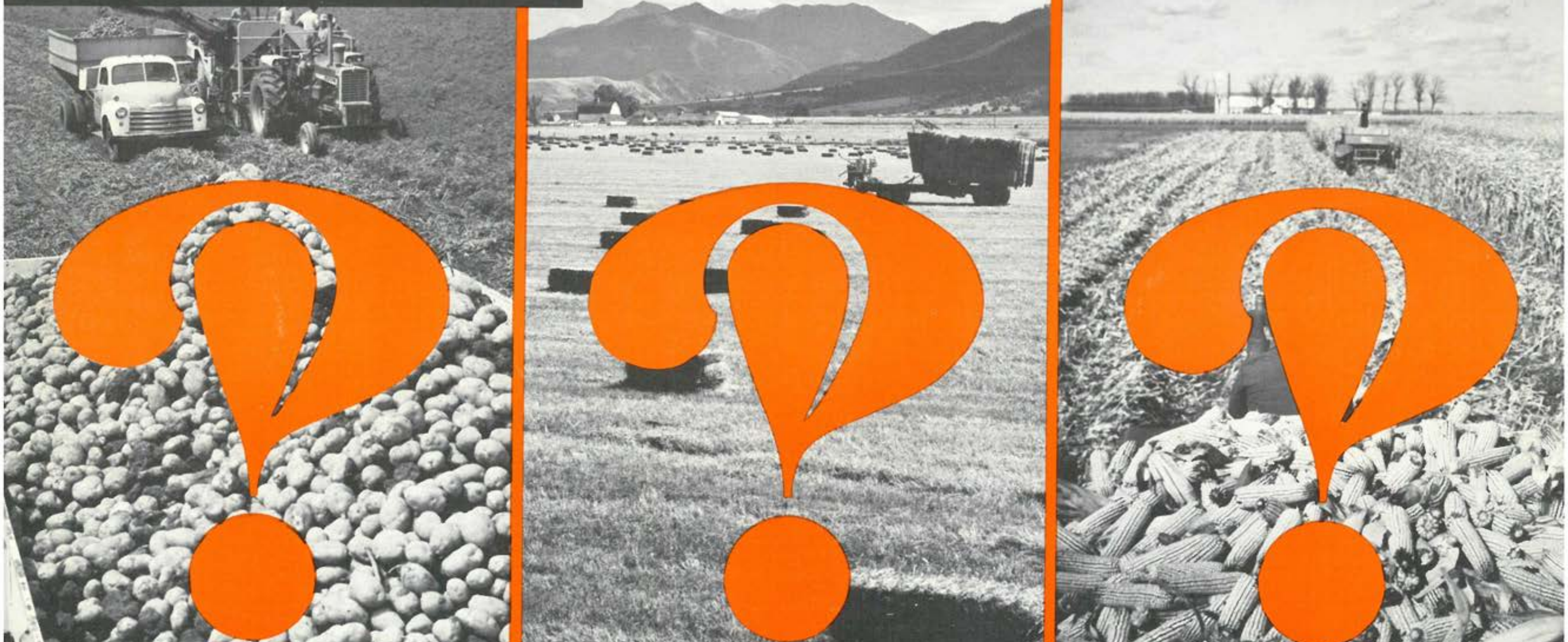
Better Crops WITH PLANT FOOD

SPRING—1972

25 CENTS



What Do Good Crops DEMAND From Our Environment?

PLANT FOOD UTILIZATION

Lb/A	CORN 180 bu	CORN SILAGE 32 tons	COTTON 1500 lb (Lint)	WHEAT 80 bu	OATS 100 bu	BARLEY 100 bu	RICE 7000 lb	GRAIN SORGHUM 8000 lb	SUGAR BEETS 30 tons	SUGAR CANE 100 tons
N	240	240	180	186	115	150	112	250	255	360
P_2O_5	100	100	63	54	40	55	60	90	40	156
K_2O	240	300	126	162	145	150	168	200	550	610
Mg	50	50	35	24	20	17	14	44	80	100
S	30	30	30	20	20	20	12	38	45	86

Lb/A	TOBACCO Flue-Cured 3000 lb	TOBACCO Burley 4000 lb	SOYBEANS* 60 bu	PEANUTS* (Nuts) 4000 lb	COCONUTS 3600 Nuts	OIL PALM 13,382 lb	PINEAPPLE 35,700 lb	BANANA 1200 Plants	APPLES 600 Boxes	PEACHES 600 bu
N	126	240	336	240	75	615	153	400	100	95
P_2O_5	26	30	65	39	25	316	125	400	46	40
K_2O	257	264	145	185	120	481	596	1500	180	120
Mg	24	27	27	25	20	196	64	156	24	—
S	19	45	25	21	12	—	14	—	—	—

Lb/A	GRAPES 12 tons	ORANGES 600 Boxes	TOMATOES 40 tons	IRISH POTATOES 500 cwt.	CELERY 75 tons	LETTUCE 20 tons	SWEET POTATOES 400 bu	CABBAGE 35 tons	SNAP BEANS 4 tons	TABLE BEETS 25 tons
N	102	265	232	252	280	100	103	228	138	360
P_2O_5	35	55	87	114	165	44	40	63	32	43
K_2O	156	330	463	354	750	198	210	249	163	580
Mg	—	38	36	32	—	7	11	36	17	104
S	—	28	54	24	—	—	—	64	—	41

Lb/A	ALFALFA* 8 tons	CLOVER-* GRASS 6 tons	COASTAL BERMUDA 10 tons	ORCHARD GRASS 6 tons	TIMOTHY 4 tons	BERMUDA GRASS 4 tons	BROME-GRASS 5 tons	SORGHUM-SUDAN 7.9 tons	BENTGRASS 2.5 tons	PANGOLA-GRASS 11.8 tons
N	450	300	500	300	150	225	166	319	225	299
P_2O_5	80	90	140	100	55	40	66	122	80	108
K_2O	480	360	420	375	250	160	254	467	160	430
Mg	40	30	45	25	10	20	10	47	12	67
S	40	30	45	35	16	15	20	—	10	46

* LEGUMES CAN GET MOST OF THEIR NITROGEN FROM THE AIR

Good Acre Yields TAKE UP Much Plant Food

Potash Institute of North America
1649 Tullie Circle, NE Atlanta, Ga. 30329

CAN YOU USE THIS IN LARGE WALL CHART FORM (16″x22″)?

When fertilizing . . .

Remember the PLANT FOOD content of your CROPS

NOTHING WILL destroy man and his environment faster than to deplete our soil nutrients in the annual struggle to get enough food.

