Better Crops

WITH PLANT FOOD

SUMMER 1966
25 CENTS

LET'S FACE FACTS

COVER 2
and
PAGE 24

FACTS FAVOR FALL-WINTER FERTILIZATION

THE GROWER ABOVE is getting his fertilizer on and plowing it down when weather is good and the ground is firm enough to take heavy equipment.

The grower with the bogged down spreader on the front cover could tell you a mouthful about unpredictable spring weather. His soil will take a year or two to get over such damage—while everyone loses time and money.

On Page 24, University of Illinois scientist Samuel Aldrich presents a strong case for fall-winter fertilization. And he doesn't stand alone. Many outstanding colleagues made suggestions to him on this important topic—including **Iowa State's John Hanway, Michigan State's R. E. Lucas and Lynn Robertson, Ohio State's Harold Shoemaker, Minnesota's Curtis Overdahl, and Purdue's S. A. Barber, plus several fertilizer industry agronomists.**

Facts favor fall-winter fertilization. Let's face them on page 24.

Better Crops WITH PLANT FOOD

The Whole Truth—Not Selected Truth

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CONTENTS

THE LAW of OMISSION

IS IT SQUEEZING YOUR CROP YOUR FARM etc.

BY ARTHUR S. KING
SOIL CONSERVATION SPECIALIST

RECENTLY a local staff economist who prefers to remain anonymous, rediscovered, and for the first time clearly defined the law of omission.

After failing by five miles for the fifth time to prove the validity of the economy claims of a foreign-built car, he succinctly summarized the situation:

"Mit yet out one essential [1] input . . . all is kaput." [2]

HOW MANY times has the law of omission caught up with you? How many times have you omitted fertilizer "to cut costs," only to lose yields?

Are you handicapped by the "how much does it cost" or "can I afford it" approach?

Back in the 1930's B.F. (Before Fertilizer), the average wheat yield in our Willamette Valley was 23 bushels per acre. Today, the average yield exceeds 50 bushels.

This sounds good. But look at Gaines, Druchamp, and similar high-yielding varieties coming in. Look at the increasing number of 100-bushel yields or higher. We might ask: Why do we farm at half our proven wheat potential?

Our average yields are modest because we have a conservative attitude toward fertilizer use, especially nitrogen. The evidence is clear. Only a few farmers use enough fertilizer to get full yield potential. Maybe too many remember when gross return from the 23-bushel average would not pay the $25 to $30 per acre top costs for fertilizer profitably used today.

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(1) The direct reference is to essence of petroleum—petrol. The broad reference is obvious.
(2) kaput—(kä-poot') [G] finished; done for; ruined; completely gone to pot.

"For the want of a nail, a shoe was lost . . . for the want of a shoe, a horse was lost . . . for the want of a horse, a rider was lost . . . for the want of a rider, the battle was lost . . . for the want of a battle, the kingdom was lost—all for the omission of one horseshoe nail."

COOPERATIVE EXTENSION SERVICE
OREGON STATE UNIVERSITY

FLATTER THAN PIZZA ON A PLATE

Growers who pioneered fertilizer use on wheat in the 1940's had another reason for low usage. The weak-strawed varieties then available could lodge disastrously from an overdose of nitrogen. It was a dismal day to awake to a fine field of fertilized "forty fold" fallen flatter than pizza on a plate.

But today, farmers are proving that lodging is no problem with Gaines and Druchamp when the variety is adapted to the soil. Gaines is the best bet on soil of high natural fertility, while Druchamp stands up and yields on soils of allegedly lower fertility levels.

THEY CAME TO KILL . . . AND STAYED TO REAP

In our Testing Tells Demonstrations last year, we learned some valuable facts about the law of omission. On two demonstrations of spring-applied nitrogen in Polk County, one object was to kill some wheat with "excessive" nitrogen applications. Rates varied up to 160 lbs. N per acre on wheat already fall fertilized. Here's what happened:

BRUNK
(1.5 lb. N per bushel)

N Treatment Lbs./A	Yield Bu./A
40	72
80	119
120	129
160	131

RIDDELL
(1.4 lb. N per bushel)

N Treatment Lbs./A	Yield Bu./A
40	69
80	106
120	123
160	122

The demonstrations did not achieve their major goal. In fact, the 160 lb. N rates even failed to de-

IF THE FERTILIZER RATES SEEM HIGH . . .

COUNTY	PLOT	CHECK Bu/A	BEST YIELD Bu/A	Treatment Fall	Treatment Spring
Yamhill	Brandt	83	118	20 N	80 N
Polk	Marx	53	122	20 N 60 P_2O_5 40 K_2O	120 N
Yamhill	Drumgoole	21	83	20 N 60 P_2O_5 40 K_2O	120 N
Washington	Kennel	24	93	20 N	100 N
Washington	Kock	39	98	....	100 N

press yields. But when you compare the yields, you can see a pattern. Properly used fertilizer produces cheap wheat. Let's look at the results from two angles:

THE RESULTS OF USAGE

On the Brunk plots, boosting N rate 40 lbs.—from 40 to 80 lbs. N —*added* 39 bushels at a cost of 1 lb. N per bushel—mighty cheap wheat. The second 40 lbs. N added 10 more bushels at a cost of 4 lbs. N per bushel, still a good buy. The last 40 lbs. N—from 120 to 160 lbs. N—was needless cost in last year's very dry weather. But another couple inches of rain might have boosted yields 10 more bushels.

On the Riddell Plots, the story was about the same: the 80 lbs. N —from 40 to 120 lbs.—produced wheat at a cost of 1.4 lbs. per bushel, almost duplicating the 1.5 lbs. N per bushel on the Brunk plots.

THE COST OF OMISSION

On the Riddell plots, 40 lbs. N made 69 bushels and 80 lbs. N made 106 bushels per acre. To omit the second 40 lbs. N would cost a grower 37 bushels. At $1.50 per bushel, this omission of 40 lbs. N would cost him $55.50. If he stopped at the 80 lbs. N level, he would lose 17 bushels—$25.50, still a HIGH price to pay for only 40 lbs. N needed for the top yield. So, omitting 80 lbs. N on the Riddell plots would cost a grower $81.00 per acre—*just over $1.00 per pound of N!*

On the Brunk plots, a grower omitting the same 80 lbs. increment —from 40 to 120 lbs. N—would lose 57 bushels: $85.50 or $1.07 per lb. of N, a high cost for omitting a few extra pounds of 12¢ nitrogen.

This surely proves ample fertilizer application is most costly when left in the bag, the barn, the warehouse, or the factory.

These Brunk and Riddell plots were spring-established on fields already fall-fertilized. So, there were no untreated checks.

OTHER PLOTS TEACH STRONG LESSONS

Six other Testing Tells plots, started in fall, involved seven different treatments, including phosphate and potash with various nitrogen levels. The tables above tell the story of five demonstrations: compare untreated checks with highest yields, give the fertilizer

. . . THEN LOOK AT THE COST OF OMISSION

Plot	Bu/A Credit to fertilizer	Cost of fertilizer	Cost fertilizer omission
Brandt	35	12.00	$ 52.50
Marx	69	24.20	103.50
Drumgoole	62	24.20	93.00
Kennel	69	14.40	103.50
Kock	59	12.00	88.50

Fertilizer priced at N 12¢ lb; P_2O_5 9¢ lb; K_2O 5¢ lb; wheat at $1.50 bu.

treatment producing the top yields, and cite the cost of omitting fertilizer.

Except for the Brandt plots, the mineral nutrients in the fertilizer made more wheat than the nutrients from the natural soil. Some pessimists may groan at the seemingly heavy fertilizer applications—in two cases, a total of 140 lbs. N per acre plus phosphate and potash. But wait! Let them compare the cost of applying fertilizer to the cost of omitting it.

One conclusion seems logical here: Impecunious fertilization can impoverish the affluent and pauperize the opulent. In other words, Penny-wise can prove to be dollar-foolish—especially today.

"UNPRODUCTIVE" OR "UNFERTILIZED"?

Fields vary in natural fertility, causing unfertilized checks to vary widely in yields. Druchamp wheat was used in these trials. And there was no lodging under heavy nitrogen applications. Even on the Brandt plots (above), where an 83-bushel check yield indicates high natural fertility, 40 lbs. N above that needed to produce the crop yield caused no significant damage.

On the Drumgoole and Kennel locations, low yields on the unfertilized plots might indicate naturally unproductive soils. **Perhaps the yields from ample fertilizer suggest that "unproductive" merely means "unfertilized."**

In four demonstrations, a little nitrogen (20 lbs. N per acre applied at seeding time) proved profitable—contrasting with previous ideas that fall nitrogen is not always necessary. These results suggest $2.40 invested in nitrogen at seeding is low-cost insurance.

PHOSPHATE-POTASH NEEDS FORESEEN

Responses to phosphate and potash on the Drumgoole plots were predicted by earlier soil tests. Banding 60 lbs. phosphate and 40 lbs. potash with nitrogen at planting added 11 bushels to the yield. Broadcasting the same rates increased the yield only 2 bushels. This sells the value of banding equipment on the drill. In this instance, operating a drill without banding equipment cost $13.50 per acre—high rental for a machine that does only half the job.

Fall fertilization is usually necessary with winter wheat. And spring-applied nitrogen adds a payoff punch!

YOU CAN'T BEAT THE LAW!

Yields from the sixth demonstration (Benton County) were not reported because all plots virtually failed from no weed control. The law of omission really told here: omitting spray for rye grass cost 100-bushel wheat per acre, PLUS $24.20 per acre for wasted fertilizer. Total loss: $174.20 per acre!

More and more 100-bushel yields are coming each year. But why stop with 100 bushels? Some farmer soon will "shoot the moon" by irrigating in May and June—and get 200 bushels! It's in range. And—incidentally—the cost of NOT using irrigation during a dry May or June could total more than the original cost of equipment.

You just can't beat the law of omission!

