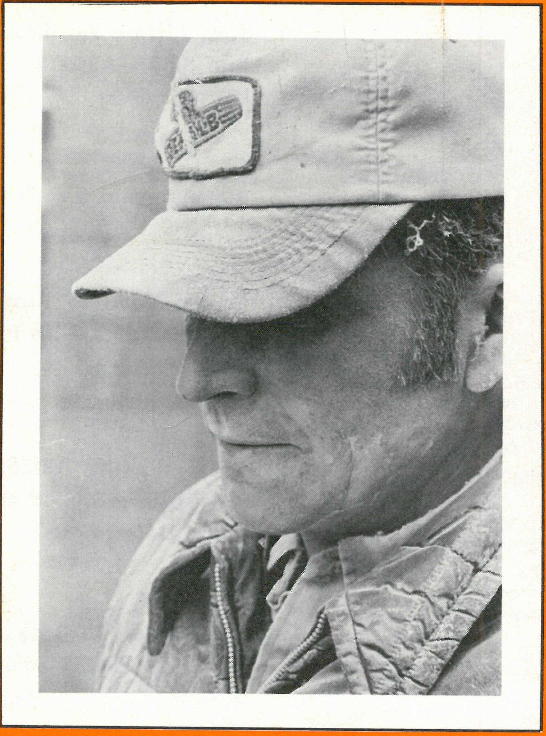
# Better Crops WITH PLANT FOOD

NUMBER 3—1976 25 CENTS



## From Dawn To Dusk . . . 365 Days

PAGE 24

**Better Crops**
**WITH PLANT FOOD**

**Published Quarterly by**
Potash Institute
1649 Tullie Circle, N.E.
Atlanta, Georgia 30329

**Santford Martin, Editor**
**Selma Bushman, Assistant Editor**



**VOL. LX** **3/76**



**$1.00 per year, 25¢ Per Copy**
Controlled circulation postage paid at Washington, D.C.

# CONTENTS

# GENETIC STRESS

## The Quest For Higher Yielding Crops Puts New Stress On Plant and Soil Nutrients

W. R. THOMPSON, JR.
STARKVILLE, MISSISSIPPI

DO WE SHORTCHANGE ourselves when we breed a plant that better tolerates problem soils—including low fertility—but CANNOT respond enough to higher fertility conditions to make it a real winner?

Do we shortchange ourselves when we breed a plant that CAN respond to higher nutrient rates with top-dollar yields but doesn't receive enough nutrients to reach the top? Such neglect puts the plant's genetic system under real stress.

Consider two hypothetical cases that could easily happen:

1. **An Ohio grain farmer with a poor lime program decides to grow half his wheat crop in high-yield Arthur variety, originally developed in Indiana, and half in Seneca, an older variety developed in Ohio. The higher-yielding Arthur wheat is stunted and shows aluminum toxicity. The lower-yielding Seneca wheat produces its normal yield. Why? Because Seneca tolerates low soil pH and higher soluble aluminum. What a blue chip investment LIME would have been to realize the full potential of that higher-yielding wheat.**
2. **A plant breeder, animal nutritionist, and soil scientist put their talents together at an agricultural experiment station to come up with a forage crop that produces consistently high yields of quality forage. AND it contains above-average levels of phosphorus and calcium, two nutrients so vital to cattle and horses. But the farmer's fertility program does not PROVIDE enough for those high phosphorous and calcium levels. Soon crop yield and quality drop off. What a blue chip investment ADEQUATE FERTILITY would have been to gain full potential of that forage variety high in P and Ca.**

Two factors influence the nutrients a plant accumulates—the genetic potential of the plant and the quality of environment during its growth. Scientists in American agriculture have done a remarkable job of improving the plant's environment and its ability to face that environment as well as breeding higher yielding, better quality crops.

Just one crop can tell this amazing story—corn. Today we AVERAGE about double the corn yields of 25 years ago. If someone wanted to compute out the major factors causing this increase, it might be safe to bet one-third on new hybrids, one-third on improved fertilization, and about a third on other technological and natural influences.

When we think of plant genetics, we may dream of varieties that use less nutrients to get higher yields. But a plant can go just so far on a limited diet, so to speak, just as an animal can gain just so much on a minimum ration.

• Varieties certainly vary in capacity to yield. In one corn hybrid study in Ohio in 1975 the top 5 corn hybrids averaged 202 bu/A—the lowest 5 averaged 145 bu/A. In an alfalfa study in Michigan the top variety over a 6-year period averaged 7.9 T/A. The lowest averaged 4.5 T/A. In a soybean test in Indiana the top variety yielded 67 bu and the lowest 36 bu.

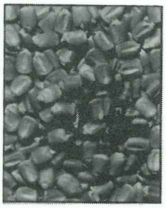
In such variety trials adequate P and K as well as N for corn and wheat are applied in order to make certain nutrients are not limiting the full expression of a plant's yielding ability. If all known controllable growth factors are in adequate supply, there is a true stress on the genetic capability of the plant.

When we consider the need for more food and feed with high nutrition value, it seems logical that tomorrow's high crop yields must come from varieties bred to respond vigorously to higher nutrient rates. Plants that can use more nutrients more efficiently to get much better yields—that seems to be a key need.

What an exciting future! What intriguing questions for bright, ambitious young minds to pursue and answer more fully tomorrow:

- **How much of a plant's response to nutrients is genetically controlled?**
- **Is it possible to breed plants that are so selective they will take up more of a certain nutrient, such as P or K, adding to their food or feed value?**
- **Why do some varieties take up and use a well balanced fertility program much more readily than others?**
- **Why don't nutrient concentrations increase in some varieties when available nutrients in the soil are greatly increased?**
- **Can low accumulation of essential plant nutrients produce the high yields demanded by today's agriculture?**
- **How much stress will new varieties put on the soil and environment when their "nutrient uptake carburators" are tuned for top mileage.**

A plant's genetic system says a lot about what that plant will do with the fertility environment it faces. Much fine work has been done in this area:



**ON CORN. . .**

Potash slowed stalk aging much more effectively in some hybrids than in others, Tennessee found.

Four single cross hybrids accumulated different levels of Ca, Mg, and K, Pennsylvania reported. Three out of the four hybrids were high K accumulators—shown in **Table 1.**

When potash was applied to two different hybrids on medium-K soil, it gave up to 25 extra bushels to the lower-yielding hybrid, up to 26 extra bushels to the higher yielder—shown in **Figure 1** from Wisconsin work. Even with added K, hybrid 1 is barely

**Table 1—Chemical element accumulation of 4 single cross corn hybrids.**

| Hybrid | Element | | |
|---|---|---|---|
| | Ca | Mg | K |
| I | M | H | H |
| II | H | L | L |
| III | L | L | H |
| IV | H | L | H |

Pa.

L = Low M = Medium H = High

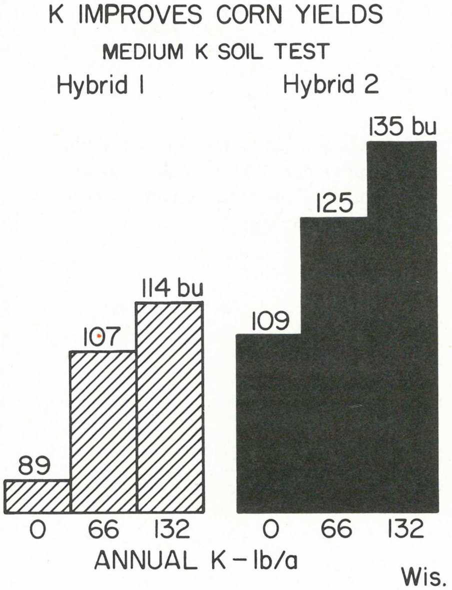
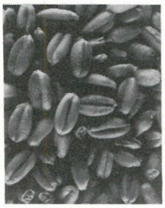



**FIGURE 1—Extra potash applied to two different hybrids on medium-K soil, gave up to 25 extra bushels to the lower-yielding hybrid, up to 26 extra bushels to the higher yielder.**

breaking even, emphasizing the effect of corn hybrid on yield potential.

When high and low P accumulators were both grown under P stress, the low accumulators tested lower P.

Other tests have shown that nutrient accumulation may be genetically controlled, at least partially—that element accumulation may be controlled by selective breeding—and that varieties for silage crops should be selected for their nutrient accumulation abilities to insure the most nutritious feed.



## ON WHEAT & RICE. . .

Higher yielding wheat varieties used almost 3 times more applied nutrients to give 1.5 times greater monetary return than native varieties. This impressive monetary return was due to the greater extra yield from the first increments of applied nitrogen—shown in **Table 2** from the TVA report on High-Yielding Cereals and Fertilizer Demand.

As with other crops, rice varieties vary in their capacity to use increased K for greater yields. Work from India shows this in **Table 3**—up to 3.4 tons/ha increase from K with the high-yield variety and 1.3 ton/ha increase with the low yielder.

High-yielding rice varieties used N fertilization effectively to increase yields in problem seasons (both dry and wet) while native varieties tended to decline. **Figures 2 and 3** show this

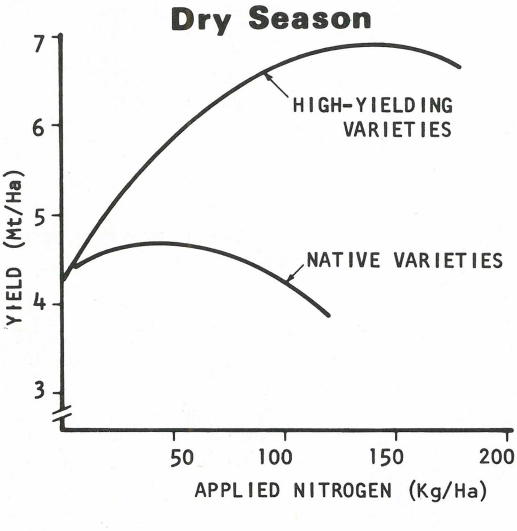



**FIGURE 2—Generalized curve for the response of rice to nitrogen applications in the dry season. From TVA Bulletin Y-4.**

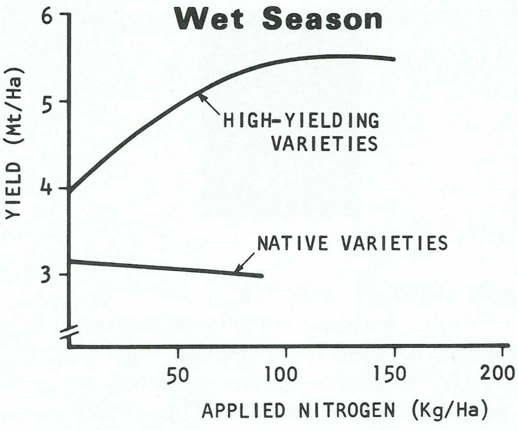



FIGURE 3—Generalized curve for the response of rice to nitrogen applications in the wet season. From TVA Bulletin Y-4.

from the TVA report on **High-Yielding Cereals and Fertilizer Demand.**

**Table 2—Average Response of Wheat to Nitrogen Fertilization**

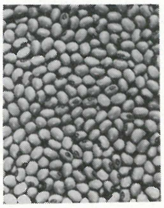
| Rate of N (Kg/ha) | Yield (Kg/ha) | Extra Yield (Kg/ha) | Extra Yield Kg N (Kg) |
|---|---|---|---|
| | | High Yielding Varieties | |
| 0 | 2100 | — | — |
| 40 | 3270 | 1170 | 29.3 |
| 80 | 3900 | 630 | 15.8 |
| 120 | 4200 | 300 | 7.5 |
| 160 | 4350 | 150 | 3.8 |
| | | Native Varieties | |
| 0 | 1450 | — | — |
| 20 | 1815 | 365 | 18.2 |
| 40 | 2030 | 215 | 10.8 |
| 60 | 2105 | 75 | 3.8 |
| 80 | 2030 | — | — |

From TVA Report—Russell, et al.