Farmers work daily to prevent this depletion. A popular aid has been a PFU (Plant Food Utilization) chart-story, first created in 1940 by Potash Institute scientist J. D. Romaine, now retired.

About 1,000,000 copies have been used around the world, alerting farmers and advisors to the pounds of nitrogen, phosphoric acid, and potash contained (taken up) in the total plant with good acre yields.

The 1940 PFU story featured 60 bushels of corn per acre as "good acre yields"—a big challenge in a day when 500 lbs lint cotton, 30 bushels of wheat, 3 tons of alfalfa, 25 bushels of soybeans, 10 tons of tomatoes per acre were called BIG yields. That's why they were used in the first PFU chart—as challenges to shoot for.

Today's PFU figures mark the third upward revision of Romaine's pioneer calculations in 32 years. Tomorrow many farmers and researchers will get these yields consistently. Some will not get them consistently.

Why? Because many factors affect the amount of plant food a crop takes up: (1) The crop variety, (2) yield goal, (3) harvesting method, (4) soil type, (5) rainfall, (6) temperature, and (7) fertility level.

Regardless of region or crop, experience has taught one thing: New high-yield varieties, bred to keep our food supply ahead of our population, demand more and more fertility from our soils.

Man must meet this demand if he is to survive. And in the process, he must face some facts of life:

- **Each soil area has just so much natural nutrition—organic matter, minerals, etc.—sometimes not too available to the crop. Why? Because many soils tend to "lock up" or "fix" such minerals as potash and phosphate.**
- **Manure contains only the nutrition of a previous crop, so it can enrich one field only by robbing another.**
- **Composting offers little to farmers because they already leave residues on their fields or work them into the soil when produced by the preceding crop.**
- **American crop and livestock farming STILL removes more nitrogen and minerals (phosphate, potash, etc.) than we add, scientists report. Many other nations may well suffer the same trend.**

What about your program? Do your crops—the new high-yield varieties—require more plant food than you return to the soil? We must be **UPTAKE** conscious today—to insure better yields the farmer **MUST** have, to insure richer residues and organic matter the environment **MUST** have.

From these new PFU figures for the 70's, you can calculate a reasonable uptake figure for lower or higher yields, if necessary.

Plant Food Utilization BREAKDOWN By Specific Crops

CROP	YIELD	Pounds Per Acre N	P_2O_5	K_2O	Mg	S
Corn	180 bu grain	170	70	48	16	14
	8000 lb stover	70	30	192	34	16
Cotton	1500 lb lint and 2250 lb seed	94	38	44	11	7
	Stalks, leaves, burrs	86	25	82	24	23
Wheat	80 bu	144	44	27	12	5
	6000 lb straw	42	10	135	12	15
Oats	100 bu	80	25	20	5	—**
	Straw	35	15	125	15	—**
Barley	100 bu	110	40	35	8	10
	Straw	40	15	115	9	10

CROP	YIELD	N	P_2O_5	K_2O	Mg	S
		Pounds Per Acre				
Rice	7000 lb grain	77	46	28	8	5
	7000 lb straw	35	14	140	6	7
Grain Sorghum	8000 lb grain	120	60	30	14	22
	8000 lb stover	130	30	170	30	16
Sugar Beets	30 T roots	125	15	250	27	10
	16 T tops	130	25	300	53	35
Sugar Cane	100 T stalks	160	90	335	40	54
	tops and trash	200	66	275	60	32
Tobacco (flue-cured)	3000 lb leaf	85	15	155	15	12
	3600 lb stalks, tops, suckers	41	11	102	9	7
Tobacco (burley)	4000 lb leaf	145	14	150	18	24
	3600 lb stalks, tops, suckers	95	16	114	9	21
Soybeans*	60 bu	252	49	87	17	12
	7000 lb stalks, leaves, pods	84	16	58	10	13
Peanuts*	4000 lb nuts	140	22	35	5	10
	5000 lb vines	100	17	150	20	11
Coconuts	3600 nuts+12 fronds lost annually	75	25	120	20	12
Apples	600 boxes (42 lb)	20	8	50	2	—**
	blossom, fruit, new wood	80	38	130	22	—**
Peaches	600 bu	35	10	65	—**	—**
	tree annually	60	30	55	—**	—**
Grapes	12 T fruit	66	23	120	—**	—**
	vines	36	12	36	—**	—**
Oranges	600 boxes (90 lb)	90	23	162	10	7
	trees (70/A)	175	32	168	28	21
Tomatoes	40 T fruit	144	67	288	10	28
	4400 lb vines	88	20	175	26	26
Potatoes	500 cwt	150	80	264	12	12
	vines	102	34	90	20	12
Celery	75 T tops	255	130	680	—**	—**
	roots	25	35	70	—**	—**
Sweet Potatoes	400 bu	53	26	126	5	—**
	vines	50	14	84	6	—**
Cabbage	35 T	—**	35	128	9	64
	23 T stem & leaf	—**	28	121	27	—**
Snap Beans	4 T	70	21	77	8	—**
	Plants	68	12	86	9	—**
Table Beets	25 T roots	170	30	210	30	13
	20 T tops	190	13	370	74	28
Flax	30 bu	76	20	16	7	4
	2100 lb straw	19	5	44	6	5
Cucumbers	10 T	40	14	66	4	—**
	vines	50	14	108	21	—**
Peas	3 T	45	9	17	8	—**
	Pods & Vines	105	17	62	14	—**
Onions	30 T	180	80	160	18	37
Lespedeza*	3 T	150	50	150	25	20
Johnsongrass	12 T	890	190	630	60	50
Paragrass	12 T	308	98	460	79	41
Napiergrass	12.5 T	303	147	605	63	75
Guineagrass	11.5	288	101	436	99	46
Bluegrass (turf)	3 T	200	55	180	20	25
Tall Fescue	3.5 T	135	65	185	13	—**

*Legumes can get most of their nitrogen from the air.
**Figure unavailable.