The End

Plant Analysis and Fertilizer Problems IV

Volume IV, PLANT ANALYSIS AND FERTILIZER PROBLEMS, edited by Dr. C. Bould, England, Dr. P. Prevot, France, and Dr. J. R. Magness, U.S.A., has been published by the American Society for Horticultural Science. It contains 29 papers dealing with fertilizer and plant nutrition research that were presented at the fourth colloquium on that subject, held in Brussels, Belgium.

The papers cover a wide range of research with specific crops. Included are papers on **fruits**—citrus, banana, pineapple, grapes and raspberry; on **vegetables**—celery, peas, potatoes and tomatoes; on **agronomic crops**—cotton, sugar beets and oats; and such **other crops** as rubber trees, tea, tung and chrysanthemums. Special subjects covered include effects of nematodes, salinity, and weather conditions on plant nutrition.

The volume contains 430 pages, contributed by outstanding specialists in the field. Six of the papers are in French, all others are in English. This volume should be available to students, teachers and research workers in all departments of horticulture, agronomy and soils.

Also, it is a valuable reference for technical advisors and others interested in the soil fertility aspects of crop production.

The price of the volume is $7.50 delivered to individuals, libraries or firms, both in the U.S.A. and other countries. A discount of 10% is allowed to agencies. Checks or drafts should be made payable to the American Society for Horticultural Science. **Order from:**

Cecil Blackwell, Executive Director, American Society for Horticultural Science, P.O. Box 326, St. Joseph, Michigan 49085, U.S.A.

FACTS FAVOR FALL-WINTER FERTILIZATION

PREVENT EMPTY BIN

WINTERIZE FORAGES

Some fertilizer bins may be empty in spring because rail cars are in short supply. Though new cars are being manufactured, car shortages become more critical each spring because of the larger fertilizer and freight volume. So, getting the fertilizer delivered in time in spring is becoming a bigger problem each year.

Plowdown gives higher yields than disced in. Discing leaves most of the P and K in the surface 2 or 3 inches. But plowdown puts much of the fertilizer down deep where the soil is more likely to be moist and roots active. Ontario work got much better yields of corn from plowdown.

Of course, with small amounts of P and K, you'll get best efficiency from band application at planting. Also, such crops as small grain best use all P applied at planting. Twenty-five to 50 pounds per acre of a high-P fertilizer directly with the corn seed is receiving considerable attention.

Fall plowing is a plus in itself. With fall fertilization, the land is usually fall plowed. This fall plowing may increase yields up to 10% on level dark-colored medium and fine textured soils. And winter freeze-thaw action on such soils should help aeration. Over the years, look for rising yields through better soil physical condition. Soil type and slope are the keys to plowing in fall or in spring. Leave the soil rough to permit maximum moisture penetration and quicker drying in spring.

Fertilize to winterize. Seven to 10-ton alfalfa yields remove much plant food, especially K. Fall is the ideal time to apply P and K and prepare alfalfa for winter —and the ground is usually solid. Heavy spreaders on soft soils in spring may crush crowns, compact soil, and reduce any chance for top yields.

(From Slide Set On Fall Fertilization)

Tell The Facts To Your People

WALL CHART, FOLDER, NEWSLETTER, PICTURES & SLIDES, NEWSPAPER AD MATS

ORDER SUPPLY TODAY—PAGE 29 – 32

TEN TONS ALFALFA

YES, we do mean ten tons of alfalfa hay from one acre of **non-irrigated** land in the Cornbelt. It **is** possible!

One variety yielded 9.7 tons in a University of Illinois Variety Trial in 1965. Many varieties in this trial averaged from 8.5 to 9.5 tons per acre per year in 1964 and 1965. **Our better farmers are already harvesting 7, 8, and 9 tons.**

What's the secret? We don't know all factors contributing to maximum alfalfa yields. But important ones we do know demand our attention. Let's take a look:

1. EXCELLENT VARIETIES

Today many varieties are top yielders. Look at the yields from a 1963 seeding in Table 1. These yields are corrected to 88% dry matter (12% moisture) and are two year averages. The highest annual yield was 9.7 tons per acre, from WL 303, in 1965.

Most of the fast-growing Flemish varieties do not resist bacterial wilt, must be used for short-term stands. But one new variety of a Flemish type, Saranac, will resist bacterial wilt and can be used for either short or long term stands.

BY
O. N. HITTLE
AND
J. A. JACKOBS

UNIVERSITY
OF
ILLINOIS

TABLE 1. ALFALFA YIELDS AT URBANA, ILLINOIS 2-YEAR AVERAGES 1964-65 FROM 5 CUTTINGS PER YEAR

FLEMISH VARIETIES	T/A
DuPuits	9.4
Flamande SC-118	9.4
Saranac	9.2
Alfa	9.1
FD-100	9.0
Ave. =	9.2
U. S. VARIETIES	
WL 303	9.4
525	9.0
Cayuga	8.8
Cody	8.7
Buffalo	8.6
Vernal	8.4
Ave. =	8.8

All U. S. varieties in Table 1 show high resistance to bacterial wilt except WL 303 which shows moderate resistance. These varieties are suggested for long-term stands but can also be used in short rotations.

Many superior varieties not in Table 1 performed well in Central Illinois. They were just not included in this particular trial. Progress, WL 202, and Europa have performed very well in other trials.

HOW?

1. Choose a top variety and use the right variety in the right place.

In central Illinois, Indiana, and Ohio forget about extreme winter hardiness . . . go for varieties that bounce back after cutting, that keep growing late in the fall. You want enough winter hardiness, but don't sacrifice late-season yield for more winter hardiness than is needed.

2. Cut early and often. In the central Cornbelt, we want at least 4 cuts—maybe 5!

Take the first cut in the early bud stage. This will boost both quality and yield and allow the second cut to come on when growing conditions are good.

Cut the second and third cut on the basis of number of days, usually 30 to 35, between the time of the first cut and around September 1. This means June 20-26 for the second cut; July 20-26 for the third cut. Removal of the fourth cut as early as September 1 is desirable. This will allow more time for growth of the fifth cut which should not be removed until late October.

3. Encourage improved seeding practices. Cultipackers help.

4. Put on enough fertilizer before or at seeding time and add enough each year through topdressing to maintain top production.

5. Get the machinery it takes to get forage out of the field and into storage, with a minimum of field losses and with the least possible use of labor and time.

TABLE 2. DISTRIBUTION OF 9-TON YIELDS BY CUTTINGS
TWO YEAR AVERAGES 1964-65
T/A at 12% Moisture (88% Dry Matter)

Varieties*	Year 1964 1965	Cutting 1st May 21 May 14	2nd June 26 June 22	3rd July 30 July 26	4th Sept. 14 Sept. 9	5th Nov. 5 Oct. 28	Season Total
Flemish........		2.5	2.4	2.2	1.6	.5	9.2
U. S............		2.5	2.2	2.1	1.6	.4	8.8

* Average of the 5 Flemish and 6 U. S. varieties listed in Table 1.

2. EARLY CUTTING— FREQUENT REMOVAL

Right cutting schedule is a **must** for maximum yields. Usually the first cut cannot be taken on a "calendar date." The date of the first cut depends on the kind of spring we have.

In our trial, we took the first cut in the early to mid-bud stage on May 21 in 1964 and on May 14 in 1965—Table 2. Under normal soil moisture, alfalfa should be cut every 30 to 35 days. With the first cut on May 15 to 20 and the last cutting on September 1 to 10, four harvests are no problem.

Early and frequent cutting pays off:

(1) No lodging, which reduces field losses.

(2) Little to no leaf losses from leaf diseases and leafhoppers. Early, frequent removal usually does not allow leaf diseases or insect infestation to build.

(3) Better quality. Young alfalfa plants hold their leaves—mature plants do not. Crude protein levels in our 1965 harvests averaged 19% for the first, third, and fourth cut, 21.5% for the fifth cut. Crude protein for the second cut was down to 14.5% because of some leafhopper damage. Crude protein differences among varieties were insignificant.

(4) Moisture for second growth. Allowing second growth to come on in late May and early June means plenty of soil moisture still available.

Note the yield distribution in Table 2. With the first cut taken on or about May 15, nearly as much yield was obtained from each of the second and third cuts as from the first. Everyone has plenty of forage during May and the first part of June. But an early cutting program that will increase late summer production pays off.

Many varieties are characteristically high first-cut yielders, but yields drop off in later cuts. The Flemish and some of the newer U. S. varieties maintain somewhat better yields throughout the season. Alfalfa breeders are shooting for varieties that will have higher yields in the later cuttings.

3. LATE FALL HARVEST

In some seasons, the fifth cutting of alfalfa may not be worth taking but in other seasons **it can add another ton.** If you need it, cut or graze it! If not, leave it! In 1965, our fifth-cut yields were .7 ton for the Flemish varieties and WL 303. Quality was high: 21.5% crude protein. The fall growth habit of most varieties results in short internodes and a high leaf-stem ratio.

Late fall harvests do not adversely affect alfalfa stands in later years, our experience shows. But leave the alfalfa alone during early fall, from

TABLE 3. FERTILITY HISTORY OF 9-TON ALFALFA TRIAL AT URBANA, ILLINOIS

Year	Pounds Per Acre				
	Limestone	N	0-20-0	0-0-60	Crop
Before 1930	14,000				
1952	6,000				
1958		80			Corn
1959		95		400	Corn & soybeans
1960			550	183	Corn & soybeans
1961		165			Corn
1962			500	167	Corn
1963	8,300				Alf. seeded
1964				460*	Alfalfa

* Applied in the fall after removal of the 5th cut.

the first or middle of September to the last of October. This gives root reserve time to build up for the job of getting the plants through winter and into strong early growth next spring.

4. ADEQUATE SOIL FERTILITY

When it comes to fertility, it doesn't pay to take a chance.

