluminum may be high enough to restrict root penetration beyond six feet. On many clay soils of the region, roots penetrate about 3 feet.

2. MOISTURE DISTRIBUTION. Annual precipitation is usually above 40 inches. But periods of severe moisture stress are common during the growing season.

Because of restricted root penetration, moisture stress tends to limit growth more than in areas of the Midwest where roots may penetrate to 10 feet or more.

3. PESTS. The humid environment of the Southeast favors many alfalfa pests that may not be as prevalent in other sections of the nation.

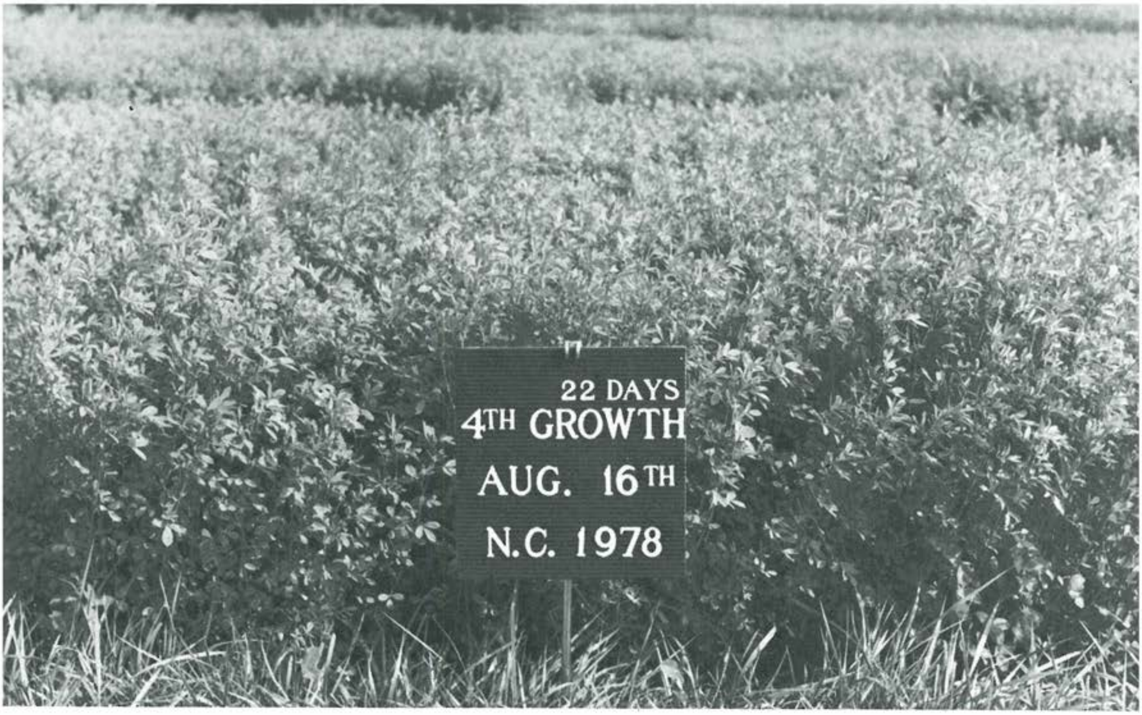
Diseases such as Anthracnose, Sclerotinia, Rhizoctonia, Fusarium, Phytophthora and various leafspotting fungi are common.

Insects such as the alfalfa weevil, potato leafhopper, three cornered alfalfa hopper, and fall armyworm can cause serious losses. Before chemical control of the alfalfa weevil, alfalfa production was all but eliminated from many areas of the Southeast.

4. INOCULATION. Many soils in the Southeast are completely devoid of alfalfa **Rhizobia.** Where proper inoculation procedures have not been followed, severe problems have resulted with establishing a good stand.

5. CULTIVARS. Limiting factors associated with alfalfa production in the Southeast are very complex. It is necessary to grow cultivars specifically adapted for the region.

They should have good disease resistance and also the potential for rapid, vigorous growth necessary to take advantage of the lengthy growing season.



6. FERTILITY. High alfalfa yields require relatively high fertilizer rates. Most producers know the increased costs per acre from extra lime and fertilizer. But many do not realize costs per ton of alfalfa produced may actually decline with high yields.

In many cases, mediocre yields from minimum fertilization do not allow the alfalfa producer to reach full profit potential.

HIGH YIELD POTENTIAL. For 10 years—from 1948 to 1958—W. W. Woodhouse, Jr. worked with "Oklahoma Common" alfalfa. He studied the effects of 18 different fertilizer treatments on the yield and mineral composition of the forage.

A 10-year average of 8,633 lb/A dry forage was produced where 400 lb/A K_2O, 100 lb/A P_2O_5, and 2 lb/A B were applied annually.

This treatment also produced the highest yield during any single year of the 10-year trial—10,244 lb/A of dry forage. Annual applications of 200 lb/A K_2O, 100 lbs/A P_2O_5, and 2 lb/A B produced a 10-year average yield of 7,837 lb/A of dry forage.

In 1976 an experiment was established to test the alfalfa yield potential in North Carolina. An improved, disease resistant variety, ARC, was used, while attempting to control a number of potential yield limiting factors.

Several variables were studied, including fertilizer treatments. Establishment fertilizer was applied according to soil test recommendations before seeding in 1976. But the maintenance fertilizer treatments were not applied until the spring of 1978. During the first harvest year, 1977, all plots were cut uniformly and discarded.

General fertility level involved a base maintenance fertilizer application of 70 lb/A P_2O_5 and 200 lb/A K_2O (1X) and 140 lb/ A P_2O_5 and 400 lb/A K_2O (2X).

The 2X treatment involved splitting fertilizer applications in two equal parts, half applied in March and half after the second harvest. The most dramatic treatment effect to date has been the general fertility level.

The first two growing seasons have produced yields not attained before in North Carolina tests. This is quite interesting since our experimental site is near the one used by Woodhouse and is on the same soil series, Cecil Clay loam.

The two general fertility treatments in our experiment were somewhat comparable to the two treatments mentioned in Woodhouse's work. The first cutting was taken at late bud stage and subsequent harvests at 30 to 35-day intervals (10-25% bloom).

Five cuttings were made in 1978 and six in 1979. Woodhouse's highest yielding treatment for a single year was about 5 tons/A. Ours was about 8.5 tons/A dry forage. The use of a disease resistant variety with rapid growth traits, ARC, versus the "Oklahoma Common" strain of 30 years ago may explain the yield difference.

The 1X treatment produced very high forage yields. But doubling the rate (2X) gave more than a ton increase based on the 2-year average, shown in Table 1.

TABLE 1. Alfalfa yields under two fertility treatments, Raleigh, NC, 1978 and 1979.

Fertilizer Treatment[1] (lb/A)	5 harvests 1978	6 harvests 1979	Two year average
	lb/A of dry forage[2]		
70 P_2O_5, 200 K_2O (1X)	14,010	14,087	14,049
140 P_2O_5, 400 K_2O (2X)	15,523	17,330	16,427
2X - 1X (Difference)	1,513	3,243	2,378

[1]Both 1X and 2X treatments received 70 lb/A P_2O_5 and 200 lb/A K_2O in March. A second increment was applied to the 2X treatment after the second harvest.

[2]Moisture content of the dry forage ranged from 4 to 7 percent and did not vary within harvests.

The data are limited to two years at one location. And the two years reported, 1978 and 1979, were very favorable growing seasons with good moisture distribution. Further studies with more than two fertilizer rates are needed to determine the annual fertilizer requirements under a high yield system.

If one assumes a per pound cost of 29¢ for P_2O_5, 18¢ for K_2O, $4/A for spreading, and a hay value of $90/ton, the following relationships are evident:

The per acre value of the EXTRA hay produced (assuming good quality) is $107 while the per acre cost of the extra fertilizer applied, including spreading costs, is $60.30.

This means a return over additional fertilizer costs of $46.70 per acre.

Since only two general fertility treatments were tested, 1X and 2X, it is possible the extra ton of hay produced from the 2X treatment could have been obtained with less fertilizer than the 2X amount.

For example, a 2-year average of apparent nutrient removal based on tissue analyses taken from each harvest, shown in Table 2, suggests the amount of P_2O_5 applied to alfalfa receiving the 2X treatment could possibly have been reduced without loss of yield.

TABLE 2. Apparent nutrient removal by alfalfa under two fertility treatments, Raleigh, NC, 1978 and 1979 average.

Fertilizer Treatment (lb/A)	N	P_2O_5	K_2O
		lb/A	
70 P_2O_5, 200 K_2O (1X)	465	103	297
140 P_2O_5, 400 K_2O (2X)	520	113	414

Potash and phosphate removed at the 1X treatment exceeded the P and K applied.

So, it is important to realize that once a cost efficient yield potential has been established, it pays to set yield goals high enough to achieve full profit potential.

It is difficult to predict regional shifts in livestock production. But it appears the Southeast has much potential for increased alfalfa production. **The End.**

Soil Physical Properties For A K Soil Test?

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Montana State University

SOIL SCIENTISTS KNOW most K which reaches a plant root has moved through the soil by diffusion, rather than being carried by flowing water or intercepted by roots.