**Table 3—High Yield Rice Varieties Use K More Efficiently Than Native Varieties**

| | | Metric Tons/ha | |
|---|---|---|---|
| High Yield Variety | No K | 300 kg/ha $K_2O$ | Increase |
| TN-1 | 1.4 T/ha | 4.8 T/ha | 3.4 T/ha |
| Tainan-3 | 1.8 | 4.4 | 2.6 |
| Native Variety | | | |
| Peta | 1.1 | 2.4 | 1.3 |
| Panganahoo | 1.8 | 2.6 | 0.8 |

India



**ON SOYBEANS. . .**

Some varieties respond much better than others to high P and K fertilization rates. In Maryland tests, one genotype gave nearly 16% more seed yield at high K than moderate K rates, while a currently recommended variety did not increase in yield from moderate to high K fertilization—shown in **Table 4.**

**Table 4—Seed Yields of Two Soybean Genotypes Under Two K Fertility Levels in Maryland.**

| K Fertility Level | Yield, 1971-1973 FC 31702 | Lincoln |
|---|---|---|
| | —Kg/ha— | |
| Moderate | 1947 | 2037 |
| High | 2255 | 2002 |
| % Change | 15.8 | −1.7 |

Md.

Another test showed two varieties responding alike to moderate P levels. But when P was increased 5 to 10 times, an interesting contrast set in. With high P, Variety 1 increased in vegetative growth and seed production. But Variety 2 developed reddish-brown leaves, slowed down in growth, and produced fewer seed under high P.

Many more interesting studies could be cited on other crops—from grasses to cotton—but space does not permit. Scientists as recently as 1975 pointed to the opportunities for correcting animal and human nutrition problems by breeding varieties of more nutritious plants. And in that pursuit, we will seek varieties that use fertilizer more efficiently.

To some, that efficiency may mean less nutrients. To others, more nutrients. If the future demands higher yields of more nutritious plants, that additional nutrition must come from somewhere. So, it seems logical to look toward varieties that will use reasonably more nutrients much more efficiently to produce much more quantity of quality food and feed. **The End**

## OFFICIAL RESEARCH YIELDS MOVE SOYBEANS TO HIGH LEVELS—1975

| State | Researchers | Variety | Planting | Rows | Other Steps | Fertility | Yield |
|---|---|---|---|---|---|---|---|
| Indiana Lafayette | M. L. Swearingin | 3 Varieties | May 9 | 8″ | | **pH 6.7** | 82.0 |
| Illinois Urbana | R. L. Cooper | Corsoy | May 6 | 7″ | 200 lbs N as Anhydrous preplant—2 wks. Irrigated | **pH 6.5 P–High K–High** | 92.5 |
| Illinois Belleville | D. W. Graffis George Kapusta G. L. Ross Jim Bowan Richard Mulvihill | Williams | May 22 | 30″ | | **pH 6.3 P–Med–High K–Med–High** | 84.3 |
| Illinois Carbondale | ″ | Peterson 3125 | May 23 | 30″ | | **pH 6.0 P–V.High K–High** | 83.6 |
| Illinois Carbondale | ″ | Schultz-Mitchell | May 23 | 30″ | | **pH 6.0 P–V. High K–High** | 82.0 |
| Illinois Carbondale | ″ | Woodworth | May 23 | 30″ | | **pH 6.0 P–V.High K–High** | 80 9 |
| Minnesota Waseca | G. E. Ham G. W. Randall | Corsoy | May 13 | 15″ | 100 lbs Urea-N Spring applied | **pH 6.2 P–High K–High** | 81.5 |
| Ohio Columbus | G. J. Ryder J. E. Beuerlein | Several | May 3 | Variable —many narrow | | **pH 6.5 P–High K–High** | 80+ |
| Wisconsin Evansville | Ed Oplinger | Wells | May 20 | 10″ | Manganese Chelate-Foliar | **pH 6.2 P–V.High K–High** | 86.0 |

**DAVID W. DIBB**
**COLUMBIA, MISSOURI**

**TOP FARMERS** must think like top researchers—or a lot like them. Recent soybean yields seem to say this.

After presenting the chart above showing research steps to high yields, we wrote the winners of soybean contests in 14 states—leaders featured in the March 1976 **Soybean Digest.**

We sought additional facts about their cultural and management practices. We wanted more insight into the ingredients of high-yield soybean production. Ten out of the 14 states responded.

The chart on the facing page was created from their replies. The amazing thing—and yet not at all amazing when you really think about it—are the similarities between the innovative farmers and the progressive research scientists.

The road to high soybean yields is marked by certain signs in research and on the farm:

| TOP FARMER YIELDS MOVE SOYBEANS TO HIGH LEVELS—1975 | | | | | | | |
|---|---|---|---|---|---|---|---|
| PRODUCER | VARIETY | PLANT-ING | ROWS | FERTILITY | FERTILIZER APPLIED | OTHER STEPS | YIELD |
| Tildon Whitehurst and Sons Hertford, N. Car. | York | May 10 | 41″ | P-V. High K—High | 15-45-90 | | 61.6 |
| L. W. Hutchinson, Jr. Baxley, Ga. | Bragg | May 14 | 30″ | pH 6.1 P—High K—Med. | 32-48-96 | Mo treated seed | 76.1 |
| Allen Bragg Toney, Ala. | Forrest | May 1st week | 38″ | pH 6.0 P—High K—High | 16-48-48 | Chisel twice, Fall 2 app. Benlate Mo seed innoc. | 63.1 |
| John E. Matthews Robinsonville, Miss. | Forrest | May 8 | 38″ | pH 7.6 | | Good land prep. Good weed control Good Lord | 66 |
| W. Eugene Peace Hanover, Va. | Forrest | May 20 | 36″ | pH 6.5 P-V. High K—Med. | 15-45-135 | | 62.7 |
| Vince Drendel Chris Dickert Lakeland Farms Evansville, Wis. | SRF 200 Certified | May 12 | 24″ | pH 6.8 P—High K-V. High | 8-50-140 | Foliar Mn. (Krealeys) Chisel plow—16″ 10 tons hog manure | 75.2 |
| Richard Johnson Beloit, Wis. | XK 250 Americana Certified | May 5 | 30″ | pH 6.8 P-V. High K-V. High | 87-30-270 | Trace elements applied | 75.1 |
| Kenneth Birkey Hopedale, Ill. | SRF 200 | May 11 | 7″ | pH 6.2 P—High K—High | 200-90-90 on corn previous 2 yrs (ea.) | Innoculation implant | 75.8 |
| Preston L. Bell Rehobeth, Md. | York | June 16 | 19″ | pH 6.0 P-V. High K—High | 25-50-50 On double-cropped Barley | No-till beans, double-cropped after barley. | 62.9 |
| M. F. Boland Pomaria, S.C. | Hutton | May 15 | 38″ | pH 6.7 P—High K—High | 48-192-192 on corn the previous year | | 70 |
| Stan Compton Larned, Kansas | Williams | May 12 | 30″ | pH 7.7 P—High K-V. High | 36-92-40 | 40 tons manure—Fall 6# $ZnSO_4$ Flood Irrigation | 74.4 |

**SIMILARITIES: (1) Variety selection**—An adapted variety with high yield potential.

**(2) Early Planting date**—All of the farmers planted by May 20 except where beans were double cropped.

**(3) High fertility**—pH was above 6.0 and P and K levels were High or Very High except in two cases. Good fertility programs.

**(4) Good weed control**—Almost all the farmers and researchers stressed its importance.

**DIFFERENCES:** Not many. But the researchers seem to be moving to closer rows to attain even higher yields.

Many think this will continue to be the trend. Vince Drendel of Evansville, Wisconsin agrees when he notes . . . "in 1976 we are planting all our beans . . . in 13 inch rows."

These 20 research and farm sites in 13 states averaged 75.8 bu. That is more than two and one-half times the U.S. average of 28.4 bu/A for 1975.

High fertility, careful management, early planting help make the difference. **HIGH YIELDS** are the key to **HIGH PROFITS.**

John Matthews of Robinsonville, Mississippi seemed to sum it up when asked about any other comments on his winning yield: **"Good land preparation, good weed control, and THE GOOD LORD."**

It's worth a try.

# Turn Alfalfa Fertility Into Profitability

LEO M. WALSH
UNIVERSITY OF WISCONSIN

**LAND CROPPED** to forages has often been referred to as the "forgotten acres." Statistics indicate such a title is appropriate.

In the past 30 years, for example, average alfalfa yields in the Midwest increased only 20% to 25%, while average corn yields were doubling.

A big reason forage production has lagged behind corn and other grains is that farmers have not used the technology available to them to increase forage yields. Statistics demonstrate this point.

Over 95% of the corn grown in the Midwest is fertilized, but less than 15% of the alfalfa, even though recommended fertilizer rates are **very profitable on both crops.**

Such an observation is very disconcerting when you consider forages are the foundation for dairying, the most important livestock enterprise in Wisconsin.