Our planting was on fertile Drummer-Flanagan soil capable of high crop yields. We did not apply excessive fertilizer rates. The fertility history of the field is in Table 3. Five and a half tons of rock phosphate and 225 tons of manure were applied before 1930. Soil test results are in Table 4. Samplings were made at 6-inch intervals from the surface down to four feet.

pH—Even though pH values of this highly buffered soil at the plow sole are only 6.2, they gradually increase to 8.0 at the four-foot depth. Many alfalfa roots are undoubtedly feeding at the 30-48 inch depth.

PHOSPHORUS—The low P_1 values, measuring readily available phosphorus, are in line with the past fertilizer program of this field. They are lower than expected on the basis of alfalfa harvested. Plant analyses, from each cutting, ranged from .17 to .25% P and averaged .22%. These values are rather low according to some reports.

The P_2 values, measuring reserve phosphorus, are high at the surface, drop drastically at the 18-inch depth, but go back up at the 36-48 inch depth.

TABLE 4. SOIL TEST RESULTS 9-TON ALFALFA TRIAL—URBANA, ILLINOIS
Average of 27 Samples Taken Throughout the Test Area on June 18, 1965

Sample Depth	pH	P_1	Rating	P_2	Rating	K	Rating
0-6″	6.2	36	M	109	VH	277	VH
6-12″	6.3	19	S	82	H	232	VH
12-18″	6.9	2	VL	20	VL	243	VH
18-24″	7.1	2	VL	27	L	254	VH
24-30″	7.4	2	VL	39	S	262	VH
30-36″	7.7	3	VL	71	M	249	VH
36-42″	7.9	3	VL	110	VH	240	VH
42-48″	8.0	4	VL	114	VH	226	VH

VL—very low S—slight H—high
L—low M—medium VH—very high

POTASSIUM—The soil test potash values are high all the way down to the four-foot depth. But plant analyses from each cut were not as high in K as expected. They varied from 1.4% for the third cut to 2.6% for the first cut, averaging 1.8%.

After taking off the 9 tons in 1964, we wanted to be sure the alfalfa had enough potassium for 1965, so we applied 460 lbs. of 0-0-60 in November. See Table 3. Thus, the 1965 crop had the 276 lbs. K_2O per acre to feed on as well as the naturally high potash level of the soil.

Nutrient Removal. Table 5 indicates actual nutrient removal by the Vernal and DuPuits varieties. With such heavy removals, the grower shooting for 10-ton yields can't afford to take a chance with fertility.

We may not need to apply real high fertilizer rates on deep silty clay loams of the Cornbelt. These soils can apparently supply large amounts of nutrients—important when we consider the high levels removed. The cost involved for complete replacement each year would be no small item.

In many cases, we may not have to replace removal completely, but we will have to raise our **present** rates of phosphorus and potassium. In some cases, complete replacement may be needed.

Table 5. Nutrient Removal in Pounds.* From 9-Ton Alfalfa Trial in Illinois.

	Vernal	DuPuits
	lbs.	lbs.
K**	278	299
P**	35	34
Calcium	220	229
Magnesium	47	52
Boron	.7	.7
Manganese	1.0	1.0
Zinc	.3	.3
Hay Yield (12% Moisture)	8.5 T/A	9.4 T/A
DM Yield	7.5 T/A	8.3 T/A

* Calculated by multiplying the plant analysis for each cut by the dry matter yield of the cutting.
** K x 1.20=K_2O; P x 2.29=P_2O_5

5. MINIMIZE FIELD LOSSES

We harvest with a field chopper, holding our field losses to almost zero. The farmer who makes low-moisture or wilted silage at 30-65% moisture also reduces his field losses. Hay-making usually means increased field losses. But more accurate weather forecasting and use of crimpers or crushers can cut losses.

6. IF YOU GO TO FORAGE, GO TO STORAGE

Get the machinery you need to get the forage out of the field and into storage with minimum losses. You can't afford to lose a cutting because it gets rained on.

7. GET A GOOD STAND

There is little excuse today for poor stands. Prepare a good seedbed with proper liming, adequate fertility, seed inoculation, proper planting depth, proper management of the companion crop, fall stubble management to control weeds, and good seed. High seeding rates are no substitute for good seedbed preparation. Under most conditions, 12 lbs. of alfalfa seed per acre are adequate.

YIELD LEVELS ELSEWHERE IN ILLINOIS

Many areas are breaking the alfalfa yield barrier without really trying. At our Northern Illinois Research Center (DeKalb County), top varieties went 7.8 tons per acre, with many entries producing 7.0 tons in 1964. Cutting dates were June 1, July 13, August 24, and a late October 27 cut. Soil type was Flanagan-Drummer.

In southern Illinois (Carbondale), yields reached 6 tons in 1964 and 7.4 in 1965. Cutting dates were May 18, June 22, July 28, and September 10. **The End**

FACTS FAVOR FALL-WINTER FERTILIZATION

INSURE EARLY PLANTING

REDUCE SOIL DAMAGE

There is a rush to early planting. Why? It pays off. **Each day's delay after May 1 can reduce yields one to two bushels per day in the Cornbelt.** Growers will plow down more fertilizer and apply less in row to save time at planting. Many growers have moved to minimum tillage to speed corn planting. All this means there are few days to broadcast fertilizer in spring.

Too few good days to work in field just before planting. Take advantage of those good days in fall and winter. In Illinois, 50% of the corn is harvested by October 30 and 75% by November 10. Be sure the fertilizer gets on.

Can't supply full needs through the corn planter. High yields require high nutrients, and NPK use is increasing rapidly to meet this fact. More and more of this will be plowed down or knifed in to get greater total efficiency from the fertilizer and to save time and labor at planting. Fall fertilization is a key part of early planting.

Fall apply P and K on unfrozen fields of all but the most sandy soils.

Apply P and K on frozen or light snow-covered ground on essentially level land. If there is a heavy cover of corn stalks, stubble, or sod, up to 5 percent slopes can be fertilized satisfactorily.

K moves very little. Potassium has a plus charge (K+) and attaches to the negatively charged soil particles. So, it stays about where it's put unless moved about physically by water, plowing, or discing. It is well known that P moves even less than K.

(From Slide Set On Fall Fertilization)

ARTHRITIS and POTASSIUM DEFICIENCY

ANY RELATIONSHIP?

All milestones have been reached on the road of theories—often sound, usually provocative, always urging new generations not to give up the search, not to be inhibited by colleague-sensitive Babbits in the scientific world, not to lose energy or imagination or, above all, hope.

Does potassium deficiency in the cells of the human body cause arthritis?

Better Crops Magazine does not know, of course. But it reviews here an interesting treatise by Chemist Charles Weber of Plainfield, N. J.—not as an ultimate answer, but as another interesting theory in the long search.

This review touches the high points of Chemist Weber's 22-page booklet which concludes with a full week's diet (3 meals a day) for maintaining adequate potassium in the human body, plus a table comparing sodium and potassium content of important foods.

The complete booklet—covering potassium physiology, excretion, potassium in foods, sodium relation, evidence of tissue degeneration, diet, and important bibliography — can be ordered from Charles E. Weber, Mt. Horeb Road, Plainfield, N. J. 07060. Price: $4.00

CONDENSED FROM BOOKLET, "ARTHRITIS AS A CHRONIC POTASSIUM DEFICIENCY," BY CHARLES E. WEBER, MT. HOREB ROAD, PLAINFIELD, NEW JERSEY 07060

POTASSIUM IS a mineral element required in large amounts by every form of life on earth. It is the primary mineral element of the body's cells. There is no substantial storage in the body other than that inherent in permissible limits, and probably a small amount in the bones.

How potassium deficiency affects animal bodies is generally known. Potassium hunger can cause lesions of the kidneys and muscles, degeneration of the heart hyaline (a mesenchymous or cartilage tissue), and a halt to growth. The heart hyaline under microscope shows necrosis, loss of contractile fibrils of the muscles, and a degeneration of cells. Death eventually sets in.

There is also some evidence of a greater incidence of diabetes and a less acid gastric secretion when potassium is deficient. Some scientists believe potassium is often deficient during an operation, causing a reduced serum level.

To these known difficulties, this study proposes that potassium deficiency may be either causal, a predisposing agent, or an auxiliary factor for difficulties closely connected to strength of the cartilage or mesenchyme tissues:

1. Sprains
2. Vascular degeneration
3. Strokes
4. Dislocated organs
5. Slipped discs
6. Varicose veins
7. Ruptures
8. Aneurism of the aorta

The mesenchyme tissues usually furnish the body with mechanical support or connection: the links between the bones, the main constitution of the blood vessels, and fibrous support of organs.

Arthritis is primarily associated with the cartilage or mesenchyme tissues. It is a general systemic disease ramifying throughout the body with symptoms of pain in a few joints: usually in peripheral joints, load-bearing joints, or joints with a history of injury.

This treatise suggests potassium might prove effective against arthritis. The author's identity of arthritis with chronic potassium deficiency is based primarily on personal experience.

Precisely where symptoms of arthritis show up and in what form depend on the temperature, relative size of organs, history of previous stress, status of other nutrition (especially vitamin B-1), and variations in metabolism from person to person. When the tissues on the periphery of the body become cold, sodium diffusing into the cells displaces the potassium rather quickly, and this is probably what causes arthritic pains in the hands during cold weather.

Total potassium is much lower in people with arthritis than normal people, as little as 50% of normal. There is a significantly higher statistical distribution of potassium concentration in red blood cells of arthritic people. It is a characteristic of potassium that it can be high in the blood stream even during a potassium deficiency, especially during a state approaching shock. The potassium may be moving into red blood cells in response to aldosterone secretion.

POTASSIUM INTAKE VS. EXCRETION

To believe the above theory, we must establish the possibility of a potassium deficiency in the American diet.

Potassium is probably adequate in food as grown for most organisms. Vegetation is high in potassium, so that herbivores (plant eating animals) not only should have no trouble with potassium deficiency, but may even be troubled sometimes with a high potassium to sodium ratio, necessitating salt licks. Omnivorous feeders, of which man is one, would seem to occupy a favorable, balanced position in this regard. But in civilized life, some difficulties alter the circumstances.