Better Crops
WITH PLANT FOOD

Published Quarterly by
Potash Institute of North America
1649 Tullie Circle, N.E.
Atlanta, Georgia 30329

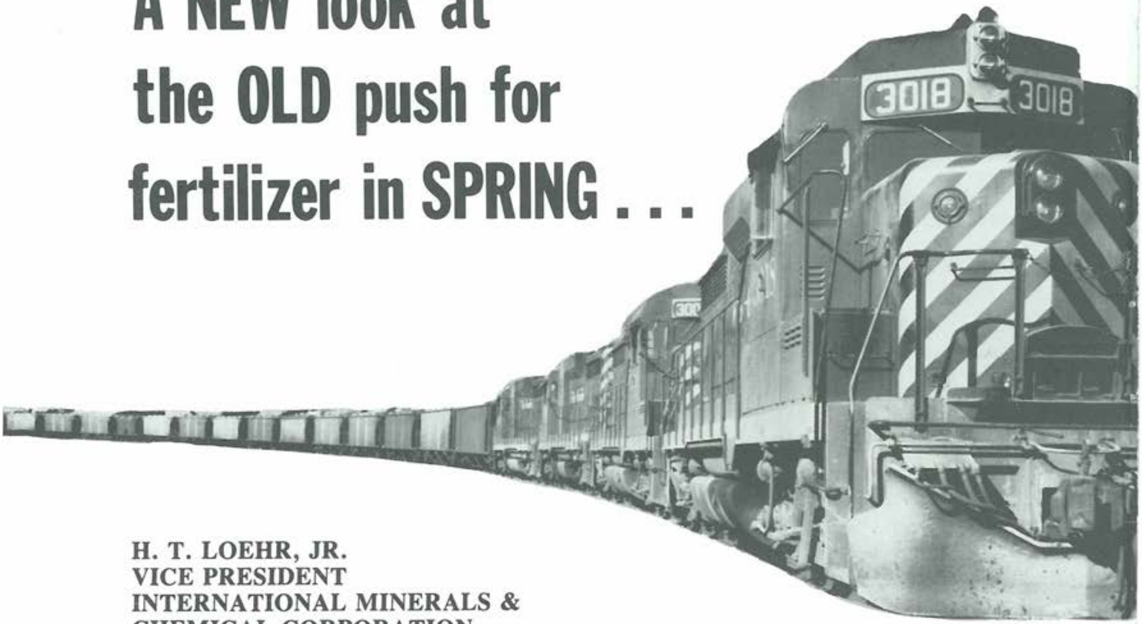
Santford Martin, Editor
Selma Bushman, Assistant Editor

Vol. LVI/1/72

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

CONTENTS

A NEW look at the OLD push for fertilizer in SPRING . . .



H. T. LOEHR, JR.
VICE PRESIDENT
INTERNATIONAL MINERALS & CHEMICAL CORPORATION

HEAVY FERTILIZER use in a few spring months is the "hard core" of our distribution problems. So far we have stayed abreast of them, but can we keep up with future demands?

Over the past twenty years, total fertilizer consumption has doubled and the concentration of NPK in each ton has also doubled. Thus, present consumption totals 40 million tons of products containing 16 million tons of NPK plant nutrients.

If the nutrient content had not doubled, we would now be trying to ship 80 million tons of product a year instead of 40. I am not sure we could have done it. On the other hand, benefits obtained from higher analysis products probably caused much of the increased usage we have today.

HOW ABOUT THE FUTURE? With a long-term growth trend of 7%, a 5% near-term annual growth is possible. Thus, with no increase in analysis, today's 40 million tons could grow to over 50 million in only five years—or over 2 million additional tons per year.

How does seasonality affect fertilizer distribution? Many efforts to get more even usage over the whole twelve months have failed. After ten years, 70% of the yearly total is still applied in the first six months of the year—**half of the yearly tonnage in only three months: March, April, May.**

We now apply 20 million tons of fertilizer in March, April and May. Unless the pattern or analysis changes, this could become over 25 million tons five years from now. What a strain on the distribution system!

CAN WE REDUCE these future burdens and perhaps reduce transportation costs at the same time? Look at three possibilities:

1. **Change Seasonal Pattern.** If we could apply the entire projected increase of 10 million during the fall months, the present 70/30 ratio would become 56/44.
   Theoretically, the present system could then handle the load, in-market storage would be adequate and spreading equipment would be used more fully.
2. **Increase the Analysis.** The 10-million-ton increase expected represents only 4 million tons of NPK nutrients at present levels. Could this average

of 40 units of plant food per ton be increased to 50 and thus hold the future tonnage total at the present level?

Theoretically yes, but practically, no, though there seems to be some room for improvement. A combination of altering the seasonality AND increasing the analysis might bring us a lot closer to a solution if we can cope with leaching losses, bad weather and run-off, plus psychological and economic factors. Wherever they make sense, fall application and higher analysis should be encouraged.

3. **Face Up To 10 Million More Tons** to distribute in five more years if success is not achieved in the first two areas. Out of the 50 million tons, 38 million tons will be solids—25 of it complete NPK mixtures, 13 directly applied as single or double nutrient materials. The remaining 12 million tons will be liquids and will consist of 5 as anhydrous ammonia, 4 as other directly-applied single nutrient liquids, 3 as liquid mixtures of NPK.

The distribution implications of the individual primary plant foods differ greatly:

NITROGEN—All major areas of the United States produce nitrogen. But there is a big production deficit in the Midwest, the biggest market. Four factors help meet this need: a large railroad network, the river system, the ammonia pipeline, and an absolutely necessary trucking system.

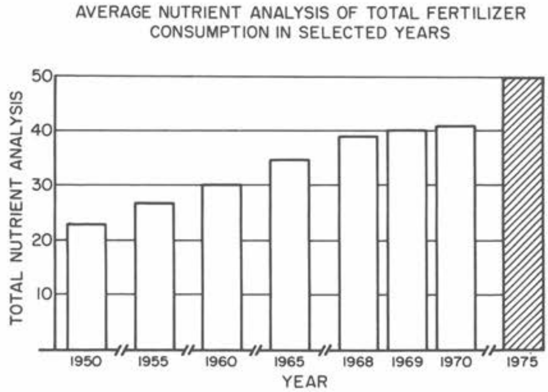
Modest expansions of each system should get additional nitrogen products to their markets.

The systems for phosphate and potash are not as flexible.

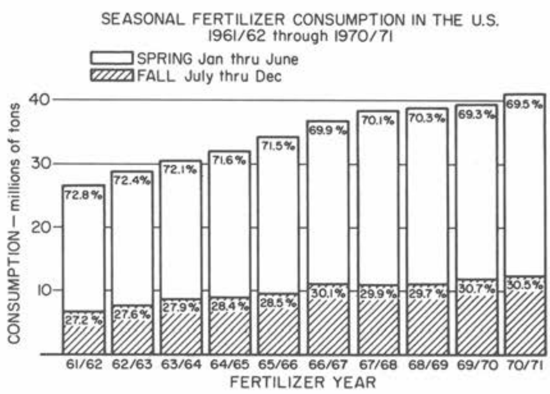
PHOSPHATE—The big surplus of phosphate production in the Gulf area can reach the Midwest by railroad and inland waterway. Modest transportation expansions should take care of future P_2O_5 needs.