Why do farmers tend to neglect forages? For different reasons:

**(1) Forages do not often show dramatic visual response corn does to fertilizer.**

**(2) The response, although large in percentage, may be grazed off or harvested three to four times a season, leaving farmers unaware that very profitable yield increases occur when a sound soil fertility program is established.**

**(3) Alternate sources of protein (primarily soybean meal) were inexpensive in the past.**

**(4) Additional forage production was not effectively utilized because farmers did not increase the size of their livestock enterprise. So excess forages were underpriced and difficult to sell because of the lack of a good forage marketing system.**

In the past three years, we have seen

**Table 1—How two annual potash applications influenced yield and stand of Ranger alfalfa (Adapted from Smith).**

| Annual[1] $K_2O$ rate | Alfalfa yield (3 yr avg)[2] 3 cuttings | 4 cuttings | Remaining stand the spring of the 4th year 3 cuttings | 4 cuttings |
|---|---|---|---|---|
| Lb/A | Tons/A | | % | % |
| 0 | 3.4 | 3.1 | 47 | 24 |
| 60 | 4.0 | 3.9 | 64 | 35 |
| 120 | 4.3 | 4.1 | 79 | 55 |
| 240 | 4.5 | 4.5 | 85 | 66 |
| 480 | 4.8 | 4.7 | 93 | 81 |
| 720 | 5.0 | 4.9 | 95 | 84 |
| 960 | 4.9 | 4.8 | 92 | 89 |
| 1200 | 4.8 | 4.7 | 93 | 86 |
| Lsd .05 | 0.19 | 0.19 | | |

[1] The initial soil test was 127 lb/A of exchangeable K. $K_2O$ added annually for two years.
[2] Average of three years' data (1970-1972), 12% moisture hay.

dramatic increases in the value of livestock products, the value of livestock feeds and forages, and the cost of inputs to produce grain and forage. But even though fertilizer price has increased somewhat, commodities sold by farmers have increased even more.

**Therefore, recommended rates of fertilizer on forages and alfalfa is more profitable today than ever before.**

Since we are in this new "ball game," how do we get farmers to treat forages as they should? Develop sound educational, promotional programs that clearly demonstrate the profitability of recommended fertilizer. Once profitability is demonstrated, farmers will adopt the technology they need to produce forages more economically.

**FERTILIZING ALFALFA** to produce optimum yields of quality forage represents a major management decision. In many cases, farmers would realize additional net income if they purchased more fertilizer to produce additional better quality forage, rather than buy hay or protein supplement to balance their livestock ration.

Grain, hay and protein supplement are much higher-priced now than they have been in the past so our livestock producers are under more economic pressure to do a good job of producing high quality forage today.

We must dispel the idea that alfalfa is a crop that can rejuvenate a rundown, infertile soil. Alfalfa **does** supply nitrogen to subsequent crops, but it needs more phosphate and potash than any other agronomic crop grown in the North Central Region.

For example, our data indicate that each ton of alfalfa will remove about 10-12 pounds of phosphate ($P_2O_5$) and 50-60 pounds of potash ($K_2O$)—a 6-ton crop up to 72 lb $P_2O_5$ and 360 lb of $K_2O$/A. Considering nutrient uptake efficiencies for phosphate and potash, application rates must equal or exceed these amounts to insure enough for the crop, depending on the soil.

It seems clear many of our soils need substantial amounts of maintenance fertilizer to produce optimum yields of high quality forage.

**HUNDREDS OF MIDWEST** trials have shown how alfalfa responds to

**Table 2—Fertilizer costs and alfalfa value affect optimum rate of potash fertilization[1] (Preliminary analysis provided by Harlan Hughes, Agr. Economics, Univ. of Wis.)**

| Cost of $K_2O$ | Value of alfalfa—$/ton | | | | | |
|---|---|---|---|---|---|---|
| | $30 | $35 | $40 | $45 | $50 | $60 |
| ¢/lb | Optimum rate of $K_2O$-lb/A | | | | | |
| 5.0 | 378 | 432 | 480 | 510 | 534 | 576 |
| 5.8 | 306 | 378 | 426 | 462 | 498 | 543 |
| 6.7 | 240 | 318 | 378 | 420 | 456 | 509 |
| 7.5 | 174 | 264 | 324 | 378 | 414 | 476 |
| 8.3 | 108 | 204 | 276 | 330 | 378 | 443 |
| 9.2 | 42 | 150 | 228 | 288 | 336 | 409 |
| 10.0 | 0 | 90 | 174 | 240 | 294 | 376 |
| 10.8 | 0 | 36 | 126 | 198 | 258 | 343 |
| 11.7 | 0 | 0 | 76 | 156 | 216 | 309 |
| 12.5 | 0 | 0 | 24 | 108 | 174 | 276 |

[1] Based on an average of 3- and 4-cutting systems from experiments conducted at the University of Wisconsin Arlington Experimental Farm (2, 3). To convert $K_2O$ ¢/lb to $/ton of 0-0-60, multiply ¢/lb x 12. If $K_2O$ is 8.3¢/lb, the cost per ton is $99.60.

phosphate, potash, boron, and sulfur. This article cannot thoroughly review the literature on all these nutrients.

But let's concentrate on a potassium study recently completed at the University of Wisconsin Arlington Experimental Farm. **Table 1** shows both three-cutting and four-cutting systems required 720 lb $K_2O$/A to reach maximum yields.

The Arlington yield data were used to prepare the preliminary information in **Table 2,** which shows optimum potash rate affected by potash cost and values for the alfalfa hay produced. Note how optimum potash rate increases markedly as alfalfa value increases, or as the cost of potash decreases.

If alfalfa value would increase from $35 to $60/ton, with $K_2O$ at 9.2¢/lb the optimum potash rate would more than double—from 150 lb to 409 lb $K_2O$/A. **Tables 1 and 2** clearly show very few dairy or livestock farmers are fertilizing their alfalfa crop at levels approaching optimum rate.

**THE PERCENTAGE** of potassium in the alfalfa tissue increased with each increment of added potassium. **Table 3** shows percent K in plant tissue was about 2.8% when maximum alfalfa

**Table 3—Potash ($K_2O$) rate in a 3-cutting system influences average alfalfa yield, concentration of K in the herbage, and uptake of potash ($K_2O$). (Adapted from Smith)**

| Annual rate of $K_2O$ | Average[1] hay yield | Concentration[1] of K | Uptake of[1] $K_2O$ | $K_2O$ in each ton of hay |
|---|---|---|---|---|
| lb/A | ton/A | % | lb/A | lb/ton |
| 0 | 3.4 | 0.9 | 65 | 19.3 |
| 60 | 4.0 | 1.1 | 95 | 23.7 |
| 120 | 4.3 | 1.4 | 128 | 30.0 |
| 240 | 4.5 | 1.7 | 163 | 36.4 |
| 480 | 4.8 | 2.3 | 238 | 49.2 |
| 720 | 5.0 | 2.8 | 301 | 60.0 |
| 960 | 4.9 | 3.1 | 326 | 66.5 |
| 1200 | 4.8 | 3.4 | 347 | 72.9 |

[1] Average of 3 years' data from two annual $K_2O$ applications.

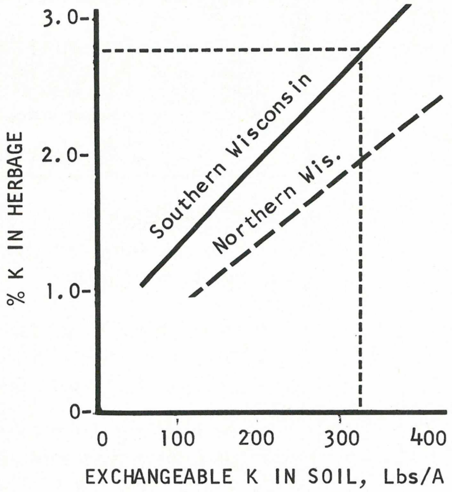



**Figure 1—The dashed line shows soil K level needed to insure a 2.8% K concentration in alfalfa in Southern Wisconsin. This Vernal alfalfa herbage was sampled at first flower of a spring crop from several farm fields of the Madison and Ashland areas in 1966. This suggests higher K levels must be maintained in cooler northern areas to insure enough potassium in plant tissue and top yields.**

yields were achieved.

At the two highest levels of applied potash, slight decreases in yields were observed. Since potassium chloride was the carrier used and the applications were not split, these slight yield depressions were likely due to accumulation of excess salts or chloride in the plant tissue.

More research is being conducted to evaluate sources of potash and effects of splitting applications of high rates on the crop.

Temperatures influence growth and chemical composition of alfalfa. Wisconsin surveys have shown that, at a given soil test level, alfalfa herbage will contain more potassium in southern Wisconsin than in northern Wisconsin, shown in **Figure 1.** This suggests higher levels of exchangeable soil potassium must be maintained in a cooler environment to insure enough potassium in plant tissue and achieve maximum yields.

**AFTER REVIEWING** research work conducted in Wisconsin and other North Central states, we recently revised our fertilizer recommendations based on soil tests for maintenance (topdressed) phosphate and potash on an established alfalfa.

For example, **Tables 4 and 5** show our suggestions for alfalfa grown on dark colored soils in southern, south central and southwestern Wisconsin. These soils resemble some of the soils in southern and southeastern Minnesota, northwestern Illinois and north-

**Table 4—Phosphorus soil test and expected yields affect potassium recommendations for established alfalfa.**

| Expected yield tons/A | Soil test P lbs/A | Recommended[1] $P_2O_5$ lbs/A |
|---|---|---|
| 3-4 | 0-30 | 40 |
| | over 30 | 0 |
| 4-5 | 0-40 | 50 |
| | over 40 | 0 |
| 5-6 | 0-50 | 60 |
| | over 50 | 0 |

[1] University of Wisconsin recommendation, 1975

**Table 5—Potassium soil test and expected yield affect potassium recommendations for established alfalfa.**

| Expected yield tons/A | Soil test K lbs/A | Recommended $K_2O$, lbs/A[1] |
|---|---|---|
| | 0-180 | 160 |
| 3-4 | 181-270 | 120 |
| | over 270 | 0 |
| | 0-240 | 200 |
| 4-5 | 240-320 | 150 |
| | over 320 | 0 |
| | 0-300 | 240 |
| 5-6 | 300-400 | 180 |
| | over 400 | 0 |

[1] University of Wisconsin Recommendations, 1975

eastern Iowa.

The amount of phosphate and potash recommended varies with the expected yield level and soil test levels for phosphorus and potassium.

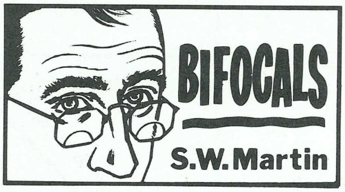
If farmers expect to achieve high yields year after year, it will be necessary to apply the higher phosphate and potash rates to maintain these yields. Also, adequate levels of lime, sulfur and boron will have to be maintained or applied.