Refined flour contains less than half the potassium of the whole wheat kernel. A primary source of potassium

"There is no indication in scientific literature that potassium has ever been tried as an arthritis corrective. A rather exhaustive search of the medical literature has failed to disclose this approach being tried. This includes Excerpta Medica 1947-1965, and JAMA 1911-1965."

"Potassium losses through urine continue daily throughout life and must be replaced if the roughly 150 grams in the body are to be maintained and life is to continue. They average about 2 grams daily for a young, healthy adult. It is not many weeks before death if the potassium is not replenished. A rat will die after seven days on a potassium free diet and adult humans would probably die in less than a month on such a diet."

"When potassium is deficient, sodium must move into the cell to take its place in order to maintain osmotic pressure. When both are deficient, the body must reduce its water content with a potential effect similar to dehydration."

"There is no organ which stores potassium, other than possibly a small amount in the bones. Low variations in the diet can not be tolerated for more than a few weeks, because an unacceptable deficiency begins to appear upon the disappearance of only 10 or 20 grams out of approximately 150 grams in the body."

"People taking potassium chloride as a salt substitute should have a low incidence of arthritis."

"A long session of diarrhea can lead to severe, acute deficiency of potassium. It has been established that the actual ultimate mortality from diarrhea in babies is an acute potassium deficiency. When the babies are supplied with potassium intravenously, their mortality is dramatically reduced from 34% to 6%."

is vegetables. Canning and freezing lowers the potassium content markedly, probably from blanching and preboiling. In some cases, they lose as much as one half their potassium. Fresh and frozen vegetables are often boiled in a large amount of water by the cook, which extracts potassium from the ruptured cell walls. The boiled water is then thrown away.

Caloric intake largely determines the amount of food consumed. Soft drinks, white sugar, many candies, tapioca, and other foods with a history of water extraction satisfy the appetite, but not the potassium need.

In our society, much less energy is necessary to gain a living than formerly, further decreasing caloric intake and the potassium. At the same time, the volume of urine is not necessarily reduced proportionately. Urine, containing seven times the concentration of the plasma, is the prime route of potassium loss. Potassium leaves the body through perspiration, the faeces (solid excrement) and the urine.

According to the U.S.D.A. tables, showing average U.S.A. food consumption, after deducting a minimum of 7% for wastage and using the mean value obtained for each class, except sweet potatoes, the average potassium intake computes to 3.5 grams per day, if no potassium is lost during preparation.

If more than 7% is lost by wastage, if one considers potassium lost in boiling and high reject rates for leafy vegetables, milk, and peas, a value closer to 2.5 and perhaps less represents an average.

The amount lost through excretion on a very hot day varies from 2.5 to 4.0 grams on a daily intake of 2.5 grams. 2.0 grams might be taken as a reasonably typical loss exclusive of perspiration.

Even this is dangerously close to the estimated intake. And the distribution curves would surely overlap within a standard deviation or so, involving a significant number of people in a deficiency of an element incapable of efficient storage.

But the situation is only apparently this good, because these experiments were carried out with a fairly moderate salt intake (3-7 grams sodium), the absence of excessive

IDEAS ARE LIKE SEED

YOU GOTTA PLANT 'EM

BEFORE YOU REAP 'EM

PAGES 29-32

emotional stress, young, healthy subjects, and the absence of intestinal disease.

Excessive secretion of steroids increase the excretion of potassium, probably primarily by their effect on sodium. Secretion of these hormones is related to emotional stress. There is a definite correlation between repressed hostility and arthritis.

High salt intake, now prevalent in our country, increases the excretion of potassium. The ratio of sodium to potassium should be about 1 to 1, but is probably closer to 4 to 1 in most diets.

During diarrhea, the normally low loss via the faeces (solid excretion)—about 70 mg/day—is much increased through inability to reabsorb potassium supplied to the gut by foods and secretion of digestive juices. There is convincing clinical data that diarrhea can cause an acute potassium deficiency in babies, sufficient to cause death. Furthermore, during hypertension and magnesium deficiency, there may be increased excretion in urine and solid excretion, respectively.

The average excretion in real life probably closely approaches the average intake. If the processes were plotted on a graph, both the excretion and the intake curves might be very broad: (1) because physiology varies greatly from person to person, (2) because potassium contents of different foods vary so greatly.

If you placed these broad distribution curves over each other, you might find enough minimum intakes coupled with maximum requirements to account for 14,000,000 arthritics.

Theoretically, the potassium economy can deteriorate seriously, since the kidneys continue to excrete potassium, unlike sodium, in the face of a severe deficiency. Once chronic deficiency occurs, it might well continue even after a marginal diet is resumed.

So, the importance of determining the potassium needs of arthritics seems clear.

THE END

"A severe injury and the shock associated with it can cause a loss of potassium. Apparently damage during shock phase causes discharge of potassium from disintegrating cells. The potassium elimination is insufficient to clear the plasma of the excess."

"It would seem logical, then, for potassium to be included in food processing salts and table salts. The very least that could reasonably be expected is that potassium be used in blanching liquors to prevent its loss in vegetables."

"Increase the consumption of vegetables at the expense of starchy and sugary food . . . and increase the consumption of foods high in potassium such as bran cereal as shown in the table."

PROGRESS IS LIKE PROFIT

YOU GOTTA WORK FOR IT

BEFORE YOU GAIN IT

PAGES 29-32

WHY FARM WIVES ARE BEAUTIFUL

BY

MRS. JOAN McCAULEY
(LAFAYETTE COUNTY, WIS.)

IN THE

WISCONSIN AGRICULTURIST

When the hot water from washing milking machines hit the cold milkhouse floor this morning, the milkhouse filled with steam. And I thought, "This is as good as a steam bath in one of those expensive beauty salons."

In the next hour and a half as I finished the chores, it became clear to me that our farm is an "unrecognized beauty parlor."

There is no need to mention all the fresh air and sunshine necessary to beauty that we farm wives get. Nor will I dwell on exercise. Farm wives get plenty of exercise, both the physical kind (lifting, pulling, shoveling and pitching) and the mental kind (lifting spirits, pulling with her husband, pushing herself to finish a weary day, shoveling ideas as she tries to keep abreast of the world, pitching into community affairs). As for good nourishing food, our own gardens and farm animals produce an unbeatable variety.

But think of the added features. For instance, the milk bath. This is the one you get as you try to teach a new calf to drink. And he gives the bucket a good butt with his head. Suddenly, you are bathed in milk—head to foot.

There is also the soft water bath—when the cows finally have turned around and are headed for home. And a sudden shower hits. Or when you are chasing cows through a dew-laden cornfield early in the morning. And the wet cornstalks slap at you as you run. (This might be called the kiss of dew.)

Then there are the mud packs. A farm wife never knows when

The tide of young people is away from the farm today—into town jobs and "positions" and suburbs and clubs and smogs and pills and diets and early cardiacs.

So, when we read Mrs. Joan McCauley's views in the WISCONSIN AGRICULTURIST, we sensed a special, fresh appreciation of farmlife. Until her marriage 5 years ago, Mrs. McCauley had never lived on a farm. She calls it "a wonderful life" as she and her husband now rent on shares toward their own farm someday. **Better Crops**

she will be getting one. It may happen while she is carrying feed to hungry pigs. Or chasing a fresh heifer through a muddy barn yard. One foot stumbles across the other. Presto the mud is applied. And if it should be an hour or so before she can get back to the house, boy, how it can pack!

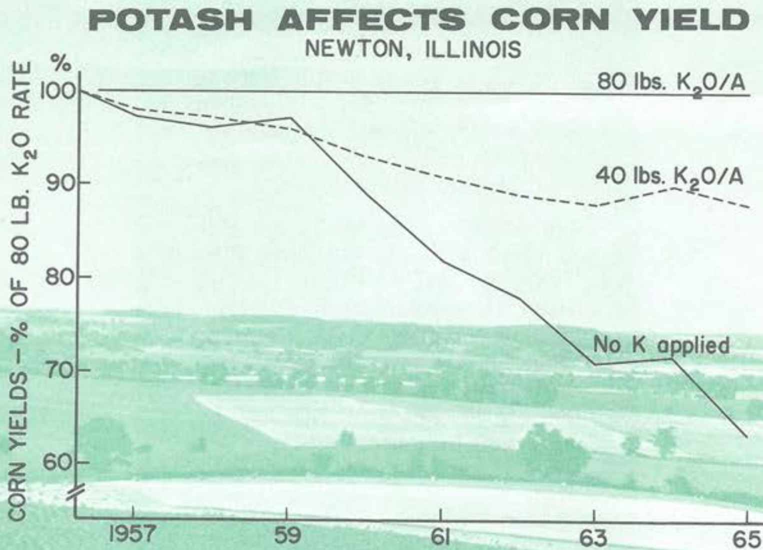
The farm also does something for our hair. After hours in the sun on a tractor, blond streaks may highlight our coiffure. After years of concern over bills, weather and crops, lovely streaks of gray add mature beauty. And nearly every day, the wind rearranges our hair style.

Finally, there's the flush of color that brightens our cheeks. It comes often. When removing hot pies or bread from the oven. When hurrying through a day's work in half a day so we can attend a meeting or an auction sale. Or when helping your husband get the barn cleaned so he can fill silo earlier.

That lovely flush may also come when a former classmate in her matching stretch pants and mohair sweater drives in the yard. And you have on your husband's jeans, have just finished feeding pigs and are trying to get the dishes done before anyone comes.

When the chores were finished and I returned to the house this morning—to undone breakfast dishes, unmade beds and dinner planned around a package of frozen meat—I laughed to myself as I thought, "You've had your beauty treatment for the day. Now get to work!"

The End



Regular Potash Use Vital

BY P. E. JOHNSON & L. B. MILLER
UNIVERSITY OF ILLINOIS

IT'S IMPORTANT to use potassium continuously—omitting it decreased corn yields almost immediately on experimental fields in southern Illinois. This longtime work shows how vital regular potassium use can be for corn on deficient soils.