POTASH—Here is the toughest, most inflexible transportation system for three reasons:

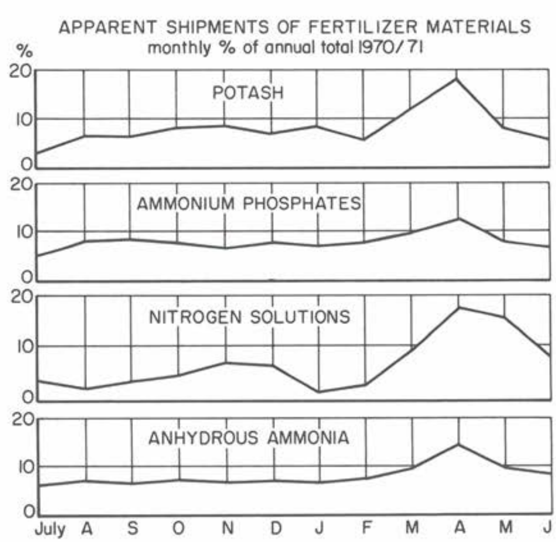
1. **85% of potash consumption is very distant from the major mining areas in New Mexico and Saskatchewan.**
2. **All potash leaves the mines by rail**



AVERAGE NUTRIENT ANALYSIS



U.S. SEASONAL CONSUMPTION



BURDEN STILL IN SPRING

only. No waterways or pipelines are nearby nor foreseen.

3. **Canada will be supplying more and more of our potash in future years.**

This last point is important because the New Mexico mines in the U.S. normally serve the South and Southeast where the planting season starts two to three weeks earlier than the Midwest.

This means the potash cars can be used for grain movements after the fertilizer season and get greater utilization. This gave the railroads an incentive to invest in more cars and they did. Car supply problems were manageable.

The Midwest picture differs due to its later and shorter planting season with little or no dovetailing of potash with grain, resulting in shortages for handling the increasing potash tonnage from Canada.

If nothing is done, some customers will not receive their potash when needed. We cannot reduce tonnage by increasing analysis. We can only urge more fall application. If this fails, we must turn to the best economic combination of in-market storage and car supply.

The storage must favor trucking to the field to minimize rail reshipments, especially where rail lines are now being abandoned. This new system must also blend in and complement the existing N and P_2O_5 systems.

WHAT COULD BE the components of this future potash system?

1. **A long haul by rail, or a combination of modes, to Regional Distribution Centers located as close as possible to the farmer-users.**
2. **Adequate storage and handling capacities at these Regional Centers.**
3. **A short haul, preferably by truck, either to a bulk blender, a chemical mix plant or directly to the farm itself.**
4. **A short final haul from mixed goods plant or blender to the fields.**
5. **The chemical mix plants may require further storing and transporting.**

In the interest of economy, as well as to reduce the load on the distribution system, as many of these steps as possible should be eliminated. Fertilizers and fertilizer materials should move in one step directly to the bulk blender, or even directly to those farms or ranches that are large enough to justify it. But we know more storage will be needed in the market areas. Let's examine these from a potash standpoint.

Within five years, domestic potash consumption is projected to go from the present 6.4 million tons to over 8 million tons. If seasonal use stays at 70/30 and we assume single 100-ton car movements and no storage, the 8 million tons would require 13,333 cars each month for the 4 million tons in March, April and May, 5,333 cars/month for January, February and June, and 4,000 cars for July through December.

For a constant monthly output, only 6,666 cars would be needed, but 2 million tons of market area storage would be needed to handle March, April and May. This is four times what is now estimated to be in existence. At $30/ton, capital investment for storage would total $60MM—just half the cost of the extra rail cars needed if there is no storage.

Theoretically, rail cars are available for other uses when not handling potash. But, practically speaking, the cars are never used to capacity and sit idle much of the time.

Car supply in Canada is further complicated because . . .

1. **Fertilizer and grain movements cannot be "dovetailed."**
2. **Canadian grain elevators use boxcars, not hopper cars.**
3. **30% of the potash moves in less than 100-ton lots due to restrictions on the railroad right-of-way or at the receiving plant. The sum total results in little incentive for the Canadian roads to buy extra cars, and more in-market storage is a must.**

If, so, how much storage? If the present potash rail fleet remains constant, about half of the expected increase or about 800,000 tons of new storage will be needed. For economy, this should be located at the fertilizer plants or on the large farms.

Outdoor storage of potash is a practical solution for storage at either location.

STORAGE NEAR usage point reduces handling and investment costs. Though this is important, the biggest advantage of nearby storage is quick product availability when needed without the danger of big-system interruptions or failures.

Will the trends in application methods help out? The phosphate and potash could probably be applied by simply getting more or larger equipment or both.

Some of the equipment for handling anhydrous ammonia is already huge, and we may be approaching the upper limits, at least for sidedressing purposes. A whole new approach may be needed in the area of application equipment and technique.

In any event, both distribution and application present challenges that we must all give a great deal of attention to in the years ahead. **THE END**

The Summer Of '70

IN OUR LAST ISSUE (Winter 1971–72 number), we reprinted an excellent feature from FARM JOURNAL on NPK hunger cropping up in corn plant tissue samples from such areas as Iowa, Illinois, Indiana, and Ohio.

It reported how the Nu-Ag Lab people had analyzed 770 plant tissue samples for Dekalb Ag Research's well known Gro-Plan program.

It cited the percentages of deficient plant samples:

"In Iowa, 37% of the plant samples were deficient in N, 15% were short in P, 49% were down in K.

"Illinois samples showed 35% deficient in N, 17% short on P, 70% below normal in K.

"Indiana: 30% short in N, 11% deficient in P, 49% down in K.

"Ohio: 25% deficient in N, 16% down in P and 26% short on K."

And it cited Nu-Ag's four theories behind the deficiencies: Drought in some areas, excessive rainfall in other areas, wet planting conditions causing compaction, and an overbalance of N calling for more K, a call that often went unheeded.

It was a revealing and competent report, of course. It lacked only one thing—our editing care in explaining that the season reported was NOT "last summer" (1971) as we ran the item, but the summer of 1970. This data applied to 1970 crop conditions. Please note this in any future reference you might make to this item in our Winter 1971-72 issue.

Potash favors regrowth of rubber bark

THE RUBBER RESEARCH INSTITUTE of Malaya reports that nitrogen and potassium are the main nutrients required for mature rubber in Malaya. Where N and K had both been given in combination, the yield response in one trial increased from 18% in 1965 to 32% in 1967.

The response to nitrogen depended on adequate potash application.