Plants demand much K. It is quickly absorbed when it reaches the root surface. Diffusion toward the root occurs when the concentration of K is low at the root surface and higher in the rest of the soil solution.

Current K soil test methods are based on chemical extraction procedures. These soil tests are run by mixing a small soil sample with a chemical solution. The mixture is shaken, filtered, and the solution then analyzed for the amount of K removed from the soil sample.

If a high K value is obtained, the predicted response to K fertilizers is low and vice versa. This method is based on correlations between what happens concerning crop response to fertilizer and the amount of K removed from a sample of soil by an extracting agent. It works reasonably well for many of the agricultural regions of the world.

But it does not account for most of the soil properties that may regulate K diffusion rate through the soil. Soil extraction results give an indirect measure of only one of the many factors relating to diffusion. So it should not be surprising to soil scientists when this test fails to work for certain soils or growing conditions.

Figure 1 illustrates these basic aspects of the K-soil-plant system as it relates to soil tests:

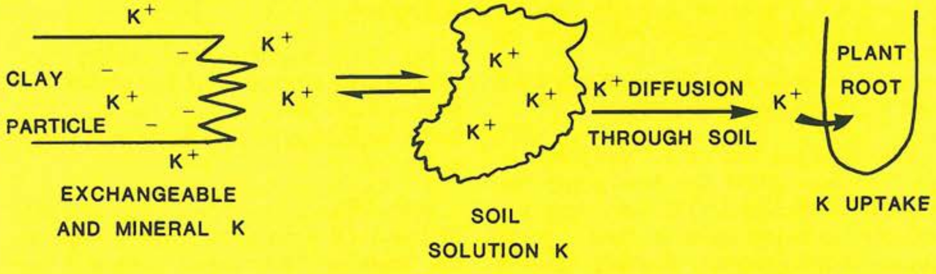


FIGURE 1

TABLE 1. Summary of crop responses to K fertilizers in a balanced N-P-K fertility program. Montana Statewide Study. 1972-1979.

Crop	Production System	No. of experiments	No. with significant* K response	Response frequency	Range of significant* yield increases	Average yield increase	Application rate for most frequent K response
				(%)			(K-lb/A)
Winter Wheat	Dryland	80	39	49	2-12 bu/A	5.3 bu/A	20
Spring Wheat	Dryland	33	10	30	3-13 bu/A	4.5 bu/A	20
Barley (Feed)	Dryland	48	21	44	3-19 bu/A	4.3 bu/A	40
Barley (Malting)	Irrigated	10	7	70	7-16 bu/A	9.2 bu/A	45
Alfalfa Hay	Irrigated	26	14	54	0.3-0.8 T/A	0.5 T/A	75-200
Corn Silage	Irrigated	22	4	18	1.3-4.2 T/A	2.75 T/A	50-100
Potatoes	Irrigated	18	13	72	20-66 CWT/A	25 CWT/A	100-180

*Significant at the 90% confidence level.

Diffusion rate is the major factor regulating K uptake. If K diffusion is limited by low exchangeable and soil solution K, extractable soil K will relate to K availability to plants. If extractable K is high, the rate of diffusion may still be inadequate due to soil or climatic conditions, or very high plant demand. The extractable K soil test method will not work in these cases.

IN MONTANA and the surrounding region, there is evidence indicating that extractable K soil test method does not work.

The data in **Table 1** illustrate the kinds of responses obtained with various crops when K was included in a balanced NPK fertility program. Responses occurred between 20 and 70 percent of the time for various crops since 1972.

Where responses to K fertilizers did occur, yields were greater than 10 percent higher than when only N and P were added. With rates resulting in these responses, the return per dollar of K fertilizer has been greater than $5 of crop value.

This is a very profitable investment when response does occur. We must be able to properly advise a producer about his K fertilizer program.

THE OBVIOUS PROBLEM in this situation is that we were not able to predict when and where the responses to K fertilizer would occur. Almost without exception, the soil test K level (ammonium acetate extractable) was high in these soils.

Also, as many responses occurred on the highest testing soils as on the lowest. Responses occurred on soils testing more than 1,000 lb/A soil test K.

Table 2 shows an example of this situation when we compared the entire range of soil test values with those from only the K response locations. There was no real difference in soil test values that would help point out or separate the responding and non-responding sites.

Considering this, we looked for other ways to determine K diffusion rate in soils. We know that many soil properties influence ion diffusion in soils but we did not know which were influential. We used a complete soil and site characterization as used in a soil survey or classification work.

TABLE 2. Soil test values for 0-6" soil depth from winter wheat sites. Thirty-two sites, Montana statewide study. 1972-1974.

Soil Test Values, K - lb/A			
All sites		K responsive sites	
Range in values	Average	Range in Values	Average
470-1,332	814	610-1,050	806

We also took a long, detailed look at other possible soil test methods, using many different extracting materials and approaches. Most of those reported in the literature were included. No large improvement over the ammonium acetate procedure was found. These results give more indication that diffusion is probably the most important factor to investigate.

We are also studying under controlled laboratory conditions the relationship between K diffusion in soils and plant response to added K (laboratory and growth chamber).

PLANT GROWTH RESPONSE to K could be predicted in these studies, if K diffusion rate were known. Soils throughout Montana and several across the U.S. showed a good relationship.

K diffusion in soil is not easily and rapidly determined. If it were, we could probably develop a very reliable K soil test. It is difficult to get a useful sample. And the diffusion technique is too complicated and time consuming to use in routine soil testing.

Considering this, we looked for other ways to determine K diffusion rate in soils. We know that many soil properties influence ion diffusion in soils but we did not know which were influential. We used a complete soil and site characterization as used in a soil survey or classification work.

SEVERAL LABORATORY ANALYSES were included. We studied the entire soil depth, layer by layer. Each value was encoded into a computer. We identified those factors most closely related to crop response with K fertilization.

This was done for 18 sites, scattered over the state during two growing seasons, using winter wheat as the test crop.

1. AVERAGE ANNUAL SOIL TEMPERATURE (at 20-inch soil depth) was the factor showing the best relationship to K response. Warmer soils provided larger yield responses. Warmer temperatures are also known to increase diffusion rates, suggesting added K could more readily move to plant roots in these soils.

2. SOIL "CONSISTENCE" WAS NEXT IN IMPORTANCE. This is a soil classification characteristic that refers to the "strength" of soil structural units (peds). As the amount of force required to break a ped increases, it is given a higher consistence rating.

This property probably showed so much importance because it relates closely to amount and type of clay, size and shape of pores, soil density, organic matter, and other physical properties that also influence diffusion.

Because it includes several such factors, it showed up as being more important than any of the individual factors themselves, such as amount or type of clay.

3. AMOUNT OF CLAY IN THE LIME ACCUMULATION ZONE OF THE SOIL was the third most important factor in this analysis. Both clay and Ca (from the lime) would influence diffusion of K.

Several other factors were shown to have a significant influence on crop response to K fertilizers. But using only these three most important factors, we could account for 88 percent of the variation in yield response.

This compares with only 40 percent accountability when the best soil test extraction procedure was used.

THE MAJOR POINT from these results is that the most important factors—those best related to variation in yield response from K fertilizers—are physical soil characteristics.

Factors put into the computer included many chemical properties: Extractable K, ratios of K to Ca and Mg, proportion of the soil exchange capacity occupied by K, and others.

These factors were much less important and contributed only a small amount to explaining why yield responses varied from site to site.

Extractable Ca in the surface soil actually appeared to be more important in this regard than extractable K.

THESE RESULTS SUGGEST we may be on the right track in developing a better approach to predicting crop response to K fertilizers in this region. We are expanding our research effort to gather more information from many more sites and crops over several growing seasons.

This process is being greatly speeded up by utilizing field sites where experiments were conducted during the past eight years. Because we are studying physical soil properties, they probably have not changed since the year when the field trial was conducted.

By relocating each site, the soil can be characterized and the needed data obtained. The crop response information is already available from the experiment. In this manner, we are collecting data from more than 150 sites and for several crops. We hope to telescope eight years of field research into two years.

THE PROCESS OF COMPUTERIZING data and using it to identify factors best related to crop response from K will be repeated.

With this number of years, sites, and crops, we should be able to develop the first steps in the system to predict crop response to K on high K soils. If it works, only limited information will be needed to predict a farmer's yield response probability.

The system will have to be refined through research. Such research can determine how much K to apply for each soil and crop, when and how often to apply, best fertilizer management methods, and more.

We are also studying, under controlled laboratory conditions, how and why certain important physical properties and different soils themselves, relate to ion diffusion in the soil. These studies should help explain some of the unknowns in this system.

Hopefully, we have laid the groundwork for a much improved K soil test approach. A soil test based on "functional" or "cause-and-effect" relationships between soil physical properties and nutrient availability should provide greater reliability than those based almost entirely on correlations with amounts of nutrients removed with an extracting solution. **The End.**

Higher Soybean Yields Mean Higher PROFIT$

RISING INFLATION and narrowing profit margins force farmers to base decisions mostly on economics rather than on preference or convenience.

What is the best way to beat rising costs?

The only way is to increase yields per acre. The farmer must spend more per acre. But production cost per bushel drops and profit per acre increases (Table 1).