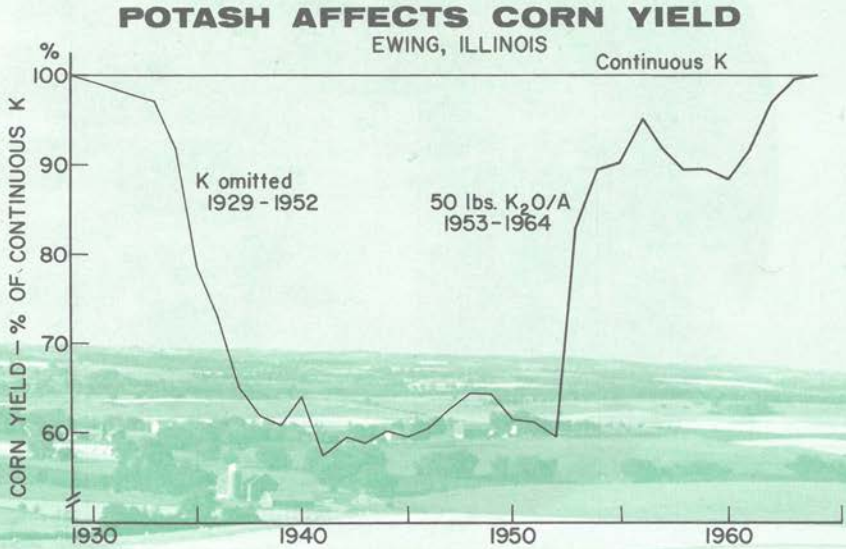
NEWTON. Potassium applications were discontinued in 1954 on plots which had a long history of lime, phosphorus, and potassium applications (since 1914). The average annual K_2O rate has been 50 lbs/A in a rotation of corn, soybeans, wheat, and legume hay. Only the grain and one hay cutting is removed.

Since 1954, the rates have been 0, 40, and 80 lbs K_2O. Corn from the no-potash plots showed almost no decline until 1959—shown above. This was due partly to the "stockpile" effect of the long-term treatment and partly to unfavorable temperature and/or moisture in 1954 and 1955.

Since 1959, yield loss from omitting K has averaged 6 percent annually! In 1965, the no-potash plots averaged only 63 percent what the 80 lbs. potash plots yielded.

The 40 lbs. potash plot yielded only 88 percent, indicating this reduced rate was not sufficient.

In 1965, the available K in surface soil was 105, 196, and 335 lbs/



To Corn On Hungry Soils

A in the 0, 40 and 80 lb. treatments, respectively.

The soil type is Cisne silt loam, similar to large areas in south central Illinois and in parts of Indiana and Missouri.

EWING. In a similar experiment, K was used from 1910-1928. It was then omitted from 1929-1952. Corn yields did not decline significantly the first three years, shown above, indicating the residual or stockpile effect of previous treatment.

The yields then declined sharply until 1938, and after that they continued at about the 60 percent level.

Renewing the annual rate of 50 lbs K_2O/A in 1952 revived corn yields to the 82 percent level the first year and above the 95 percent level by the fourth year!

In a cropping system removing only the grain and one hay cutting, a maintenance program of about 60 lbs. K_2O/A annually is usually adequate on Cisne soils—after potash buildup has been achieved.

With a corn, soybean, wheat and hay rotation, 120 lbs of K_2O/A might be applied ahead of the corn and ahead of the wheat. Fall application would fit in very well. The potash stockpile will soon be depleted if potash application is stopped.

The End

JUST PLANTING ROWS CLOSER TOGETHER WILL NOT SOLVE FERTILITY PROBLEMS

NARROW ROWS

BY HERBERT L. GARRARD
GARRARD AG PHOTOS

WHAT EFFECTS will narrow rows have on the fertility needs of crops?

1. Maximum Photosynthesis

Narrower rows primarily get more uniform spacings of larger plant populations. Equidistant spacing theoretically should give the *greatest possible light energy absorption* and *maximum photosynthesis* if all other factors are favorable, including adequate potassium (K).

2. Better Root Environment

Narrow rows help *get a leaf canopy over the soil earlier*. This shades out competing weeds, keeps soil cooler, and reduces moisture loss rates. This better over-all root environment, including more root-soil contact, should boost yield potentials. More equidistant spacing of roots *should help them pick up maximum nutrients and moisture* from the soil.

3. More Nutrient Removals

If yields rise as expected from using narrower rows—10 to 15 per cent for soybeans, up to 10 percent for corn—then nutrient needs and removals will increase.

HIGH FERTILITY MUST BE PROVIDED TO JUSTIFY NARROW ROWS—GET TOP YIELDS

GET HUNGRY, TOO!

4. Broadcast Fertilizers

With narrower rows of higher populations approaching equidistant spacings, roots may contact more soil particles—favoring more broadcast fertilization.

5. Row Rates

When going from 40 to 30-inch rows, numbers or lengths are increased by one-third. So if the same concentration of fertilizer per foot of row is used in narrower rows, the rate will equal 133 percent of that in 40-inch rows.

But if using the same rate of fertilizer per acre in narrow rows, the concentration per foot of row will be only 75 percent as great.

More band-applied fertilizers per acre can be used in narrower rows with less danger of salt injuries.

6. High Fertility Comes First

Merely narrowing rows will not substitute for any nutrient deficiency, but will actually increase the need for nutrients in most cases. Stunted starved plants planted closer together will not solve fertility problems, neither chemical nor physical.

The End

This grower is getting it on and plowing it down when weather is good and the ground is firm enough to take heavy equipment. His investment in plowed-down insurance will pay off next spring.

LET'S FACE FACTS

FALL-WINTER FERTILIZATION PAYS OFF IN MANY WAYS

BY SAMUEL R. ALDRICH
UNIVERSITY OF ILLINOIS

MORE FALL and winter application of fertilizer will benefit both farmers and the fertilizer industry.

Improved efficiency in using production and distribution facilities of fertilizer manufacturers and dealers can be reflected in cost savings and better service to farmers. It is in-

This grower and his dealer could tell you a mouthful about the problems of wet spring fields. His soil will take a year or two to get over such damage—and everyone loses time and money.

creasingly difficult to move the enormous tonnages now required in the Midwest in the typical short periods of spring and sidedressing time without more equipment investment that will add to fertilizer cost.

Each farmer needs to get all the facts, weigh the pro's and con's, and then make an informed decision for his own situation.

FIVE TIMES TO APPLY

Let's look briefly at five times fertilizer may be applied—then at some aspects of nitrogen application.

1. FALL In the midwest this often means putting fertilizer on right after corn or beans are harvested and prior to fall plowing on nearly level, non-erosive fields.

2. WINTER This is acceptable on nearly level fields in "open winters." But it is discouraged on bare, sloping fields while they are frozen because nutrients may wash off in solution or be carried off physically like soil by erosion. On hay or pasture sod, winter application is encouraged.

3. SPRING PREPLANT Though this is the most popular time to apply fertilizer, it has several disadvantages:

(a) It is a busy season for farmer and dealer. The dealer may not always be able to give as many special services as in fall.

(b) Getting equipment stuck in wet fields is a hazard.

(c) Even when the surface few inches appear dry, early spring

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Suggestions on the original manuscript were received from John Hanway, Iowa State University; R. E. Lucas, Lynn Robertson, Michigan State University; Harold Shoemaker, Ohio State University; Curtis J. Overdahl, University of Minnesota; and S. A. Barber, Purdue University; and several fertilizer industry agronomists.

IT PAYS

• Fall application gets the fertilizer on before planting, while wet spring soils may make it impossible to finish spring application before planting time. Since early planting usually favors high yield, it is undesirable to intentionally delay planting of corn, sugar beets, or small grains in order to apply fertilizer. Planting may be still further delayed by untimely rains.

• Spreading equipment run over wet fields causes ruts and often mired-up trucks. In the fall, fields are usually, though not always, drier and firmer than in spring. If a wet fall soil is compacted by the spreader, freezing and thawing and wetting and drying will correct it during winter. But compaction produced in spring often remains through the growing season.

• There is no danger of germination injury from ammonia. Though rare, some injury has occurred from anhydrous and aqua ammonia applied too shallow or shortly before planting.

• On fall-plowed fields, fall-broadcast fertilizer is preferred because:

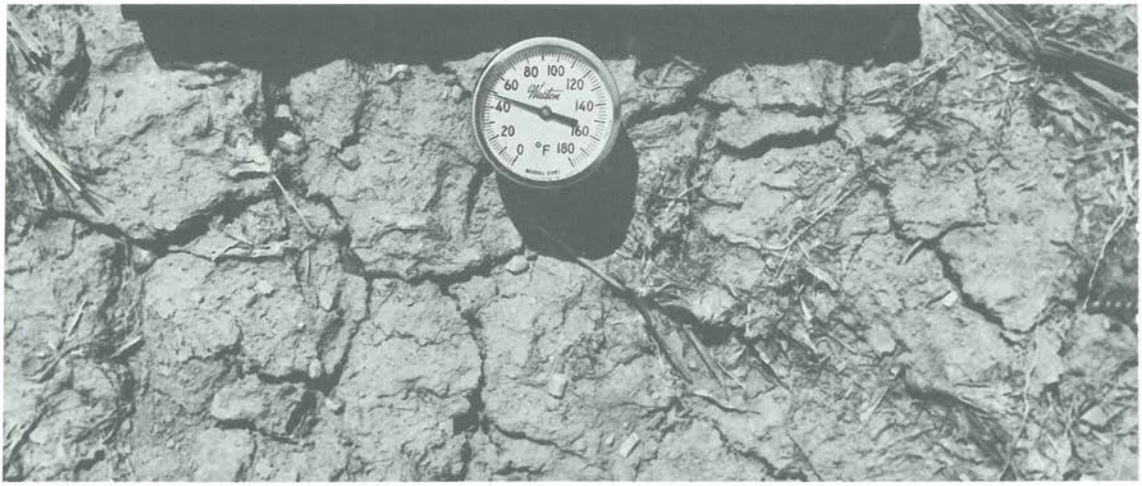
(a) Agronomists favor phosphorus and potassium worked in rather than left on the surface. Fall plowing of level, non-erosive fields is first choice for many farmers (except on clay-pan soils of Southern Illinois, Indiana, Ohio, and Northeastern Missouri), because it favors early corn planting, especially on heavy soils.