The effect of potash on bark renewal (after tapping) was much greater than the influence of K application on development of virgin bark:

BARK THICKNESS (mm)

Treatment	Virgin	3 years renewed
K_0	7.0	5.1
K_1	7.0	5.3
K_2	7.1	5.4

Therefore it can be expected that adequate potash supply will lead to increased latex yield when trees with renewed bark are exploited.

From International Fertilizer Correspondent

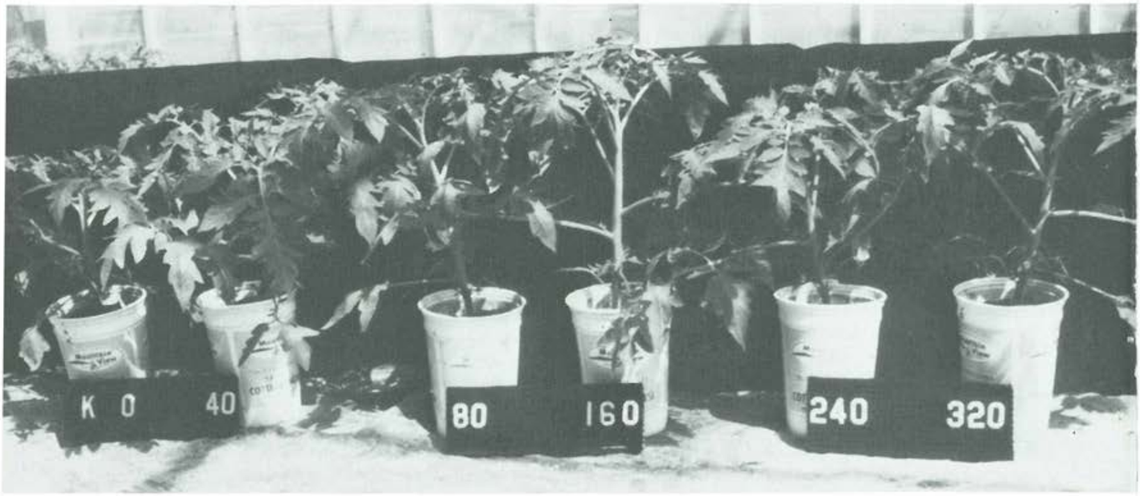


FIGURE 1 shows growth response of tomato seedlings to K applications as KCl broadcast at rates in ppm (with ppm = ½ lb/A). Response to K treatment was observed in the 0 to 160 lb/A range.

THE K STATUS of a plant can be evaluated by comparing samples of immature and mature tissues.

When the mature tissue contains as much or more K than the immature tissue, the plant's K status is optimum.

When the mature tissue contains less K than the immature tissue, K status is less than optimum.

TESTING THE THEORY. A study to illustrate the relationship of the comparative K content of the mature and immature tissue with response to K levels is reported here for tomato seedlings grown on a dark colored loam soil that contained 90 lbs/acre exchangeable K.

Potassium rates of 0, 80, 160, 320, 480, and 640 lbs/acre were mixed with the soil before planting. **Figure 1** shows how growth response to K treatment occurred in the 0 to 160 lb/acre range. **Figure 2** shows how necrotic spots developed in interveinal tissue of mature leaves during fifth week of growth by plants not receiving any K fertilizer.

At 35 days after emergence, the plants

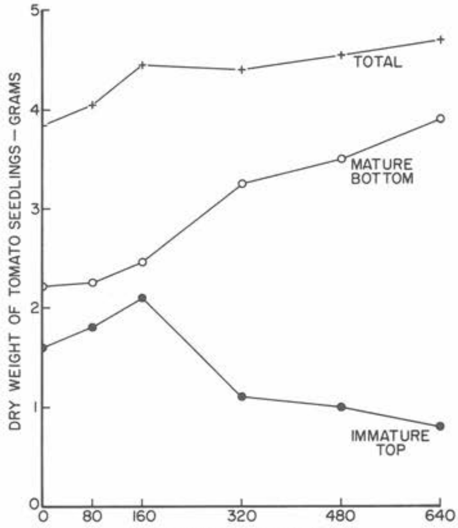


FIGURE 3 shows how dry weight of the bottom portion of the plant increased over the entire K rate range tested while the top portion increased in the 0-160 lb K/A range and then declined.

SIMPLIFYING plant evaluation of K status

FIGURE 2 shows necrotic spotting of mature leaves on plants that did not receive any potash. The spots developed in interveinal tissue of mature leaves during the fifth week of growth.

GERALD E. WILCOX
and
RANDALL COFFMAN

PURDUE UNIVERSITY

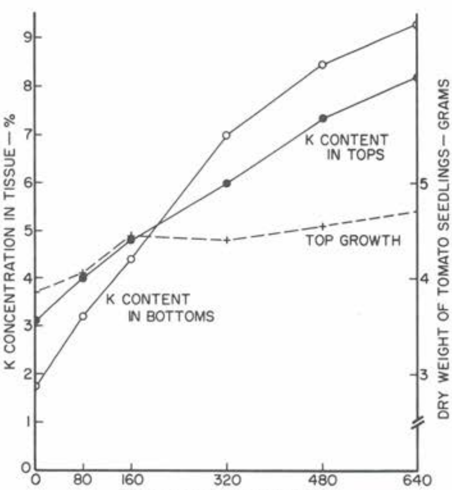


FIGURE 4 shows how the percent K in the mature bottom tissue was less than that of the top tissue in the range of growth response to K fertilization.

were divided at the internode separating mature fully developed leaves (bottom) from immature developing leaves (top). **Figure 3** shows mature bottom and immature top growth of tomato seedlings responding differently to K fertilizer rates.

The total dry weight of the plant increased in the 0 to 160 lb K/acre range with no further response to higher K rates. That part of the plant constituting the mature tissue increased to the highest K rate because increased K concentration in the tissue accelerated cell expansion.

Figure 4 shows the relation between K concentration in mature bottom and immature top tissue of tomato seedlings and growth response to various K rates.

As K rate increased, the K composition of the mature tissue increased more rapidly than the immature tissue.

The K composition of the bottom mature tissue equaled the composition of top tissue at the point of optimum growth response to

continued to p. 30

Fertilizing GREENHOUSE Flower Crops

JOHN W. WHITE
PENNSYLVANIA STATE UNIVERSITY

FLOWER CULTURE in greenhouses is the most intensive form of agriculture, capable of producing flowers worth more than $250,000 PER ACRE wholesale.

Out of the 250,000,000 square feet (5739 acres) of greenhouse space now used for flower crop production in the United States, Pennsylvania uses about 9% of it.