Table 1. Production cost per bushel decreases and profits per acre increase with higher yields.*

	Soybeans—Bu/A			
	30	40	50	60
Fixed costs $/A	$211	$211	$211	$211
Variable costs $/A	56	64	73	83
Total $/A	267	275	284	294
Cost per bu	$ 8.90	$ 6.88	$ 5.68	$ 4.90
Profit/A, $7.50 beans	—$42.00	$25.00	$91.00	$156.00

*University of Illinois. Fixed costs include $110/A for land. In other areas it may be as much as $50 less, but the principle remains the same.

Why does the production cost per bushel drop?

Fixed costs are the same for 30 bu and for 60 bu, shown in Table 1. It costs the same to plow or plant a field for both yields. Land taxes are the same. Variable costs such as fertilizer, seed, and harvesting increase, **but not as much as the value of the increased yields.**

What does this look like on a total farm basis?

Let's look at 300 acres of soybeans. Table 2 shows how most of the production cost occurred with the lower yield. By spending an extra $8,100, only a 10% increase in investment, the farmer made $46,800 rather than losing $12,600.

Table 2. With higher yields profits increase faster than costs.

Yield Bu/A	Would spend on 300 acres	To make
30	$80,100	—$12,600
40	82,500	7,500
50	85,200	27,300
60	88,200	46,800

Are there better production practices which cost little or nothing?

Many. Timeliness is the most important. It doesn't cost any more to plant May 5 to May 10 rather than June 1 . . . to have your planter ready a few days ahead of time . . . to kill weeds at the right time . . . to plant the best variety . . . to adjust combine. These practices and others could mean an extra 5 to 20 bushels per acre at little or no extra cost.

Look at Louisiana. A May 17 planting gave 50 bu/A and June 15 gave 33 bu—or an extra return of 17 bu and about $130/A. Also, rows narrower than 30 inches will increase yields in most areas. As a planter or drill is worn out or replaced, the extra cost for narrower rows is not large.

Does fertilizer play an important role?

It certainly does on most soils. Consider the estimated removal in the grain of a 60-bushel crop:

	N	P_2O_5	K_2O	Mg	S
			...........Lb/A..........		
60 bu-in grain	240	48	84	17	12
In stover	84	16	56	10	13

Positive interactions often occur when good practices are combined into a complete production program. On this soil, P alone gave no response and K alone 14 bu. But P and K together increased yield 27 bu, shown in Table 3.

Again, note the effect of higher yields on decreasing the production cost/bu even though higher input costs were required. Soil test to see where you are. Lime acid soils.

Table 3. P and K together boost yields and profits.

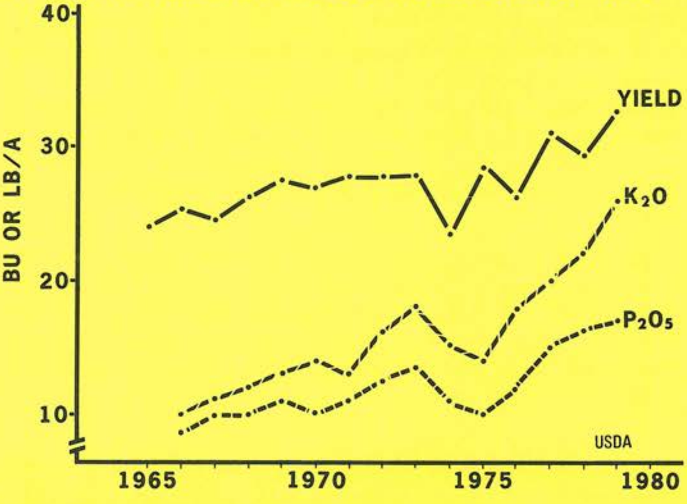
Lb/A	Yield Bu/A	Production Cost* $/A	Production Cost* $/Bu	Net Profit $/A
Check	31	$200	$6.45	$ 33.00
120 lb P_2O_5	30	236	7.86	−11.00
120 lb K_2O	45	220	4.88	118.00
120 lb P_2O_5 + 120 lb K_2O	58	260	4.48	175.00

*$7.50 soybeans, 30¢ P_2O_5, 13¢ K_2O, 30¢/bu for extra yield harvested. Medium P, low K soil, Virginia.

What about production costs in the years ahead?

Trends in the 1970's in Illinois were extrapolated to 1989. If we assume about the same inflation and rising costs, the cost to produce an acre of soybeans in 1989 would be $517 compared to $288 in 1979.

SOYBEAN YIELD & P-K USE ARE RELATED · U.S.



If soybeans were $11/bu, what would be the breakeven yield to meet a $517/A cost?

47 bu/A. Obviously higher yields and hopefully higher prices must be a part of future planning. Higher profits are closely related to higher yields. Higher soybean yields mean higher profits.

What is the U. S. yield potential?

It is large. And the maximum economic yield will vary with every area. Dr. David Dibb of PPI assumed application of today's best production practices on every acre and a good year.

Yield potential bu/A	% of U. S. soybean land
70	10
60	20
50	25
40	25
30	20

The average yield could be 48 bu/A but the highest yield has been only 32 bushels. If it is assumed that half the acreage had a bad year and production was cut one-half, the average yield would still be 36 bu/A—still higher than the best U. S. yield.

What kind of yield goals should I set?

How about an increase of 20% in your overall farm average and 40% for your best field over the next 5 years. Establish a high yield area. Select 10 acres, or part of a field, and rotate with another high yielding crop like corn or cotton. Apply the latest technology for at least 6 years:

Two or more varieties . . . appropriate tillage . . . proper lime level . . . soils built to high level in P and K maintained . . . other nutrients as needed . . . proper spacing and population . . . planting on time . . . pest control (no compromises) . . . careful harvest . . . **calculate economics.**

Then adopt the best practices on your other fields.

What is the key to survival?

Increased productivity! Dr. Roy Flannery, researcher in New Jersey, produced 94 bu/A soybeans in 1980. Net returns in this study are in the \$300 to \$400/A range.

While you will not be getting this kind of yield for a while, the way to start on the upward road is through a systematic approach. Your methods will change from time to time because it is a dynamic system.

Be a smart marketer. Get help from an expert and figure your costs. Get help from a marketing expert and lock in a profit. **The End.**

FOLDER REPRINTS AVAILABLE

HIGH K HELPS ALFALFA SURVIVE WINTER

Adequate potassium fertilization enables alfalfa to store greater food reserves in the fall. As a result, plants are able to survive lower winter temperatures.

Professor Robert S. Fulkerson of the crop science department, Ontario Agricultural College, has demonstrated the effect of temperature on plant survival. Note how the percent of plants surviving and the number of stems per plant rise dramatically with higher levels of potassium fertilization.

With good snow cover, soil temperatures seldom drop to 25°, even near the surface. At 25°, however, significant improvement in survival can be obtained.

Measurement	Aug. application	Root temperature		
		25°	15°	5°
	(lb/A K_2O)			
Plant survival (%)	0	73	56	0
	100	97	60	0
	200	90	80	25
	300	97	80	33
	0	2.8	1.9	0
	100	3.4	2.6	0
	200	3.8	3.0	1.3
	300	4.3	3.8	1.8

Apply potassium after the last harvest prior to the fall rest period.

Aluminum Is Linked To Grass Tetany

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GRASS TETANY is a disorder of ruminant animals occurring when their blood serum is low in magnesium.

It is estimated that 1 to 3 percent of the ruminate animals in the temperate regions of the world die annually from clinical tetany. But individual herds may suffer 25 percent or more deaths.

Subclinical tetany levels that go undetected have an even greater potential for reducing animal productivity by reducing milk production and rate of gain.

Grass tetany most frequently affects mature females during late pregnancy and early lactation when Mg requirements are high.

Researchers in the Netherlands and other areas of the world observed tetany is most common under very wet conditions, especially about 5 days after cold periods when grass grows rapidly. Tetany generally occurs in late winter to early spring. But it may occur in autumn if proper climatic conditions develop.

THE BASIC CONDITION causing tetany is a deficiency of available Mg in the ruminant diet. Some soils have low available Mg levels. This causes the forage crops to contain less Mg than the animals require—0.2 percent.

In other cases, the diet appears to contain adequate Mg, but tetany develops from an apparent lack of Mg utilization by the animal.

In 1977, Louisiana State University started to study mineral imbalances associated with individual grass tetany cases. Soil and forage samples were collected from several sites within each pasture where veterinarians diagnosed grass tetany.

When animals died, undigested forage was taken from the rumen of the dead animals. Samples were also collected from the rumen contents of several fistulated, non-tetany animals on various forage diets.

Sample analyses indicated forages from all tetany-producing pastures contained unusually high aluminum levels at various locations in the pasture. **Table 1** shows analyses for samples within each pasture that contained the highest and lowest Al levels.

In only one case (pasture 6) was the highest detected Al concentration less than 1250 ppm. Most values were in the 2,000-8,000 ppm range. Forage Al concentrations varied greatly, frequently within short distances, within the pastures.

This meant high Al concentrations occurred in spots rather than being evenly distributed across the pasture.