Since forages are more valuable than ever before, we strongly recommend farmers soil test at least every two to three years to arrive at realistic fertilization rates for alfalfa.

**THE POTENTIAL** for additional forage fertilization is great. Farmers have demonstrated over and over they will adopt practices proven profitable to them.

Our job is to develop programs that bring agronomic and economic information that help them make better decisions for fertilizing their alfalfa and forage crops. **The End**






**THE TRANSFER** of power is a fascinating thing to watch—in a nation, a company, or an institution.

My morning paper was full of facts and rumors about the coming changes in Washington, D.C.

As the breaking dawn helped the kitchen lamp light those exciting pages, my mind slowly asked, "What is power, anyway?"

Suddenly the window screen over the kitchen sink rattled. Bull Martin, my first wife's Rhett Butlerlike tomcat, was beginning his morning ritual. Staring me into opening the door for his inauguralish march to the permanent buffet our family maintains for the old boy's instant refueling.

A funny thing happened to me on Bull's way to the buffet this morning. I learned what power is. Influence! It's neither money nor education nor genetic standing. It is the capacity to influence—for good or bad.

And, suddenly, there were no Washington or Plains datelines but a simple Roanoke, Virginia dateline. An Associated Press account of Miss Bessie Souther's visit with John Denver after his concert there:

**An interesting story.** Of how the spotlights had dimmed, the applause had faded, and the 11,000 people had started home. How she continued to sit on the fourth row next to the aisle, waiting for friends to come take her back to the Western State Hospital, her home for many years up the beautiful Shenanago I read a news story of another star singer who allegedly said, "The worst part of having success (in show business) is to try finding someone who is happy for you." (That experience is not limited to show business, I've heard.)

Those sad words made Miss Souther's letters and cards to John Denver loom very important this morning. I learned long ago to trust the AP and the better instincts some of its stories stir in me. That instinct tells me this lady is an influence for good on an influential young man.

John Denver reaches what I like to call the only tomorrow we have, our young citizens. And they listen. **Oh, how they listen to John sing his songs!** I know! I have two who do. Hearing not only his music, but also the message in his words.

Surely Miss Souther has gone home to her Mama with him many times on "Country Road." So, we mid-50's folks would be naive, indeed, not to believe such a young man is influencing the future of our land, in his way.

Of course, I have no idea what kind of messages Bessie Souther sends John Denver from her state hospital room in the Shenandoah Valley.

They must be wise and moving and for the good. A young man in his kind of work surely receives thousands of letters. But it is **hers** the AP says he takes home to his wife and son.

# POWER

doah at Staunton.

**A touching story.** Of how she could hear John Denver with special feeling, apparently, but not see him, because her 69-year-old eyes do not work like ours.

How a young man's hand reached down to touch her on the seat by the aisle and his voice said, "You must be Bessie. I work with John and he wants very, very much to meet you, Miss Souther."

**A lifting story.** Of how her friendship with John began more than a year ago when a hospital volunteer wrote him how much she enjoyed his songs but had nothing to play them on. How he sent her tapes of every song he has sung and money to buy a player—then, after many letters, invited her to be his guest at the Roanoke concert. Fourth row, aisle seat.

How John told her outside his dressing room what her letters and cards have meant to him. How he takes them home and shows them to his wife and son, Zachary. And tells them "how much Bessie has meant to me."

It was, above all, a happy story which caused me to be thankful for Miss Souther this cold, gray morning.

**(1) First, I am thankful to her for giving the Associated Press a happy subject to put on their teletype across America.**

They are overwhelmed with bad news and often cursed for reporting it. So, when something good like her visit with John comes along, I know it does their hearts as much good to write it as it does mine to read it.

We shouldn't really complain about the bad news, however, because they and their member newspapers are the number one protection we have against the mean, arrogant men of this earth—every generation, every century.

**THEY** are the ones who have uncovered **VIRTUALLY ALL** of our charlatans, usually trapped for worshipping money, power, and bigness all out of proportion to personal needs and honorable goals.

As I write this, I was just thinking how Miss Souther lives across the Blue Ridge there from Thomas Jefferson who once told his neighbors, **"If the choice were left to me whether to have a free press or a free government, I would choose a free press."**

A wise man who knew however repression begins—through radical mobs, country club economics, or government intimidation—its first target will be the press.

**OF COURSE!**

So, I don't complain about the bad news our press must give us, but I surely make a feast out of the good news like the AP story on Bessie Souther's singing friend.

**(2) Second, I am thankful to her for being John Denver's friend.**

My reason is this. Not long

**POWER?**

We'll be seeing some fancy jockeying for that across the mountain from Bessie in the months ahead. Men going to Washington to do what men going to Washington have been doing for 200 years.

**That is why I hope Bessie Souther keeps writing John Denver.**

# Do We Need To Supplement Dairy Rations With POTASSIUM?

R. W. HEMKEN
UNIVERSITY OF KENTUCKY

**ALTHOUGH POTASSIUM** is the third most abundant mineral found in body tissue, it has not received as much attention as many other elements found in smaller amounts.

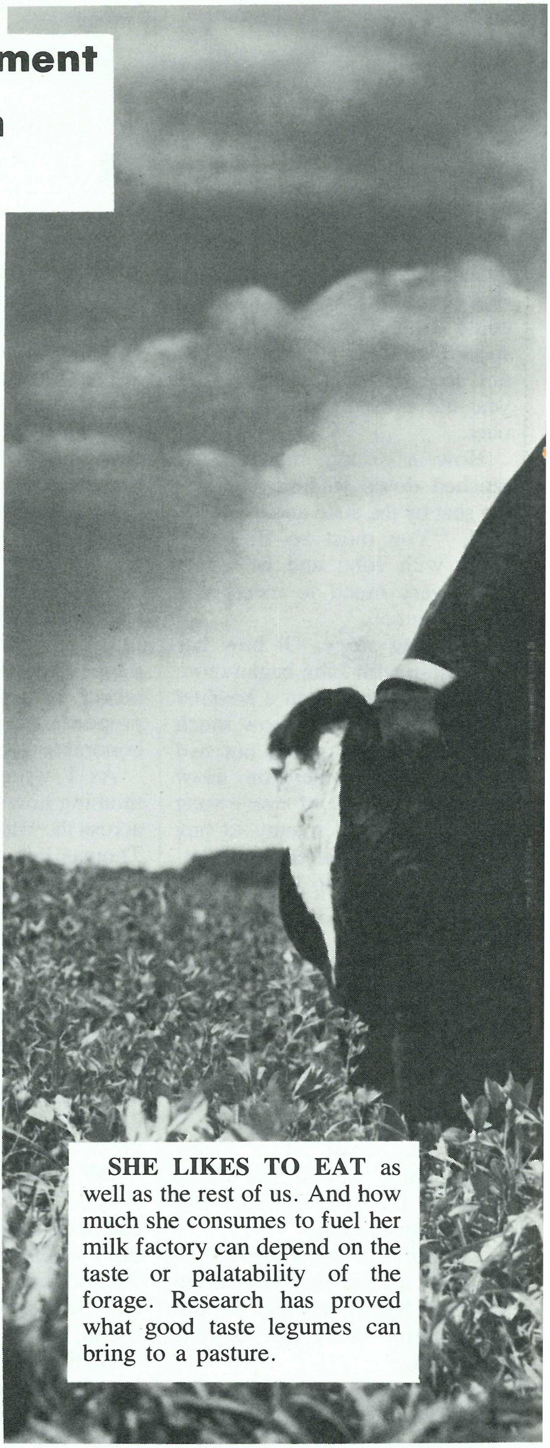
The reason for little research with potassium is the high potassium content found in many forages. And researchers have assumed ruminants receive large amounts of forages.

Several changes in dairy feeding programs have increased the need to know what the minimum potassium content can be for maximum milk production.

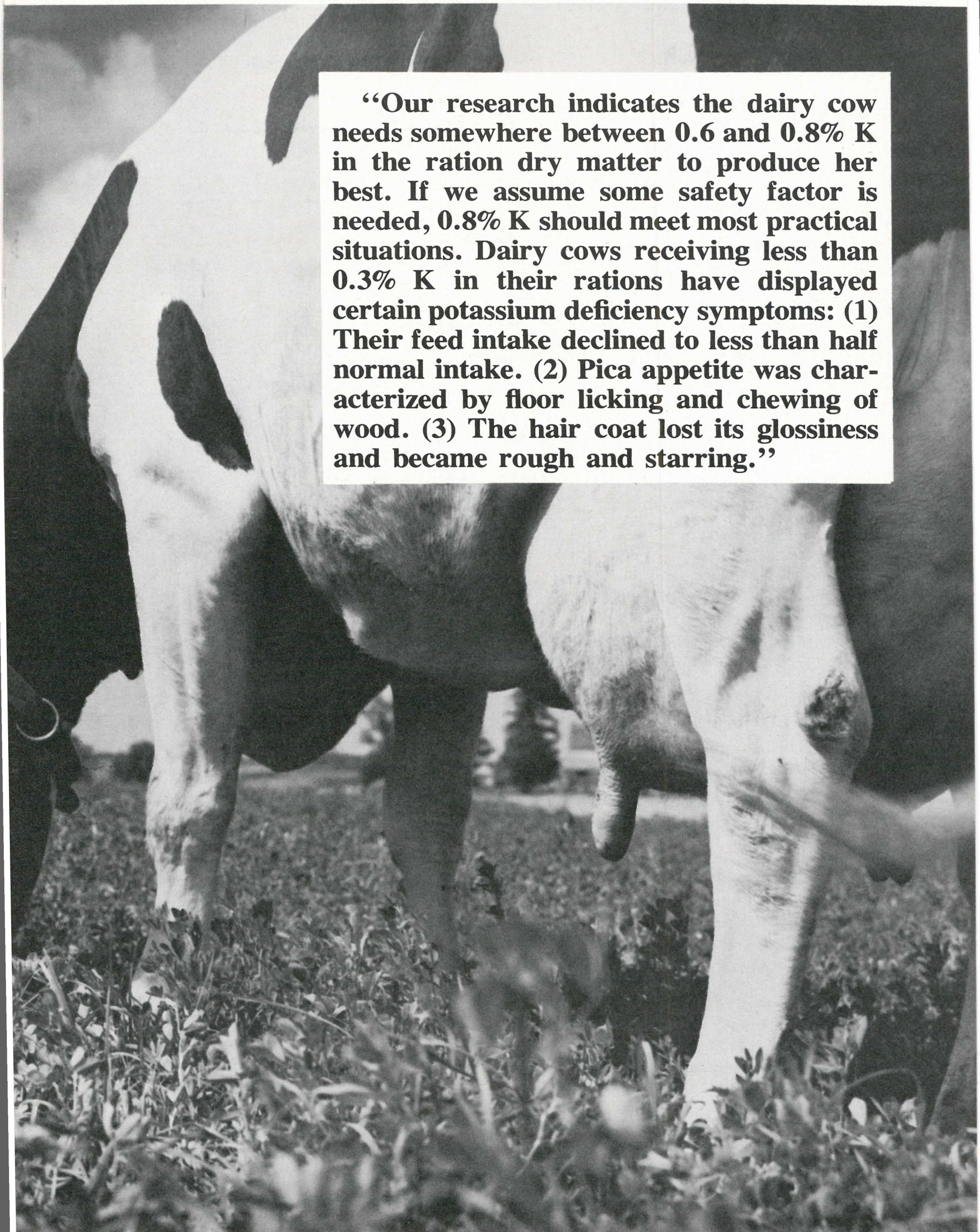
**These changes include (1) more concentrates fed to dairy cows, (2) greater use of corn silage, and (3) more roughage such as cottonseed hulls in place of normal forage in the ration.**

**Table 1** shows how many of the grains contain much less K than average forage crops. Feeds used to furnish protein vary considerably in their protein content. Using urea (0%K) as a source of crude protein to replace soybean meal can reduce the ration's K content appreciably.