Annual production costs run about $2.86 per square foot of total ground area. If the greenhouse industry continues to grow about 5 percent per year, as it has for 10 years, it will double in size in 15 years. Many consider this a conservative estimate of its future growth.

Any industry that can generate $250,000 wholesale and $750,000 retail out of an acre of production must do many things right—including its fertilization program. Let's look at the types and amounts of fertilizers that pay off.

PREPLANT FERTILIZERS. Greenhouse growers are advised to have their soil tested before use, especially for pH and total soluble salts. Most floriculture crops grow best when the pH is between 5.5 and 7.0.

What About Calcium, Magnesium, and Sulfur? To raise soil pH, either calcitic or dolomitic limestone is mixed with the media prior to planting. Because of the need for fast action, finely ground limestone (60 mesh or less) is preferred. If the pH needs to be lowered, finely ground sulfur or iron sulfate is used.

What About Phosphorus? It is a common practice to apply 5 to 10 lbs of 20% superphosphate per 100 square foot and blend it with the soil mixture. This equals 2180 to 4360 pounds per acre—or 20 to 40 times more phosphorus per acre than commonly applied for field crops.

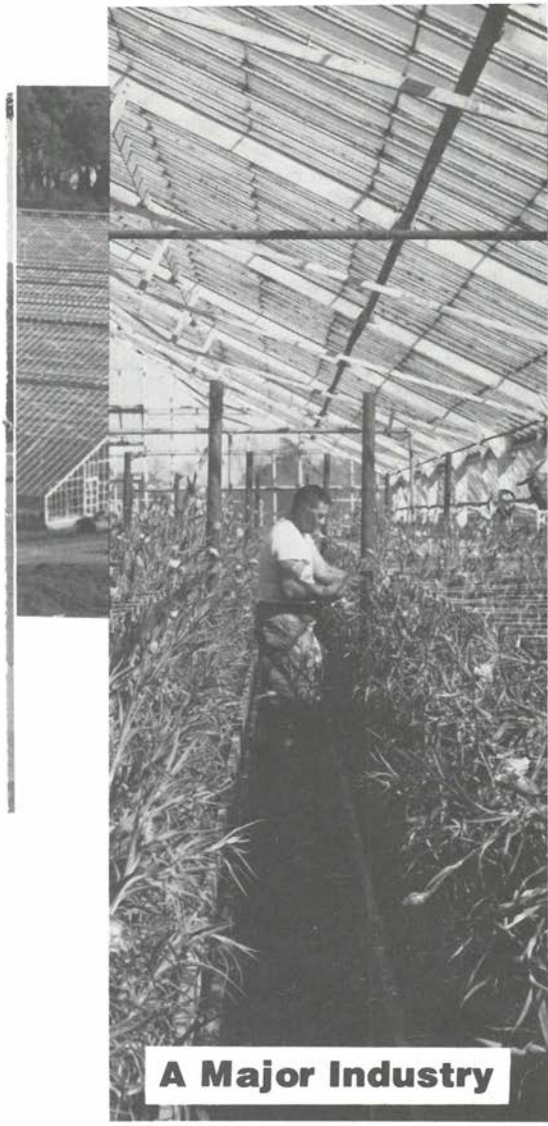
These higher rates are used because of (1) the way the smaller volume of soil affects uptake and (2) the amount needed per plant. The 0-20-0 form is usually preferred over 0-45-0 because of the 50 percent gypsum it contains. The lower percent phosphorus in 0-20-0 requires greater quantities. This makes it easier to incorporate uniformly into soil mixtures.

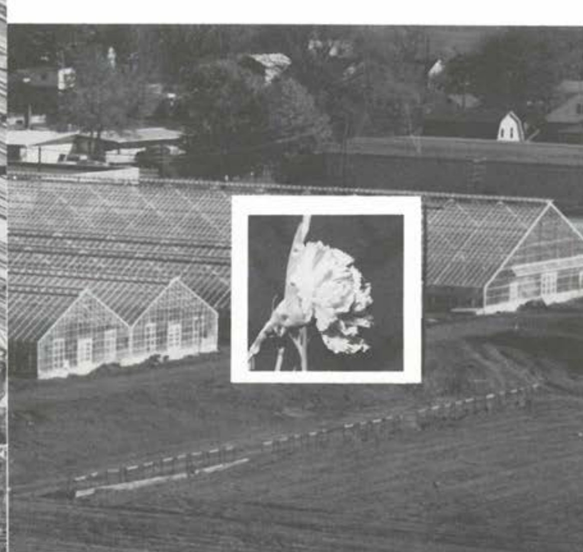
POSTPLANT FERTILIZERS. Most postplant fertilizers are applied as solutions. High analysis, easily soluble materials are best for this purpose. The greenhouse manager has a great variety of choices of single salts and complete fertilizers.

A 1:1:1 ratio (such as 20-20-20) is most frequently used, but many special blends are available for specific crops. Since many of these high analysis fertilizers are acid-forming, they require careful monitoring of soil pH.

What About Nitrogen? Most of the nitrogen fertilizers are highly water soluble. The nitrate form of nitrogen is easily leached from the soil, especially porous soils.

Ammoniacal nitrogen is held by the cation exchange capacity of the soil and can become toxic to plants if it accumu-





lates. Ammonium levels often increase following steam sterilization, especially if an organic nitrogen fertilizer has been mixed with the soil. If an ammonium nitrogen fertilizer application (such as ammonium sulfate) is followed by cold, cloudy weather, soil ammonium levels may become toxic. Under such weather conditions it is usually best to use a nitrate carrier.

What About Potassium? Most of the potassium fertilizers are water soluble, usually applied in solution. Potassium nitrate is used most frequently, perhaps, followed by potassium sulfate and potassium chloride (muriate of potash).

Sometimes slow release forms of potassium are incorporated dry into the soil before planting. These may be in the form of frits (ground glass), metal ammonium phosphates, or polymeric resin coated fertilizers.

What About Phosphorus? Phosphorus is often included in complete soluble fertilizers as ammonium or potassium phosphate. Although this reduces the importance of mixing superphosphate with the soil mixture, it is still a common practice to mix 20% superphosphate into the soil before planting and later to use complete fertilizers or solutions of ammonium nitrate and potassium nitrate.

A Major Industry

THAT produces on each acre flowers worth over $250,000 wholesale, $750,000 retail.

USES about 250,000,000 sq. ft. (5739 acres) of greenhouse space in the U. S. to produce flower crops.

INVESTS (as the greenhouse florist industry) at least $7,150,000 in fertilizer each year.

USES as much potassium on U.S. greenhouse flowers as corn growers use on nearly 230,000 acres of field corn.