In three pastures, Mn concentrations exceeded 500 ppm, a level considered high for ruminant diets. Concentrations of Mg were generally below 0.2 percent, the level considered critical for

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Dr. Allen is now Assistant Professor of Agronomy at VPI in Blacksburg, Va. Dr. Robinson is with the LSU Agronomy Department. Dr. Hembry is in the LSU Animal Science Department.

TABLE 1. Aluminum and manganese concentrations in forage samples from grass tetany pastures in Louisiana, 1977-1979.

Pasture No.	Sample No.*	Date	Al	Mn	Pasture No.	Sample No.	Date	Al	Mn
			——ppm——					——ppm——	
1	1	2/03/77	4,140	240	7	1	2/09/78	5,960	135
	2		3,050	270		2		720	84
2	1	2/05/77	2,200	1,840	8	1	2/15/78	6,170	248
	2		980	380		2		3,730	522
3	1	2/06/77	1,730	120	9	1	2/19/78	6,780	242
	2		720	170		2		1,840	396
4	1	2/09/77	1,620	120	10	1	2/23/78	4,410	741
	2		840	110		2		1,620	665
5	1	3/25/77	1,250	180	11	1	1/25/79	14,500	140
	2		250	190		2		390	80
6	1	1/24/78	450	382	12**	1	6/79	8,020	180
	2		60	243		2		90	340

*Sample No. 1 and 2 represent samples with the highest and lowest Al values, respectively, found in each pasture.

**Forage at this location was fed as hay rather than grazed pasture.

developing grass tetany. But three pastures contained forages with much greater than 0.2 percent Mg.

The observed values of other minerals were not unusual for many winter pasture grasses. Potassium concentrations were generally below 3 percent, with only one location approaching 5 percent.

SOIL TESTING data did not help much in explaining differences in mineral concentrations in the forage. Soil pH values at the site of highest Al concentration in each pasture ranged from 5.1 to 7.3 and were not significantly correlated with forage Al concentrations. No exchangeable Al was detected in any of the soils tested.

Rumen content samples taken from tetany animals average 2,373, ppm Al. Samples from non-tetany animals averaged 405 ppm. See **Table 2.**

Aluminum concentrations ranged from 1,630 to 3,390 ppm in tetany animals and from 330 to 510 ppm in non-tetany animals.

Manganese concentrations in the rumen content samples averaged 306 ppm in the tetany animals, 139 ppm in the non-tetany animals.

TABLE 2. Aluminum and manganese concentrations in rumen content samples from tetany and non-tetany animals in Louisiana, 1977-1979.

Tetany Animals	Date	Al	Mn	Non-tetany Animals	Date	Al	Mn
		——ppm——				——ppm——	
1	2/03/77	2,570	420	A	12/77	510	65
2	2/21/78	2,350	390	B	10/09/78	330	120
3	2/22/78	3,390	425	C	10/31/78	440	40
4	2/24/78	2,360	442	D	11/28/78	410	20
5	1/19/79	1,940	50	E	12/26/78	420	170
6*	1/79	1,630	110	F	12/26/78	390	170
				G	12/26/78	330	280
				H	12/26/78	410	250
Mean		2,373	306			405	139

*Sample from Tennessee

But some of the non-tetany animals contained higher Mn concentrations than some tetany animals. Concentrations of Ca, Mg, P, K, and Zn in the two groups of animals were very similar.

An **in vitro** study showed additions of Al and Mn effectively reduced the solubilities of Mg and Ca during a 48-hour digestion period. See **Table 3.**

TABLE 3. Al and Mn effects on Mg and Ca solubilities after in vitro digestion for 48 hours.

Treatment	Mg	Ca
	——ppm——	
Control	35.5	20.7
1,000 ppm Mn	22.2	12.0
2,000 ppm Mn	21.5	11.0
4,000 ppm Al	18.9	7.5
1,000 ppm Mn + 4,000 ppm Al	18.7	7.1
8,000 ppm Al	15.7	5.4
2,000 ppm Mn + 8,000 ppm Al	15.8	4.8

Adding 1,000 and 2,000 ppm Mn (dry matter basis) significantly reduced Mg and Ca concentrations in the digestion medium. But Al additions of 4,000 and 8,000 ppm reduced soluble Mg and Ca more effectively than the Mn additions did.

Adding Al and Mn in combination did not reduce Mg and Ca solubilities significantly more than Al alone. Adding 4,000 ppm Al, a level well within the range of concentrations found in forages in tetany-producing pastures, reduced Mg solubilities 47 percent, Ca solubilities 64 percent.

A FEEDING STUDY was conducted to determine the influence of ingested Mn and A1 on the blood serum Mg levels of steers.

Manganese and/or Al solutions were administered daily for four consecutive days via rumen fistula directly into the ventral sac of the rumen. Treatment levels included 2,000 ppm Mn, 4,000 ppm Al, and 2,000 ppm plus 4,000 ppm Al, calculated as ppm of daily feed allotment.

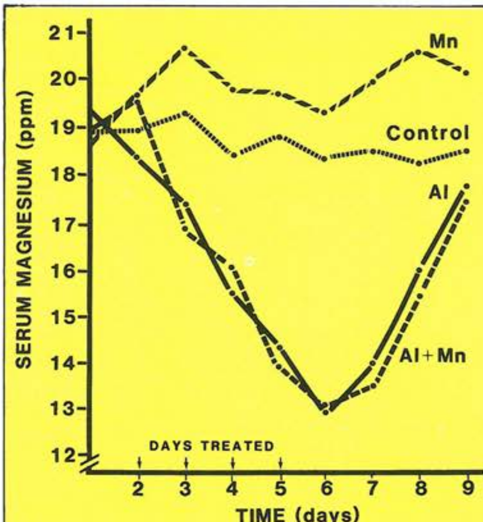

FIGURE 1

Figure 1 shows Al additions to the rumen very effectively reduced blood serum Mg levels within 24 hours. During the 4-day treatment period, serum Mg levels declined by 32 percent but began a rapid return to normal within 24 hours after treatments were terminated.

Three days later the Al-treated steers were not significantly different from control steers. The influence of Al on serum Mg was the same with and without Mn additions.

IN SUMMARY. Based on the observations made in actual grass tetany cases and the results of the **in vitro** and **in vivo** studies, we believe Al is actively involved in the etiology of grass tetany.

It appears that Al depresses Mg available to the animal at least partially by decreasing Mg solubility in the rumen. Further research is needed to determine whether there are additional effects in the animal that further depress Mg utilization.

We also need further study into the exact conditions and mechanisms which cause high Al concentrations in the forage. **The End.**

FOUNDATION FOR AGRONOMIC RESEARCH

In 1935, the American Potash Institute was founded and began its support for research and education and the training of graduate students in soil fertility.

In 1977, the Institute was expanded to include phosphate and became the Potash & Phosphate Institute (PPI). This has meant an enlargement of the Institute and an increase in funds available for supporting projects relating to P and K.

Sound P and K market expansion has become increasingly important in reaching yield levels that help farmers realize more profitable returns. However, further significant progress depends on farmers doing a better job of integrating all production inputs into a total crop management system. Farmers need new ways to utilize optimum levels of production inputs to maximize returns.

That's the job for researchers . . . to find through maximum yield research the best combination of all production factors and to fit them into a system that generates maximum economic yields and profits to the farmer.

In stressing maximum yield research, a multi-disciplinary approach is necessary in order to encompass such production inputs as soil pH, nitrogen, potassium, phosphorus, secondary and micronutrients, quality germ plasm, plant population, date of planting, tillage practices, control of insect and disease pests, and water management.

To strengthen much needed support for the "total package" concept, the Foundation for Agronomic Research (FAR) was launched in 1980. It is an independent corporation, but closely linked to the Potash & Phosphate Institute. The new Foundation will serve as a focal point for the many and varied interests concerned with increasing farmer yields and with maintaining a strong capability for sustained food and fiber production at reasonable costs. **All segments of the fertilizer industry as well as seed companies, pesticide and farm equipment industries have much at stake.**

WHY NOW?

- Because world food inventories are low and needs are accelerating. World population is projected to increase by at least 40 percent by the year 2000.
- Because of the need to strengthen research efforts at a time when public support for crop production and soil fertility research is declining.
- Because increasing yields per acre lower unit costs, they offer the best solution to farmers' rapidly rising production costs.
- Because of the need to encourage research efforts that involve interactions of all disciplines relating to increased crop yields — soils and soil fertility, insect and disease control, plant breeding, crop management, planting and tillage practices and others.
- Because of the need to focus support from the several agricultural industries to strengthen research and education efforts. This will provide much greater impact than a fragmented approach of corporations or individuals acting independently.
- Because dollars contributed through the Foundation approach will support research that is most meaningful to the total agricultural industry in helping to solve one of the world's most vexing problems—the worsening state of hunger and starvation.

WHAT IS THE FOUNDATION?

The Foundation is organized as a non-profit, tax exempt corporation exclusively for scientific and educational purposes. All activities sponsored or conducted by the Foundation are in the public interest and results are available to the public.