The average dairy cow receives about twice as much concentrates today as 20 years ago. Concentrates are generally lower in K content. And increased concentrates mean less forage usage.



**SHE LIKES TO EAT** as well as the rest of us. And how much she consumes to fuel her milk factory can depend on the taste or palatability of the forage. Research has proved what good taste legumes can bring to a pasture.



"Our research indicates the dairy cow needs somewhere between 0.6 and 0.8% K in the ration dry matter to produce her best. If we assume some safety factor is needed, 0.8% K should meet most practical situations. Dairy cows receiving less than 0.3% K in their rations have displayed certain potassium deficiency symptoms: (1) Their feed intake declined to less than half normal intake. (2) Pica appetite was characterized by floor licking and chewing of wood. (3) The hair coat lost its glossiness and became rough and starring."

TABLE 1. POTASSIUM CONTENT OF SELECTED FEEDSTUFFS[a]

| Grains | Potassium Percent[b] Mean | Minimum-Maximum | Number Samples |
|---|---|---|---|
| Barley grain, all analysis | 0.63 | 0.33 - 0.99 | (233) |
| Corn and Cob meal | 0.53 | 0.52 - 0.55 | (3) |
| Corn grain, all analysis | 0.35 | 0.03 - 0.92 | (162) |
| Wheat grain, all analysis | 0.58 | 0.18 - 0.79 | (87) |
| Sorghum grain, all analysis | 0.38 | 0.28 - 0.50 | (16) |
| Oats, all analysis | 0.42 | 0.22 - 0.89 | (83) |
| **Roughages** | | | |
| Alfalfa hay, all analysis | 1.77 | 0.22 - 3.37 | (422) |
| Brome hay, smooth, all analysis | 2.36 | 1.47 - 3.50 | (104) |
| Clover hay, all analysis | 1.97 | 0.57 - 3.81 | (435) |
| Corn Cobs | 0.84 | 0.08 - 0.91 | (60) |
| Prairie hay, all analysis | 0.74 | 0.09 - 1.18 | (37) |
| Timothy hay, all analysis | 1.66 | 0.70 - 4.11 | (195) |
| Corn silage, all analysis | 1.15 | 0.60 - 2.35 | (77) |
| **Concentrate By-products** | | | |
| Linseed oil meal | 1.52 | 0.92 - 1.66 | (27) |
| Soybean oil meal, solvent | 2.21 | 2.00 - 2.30 | (6) |
| Corn Gluten meal | 0.03 | 0.02 - 0.11 | (17) |
| Wheat Bran | 1.39 | 0.93 - 1.77 | (11) |
| Wheat Middling | 1.10 | 0.93 - 1.28 | (5) |
| Wheat Red Dog | 0.67 | 0.42 - 0.76 | (4) |
| Beet Pulp, dried | 0.23 | 0.15 - 0.36 | (8) |
| Brewer's grains, dried | 0.09 | 0.04 - 0.18 | (5) |

[a]Data taken from National Academy of Sciences–National Research Council publications 449 and 585.
[b]All data expressed on moisture-free basis.

TABLE 2. THE EFFECT OF .45 TO .66% POTASSIUM ON DAIRY COW PERFORMANCE DURING MIDDLE LACTATION.

| | Ration K Content (% of Dry Matter) 0.45 | 0.55 lbs | 0.66 |
|---|---|---|---|
| **Average daily dry matter intake:** | | | |
| Last 4 weeks experimental period | 32.1 | 38.5 | 45.2 |
| Post trial* | 41.1 | 41.4 | 45.7 |
| Difference | + 9.0 | + 2.9 | + 0.5 |
| **Average daily milk production:** | | | |
| Last 4 weeks experimental period | 44.0 | 49.9 | 44.4 |
| Post trial* | 42.2 | 46.6 | 40.7 |
| Difference | – 1.8 | – 3.3 | – 3.7 |
| **Body weight change during experimental period** | +34.5 | +119.9 | +204.4 |

*Post trial period, all animals placed on 0.66% K ration.

Forage tests from several states show corn silage is consistently low in K content. Tests from Kentucky (mean of .96% and range of .38 to 1.96) and from Pennsylvania (mean of 1.05% and range of .43 to 2.77%) show K content for corn silage is lower than the value in **Table 1.**

The large range, with many samples containing less than 0.8% K, demonstrate an average "book" value can be very misleading for an individual farm.

Other forages also show a wide range, with some samples containing less than 0.8% K. The wide range in K content is due to variations in K availability in soils and other factors such as stage of forage maturity.

**PRACTICAL RATIONS** can contain less than 1.0% K and can go as low as 0.5% in some situations. What does the dairy cow need to produce the most milk she is genetically capable of giving? Studies with sheep and growing or fattening cattle indicate about 0.6 or 0.7% K for ruminant animals.

But a milk-producing dairy cow may need more K than a growing animal. Because her milk contains about 0.16% K. And because a high-producing cow (over 80 lbs of milk per day) may consume about half the pounds of feed as she produces milk.

**Dairy cows receiving less than 0.3% K in their rations have displayed certain potassium deficiency symptoms: (1) Their feed intake declined to less than half normal intake. (2) Pica appetite was characterized by floor licking and chewing of wood. (3) The hair coat lost its glossiness and became rough and starring. Blood and milk changes in potassium and sodium content were also reported.**

We initiated a series of trials to try to determine the potassium needs of lactating dairy cows. Rodney Dennis has published his M.S. and Ph.D. thesis on potassium requirement of the dairy cow.

**IN HIS INITIAL STUDY** with cows producing between 40 and 50 lbs of milk in the second half of the lactation, he got results shown in **Table 2.** Although differences in milk production were not statistically different, body weight changes were significant.

The ration used in the initial study was a high energy ration based primarily on corn silage, distillers dried grain, and beet pulp. K content influenced the ability to consume more feed.

The increased feed intake was expressed primarily by an increase in body weight. With a high energy ration, the increase in feed intake would be most beneficial for high producing dairy cows in early lactation.

**IN ANOTHER TRIAL** with cows in early lactation, results showed some of the same trends but body weight changes were quite different, shown in **Table 3.** K content of the ration significantly affected feed intake again. And in the post trial period, milk production actually increased when the cows were switched from 0.51% K ration to 0.99% ration.

All cows were far enough along in lactation during the post trial period **to expect a natural decline in milk production from one week to the next.** The combination of weight loss, expected in early lactation, and milk production reflect the difference in feed intake. No obvious potassium deficiency symptoms described earlier were apparent.

In addition to these two trials, other trials we have conducted demonstrate **feed intake** is one of the primary factors influenced by the K content of the ration. Feed intake during early lactation is considered the limiting factor for many high producing dairy cows. And

**TABLE 3. THE EFFECT OF .51 TO .99% POTASSIUM ON DAIRY COW PERFORMANCE DURING EARLY LACTATION.**

| | Ration K Content (% of Dry Matter) 0.51 | 0.75 | 0.99 |
|---|---|---|---|
| | | lbs | |
| **Average daily feed intake:** | | | |
| Last week of experimental period | 40.5 | 42.2 | 45.5 |
| Post trial* | 48.0 | 44.4 | 46.6 |
| Difference | + 7.5 | + 2.2 | + 1.1 |
| **Average daily milk production:** | | | |
| Last week of experimental period | 63.8 | 61.6 | 66.4 |
| Post trial* | 64.0 | 61.4 | 63.8 |
| Difference | + 0.2 | − 0.2 | − 2.4 |
| **Body weight change** | −122.5 | −77.0 | −103.0 |

*Post trial period, all animals placed on 0.99% K ration.

this reduced feed intake indirectly affects milk production, most likely.

If a cow can mobilize body fat or consume enough of a high energy ration, she can probably continue to produce milk at a fairly normal rate. But if a cow's feed intake is limited during early lactation, inadequate potassium could limit milk production.

Our research indicates the dairy cow needs somewhere between .6 and .8% K in the ration dry matter to produce her best. If we assume some safety factor is needed, 0.8% should meet most practical situations.

What we do not know is how the K need might be altered by large changes in the calcium, magnesium, or sodium intakes. Some of these elements vary widely under practical conditions and studies with monogastric animals have shown an interaction between elements.

Our studies also show when potassium is in slightly suboptimal amounts in the ration, no apparent deficiency symptoms other than lowered performance can be observed by the dairyman. **The End.**

# Soil Test SUMMARIES Point To Fertility Needs and Levels

DARRYL D. WARNCKE
MICHIGAN STATE UNIVERSITY

**SUMMARIZING SOIL TEST** data from thousands of samples (over 28,000 in Michigan during 1975) can indicate average fertility levels across a state or region.

The Michigan State University Soil Test Laboratory uses computers to integrate test results with facts from farmers—their management practices, past crops, and crops to be grown. The computer calculates and recommends fertilizer and lime for specific crops. Once stored in the computer, soil test levels are easily summarized. And compiled over a number of years, soil test summaries show important trends.

**MEAN OR MEDIAN SUMMARIES**—which are better? A few very high values may bias a mathematical mean value. So, a mean may be misleadingly high.

A more meaningful soil test average is the median—because 50% of the soil test values are BELOW and 50% ABOVE the median. So the median is not influenced by extremely high values.