What About Trace Elements? They are often included in specialty type fertilizers—but in fairly low concentrations. So some crops may require additional boron, iron, or other trace elements.

This becomes a special problem with highly organic or soilless media. Often a dye is used to show the fertilizer injection (proportioning) equipment is functioning properly.

What Is "Fertigation"? It is fertilization combined with irrigation. In some cases, growers add fertilizers at every 3rd or 4th irrigation, meaning weekly fertilization in summer and monthly fertilization in winter.

Other growers fertilize with each irrigation, using very dilute concentrations. And they must use enough solution at each irrigation to cause some leaching and prevent unused salts from accumulating to toxic levels. **A proper balance MUST be maintained between all essential elements when applying fertilizer at each irrigation because the applied solution has a much greater effect on growth than nutrient reserves in the soil.** The proper balance varies with season and crop.

HOW MUCH FERTILIZER? The concentration of fertilizer applied in solution depends on **irrigation frequency, amounts of water applied, season** and **crop.**

A large range of floricultural crops receive 200 ppm of N, P_2O_5 and K_2O in the water at each irrigation during the spring and fall. The concentration may be decreased to 100 ppm during the summer because of more frequent irrigations and because of reduced water availability when a plant is under heat stress.

The concentrations may be raised to 400 ppm during the winter because of less frequent irrigations. The concentrations may be 300 ppm during vegetative development and reduced to 100 ppm during reproductive stages of development. In general, greenhouse crops use phosphorus and potassium more efficiently and nitrogen less efficiently than most field crops.

What About Cut Flowers? The amount of fertilizer per year depends on irrigation water. Carnations grown in benches in a soil mixture receive on the average 65 irrigations per year, roses about 104, and chrysanthemums for cut flowers as many as 182. About one-half gallon of water is applied per square foot each irrigation.

Thirteen and one-half ounces of 20-20-20 per 100 gallons of water supplies a solution containing 200 ppm each of N, P_2O_5 and K_2O. Therefore, carnations would receive about 4.5 ounces of 20-20-20 per square foot per year. This equals 196,020 ounces (12,251 lbs) of 20-20-20 or **2450 lbs of potash per acre per year.**

Compare this amount of potash to the 150 pounds per acre per year required to produce high corn yields.

What About Potted Plants? Some potted plants require more fertilizer than bench-grown cut flowers. Potted chrysanthemums average 400 irrigations per year—about one quart of water per square foot (per pot) per irrigation. They are usually fertilized with 200 ppm N, P_2O_5 and K_2O at each irrigation.

So, the potted chrysanthemums would receive about 100 gallons containing 13.5 ounces of 20-20-20 per square foot per year. This equals 588,060 ounces (36,950 lbs) of 20-20-20 or **7350 lbs of potash per acre per year.**

How Do Field and Greenhouse Crops Compare? Greenhouse flower crops use **20 to 40 times more potash and nitrogen per acre per year** than the best fertilized field corn. This means the 5739 acres of greenhouse flower crops in the U. S. use as much potassium as about 229,560 acres of field corn.

There are about 34,500 acres of potatoes, 300,000 acres of silage, and 326,000 acres of corn grown in Pennsylvania each year. These facts suggest the potassium used on greenhouse crops in Pennsylvania each year equals about ⅔ the quantity used on potatoes.

And the figures for greenhouse crops do not include ornamental nursery crops, field-grown flower crops, or vegetables grown in greenhouses. **THE END**

WANT A POPULAR ENVIRONMENT BOOKLET? SEE PAGE 21

THIRD IN A SERIES

How reliable are some ecological claims and counter-claims?

Many are reliable. Some not too reliable, perhaps. Mark Twain explained why: "The trouble with the world is not that people know too little, but that they know so many things that ain't so." Authorities estimate agriculture's share of nitrogen and phosphorus pollution all the way from 8 to 90%. Somebody "ain't so."

Dr. Ross McKinney, Chairman of the University of Kansas Environmental-Health Engineering Department, has been quoted as saying we are now witnessing "one of the largest con games ever played, the environmental con game." He warns us not to be conned into believing things are getting worse and worse . . . when actually "the situation is getting better and better." He reminds us this progress is not being made by the environmental con men but by the "plodding professional who does the work and is never recognized."

Are organically grown foods more healthful than chemically fertilized foods?

If they are, someone better tell the Dutch. Holland uses the most concentrated rates of chemical fertilizers in the world, **Dr. T. C. Tucker of the University of Arizona** reports. And with it, the Dutch enjoy the world's highest crop yields and health standards: (1) Highest birth rate, (2) Lowest mortality, (3) Life span two years longer than U. S. residents.

Dr. Willard Garman, widely respected Senior Agricultural Chemicals Specialist of the U. S. State Department, concludes any water or health problems from fertilizer use would "surely have been evident before now in Holland, Denmark, and Japan where fertilizer use is older and more intense than in the U.S."

What are those "plodding professionals" working on?

Many problems in many universities and research stations all over the nation . . . too many to cite here. But a few projects will show what these quiet, dedicated pros are doing . . . in close teamwork with progressive farmers:

- INTRODUCING no-till or minimum-till systems for row crops . . . to cut soil erosion 65 to 95% . . . growing from 10,000 acres 5 years ago to 7,000,000 acres now.
- SEARCHING for ways to recover useful products from feedlot waste—propane for fuel or foodstuffs for a nutritious diet.
- USING a modified root plow to apply herbicides, not to the soil surface, but to the roots for sure action against waterlogging shrub-weeds.
- DEVELOPING a water recycling-saving system (for hog pens) that sends the liquid and solid wastes through a sewage gutter to a retention tank where the solids settle to the tank bottom and the liquid flows back into the sewage gutter to carry more solids to the tank.
- TESTING very small amounts of low-cost chemicals sprayed on soil (with herbicide) to prevent surface sealing by raindrops that leads to erosion.
- PRODUCING 150 bushels/A corn in windblown sandhill areas . . . on soils that wouldn't support a corn crop before . . . through irrigation PLUS sod planting of corn to control blowing on light soils.
- SEARCHING for insect control with diatomaceous earth (a by-product of small diatom algae) apparently abrasive with absorptive power . . . following earlier work with abrasive dust that scratches off the protective coat of some insects, causing dehydration.
- FINDING chemical additives for herbicides that may give good weed control with fewer applications at lower herbicide rates.
- MONITORING problems by aircraft . . . to pinpoint exact pollution sources and avoid costly area-wide controls when not needed . . . to (one day) detect amount of suspended silt in streams, occurrence of lake-aging algae, and dilute concentrations of chemicals or dissolved solids . . . through refined detection from the air.

What about "blue baby disease" some associate with liberal use of nitrogen fertilizers?