The primary purpose of the Foundation is to sponsor agronomic and related research on:

- **Maximum crop yield systems, including the efficient use of energy and fertilizers.**
- **Cropping systems for maximizing biomass production.**
- **Reduced tillage and crop residue management to maintain or improve soil quality and the environment in high yield agriculture.**
- **Interactions of plant nutrients, germ plasm, pest control, water relations, and other factors in reaching upper limits of plant growth.**
- **Implementing maximum yield research results to help farmers achieve maximum economic yields.**

The Foundation funds such broad based research in the U.S. and other countries. Support includes research grants to universities and other research agencies; faculty study grants; support to conferences, symposia, special studies and surveys and to persons, corporations and government bodies engaged in research and education.

WHO CONTRIBUTES?

Industry, government, associations, foundations, and private individuals are encouraged to participate in funding the Foundation. Such contributions are tax deductible to the donor. **All contributions are welcome regardless of size. It is suggested that companies or corporations consider annual gifts ranging from $10,000 to $100,000 or more, depending on their size and their share of the food production input market. Commitments for a minimum of three to five years are desirable because of the need for continuity of research support.**

Progress reports will be provided for contributors. Lists of donors will be published periodically.

EARLY UNSOLICITED CONTRIBUTORS

- **Agrico Chemical Company**
  $70,000 x 3 yrs. . . **$210,000**
- **Chemical Enterprises, Inc.**
  $10,000 x 5 yrs. . . **$ 50,000**
- **International Minerals & Chemical Corp.**
  $70,000 x 3 yrs. . . **$210,000**
- **Kalium Chemicals — PPG Industries, Inc.**
  $33,333 x 3 yrs. . . **$100,000**
- **Potash Corporation of Saskatchewan**
  $100,000 x 3 yrs. . . **$300,000**
- **Sulphur Institute**
  $16,667 x 3 yrs. . . **$ 50,000**
- **Texasgulf Inc.**
  $70,000 x 3 yrs. . . **$210,000**

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Seeding Date And Response To Phosphorus In Northwest Saskatchewan

W. EARLE JOHNSON
Regina, Saskatchewan

RESEARCH WORK in Saskatchewan has shown crops sometimes respond to phosphorus on soils testing moderately high in available phosphorus.

It happens when crops are seeded early in low-temperature soils. Response is not shown when seeding is done later. Other research has shown low soil temperatures reduce the availability of soil phosphorus.

Luvisolic (gray-wooded) soils in northwestern Saskatchewan are located in a region of short growing seasons. The frost-free period averages well under 100 days.

TABLE 1. Spring Wheat Yields and Response to Phosphorus at 4 Seeding Dates

Seeding Date			Yield bu/A	Increase From 20 Lbs. P_2O_5/Acre bu/A
Early	First	Check	22.2	
		Fertilized	28.8	6.6
	Second	Check	22.1	
		Fertilized	26.0	3.9
	Third	Check	17.9	
		Fertilized	20.3	2.4
Late	Fourth	Check	12.2	
		Fertilized	15.7	3.5

Research work by Agriculture Canada on a luvisolic soil shows crop response to phosphorus is good with early seeding. As seeding date advances, crop yields and response to phosphorus are reduced.

Table 1 shows the response of spring wheat to in-row applications of 40 lbs of 11-48-0 monoammonium phosphate per acre at four seeding dates.

Both yield and response to applied phosphorus were reduced almost 50 percent by the fourth seeding date. This happened in a year of below average rainfall. Early seeding with adequate phosphorus sometimes cushions the crop against drought.

FURTHER DATA were obtained for several seeding approaches. Delayed seeding is frequently used by farmers to improve cultural weed control. **Table 2** shows average yields and increases in wheat yield for seeding about as early as land was fit, and for delayed seeding. The same rate of P (40 lb/A of 11-48-0) was drilled in at planting time.

The fertilizer applied at the early seeding date, using surface tillage and plough-pack operation, increased yields 4.7 and 6.7 bu/A over early seeding without fertilizer.

TABLE 2. Average Spring Wheat Yields and Response to Phosphorus, Northwest Saskatchewan

	Yield bu/A	Increase or Decrease From Check bu/A
Early Tillage and Seed No fertilizer (check)	30.2	—
Early Tillage, Delay Seeding Fertilized	28.9	−1.3
Early Tillage, Delay Seeding Fertilized, Harrowed	29.4	−0.8
Plough, Pack, Seed, Fertilized	36.9	+6.7
Early Tillage, Seed, Fertilized	34.9	+4.7

On both treatments where seeding was delayed, yields with fertilizer were actually slightly below that for early seeding without fertilizer.

This luvisolic soil is low in organic matter, slightly acid, and characterized by a dense subsoil. The soil has poor physical condition. And the slightly higher yields on plough-pack are probably due to some improvement in tilth.

FIELD OBSERVATION shows a relatively high percentage of moisture evaporation from the soil surface. Early seeding and phosphate fertilizer establish an earlier, better crop canopy to reduce evaporation.

Late frosts occur rather frequently. Phosphate application helps crops resist and recover from frost.

Earlier assessment of bicarbonate extractable phosphorus in soil testing showed gleysolic (imperfectly drained) soils testing moderately high in phosphorus. But they still responded to moderately high phosphorus applications.

The same response with low soil temperature may have occurred.

The luvisolic soils also have other characteristics similar to gleysolic soils. Iron and aluminum are more involved in phosphorus fixation than calcium which characterizes chernozemic soils.

The fixation by iron may increase as the soil dries and aeration improves. Luvisolic soils show pseudo-gley characteristics. There may be less phosphorus fixation in early spring while the soil is moist.

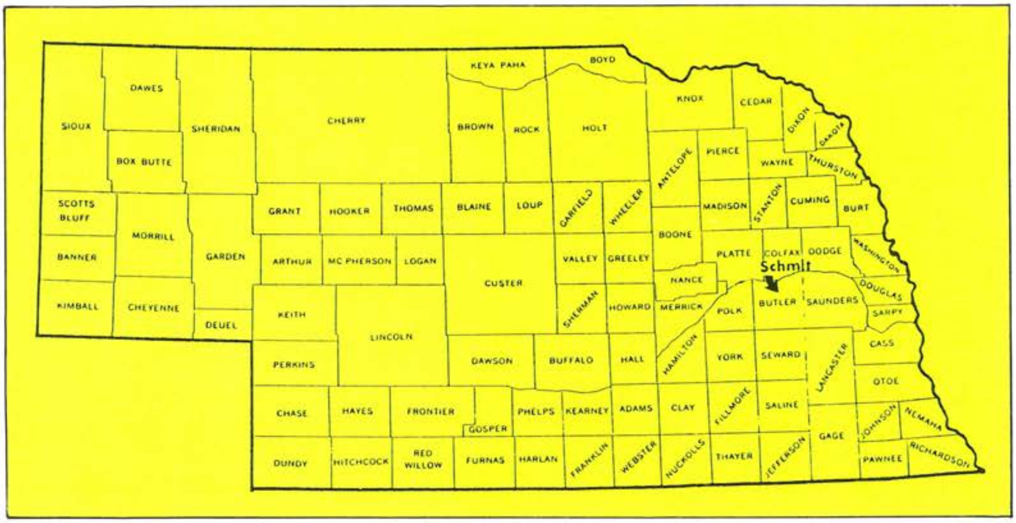
BICARBONATE EXTRACTABLE PHOSPHORUS is a good general guideline to phosphorus requirements. But rate may not be well assessed on this soil. The much higher response to phosphorus at early seeding dates on this soil becomes important in making recommendations.

Soil testing services in Saskatchewan estimate the expected yield increase from a rate of phosphorus application. The results in northwestern Saskatchewan on this luvisolic soil indicate expected yield increases will occur only when seeding is early.

Capability for seeding early may be improved where legumes are used in the crop rotation on this soil. Workability at higher moisture content is improved.

On dark-gray to gray soils in northeastern Saskatchewan some years ago, farmers frequently reported satisfactory response to phosphorus occurred only where legumes (alfalfa and sweetclover) were used in rotation.

Internal drainage is improved and earlier tillage and seeding are possible. **The End.**



Maximum Yields Lead To Profit In Nebraska

GERALD SCHMIT, sons Bruce and Brent and nephew Jeff of Bellwood, Nebraska, decided about 7 years ago a farm-wide average of 140 bu/A just wasn't the way to make money on irrigated corn.

The Schmit farm is labeled Schmit Brothers. It is located in the Platte River Valley, 8 miles south of Columbus, 2 miles east of U.S. 81.

Soils are mostly sandy loams. Some fields have higher clay contents and higher cation exchange capacity. All irrigation is from wells, mostly gated pipe (36 inch) with one center pivot and some tow-line.

Several years ago the Schmits began working closely with their fertilizer supplier. Their fertilizer manager was Virgil Gellerman of Farmers Coop Grain Company of Columbus.

They all looked over the records together. Then they decided to start a field-by-field soil testing program. They wanted to determine just what their nutrient inventories were. They also wanted to shoot for yields many would consider out of sight.

THEY ESTABLISHED a 300 bushel per acre challenge field—40 acres. They wanted to see what would happen with high populations and high nutrient rates. This doesn't mean the whole farm didn't undergo some dramatic changes in management level.

No wait and see here. Improved practices were the rule all over.

With coarse textured soils on most of the fields, limited tillage is the rule. Some fields are chiseled and disked. This depends on amount of surface residue. Good residue management helps reduce wind erosion. It also helps conserve moisture, so critical in the early growth stages before irrigation.