For example, Michigan's MEAN phosphorus and potassium soil test levels were 98 lb P/A and 182 lb K/A in 1975. But the MEDIAN values were 67 lb P/A and 155 lb K/A. Michigan State University uses MEDIAN values to summarize soil test results.

**TRENDS IN SOIL TEST VALUES** from 1962 through 1975 are shown in the median values of **Table 1.** Soil pH gradually declined from 6.6 to 6.4 as less lime and more nitrogen was used. Even more dramatic, samples requiring 3 or more tons of lime per acre increased from 6.5 to 22%.

Median phosphorus levels increased greatly during these 14 years—after using liberal amounts of phosphate fertilizers. Phosphates are quite immobile in soil and crops use less than 20% of the phosphate fertilizer the first year. The remainder is left in the soil—some helping to buildup or maintain soil test levels.

Median available potassium levels increased from 1962 through 1971 then

**Table 1. Median Soil Test Values for 1962, 1967 and 1970 through 1975.**

| Year | Soil pH | Available P | K | Ca | Mg |
|---|---|---|---|---|---|
| | | lb/A | | | |
| 1962 | 6.6 | 24 | 115 | 2682 | 254 |
| 1967 | 6.6 | 34 | 151 | 3322 | 326 |
| 1970 | 6.6 | 45 | 165 | 2053 | 249 |
| 1971 | 6.4 | 52 | 169 | 2139 | 262 |
| 1972 | 6.4 | 54 | 163 | 1816 | 205 |
| 1973 | 6.4 | 57 | 153 | 1882 | 206 |
| 1974 | 6.4 | 63 | 149 | 1658 | 178 |
| 1975 | 6.4 | 67 | 155 | 1646 | 180 |

Table 2. Relationship between soil texture groups and soil pH available phosphorus, potassium, calcium and magnesium levels 1975.

| Soil Texture Code* | Soil pH | Available P | K | Ca | Mg |
|---|---|---|---|---|---|
| | | lb/A | | | |
| 1 | 6.5 | 39 | 187 | 3566 | 507 |
| 2 | 6.5 | 53 | 168 | 2469 | 307 |
| 3 | 6.4 | 89 | 149 | 1234 | 132 |
| 4 | 6.4 | 86 | 120 | 988 | 94 |
| 5 | 6.4 | 88 | 98 | 788 | 84 |

*Soil texture group 1 is comprised of clay soils; 2 includes clay loams, loams, sandy clay loams and similar soils; 3 is sandy loams; 4 is loamy sands and 5 is sand soils.

started decreasing. The 10-year increase corresponded with increased use of muriate of potash.

In late 1972, demand for potash exceeded supply in Michigan—so less potassium was applied per acre. And many idle acres with lower fertility levels were brought back into production in response to the all out production policy of the USDA.

These two factors contributed to the gradual decline in median potassium test levels. With increased potash availability, the median potassium test level should stabilize or begin to increase again.

Weather may affect long time trends. With less than normal rainfall, as occurred from 1961 to 1967, salts tend to accumulate in the surface layer. During wet spells when above normal rainfall occurs, salts tend to leach out of the surface soil, especially in organic and sandy soils.

Since 1967, precipitation has been above normal in Michigan, except for 1971. Median calcium and magnesium levels decreased, except 1971. So, precipitation can influence soil test values. These calcium and magnesium decreases were also related to less lime use and more use of lower fertility idle acres.

**SOIL TEST VALUES** can vary according to soil texture—or the predominant mineral fractions, sand, silt or clay. **Table 2** shows this.

Clayey soils have a higher exchange, buffering, and fixing capacity than more sandy soils. The more buffered clay soils have higher median pH's than the less buffered loamy sands and sands. But the total potential acidity may be greater in the clayey soils.

In sandy soils (Textural groups 3, 4 and 5), available phosphorus levels are about double those in the clay soils (Textural Group 1). Since fixing capacity of sandy soils is relatively low, available phosphorus levels built up more quickly. Many of Michigan's sandy soils produce high value vegetables that demand higher phosphorus levels. This also contributes to higher phosphorus levels in the sandy soils.

With their higher exchange capacities, clayey soils provide more available potassium than sandy soils—and generally more calcium and magnesium than sandy soils. Sandy materials have fewer exchange sites to hold potassium, calcium, and magnesium. So, these cations may leach some in sandy soils.

**PUTTING SOIL TEST AND CROP** together, one can gain an insight into fertility practices used for various crops. **Table 3** shows this. Median phosphorus and potassium test levels do not vary greatly among *field crops*, because field crops are grown in

Table 3. **Median available phosphorus and potassium levels as related to crop to be grown (1975).**

| Intended Crop | Soil pH | Available P (lb/A) | Available K (lb/A) |
|---|---|---|---|
| Field Crops | 6.40 | 60 | 150 |
| Corn | 6.40 | 63 | 158 |
| Small Grains | 6.35 | 56 | 145 |
| Soybeans | 6.60 | 54 | 162 |
| Field Beans | 6.75 | 68 | 159 |
| Alfalfa (est) | 6.65 | 52 | 130 |
| Sugar Beets | 7.25 | 71 | 190 |
| Potatoes | 6.25 | 163 | 223 |
| Vegetables | 6.30 | 127 | 177 |

some type of rotation even though continuous corn is common.

**Table 3** soil test values indicated corn fields are being fertilized as well if not better than other field crops.

Forages can be managed better as the lower phosphorus and potassium levels indicate.

Specialty and high value crops (potatoes, sugar beets, vegetables, etc.) are receiving fertilization rates as the higher median phosphorus and potassium levels indicate.

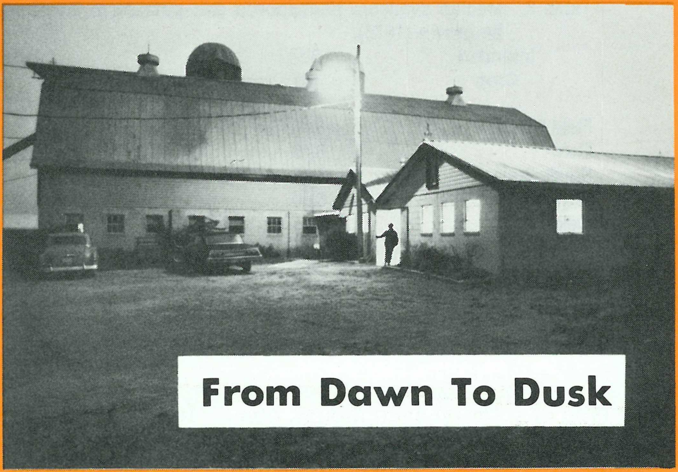
**WE ALSO SUMMARIZE** soil test results (1) by the various ranges from very low through very high, (2) by mineral soils and organic soils separately, and (3) by counties to get an idea of fertility practices in each county.

Summarized soil test data is provided to county extension agricultural agents for them to use in educational programs. Such programs may (1) promote soil sampling and testing in a profitable fertilizer program, (2) stress different fertility management practices for various soil texture groups, (3) point out possible pollution situations to help protect our environment.

Once soil test information is collected and summarized, potential uses of the summaries are almost limitless.

Individual farmers can use their own soil test information to indicate whether their fertilizer programs are improving, maintaining or decreasing the soil test levels.

By following these changes, farmers can adjust their fertilizer program accordingly. So individuals and soil testing labs alike should make the most of available nutrient soil test information. **The End.**



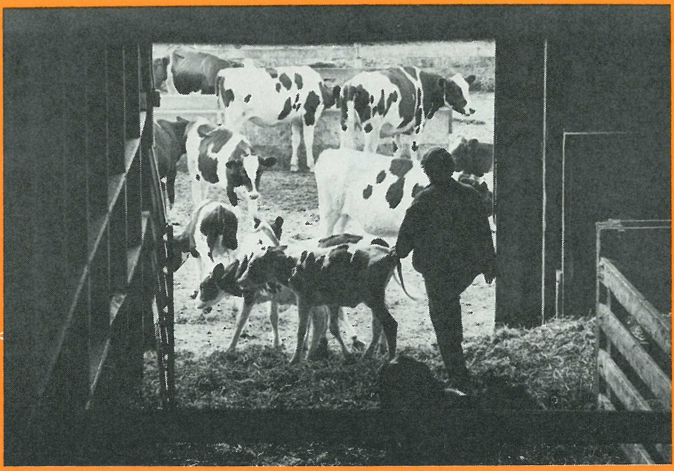

**With the lights inside already ablaze, Nona Schwartzbeck enters the milking parlor on their Maryland dairy farm to help with another 4 a.m. milking.**

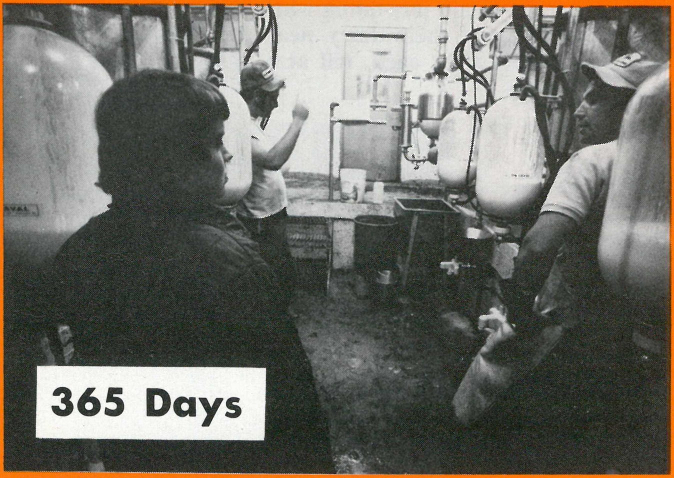
## A BETTER CROPS Salute Of Appreciation

**DAWN FINDS** the workday of Joe and Nona Schwartzbeck already two hours old as the young Maryland couple move their herd of nearly 90 dairy cows on the first of two daily trips through the milking parlor.

Across America, another 300,000 dairy farmers, under 300,000 different circumstances,

**Getting calves and heifers in their places is all in a days work for Nona Schwartzbeck on the farm she and husband Joe own west of Baltimore, Md.**






Milking on the Schwartzbeck dairy farm occurs at 4 a.m. and 4 p.m. It takes about 2 hours for the 90-odd cows to be milked.