(b) Most persons object to driving heavy spreading equipment over rough plowed ground while it is frozen in winter.

• Some companies provide more extra services—soil sampling and testing in fall—when they are less rushed.

• Many fertilizer companies have some pricing or billing procedure to encourage fall fertilizer purchase.

• When the main nitrogen application can be combined with P and K application in fall, one trip over the field is saved, compared to spring or sidedressing application of N.



soil is usually *wet at plow depth or below and will compact under heavy equipment.*

(d) Shortages of some grades occasionally develop at this time.

4. AT PLANTING TIME through the planter. Use of fertilizer through the planter has increased, but midwest farmers do it reluctantly because it slows down planting. They prefer to apply most fertilizer at other times, using just enough at planting for a quick starter effect. Many farmers place 40 to 50 pounds of fertilizer in direct contact with corn seed ("pop-up") or even with the seed instead of two to three times as much to the side and below the seed.

5. SIDEDRESSING This is an excellent way to apply needed nitrogen, but is not very practical for other nutrients. Phosphorus and potassium may be side-dressed **only as an emergency measure for trial** on fields that are low in these nutrients but were not fertilized before planting.

FALL APPLICATION OF NITROGEN

Most agronomic questions raised about fall fertilization concern nitrogen. The following points can help one decide whether to apply nitrogen in fall or winter and when to do it. The comments cover fields where corn will be planted in spring, but many points on **nitrogen behavior** can apply to other crops.

Today Midwest agronomists generally look with more favor on fall applications of nitrogen than they did a few years ago. But nitrogen is an elusive element, demanding careful study of all agronomic factors before use on specific fields. Economic factors and seasonal labor needs are important factors, in many cases.

Under normal conditions, the nearer nitrogen can be applied to the last cultivation, the more efficiently corn can use it. **But differences in efficiency will often be so small (except on sands) that other considerations will offset them.**

In the Midwest, fall N application is **relatively** more acceptable in the Northern part because of low soil temperature and in the Western part because of low rainfall.

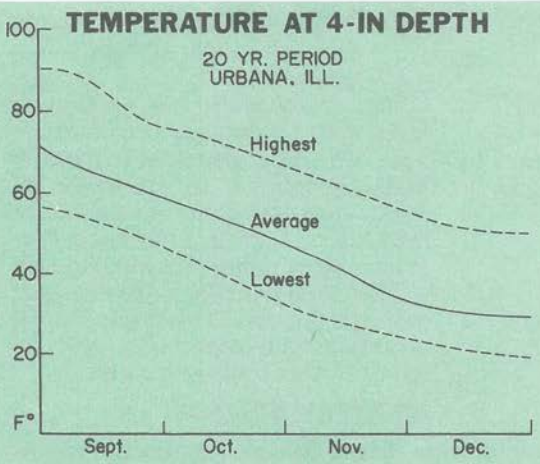
NITROGEN BEHAVIOR

NITRIFICATION

Most nitrogen fertilizer is already in ammonium form or converts to

A NEW TOOL

The date a soil reaches a certain temperature varies by the year. So, the best tool is a soil thermometer: to tell when to apply N, to estimate nitrogen transformations, to decide when to plant in spring.



ammonium (anhydrous ammonia and urea, for example) soon after application. This nitrogen is held by negative charges on soil clay and organic matter and cannot move very far until it is nitrified.

Whether ammonium is nitrified in fall depends mainly on soil temperatures after application. A common rule-of-thumb is to delay fall application until soil temperature at 4 inches is 50°F or less. Why? Because nitrification rate (changing ammonium NH_4+ to nitrate NO_3-) proceeds only half as rapidly at 50°F as it does at 60°F, only a fifth as rapidly at 40°F, and stops completely at 32°F.

Average dates at which soil reaches specific temperatures are not satisfactory guides because of great variation from year to year. The chart shows this variation. Local dealers and farmers can make good use of soil thermometers: To guide fall N application, to estimate nitrogen transformations, and to decide right time to plant in spring.

In the Central Cornbelt, most nitrogen applied in late fall or very early spring **will likely be converted to nitrate by corn planting time!** Soil temperature holds between 32°F and about 45°F a relatively long time, causing much nitrification to occur at a slow rate.

LEACHING

On medium and fine-textured soils (silt loams and clay loams) leaching of nitrogen applied in fall or early spring may not be an important loss in **normal years** because:

1. Much of the nitrogen is in ammonium form and not leachable.
2. The net amount of water (rainfall minus evaporation) from November 1 to May 1, available for downward movement of nitrates while the soil is unfrozen is seldom more than 8 to 10 inches. Since 1 inch of water penetrates about ½ foot, this will move **some** but not all the nitrates as deep as 4 to 5 feet.
3. Corn roots feed effectively down to 4 to 5 feet in many soils. Fortunately corn roots are likely to penetrate deepest on the well-drained soils where nitrates are likely to move farthest. In a mid-summer drouth, having nitrates in the subsoil may actually be an advantage because they can be

taken up by corn whereas nitrogen in dry surface soil is unavailable.

On **sandy soils,** fall application cannot be encouraged because each inch of water penetrates about 1 foot, meaning 8 to 10 inches of water may move nitrates below the root-zone. A grass cover crop over winter helps reduce leaching but will seldom hold more than 40 pounds of nitrogen per acre. This is not enough to make fall application safe on sands at usual nitrogen rates.

DENITRIFICATION

Many Midwest agronomists now feel the main route of nitrogen loss (except on sandy soils) is through denitrification, either chemical or biological.

Biological denitrification is caused by soil organisms, in the absence of air, taking oxygen from nitrate and, through a series of steps, producing nitrogen compounds that may be lost into the air. Since biological denitrification is caused by living organisms, it proceeds most rapidly when the soil is warm—and so does chemical nitrification. It is also favored by low oxygen (water-logged soil) and high organic matter content.

Nitrogen in nitrate form in the subsoil does not denitrify. Why? Though in an anaerobic situation, there is little or no organic matter on which the denitrifying organisms can feed.

Considering the date at which nitrates are formed and the temperature and moisture conditions prevailing thereafter, late fall and early spring applications usually differ little in susceptibility to denitrification loss.

The main threat of denitrification loss is from water-logging in late May and June when nitrogen from either fall or spring application will be mainly in nitrate form.

TIE UP BY ORGANIC MATTER

If ammonium converts to nitrate in the fall, part of it will be tied up by microorganisms decaying the residues from 100 to 180-bushel yields of corn. This reduces loss by leaching or dentrification, but this nitrogen is less efficiently used the following year than nitrogen that has not been tied up in microbial tissue. So, tie-up by soil organisms should be considered a mixed blessing.

. . . AND SOME DRAWBACKS TO FALL N USE

To balance the many reasons for applying N in fall, some drawbacks must be considered:

- The nitrogen cannot be recovered if the field is not planted because circumstances force a change in cropping plans or the farmer decides to plant beans or oats instead of corn. Beans and oats make far less efficient use of nitrogen fertilizer than corn.
- If low spots in the field either drown out completely or have ponded water for a few days when the temperature is high, most of the nitrogen that has already converted to nitrate will be lost to the air through denitrification.
- Unless billing is delayed, the farmer has his money tied up for a longer time.

When all factors are considered, an increasing number of farmers will find it profitable to apply more fertilizer in the fall and winter.

The End

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NEW BOOK

SOIL FERTILITY AND FERTILIZERS

(SECOND EDITION)

SAMUEL L. TISDALE
WERNER L. NELSON

REVIEW BY SWM

THE MACMILLAN COMPANY
NEW YORK, N.Y.

SOIL FERTILITY AND FERTILIZERS is described in the preface as a text "for college juniors and seniors . . . of greatest value to those who have completed a fairly comprehensive beginning course in soils."

This is the second edition of this widely used book, completely rewritten and re-illustrated, with fast summaries and self-testing questions at the end of each chapter.

In our judgment, every progressive farmer and agricultural adviser in America—teachers, county agents, extension specialists, station scientists—would find useful principles and ideas in it, 17 chapters delivering a remarkable quantity of facts about soil fertility and the role of fertilizers in building soils into food-producing factories.

Many of these facts are obscured in technical college language. That is unfortunate. But some of the principles described—such as the Mitscherlich-Baule concepts and cation exchange in soils—can hardly be treated in any other language.

This is a book for people with time to add real knowledge to their working habits—to learn WHY they do many of the things they do to their soils and WHAT gets best results.

For example:

It gives the reader a brief look at the growth pattern annual plants follow, how environmental conditions influence crop response to applied nutrients. It acquaints the grower with the 20 elements essential to plant growth: many of their functions in the plant, distinctive hunger signs of some, and steps to insure adequate supply for the plant.

It reviews briefly the nature of cation exchange in soils, a highly technical area but very important to crop production: why chlorides and nitrates leach from soils while phosphates, also containing a negative charge, don't leach out.

Did you know soil structure can influence a crop's response to applied nutrients? Why?

In four consecutive chapters, the reader gets a rather thorough look at vital nutrient elements as they exist in soil and fertilizer: nitrogen, phosphorus, potassium, magnesium, calcium, sodium, sulfur, and the micro-elements. Here are just a few pointers a reader picks up:

. . . what ammonia fixation is, how it occurs, and how potassium and ammonia influence each other in the fixation and release of the other.

. . . how to choose the best source of fertilizer nitrogen for specific needs and conditions.

. . . best placement method for water-soluble phosphates and the two most important factors influencing phosphorus uptake by plants.