Surface residue from extra good plant growth can be a problem. Their planting system involves a Buffalo minimum-till flex planter with White air units. Cutting tillage costs was one of the goals in their improved management program.

FULL SEASON HYBRIDS are used by the Schmits. Planting starts around the last of April, preferably the week of the 20th. Normally, planting is completed by May 10.

Populations are high—around 24,000-28,000 plants per acre and ranging up to 47,000 on some of the 300 bushel per acre challenge area in 1980. That's a change from 1979 when 41,000 was the high population on the experimental area.

Their thrust toward higher yields has changed the Schmit fertilizer program dramatically, too.

In 1977, their challenge field received 273 lb N, 90 lb P_2O_5, 78 lb K_2O, 11 lb S, 9 lb Mg, and 4 lb Zn per acre.

In 1979, the 300 bushel challenge field received preplant applications of 68 lb N, 132 lb P_2O_5, 202 lb K_2O, 71 lb S, 18 lb Mg, and 14 lb Mn.

A starter application of 100 lb of 7-21-7 with Zn was followed by 60 lb of N as a nitrogen solution combination with Dual/Aatrex. Ammonia was sidedressed twice—150 and 120 lb N per acre. Actually the highest yield area, 311 bushels, received an additional 120 lbs of N in a third ammonia sidedressing, a whopping 525 lb of N per acre in that area.

Table 1 gives some idea of the overall fertilizer program in 1979. **Table 2** shows how higher 1979 yields were associated with high nutrient applications. This is not to say other management factors weren't changed simultaneously. But it's interesting to note the trend.

Soil test values from the high yield challenge field have been increasing. Phosphorus tests are up noticeably. High residual nitrate in the fall of 1980 indicates that lower yields in 1980 were not using all the applied N.

THE IMPORTANT TRENDS from Schmit's innovations are the way higher yields increased net returns per acre to land, labor, and management. **Table 3** shows how net returns improved in 1979 with higher yields.

TABLE 1. 300 bushel challenge area—Schmit Fertilizer program

Nutrient	1977	1978	1979	1980
		lb/A		
N	273	387	405	401
P_2O_5	90	125	153	86
K_2O	78	115	209	149
S	11	60	71	28
Mg	9	18	18	18
Zn	4.5	4	0	1.5
Mn	0	5.6	14	0
Yield, bu/A		255	285	240

TABLE 2. Fertilizer program on farm, individual fields, Schmit (1979)

Nutrient	190 bu/A	285 bu/A	311 bu/A
N	246	405	525
P_2O_5	64	153	153
K_2O	83	209	209
S	27	71	71
Mg	12	18	18
Zn	4	0	0
Mn	3	14	14

TABLE 3. Economics—Schmit (1979)

Yield bu/A	Fertilizer cost $/A	Net Return $/A
190	58.03	262
230	68.00	317
285	105.70	389
311	116.50	446

TABLE 4. Effects of high yields on corn production costs—Schmit (1979)

Source	Yield bu/A	Production cost $/A	Production cost $/bu
Central NE	130	284.63	2.19
Schmit	190	329.06	1.73
Schmit	230	339.03	1.47
Schmit	285	376.93	1.32
Schmit	311	387.53	1.25

Nebraska land cost $66/A/yr.Schmit land cost $150/A/yr.

The farm-wide program was successful—190 bu/A or 36 percent increase over the former 140 bu/A average. That 190 bushels included one quarter-section that was dryland.

The 190 bu/A yield produced a net return of $262 to land, labor, and management. In 1979, the high yield challenge field averaged 285 bushels per acre for a net of $389 per acre. One area in that field was scale checked at 311 bushels per acre for a net of $446. Even that wasn't tops.

Gerald recalls, "I was getting tired of taking all that corn to the scales. While the boys were gone with the last load we weighed, I had to stop the combine even further out in the field with the next round indicating even higher yields."

Just how successful were the Schmits in 1979? **Table 4** compares the University of Nebraska crop production costs projections for central Nebraska with the Schmit operation.

Production costs for that region for 130 bushel corn (adjusted to exclude labor for comparison to Schmit records) show a total of $284.63 per acre **—or $2.19 per bushel.**

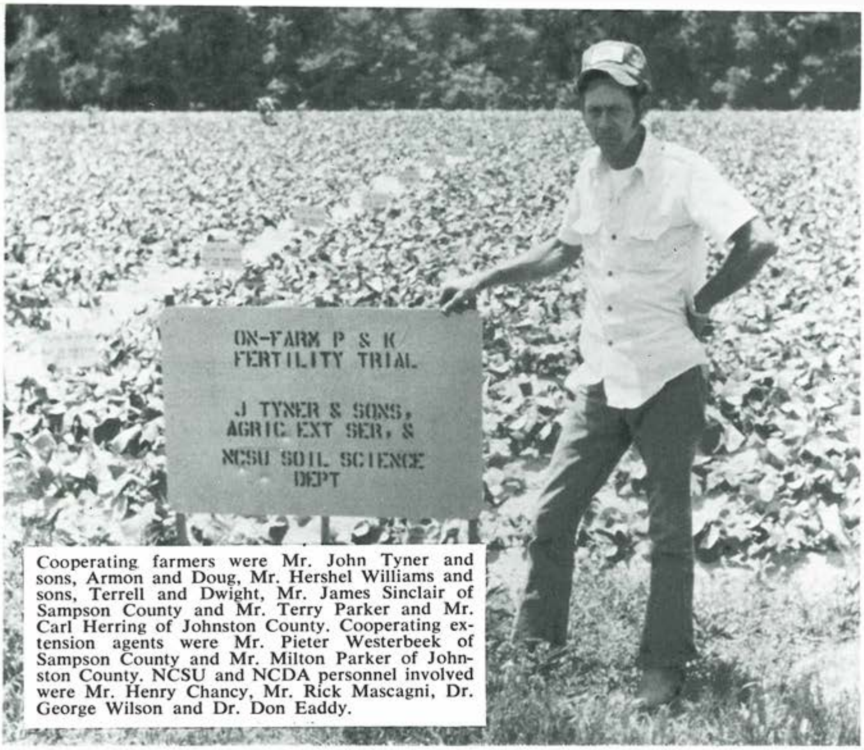
Schmit's farm average (190 bu/A with costs adjusted to contain $150 per acre land charge) was $329.06 per acre**—or $1.73 per bushel.**

When the yields soared to 311 bu/A, the per acre costs were $387.53. But look at the production costs—**a low $1.25 per bushel!** That's a 94 cent per bushel difference.

The 1980 yields were substantially lower in the whole region due to extreme heat stress in July and August. Yields topped out at 240 bu/A, about twice the average for irrigated corn in Nebraska.

Extremely high populations (41,000 to 47,000 ppa) proved to be less effective than 28,000 ppa in the heat stress of 1980. Even with 15 percent inflation in production costs, unit production costs were around $1.62 in 1980, a healthy margin for profit.

Gerald, Bruce, Brent, and Jeff Schmit are a research organization in their own right. We can all learn from their successes or failures. We'll keep a close eye on what happens. **The End.**



The on-farm potash and phosphate sweet potato trial managed by Mr. Armon Tyner of Sampson County.

Improve Sweet Potato Yields With Adequate Potash Fertilization Based On Soil Testing

JOHN J. NICHOLAIDES III
North Carolina State University

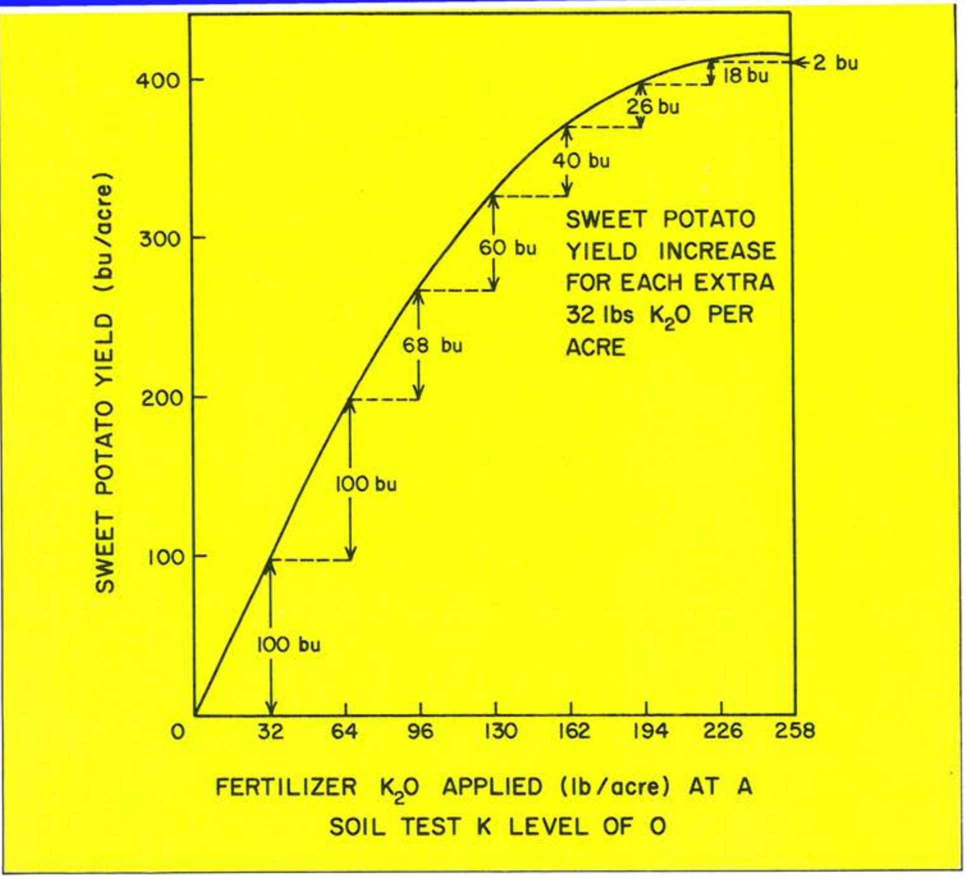
SWEET POTATO FARMERS may be able to improve their yields substantially with adequate potash fertilization based on soil testing.