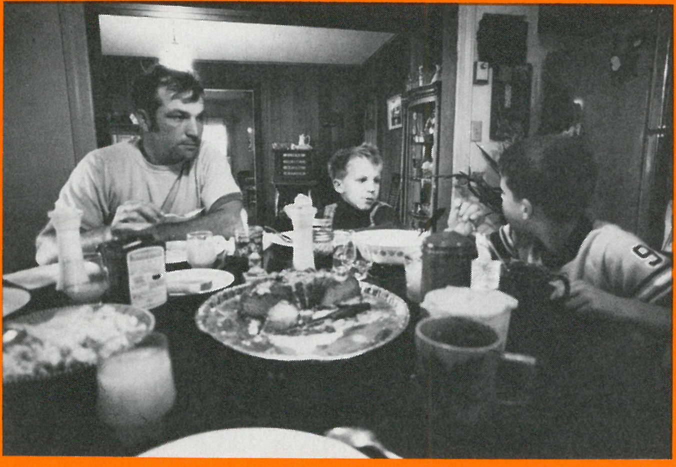
**From USDA Picture Story 295**

have started their days also.

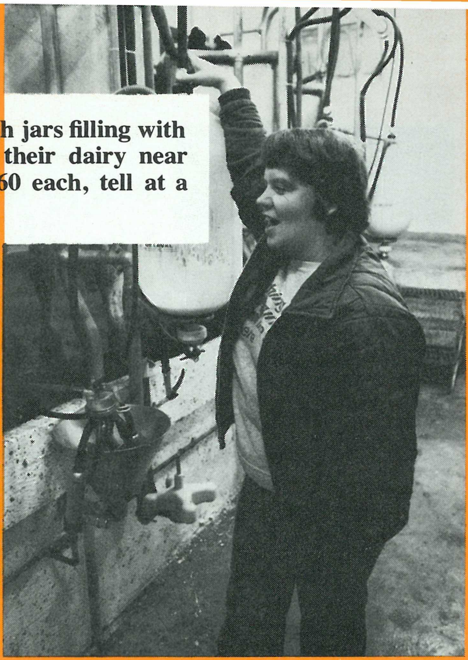
Within hours, 3½ million gallons of milk and milk products will be delivered to children and their parents in cities, large and small, across the country.

Dairying ties people down. The cows have to be milked twice-a-day, 365 days a year.

The Schwartzbecks have breakfast about 7 a.m. after the morning milking is completed. Their children are Gus, 10 and Shane, 6.



**Nona Schwartzbeck checks one of the weigh jars filling with milk during an early morning milking at their dairy near Baltimore, Maryland. The jars, costing $360 each, tell at a glance how much milk a cow is giving.**



Between milkings there's what most folks would consider a full days work.

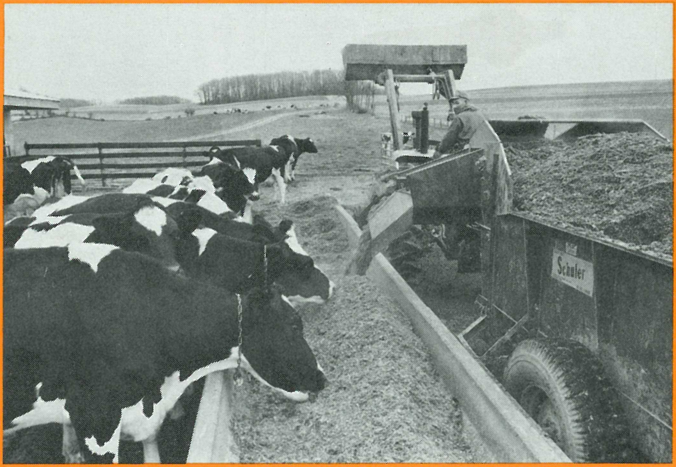
Depending on the season, it's either planting corn, making hay, or harvesting grain. Repairing and cleaning equipment. Tending the animals. Plowing to raise a new crop of feed.

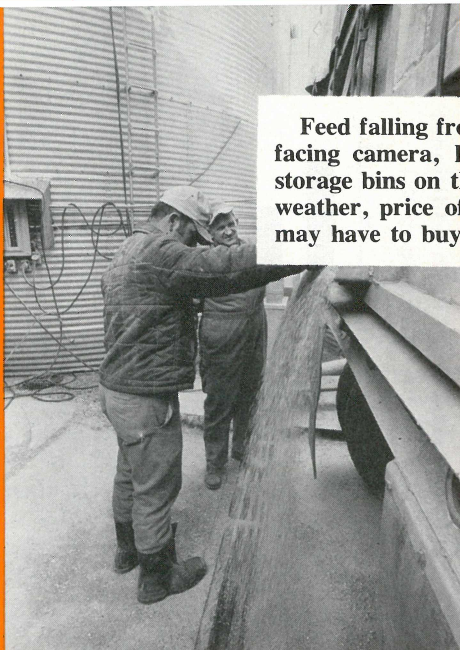
And dairying takes a big investment. The average family dairy operation has more cows than one of a generation ago. And more mechanization. Expensive mechanization.

The Schwartzbecks have five tractors, seven hay wagons, three silage wagons, two trucks, and various planters, mulchers, lifters, spreaders, dryers, balers, and rakes. Altogether—land, buildings, animals, and equipment—they have about $300,000 invested in dairying.

While this is above the national average of $175,000 total investment on a U.S. dairy farm, it is representative of the future direction many dairymen will be going.

**The cows on the Schwartzbeck dairy farm—all purebred registered Holstein-Friesians—are fed silage from a tractor-pulled power-driven feed wagon. "You can get $100,000 tied up in equipment real quick," a dairyman remarked.**





**Feed falling from a delivery truck run by Floyd Devilbiss, facing camera, hits an auger that will carry it to nearby storage bins on the Schwartzbeck dairy farm. Depending on weather, price of grain, and other variables, Schwartzbeck may have to buy feed one year, have extra to sell the next.**

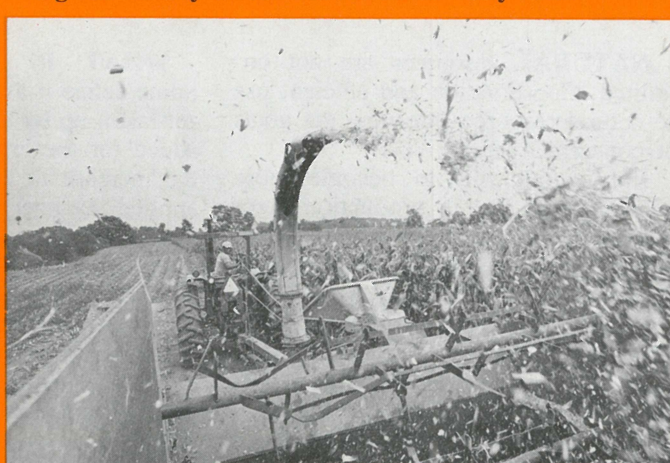
Why do people stay in dairying where the investment and risks are high, the hours are long, and work goes on 365 days a year?

They stay, they say, because it's a way of life, not a job. A good way of life. They like working for themselves. They think it's a good way to bring up kids.

**But no matter how they feel about the virtues of the life-style, they have to make a living at dairying in order to stay. If they can't make a living, they have to quit and go into something else. And that will mean less milk and milk products coming into cities.**

Many, like the Schwartzbecks, use their income to pay interest on their indebtedness for land and equipment. And by nibbling away at their mortgage, they some day hope to pass on a considerable equity to their children—**depending on weather, good management, and adequate prices for their milk.**

**Chopping hundreds of acres of corn into tons of silage is a big full activity on the Schwartzbeck dairy farm.**



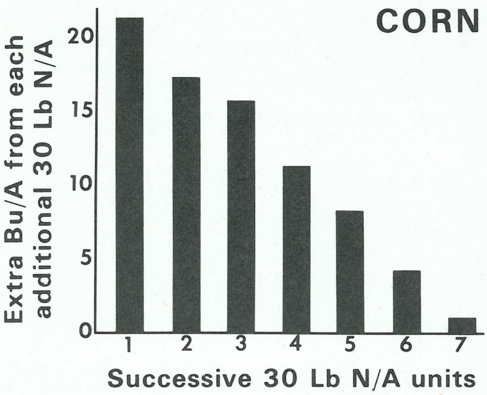



**Figure 1**—Each successive nitrogen increment increases corn yield less than the previous increment.

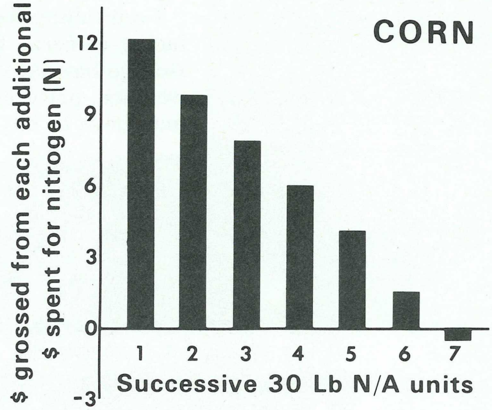



**Figure 2**—Each additional dollar spent for fertilizer grossed less than the previous dollar.

# What Is Fertilizer EFFICIENCY?

L. F. WELCH
UNIVERSITY OF ILLINOIS

**The second 30 lbs of nitrogen were less efficient than the first 30 lbs, but still outstanding. The key to additional fertilizer increments is not whether the last increment produced as well as the previous increment, but whether returns from it are greater than cost. The grower reaches maximum profit by adding fertilizer until returns equal cost of the last fertilizer increment.**

NATURAL resources are not unlimited. Conservation and efficient use of natural resources are now the goals of concerned people.

But in our zeal to become more efficient with certain production practices, let's not make the whole system less efficient—then less profitable to the farmer.

When the crop production system is less profitable to the farmer, the produce is more expensive for the consumer.

WHAT IS fertilizer efficiency? Some define it as the relation of fertilizer taken up by the crop to the amount added for the crop. Some define it as the increase in crop yield per unit of applied fertilizer. Economically, fertilizer efficiency may be the maximum dollar return for each dollar spent for fertilizer. When viewed alone, maximum fertilizer efficiency is not a worthy goal—because maximum fertilizer efficiency usually occurs with the lowest increment of added fertilizer.

**Table 1—Actual and Predicted Corn Yields With Nitrogen Fertilizer Added to Corn in Central Illinois. (8-yr avg)**

| N Rate lb/A | Corn Yield, Bu/Acre Actual | Predicted |
|---|---|---|
| 0 | 78 | 79 |
| 30 | — | 100 |
| 60 | 119 | 117 |
| 90 | — | 131 |
| 120 | 142 | 142 |
| 150 | — | 150 |
| 180 | 152 | 154 |
| 210 | — | 155 |
| 240 | 153 | 152 |

The desired goal is maximum fertilizer efficiency from the rate required for most profitable crop yield.