. . . how to reduce the amount of fixation by phosphorus fertilizer.

. . . why soils containing large amounts of potassium often have very little of it available to the plant.

. . . what happens when a crop consumes "luxury" amounts of potash and how to make the most of it.

. . . specific soil conditions that help cause sulfur leaching and that help prevent it.

. . . soil and climatic conditions most likely to cause sulfur deficiencies.

. . . how boron is lost by leaching and iron chlorosis is overcome in plants.

Did you know molybdenum behaves differently from all other micro-elements in soil? How?

In two chapters, the reader receives some helpful knowledge of how basic nitrogen-phosphorus-potassium fertilizer materials and mixed fertilizers are manufactured and what properties they contain. Here the reader gets some basic facts. . . .

. . . on processes used to produce the different nitrogen fertilizers, to treat phosphate rock, to produce sulfur and sulfuric acid, to recover and refine potassium salts from deposits deep in the earth.

. . . on the economic value of higher-analysis fertilizers, the advantages of granulated fertilizer, some economic savings in bulk blending and spreading, advantages and disadvantages of liquid mixed fertilizers.

Did you know well over 2,600 fertilizer grades and ratios are now sold annually in the United States? Why?

The last 7 chapters convince the reader that soil fertility checkups (diagnostic programs including soil and plant tests) are as important to modern farming as medical checkups are to human life.

They show why diagnostic approaches should be used more often to prevent serious deficiencies than to identify them: "by the time a plant has shown deficiency symptoms . . . the grower will have lost considerable money. By the time potassium deficiency symptoms appear in potatoes, yield reduction may be as much as 50%."

They help the reader understand the insidious nature of hidden hunger and how to get best soil and plant samples for accurate tests in the lab and in the field. Just any part of a plant, for example, cannot be used to run quick tissue tests in the field. And many factors must be carefully considered when interpreting test results.

They suggest many of the calibration experiments might be rerun, using *new crop production techniques* to get high yields and *open the door for greater response*. They show how soil test summaries can help advisors make more realistic fertilizer recommendations for growers who do not have their soils tested.

Did you know a response to phosphorus is more generally expected in the northern United States than in the South? Why?

They sell the reader on right fertilizer application—how band and broadcast applications can team up to get best results for the farmer.

. . . how fertilizer salts move differently in soils . . . and why placement methods vary between sandy and silt loam soils, for example.

. . . how roots expand with plant nutrients on an unfertile soil . . . and the nature of a crop's root system can help dictate which application method to use.

. . . how some growers put enough on

by bulk programs to insure carry-over value for a rotation system . . . when it is practical.

They show what plant nutrients mean to a profitable cropping system —and how the major cause of erosion is "impoverishment of nutrients."

Do you know what nutrient may give the best yield response on corn grown on an eroded soil? Why?

They explain why organic matter must decay to serve as a storehouse for nutrients: increasing exchange capacity, providing energy for micro-organisms, releasing carbon dioxide, improving tilth.

They give the pros and cons of rotations and monoculture (continuous cropping to one crop) in this age of efficient chemical plant foods.

And they advocate minimum tillage as a principle, not a practice, to give fewer trips over the field, insuring better soil tilth, lower production costs, generally higher yields.

They document two economic principles many lime and fertilizer users have come to know:

1—Profit per acre is more important than return per dollar spent: top profit from fertilizer application comes when the added return in yield just equals the cost of the last increment of fertilizer.

2—Higher-analysis fertilizers are generally the most economical in cost and in labor needed to apply them.

Did you know funds invested in plant nutrients usually return more profit than investments in other phases of a farm business? Why?

They reveal how water stress has long been a "convenient scapegoat" for explaining a poor crop, though nutrient deficiency may be a "full-fledged accomplice." When applied on deficient soils, fertilizer actually increases crop yield per inch of water used. Adequate fertility creates a more extensive root system that can forage further for more moisture. It promotes stronger plant growth which creates a heavier crop canopy to reduce direct moisture evaporation from soils and insure higher use by the plant.

They cite the new trend in grower attitude: from concern about enough moisture to get the most out of fertilizer to concern about enough fertilizer to get the most out of moisture.

Did you know crop response to potassium is greater in dry years and in very wet years? Why?

The book concludes with a strong chapter urging readers to use sound steps in attacking soil fertility problems.

. . . to set research goals beyond "what is currently considered a practical farm practice."

. . . to use the best methods and materials available in controlling all factors beyond the variable under study.

. . . to insist on the full story behind any glowing claims: whether contrasting plots, for example, received the same rates of different fertilizers, used the same varieties, received other cultural practices in similar amounts and methods.

. . . to apply field diagnosis as the ounce (or penny) of prevention worth many pounds (or dollars) of cure.

This review does not mean to imply that SOIL FERTILITY and FERTILIZERS is a handy booklet full of six easy steps to profit-making soils. Such steps do not exist. But such soils can be built by careful study, hard work, and a fair share of luck. This book is a 694-page teacher—a tough teacher —with the obvious conviction that successful farmers and advisers did not get that way with soft bodies and lazy minds.

SOIL FERTILITY and FERTILIZERS (second edition) by Tisdale and Nelson can be secured from The Macmillan Company, New York City, N.Y. Price: $12.50

LEFT: WITH LIME
RIGHT: NO LIME

FIGURE 1—THE NEED FOR LIME SHOWED IN ALL HYBRIDS

LEAF ANALYSIS OF CORN

BY DALE E. BAKER
B. R. BRADFORD, AND
W. I. THOMAS

The soil test remains the most practical means of predicting needs for lime, phosphorus, and potassium in the corn field.

The amount of nitrogen required for a corn crop is generally estimated from the percent organic matter in the soil and the amount and kind of crop residues to be plowed down. Some soil test laboratories determine the level of soil magnesium.

In addition to the major elements (nitrogen, phosphorus, potassium, calcium and magnesium), plants must obtain adequate amounts of at least eight other chemical elements from the soil. Today many of these elements can be determined simultaneously by direct reading spectrometers. This has built much interest in using leaf analysis to predict the level of each essential chemical element.

A FOLLOW UP TOOL

For corn, the ear leaf is removed **20 to 30 days after the silks first appear.** At this stage of maturity, of course, a deficiency cannot be corrected until the following year. So, for corn and other annual crops, leaf analysis is a good "follow up" tool to the soil test. It'll uncover any macro elements or trace elements responsible for reduced yields. Tissue testing, used in the field to test plant sap for nitrogen, phosphorus, and potassium, helps determine the availability of these elements to the plant.

Many factors affect the interpretation of leaf analysis results for corn and other crops. The corn variety—or, more specifically, the inherent characteristics of corn

TOOL FOR PREDICTING SOIL FERTILITY NEEDS

AGRONOMY DEPARTMENT PENNSYLVANIA STATE UNIVERSITY

lines making up the hybrid—is a very important factor. Various corn hybrids accumulate different concentrations of most chemical elements. Chemical analyses of more than 50,000 corn ear leaf samples show ear leaf concentrations of various chemical elements accumulated by different corn hybrids differ greatly. See Table 1.

These and other results indicate the level of accumulation of each chemical element in the ear leaf of corn hybrids is under partial genetic control. So, we should know the chemical element accumulation characteristics of a hybrid before we can evaluate the nutritional status of a corn plant from leaf analysis.

Corn lines and hybrids accumulate different concentrations of each chemical element even when soil availability of that element is low. The results in Table 1 were obtained on productive soil under field conditions. Additional work determines whether corn hybrids would be different with respect to concentrations of each element if their availability was changed.

Figures 2, 3, and 4 tell how four corn hybrids tended to accumulate calcium, magnesium, and potassium at four different rates of lime in calcite and dolomite form. Some hybrids were high accumulators. Some were low. Some were hard to predict with certain elements.

Figure 2 clearly shows hybrids 2 and 4 were high accumulators of calcium, while hybrids 1 and 3 were low accumulators. At zero lime (soil pH of 5.0), calcium concentrations in the four hybrids were 0.73, 0.83, 0.60 and 0.97 percent, respectively. Thus, hybrids 2 and 4 were higher in calcium than hybrids 1 and 3 at all lime levels.

Without lime, all four hybrids were extremely stunted, shown in Figure 1.

Figure 3 shows hybrids 1 and 4 were high accumulators of magnesium, while hybrids 2 and 3 were relatively low. As expected, only added dolomite increased the concentration of magnesium in the corn leaves.

Figure 4 shows hybrids 1 and 3

This is paper NYO-2744-30 of the Agronomy Department, The Pennsylvania State University. Partial support of this research by the U.S. Atomic Energy Commission is gratefully acknowledged.

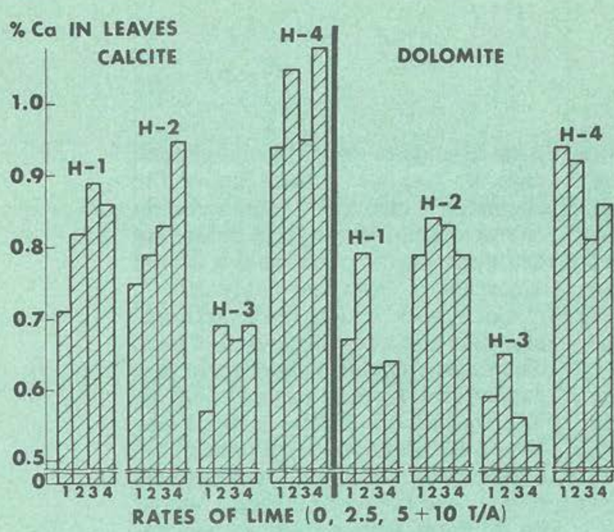

FIGURE 2.

Percent calcium in ear leaves of different corn hybrids (H) at each of four rates of lime added as calcite and dolomite.