The results of a three-year study, partially funded by the Rainbow Division of IMC and conducted by North Carolina State University (NCSU) scientists, showed that when the soil test K level was less than 133 lb/A K_2O (0.16 meq K/100 cc soil), there was a need for more potash fertilization than was being recommended to produce maximum and economical yields.

Potash recommendations for sweet potatoes have been increased by North Carolina's Department of Agriculture (NCDA) based on the results of this study.

North Carolina farmers produced nearly 37 percent of the U.S. sweet potato crop in 1979 for a value of approximately $34,000,000. This crop yielded 250 bu/A, 15 percent better than the U.S. average.

Yields are higher due to a combination of factors, among which are favorable climate and soils, use of the



Jewel variety, good farm management and perhaps better fertilization practices.

During 1973 and 1974 when fertilizer prices increased markedly, sweet potato farmers began to question (1) whether they should be using more nutrients than suggested by NCDA and (2) whether the more expensive sulfate of potash in 8-0-24, widely used for lay-by fertilization, was necessary.

A THREE-YEAR STUDY from 1976-1978 on sandy-surface Wagram and Norfolk soils on five farms in two eastern North Carolina counties, Johnston and Sampson, was conducted to determine effects of K fertilization rate on sweet potato yield and quality.

The study was also designed to determine whether the less expensive muriate of potash produced yields and quality different from the sulfate source.

More than 54 percent of soils sampled for sweet potato production in North Carolina tested very low to low in exchangeable K (less than 0.10 meq K/100 cc soil, which is equal to 84 lb/A K_2O). **The findings of this study, therefore, are pertinent to the majority of soils for sweet potato production in North Carolina,** and possibly in other states.

The farmers managed the trials, except for researcher-applied fertilization. Both potash sources were applied at 5 rates in each trial, one-fifth at planting, remainder at lay-by, with blanket N and P fertilization at the recommended rates.

Potassium rates were according to soil tests and were set to have the NCDA recommended rate fall between the third and fourth fertilization rates. Jewel was the variety evaluated in four trials, with Centennial in the fifth.

NO YIELD, GRADE OR QUALITY ADVANTAGE of the sulfate source over the muriate source of potash was found. In fact, in the two trials conducted in 1978 the average sweet potato yields over all K rates were 300 bushels per acre for both muriate and sulfate sources.

This lack of sweet potato response to the sulfate source of potash on these soils could be due to the fact that sweet potato farmers are also tobacco farmers.

Tobacco followed by sweet potatoes is a common rotation in the sweet potato-producing areas of North Carolina. Tobacco growers, with good agronomic justification, traditionally use sulfate of potash. Although the soil test S levels were low, S was present in sufficient amounts in these sandy soils to supply the sulfur needs of the sweet potato.

As long as sweet potatoes are used in rotation with tobacco, this situation is expected to be the same. Where sweet potatoes follow corn or another crop which has received little or no sulfur, one might guess the situation could be different.

TOTAL SWEET POTATO YIELD was increased by potash applications in all experiments. The researchers found that the soil test K plus the fertilizer K should total 226 lb/A K_2O to produce maximum yields. This means if the soil test K level is 0.08 meq K/100 cc soil (66 lb/A K_2O), then it is necessary to apply 160 lb/A K_2O.

These new potash recommendations are equal to the amount of K_2O required for a yield goal of 412 bu/A of sweet potatoes and closely match sweet potato K_2O uptake data of the Potash & Phosphate Institute. The study also indicated that whether sulfate or muriate is the source of potash, the higher yields produced by K_2O additions up to 226 lb/A are quite profitable **(Table 1).**

Due to the findings of this three-year study, the general fertilizer recommendations for sweet potatoes in North Carolina, without benefit of soil tests, were increased for potash (formerly 150 lb/A K_2O) and now call for 90-60-180 lb of N-P_2O_5-K_2O per acre, with applications being split as previously recommended.

Table 1. Net profit/A possible assuming potash sells for $0.11/lb K_2O and sweet potato prices average $3.00/bushel.

lb/A K_2O at 0 soil test K		Net profit/A with potash at $0.11/lb K_2O	
Additional	Total	Additional	Total
32	32	$296	$ 296
32	64	296	592
32	96	200	792
32	130	176	968
32	162	116	1084
32	194	74	1158
32	226	50	1208
32	258	2	1210

When soil test information is available, the recommendations also call for increased K_2O applications when the K level is 0.16 meq/100 cc or less **(Table 2).** This soil test level represents virtually all of the soils sampled for sweet potato production in North Carolina.

Table 2. Former and new potash recommendations for sweet potato production with yield goal of 412 bu/A.

Soil Test K		K Fertilizer Rates	
Meq K/100 cc	lb/A K_2O	Former	New
		lb/A K_2O	
0	0	195	226
0.04	34	165	192
0.08	66	136	160
0.12	100	110	126
0.16	133	91	93
0.20	166	75	60
0.24	200	60	26
0.28	233	50	0
0.32	266	45	0
0.36	300	40	0
0.40	333	40	0

Thus, it is obvious that sweet potato farmers can benefit financially by soil testing and following the increased K_2O recommendations. The End

Nitrogen's Effect On Seeding Date of Barley And Spring Wheat

ARTHUR L. DUBBS
Central Montana Agricultural Research Center
Moccasin, Montana

SPRING CEREAL GRAINS are generally quite sensitive to the effects of seeding date and fertilization.

Since they are cool season crops, they make their best growth during the cooler part of the spring and summer. Cool season crops then would be expected to yield higher and respond better to fertilizer if seeded early.

Seeding date and fertilization trials with barley (Compana) and spring wheat (Fortuna) were conducted at the Central Montana Agricultural Research Center from 1968 to 1973 on fallowed land.

Average seeding date for the 5-year period was April 6, May 6, and June 3.

Four rates of ammonium nitrate nitrogen were used: 0, 20, 40, and 60 lb/A N.

Two rates of potash as potassium chloride were used—0 and 20 lb/A K_2O.

Phosphorus at the rate of 25 lb/A P_2O_5 was applied with the seed to all nitrogen rates. Potash was applied at seeding while nitrogen was topdressed.

Soil tests taken on summerfallowed land at this location show grain crops will usually need a small amount of nitrogen (10 to 30 lb/A), while potash will test high.

BARLEY RESPONDS very well to early seeding with fertilization. See **Table 1** (page 28). Seeding as early as possible increased yields nearly 8 bushels per acre over the yields of a month later. Late seeding, near June 1, averaged 18 bushels less than early seeding.

Potash increased yield 5 bu/A when used with nitrogen at the early seeding date. Even though high amounts of potassium were present in these soils, additional potash was beneficial.

This response was probably due to cold soils in early spring. When spring weather conditions were warm during this 5-year period, there was no response to potash. Under adequate soil potash, rates higher than 20 lb/A K_2O did not produce yield increases.

NITROGEN INCREASED protein at all seeding dates. The percent protein increased and yields declined with later seeding dates. Potash did not affect percent protein at any seeding date in this study.

Test weight of barley decreased as seeding date was delayed. Nitrogen decreased test weights at all dates. Potash did not affect test weight.

What about growing barley for malting? These data indicate early seeding on summerfallowed land is essential to get grain that is 12.5 percent protein or less with good test weight for plumpness. The required nitrogen can be applied for maximum yield at this time without affecting some malting characteristics.

Although soil tests at this location showed adequate potash, yield response can be expected if applied over a period of years.

SPRING WHEAT RESPONSE to seeding dates and fertilization was different from barley. See **Table 2** (pg. 28). Yield loss due to seeding date did not occur on average until after May 6.