**CORN GROWN** at the Hartsburg Agronomy Field in central Illinois received five nitrogen rates each year in the 8 years of 1968-75. Rates varying in 60-lb increments produced yields shown in **Table 1.**

For this report, results are discussed in terms of 30-lb increments of nitrogen. So, a mathematical equation was developed which predicted yields shown in **Table 1.** Note the very close agreement between actual and predicted yields.

**THE LAW** of diminishing returns is shown in **Figures 1 and 2.**

Each additional 30-lb increment of nitrogen produces less additional corn than the preceding 30-lb increment in **Figure 1**—expected from added fertilizer and known as diminishing returns.

Gross profits (value of additional corn divided by cost of 30 lbs nitrogen, with corn $2.25/bu and nitrogen $0.12/lb.) from each additional dollar spent for nitrogen follow the same law of diminishing returns in **Figure 2.**

The first 30-lb nitrogen increment added 21 bushels corn, the second 30-lb increment 17 bushels.

Gross profits from each dollar spent for nitrogen were $12.12 for the first increment, $9.62 for the second increment.

If we consider only nitrogen fertilizer, the second 30 lbs of nitrogen were less efficient than the first 30 lbs, but **still outstanding.**

**The key to additional fertilizer increments is not whether the last increment produced as well as the previous increment, but whether returns from it are greater than cost. The grower reaches maximum profit by adding fertilizer until returns equal cost of the last fertilizer increment.**

**Figure 3** shows 180 lb nitrogen per acre would be the most profitable rate.

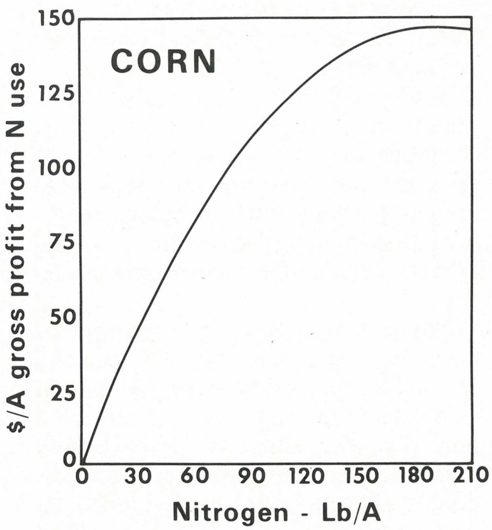



**Figure 3**—Gross profits from nitrogen fertilizer on corn were greatest with 180 lb N per acre.

**OTHER INPUTS** become more efficient through fertilizer—a vital fact in a high-cost age. Many production practices cost about the same whether yields are low, medium, or high.

Moldboard plowing costs about $8.75 per acre in Illinois, regardless of how much nitrogen the grower adds to a particular field.

**Figure 4** shows how nitrogen lowered the cost of moldboard plowing.

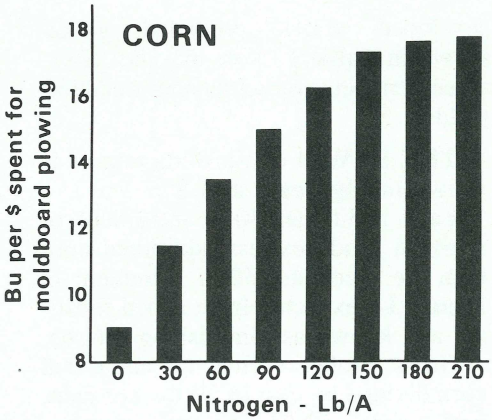



**Figure 4**—Fertilizer increases the efficiency of other production inputs. Here more bushels of corn from nitrogen lowers cost of moldboard plowing per bushel of corn produced.

No nitrogen produced 9 bu corn, while 180 lb N/A produced about 18 bu/A **for each dollar spent on moldboard plowing.** Nitrogen got twice the yield mileage out of those plowing dollars.

Nitrogen not only reduces production cost per bushel, but also increases efficiency of limited resources such as gasoline.

**Figure 5** shows how nitrogen lowered the cost of gasoline. No nitrogen produced 49 bu. corn, while 180

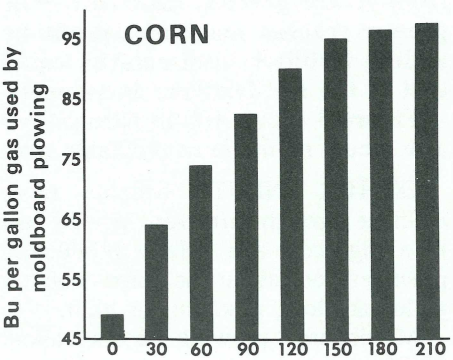



**Figure 5**—Fertilizer increases the efficiency of gasoline used for moldboard plowing.

lb N/A produced 96 bu/A **per gallon of gas used in moldboard plowing.**

Fertilizer increases the efficiency of many other inputs—such as, bushels of corn per hour of labor, bushels per dollar of interest on land investment, bushels per dollar spent for limestone, phosphorus and potassium, etc.

While the efficiency of nitrogen fertilizer may decrease after the first increment of added nitrogen, the efficiency of other production inputs continues to increase beyond the first increment—more than offsetting the reduced nitrogen efficiency beyond that first increment.

Although nitrogen has been used for this discussion, potassium, phosphorus, and other fertilizer materials also increase the efficiency of other inputs in direct proportion to the extra yield they give.

For example, when potassium increases corn yield 30%, the efficiency of gasoline used in moldboard plowing is increased 30%.

**DELAYED EFFICIENCY** can be a big bonus. Once a gallon of gasoline has powered an automobile so many miles, the gas is gone and can never be used again.

With fertilizer, especially phosphorus and potassium, efficiency may continue for a few years—because any fertilizer not used by the immediate crop is partially used by future crops. So the grower has more than one opportunity to capitalize on added fertilizer.

**Soybean yields** were increased 20 bushels per acre (from 50 to 70 bushels) in one Illinois study when potassium was added to corn for 4 years. No potassium was added to the soybeans.

In this case, potassium fertilizer was doubly efficient—increasing immediate corn and future soybean yields—a fact worth remembering when computing K's influence on crop yields.

**OTHER PRODUCTION** practices

| COLOR SLIDE SETS with SCRIPTS | 10-Day Loan | Purchase |
|---|---|---|
| Facts Point to Fall-Winter Fertilization, 37 slides | ________ | ________ $10 |
| Fertilizer Time Is Anytime Down South, 35 slides | ________ | ________ $10 |
| Build Quality Lawns for Beauty, 41 slides | ________ | ________ $10 |
| Fertilize Forages for Profit, 43 slides | ________ | ________ $10 |
| Potassium for Agriculture, 68 slides | ________ | ________ $10 |
| Coastal Bermudagrass, 49 slides | ________ | ________ $10 |
| Field Diagnosis & Tissue Testing, 51 slides | ________ | ________ $10 |
| Fertilizer Application For Top Yields, 45 slides | ________ | ________ $10 |
| Potassium Hunger Symptoms, 40 slides | ________ | ________ $10 |
| Phosphorus & Potassium in No-Till Crop Production, 10 slides | ________ | ________ $5 |
| Potassium Production & Properties, 38 slides | ________ | ________ $10 |
| La Fertilizacion Del Maiz (Spanish), 33 slides | ________ | ________ $10 |
| Know Plant Food Uptake Powers of Your Crops, 17 slides | ________ | ________ $5 |

**(Sign name & address on other side of this coupon)**

can improve or inhibit fertilizer efficiency.

When the practice leads to higher crop yields at a given fertilizer rate, fertilizer efficiency increases. Fertilizer efficiency declines when the practice leads to lower crop yields.

**Figure 6** shows how early planting increased nitrogen efficiency in Illinois.

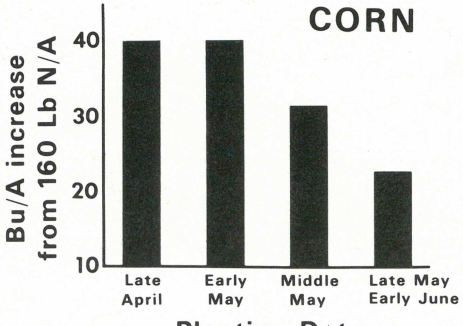



**Figure 6**—Other production factors such as corn planting date affect fertilizer efficiency. In this study at DeKalb, Illinois, early planting helped the crop respond more fully to nitrogen.

The 160 lb N/A treatment increased early-planted corn 40 bushels, late-planted corn 22 bushels per acre—or 18 MORE bushels per acre from the same fertilizer in a different practice.

The same principle happened with potassium in Indiana. Potassium increased early-planted corn 26 bushels, late-planted corn 11 bushels per acre.

Any factor that increases crop yields usually increases fertilizer efficiency. Any given fertilizer nutrient will be most efficient when other nutrients and other growth factors are properly managed.

One way to improve fertilizer efficiency is to do everything required for high crop yields—such as right variety selection; planting date; population; control of weeds, diseases, and insects; and harvesting, storage, and marketing.

Good management—including proper fertilizer rate—increases fertilizer efficiency as well as other production factors. **The End**

## NEW CASSETTE TAPE SERVICE with THREE SLIDE SETS

**THE POTASH INSTITUTE** has developed cassette tapes for three of its popular slide sets—corn, soybeans, alfalfa. The tapes are for loan only and will serve non-automatic machines. The three slide sets are also accompanied by compact script booklets. Narration time for the three tapes are: **Corn, 22 minutes; Soybeans, 14 minutes; Alfalfa, 17 minutes.**

Order early for your meetings:

| SLIDE SETS | Loan Date (10 days) | Purchase | Cassette Tapes (Loan only) | Booklets (Quantity) |
|---|---|---|---|---|
| Top-Profit Corn (44) | ________ | ______ $10 | ________ | _____ 15¢ ea. |
| Alfalfa, Cash Crop (35) | ________ | ______ $10 | ________ | _____ 15¢ ea. |
| Fertilize Soybeans (36) | ________ | ______ $10 | ________ | _____ 15¢ ea. |

Name ______________________ Address ______________________
State ______________________ Zip ______________________
Organization ______________________________________

Potash Institute 1649 Tullie Circle NE Atlanta, Ga 30329

**MORE COUPON ON OTHER SIDE OF THIS SHEET**

**ORDER SLIDE SETS WITH NEW CASSETTE TAPES ABOVE**

**Better Crops**
**WITH PLANT FOOD**

Controlled circulation postage paid at Washington, D. C.

Potash Institute
1649 Tullie Circle, N.E., Atlanta, Ga. 30329

THE POCKET BOOK OF AGRICULTURE