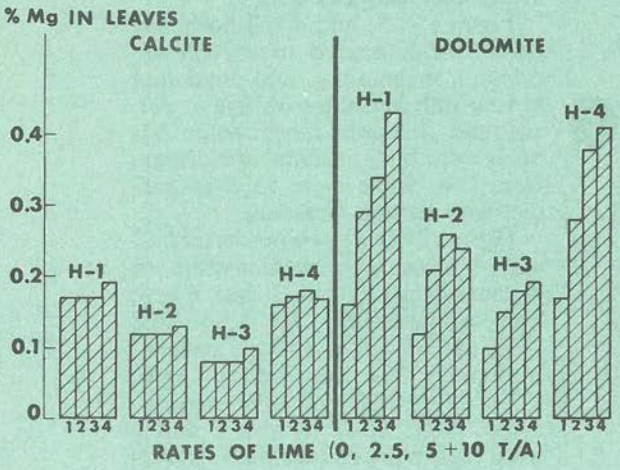

FIGURE 3.

Percent magnesium in ear leaves of different corn hybrids (H) at each of four rates of lime added as calcite and dolomite.

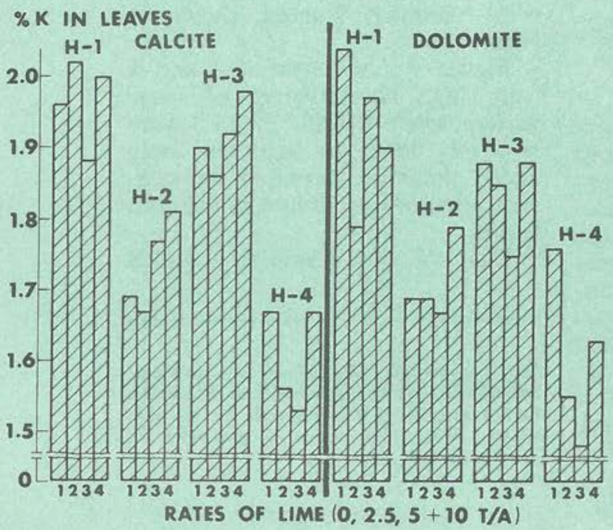

FIGURE 4.

Percent potassium in ear leaves of different corn hybrids (H) at each of four rates of lime added as calcium and dolomite,

TABLE 1. RANGES IN CONCENTRATIONS OF CHEMICAL ELEMENTS FOUND IN DIFFERENT CORN HYBRIDS RESULTING FROM GENETIC DIFFERENCES AMONG GENOTYPES OF CORN.

Chemical Element	Concentration* in Ear Leaf Low	Average	High	L.S.D. (.05)
Phosphorus	0.14	0.33	.65	0.14
Potassium	1.70	2.06	2.80	0.20
Calcium	0.60	0.82	1.19	0.16
Magnesium	0.18	0.30	0.45	0.08
Manganese	19	45	84	40
Iron	86	106	147	19
Copper	11	19	34	5.5
Boron	7	14.5	23	5.1
Aluminum	26	47.6	94	N. S.
Zinc	12	57	104	9

* Concentrations of P, K, Ca, Mg, expressed in percent and all others in ppm. All leaf samples were taken from plants 20 to 30 days after mid silk. All of the hybrids were grown in the field where the soil was fertilized uniformly.

accumulated more potassium than hybrids 2 and 4. But the way the hybrids varied at the different lime levels made it difficult to predict the accumulation characteristics of each hybrid. Potassium concentrations tend to vary more than other elements, making it more difficult to determine potassium accumulation characteristics of hybrids.

Figures 2 and 3 show that all hybrids will **not accumulate equal concentrations** of calcium and magnesium when grown on soil deficient in the availabilities of these elements.

Leaf concentrations of chemical elements in some hybrids do not increase with increased availabilities of these elements in soil. Leaf concentration of calcium in hybrid 2 increased with each increment of calcitic limestone added to the soil, while hybrid 3 responded to the first increment only. Leaf concentrations of magnesium increased in all hybrids receiving dolomitic limestone, with hybrids 1 and 4 responding more than hybrids 2 and 3.

Figure 5 tells how six corn hybrids tended to accumulate phosphorus at four different rates.

Hybrids 1 and 4 were low accumulators, with even the highest rate of added phosphorus (300 ppm of 1380 lb. P_2O_5 per acre) not raising leaf phosphorus to the levels in

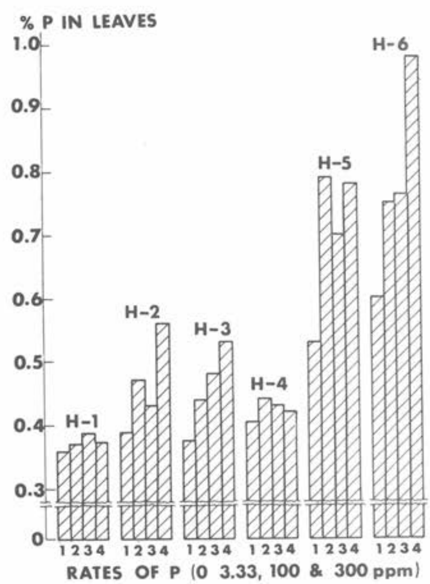

FIGURE 5. Percent phospohorus in corn leaves of different corn hybrids (H) at each of four rates of phosphorus under field conditions.

hybrids 5 and 6 at zero phosphorus.

The response in leaf phosphorus to phosphorus added to the soil was different for each hybrid.

At zero phosphorus, grain yields for the six hybrids ran 57, 34, 79, 82, 68, and 61 bushels per acre, respectively. But at top P availability, yields ran 94, 68, 132, 126, 96, and 96 bushels per acre, respectively.

Not all hybrids required the same rate of added phosphorus to get top yields. For example, hybrid 1 required only 33.3 ppm of phosphorus (153 lbs. per acre of P_2O_5) for highest yields, while hybrid 3 required the highest rate of phosphorus (300 ppm or 1380 lbs P_2O_5 per acre) to get 132 bushels per acre.

AS A RESEARCH TOOL, leaf analysis may help develop and select corn hybrids that make better use of added fertilizers and lime. Corn hybrids with below-average yield potential on medium-fertile soil may be high yielding hybrids on very fertile soils. Corn hybrids developed for use on soils of marginal availability in some elements, especially phosphorus, may not have desirable yield potentials on highly fertile soils. These tests imply this.

FOR FARMER USE, leaf analysis helps find the reasons for poor growth of some plants in a field. Where soil tests and soil characteristics do not explain why part of a field does not produce as well as other parts, leaf analysis comparisons from the two locations might furnish the answer.

In such cases the corn hybrid, plant age, plant part (ear leaf), and climate are all constant as they must be if a comparison is to mean anything.

The End

DR. JOHN W. TURRENTINE, founding president of the American Potash Institute, is dead at 86.

He was a wiry man—small body, huge mind, brilliant chemist.

A big university once invited him to one of those "prestigious" banquets and, thinking to honor him, sat him beside the biggest name they had, their All-American football star—a household word of that day about which songs were sung.

The little chemist spoke a sentence. The star athlete spoke back—a sentence. Deafening silence set in. They couldn't understand each other's language. This was ironic, because the little chemist's father had wanted him to be a big athlete.

He never made the grade on the ball field. But the gleam of something in a test tube caught his eye in a dusty corner of an old Chapel Hill chemistry lab around the turn of the century. He followed that gleam through many decades of potash studies, tests, and discoveries that contributed important knowledge to the American people.

He did as much as anyone on this earth to sell a great government on the importance of the life-giving element, potash, and then to develop an industry that could mine and produce it in sufficient quantity and quality to help meet the needs of a growing world.

DR. T

He had strong beliefs. He couldn't stomach pomposity, though an element of it (a scientific brand) tended to creep out of him now and then. He cherished professional status, much more strongly than the average scientist, the kind that meant Cosmos Club membership, delegateships to top-level scientific conferences at Paris, Berlin, Madrid, Rome. France once awarded him its gold medal for his work in potash research.

But he was not a narrow scientist, the kind that flounders like a sick fish when out of its "pond." He took much interest in civic culture: music, theater, art, none of which had a thing to do with the chemistry of potash. He once said that one of the most unforgettable evenings he ever spent was a night in third row center at the footlights of Miss Mary Martin singing her way through the South Pacific.

One of the best ways to peg him, perhaps, is to say he was a close friend and admirer of Big Hugh Bennett, the huffing, puffing scientist-salesman of soil conservation.

Hollywood could not create two more opposite characters in appearance, in personality, in their styles of doing things. But Dr. T believed in the democracy of Big Hugh's science. He believed in it, but his small stature and coldly analytical mind would usually step to the side when the sweat-soaked hand pumping and back thumping began. Big Hugh loved people. Dr. T loved projects that would help people.

One of the first things he said to his first Board of Directors was a simple policy: "Consumer betterment is fundamental in our promotion of potash use. We shall increase the agricultural usage of potash ONLY on a basis that is sound and profitable to the farmer. If we do not believe this, then we have no moral justification to exist as an Institute. The prosperity of the consumer is the best assurance of the prosperity of the producer."

That is mental honesty in a clean, clear, perhaps cold capsule—but honesty!

It was typical of him to put one service at the center of all Institute services: the research grant program for graduate students doing potash or soil science studies in land-grant universities. He liked to think the program was always reaching "struggling young graduate students."

The degree of "struggle" was never really known. But the record shows scores of graduate students and their teachers have been aided by potash grants over the years.

Not long after coming to work in Washington, Dr. T. met President Taft at a White House reception for chemists. The huge Ohioan, leaning forward to catch the Turrentine name, thrust his hand at the wiry little Tar Heel saying, "Turpentine—that's a fine name for a chemist."

Dr. T. cherished that reaction the rest of his life—perhaps rightly. He **stuck** to projects he believed in. And he lived to see potassium recognized as one of the vital elements for life on earth. His Institute will miss him.

What WOULD Happen?

What **WOULD** happen if industry sold fertilizer in fall with the same zeal as in spring. Can the idea of off-season be changed to year-round fertilization?

An idea is like a seed . . . you gotta plant it before you can reap it!

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