TABLE 1. Barley Date of Seeding and Fertilization.
Central Research Center, Moccasin, Montana (1968-73)

Nitrogen Rate lb/A of N	Seeding Date and Rates of Potash: April 6, 0	April 6, 20 lb/A K_2O	May 6, 0	May 6, 20 lb/A K_2O	June 3, 0	June 3, 20 lb/A K_2O
			Yield—bu/A			
Check	41	41	37	37	28	28
20	45	51	42	42	29	28
40	47	51	39	40	30	32
60	48	55	36	42	30	33
Mean	45	50	39	40	29	30
Date Mean	47.5		39.5		29.5	
			Percent Protein			
Check	11.3	11.3	13.0	13.0	15.5	15.5
20	12.7	12.0	13.6	13.6	15.9	15.8
40	12.9	13.2	14.4	13.9	16.5	16.3
60	13.5	13.7	14.9	14.7	16.4	16.2
Mean	12.6	12.6	14.0	13.8	16.1	16.0
Date Mean	12.6		13.9		16.1	
			Test Weight (lb/bu)			
Check	50.6	50.6	49.0	49.0	47.6	47.6
20	49.3	49.4	48.4	48.2	47.7	49.0
40	48.8	48.5	48.0	47.5	48.2	47.8
60	47.8	47.9	47.5	46.9	47.0	47.7
Mean	49.1	49.1	48.2	47.9	47.6	48.0
Date Mean	49.1		48.1		47.8	

TABLE 2. Spring Wheat Date of Seeding and Fertilization.
Central Research Center, Moccasin, Montana (1968-73)

Nitrogen Rate lb/A of N	Seeding Date and Rates of Potash: April 6, 0	April 6, 20 lb/A K_2O	May 6, 0	May 6, 20 lb/A K_2O	June 3, 0	June 3, 20 lb/A K_2O
			Yield—bu/A			
Check	27	27	27	27	19	19
20	30	32	30	30	20	23
40	31	32	30	32	20	25
60	30	33	31	33	21	22
Mean	30	31	30	31	20	22
Date Mean	30.5		30.5		21.0	
			Percent Protein			
Check	13.5	13.5	15.7	15.7	16.4	16.4
20	14.5	14.0	16.0	15.9	17.1	16.6
40	15.4	14.3	16.1	16.1	17.2	16.8
60	16.0	15.6	16.7	16.1	17.7	17.1
Mean	14.9	14.4	16.1	16.0	17.1	16.7
Date Mean	14.7		16.1		16.9	
			Test Weight (lb/bu)			
Check	60.0	60.0	59.1	59.1	58.0	58.0
20	59.7	60.1	59.8	59.5	58.4	58.4
40	59.3	59.5	58.6	58.9	56.9	58.9
60	58.9	59.3	58.1	59.1	56.9	57.1
Mean	59.5	59.7	58.9	59.2	57.6	58.1
Date Mean	59.6		59.1		57.9	

Fertilizer Stretches Moisture

THE HOT, DRY SUMMER OF 1980 hurt crop yields over much of the nation . . . the worst growing season in six years, according to USDA.

The yield estimate for corn in 1980 was about 91 bu/A, down from 109 bu/A in 1979. Even so this makes it the **sixth best year** for corn on record . . . not bad for such a poor growing season.

1. Why have yields held up as well as they have?

Improved technology. If we had had such a poor season 10 or 20 years ago, the yields would have been much lower than yield averages of those years. For example, in the five states of Iowa, Illinois, Indiana, Missouri, and Ohio the corn yield will average about 98 bu/A in 1980.

This will be an 11% drop from the long-term trend line, according to Dr. L. M. Thompson of Iowa State University. If an 11% drop had occurred in 1970 and 1960, the corn yields would have been 85 bu and 59 bu respectively.

Improved technology, which includes higher fertilizer rates, has held up corn yields 13 bu over what a hot, dry summer would have allowed with 1970 technology and 39 bu over 1960 technology.

2. Why do good managers shine in dry years?

Because they have prepared their fields for dry weather by building soil fertility . . . by using adapted hybrids or

---

The response to nitrogen and potash was consistently less on wheat than barley.

Nitrogen increased yield only 3 bu/A at the first two seeding dates, only one bushel near June 1.

Potash did not increase spring wheat yields significantly at any seeding date. But the last seeding date did approach significance.

Delaying seeding date from April 6 to May 6 increased percent protein nearly 2 percent. This means substantial protein premium payments when grain is sold.

Nitrogen at early seeding produced more protein than at other seeding dates. Potash at all seeding dates tended to reduce the percent protein.

Spring wheat test weight decreased with later seeding date. The decrease between April 6 and May 6 was an insignificant 0.5 lb per bushel.

Nitrogen decreased test weight at all seeding dates. When potash was combined with nitrogen, test weight decreased less than with nitrogen alone.

IN SUMMARY these data show spring wheat can be seeded later than barley without affecting yield. And the wheat will also have a higher percent protein.

When seeded early, barley responds more to nitrogen and potash than does wheat. **The End.**

varieties . . . by planting earlier . . . by using moisture-conserving tillage systems.

Yield response to fertilizer, in fact, is often greater in a dry year, especially to P and K. This is one reason the good managers do well economically most every year, regardless of the weather.

3. How does good soil fertility help stretch available water into more bushels?

Adequate fertility stimulates deeper root growth and exploration of the soil. This makes more soil water available to the plant.

Adequate fertility speeds maturity. It is very important for corn pollination to occur before summer drouth hits. On an Illinois soil high in K, corn receiving no extra K was 14% silked and with adequate K was 67% silked on a given date.

Adequate fertility reduces the crop's water requirement. Potassium reduces water loss in plants by lowering transpiration rate and aiding the closing of stomates (pores where plants expel water).

Adequate fertility compensates for lower nutrient uptake. Such nutrients as N, P, and K need to be swept into plants along with the water. Drouth can damage crops worse when nutrient uptake is reduced. A higher fertility level allows more nutrients to be taken up by a water-stressed crop to help lessen the yield loss.

4. How well do crops respond to fertilizer in dry years?

Crops often respond as well or even better than in normal years. Especially with potassium and phosphorus.

In an Ohio experiment, the first year had ample rain. Yields were high (160+ bu), but there was **no response** to potash. The second year was dry. Yields were down (120-130 bu). But there was a **50 bu** response to K.

In Virginia, corn yielded much better in good years than bad. But phosphorus increased yields about the same in both—40 bu/A in good, 37 bu/A in bad years. **Table 1** tells the story.

Table 1—P increases corn yields in good & bad years.

P_2O_5 lb/A	Good Years	Bad Years
	Corn Yield increase—bu/A	
25	36	19
50	45	29
100	40	37

In another Virginia study, high fertility more than doubled the yield in a poor year and also gave an excellent increase in a good year **(Table 2).**

Table 2—High fertility increased corn yields in good and bad years.

Fertility	Seasonal rainfall Good	Poor
	bu/A	
Low	127	53
High	205	111

Indiana spent many years measuring corn's response to potassium. The largest yield increases occurred in years of either low or high rainfall. When yields were reduced by too little or too much rain, fertilizer gave the greatest response as indicated in **Table 3.**

Table 3. Corn responds more to K when there is too little or too much rain.

Rainfall in growing season	Corn Yield —K	+K	Increased Yield	Increased Value*
	bu/A		bu/A	$/A
Low (7 in)	91	130	39	117
Medium (18 in)	148	156	8	24
High (26 in)	92	140	48	144

*Assuming $3/bu corn

5. Can farmers get more bushels per inch of water in dry areas?

Yes. With adequate fertility, Western U.S. and Canada frequently experience dry weather. Getting the most bushels out of every inch of water is important **every** year.

Adequate nitrogen and phosphorus are very important for the highest wheat yields when water is limiting. Both N and P were needed for the highest yield, greatest profit, and most bushels per inch of water—shown in **Table 4.**

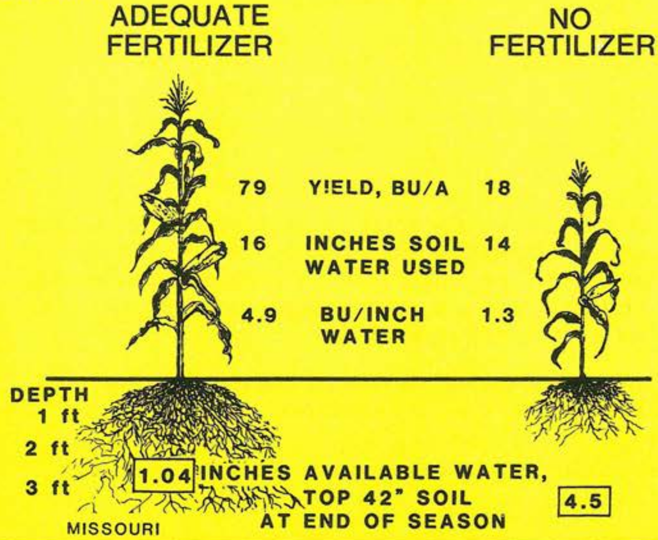
Table 4. N and P together give highest wheat yields and profits and get the most from the water available.

N	P_2O_5	Wheat Yield	Profit*	Bushels per Inch of Water
lb/A	lb/A	bu/A	$/A	bu/in
0	0	29	—	2.7
0	45	38	25.00	3.5
0	92	40	21.00	3.7
40	0	26	—20.00	2.4
40	45	42	33.00	3.9
40	92	49	49.00	4.6
				MT

*Assuming $4/bu wheat, 20¢/lb N, 25¢/lb P_2O_5

6. How do farmers get deeper rooting?

Through a healthy, well nourished plant. It has a deeper rooting system which can extract more water from greater depths in the soil profile. **Figure 1** shows this principle. **The End.**



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