U. S. National Institutes of Health records and various State Health Department records "do not reveal a single instance associated with fertilizer use . . . nor a case where a child has become afflicted with the disease from eating processed baby foods," **Dr. Garman** reports.

Dr. George Smith (Mo.) says some reports have tried to alarm mothers that nitrates in fertilized spinach could cause "blue baby disease." But the alarm does not mention 3 vital facts: (1) THAT a given spinach variety has a natural nitrate content controlled by genetic make-up. (2) THAT nitrates are a normal constituent of many green plants and root crops. (3) THAT high nitrate may accumulate from many adverse growth conditions.

What growth conditions may favor nitrate accumulation in plants?

Dr. Smith (Mo.) cites seven: (1) Drouth and high temperatures. (2) Cloudiness impairing photosynthesis. (3) Too much nitrate nitrogen available in the soil and too little phosphate and potassium. (4) Acid rather than alkaline soil reaction. (5) Damage from insects and certain weed control methods. (6) Plant variety or species susceptibility.

Dr. Sam Aldrich (Ill.) says any problems of nitrates in foods is limited to green, leafy vegetables used for their vegetative parts . . . and "desired yield level rather than type of fertilizer" determines their nitrate level. He concludes, "We would not reduce nitrate content of spinach one iota if we produced the same acre-yield by shifting from nitrogen fertilizer to livestock wastes or to plowed-under legumes as a nitrogen source."

What about "blue baby" threat from nitrate content of drinking water?

Dr. Smith (Mo.) has not found "a single documented case where blue baby disease was caused by nitrogen from chemical fertilizers entering water supplies." He has found "no evidence that nitrate toxicity in infants or cattle is any more frequent now than in pioneer days."

Most infant cases have shown up on "poorly built wells near livestock or in low rainfall areas where nitrate may accumulate in the soil from soil organic matter." A survey of some 6,000 Missouri wells uncovered no conclusive evidence tying fertilizer use with high nitrate in water, and "no nitrate has been found in any major municipal water supply in the state."

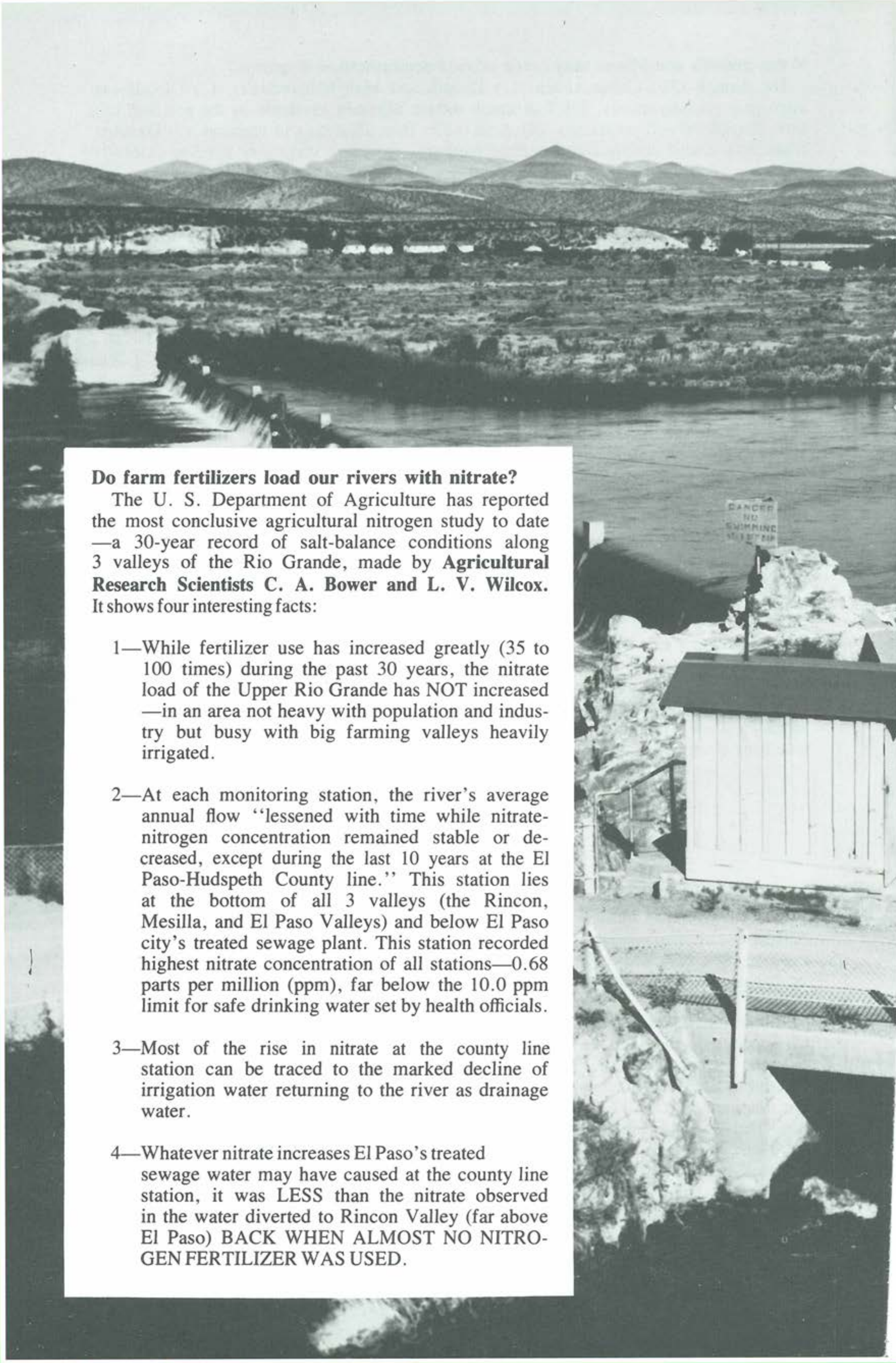
He cites one village with a new well that showed nitrate in the water. Some immediately blamed this on nearby anhydrous ammonia storage. Careful scientific tests uncovered the culprit: Old cisterns that had been converted to septic tanks when the community gained a public water supply. He also cited rainfall, bat guano, and natural soil leachates causing nitrates in some southern Missouri springs.

Why do they call it "blue baby disease"?

Because human infants suffering from it turn blue from oxygen deficiency. Scientists call the condition methoglobinemia, **Dr. Robert White-Stevens** (Rutgers) explains. It occurs where excessive nitrate nitrogen (NO_3) in plant sap may enter animal or human diet and become converted to nitrate nitrogen (NO_3) in the gastrointestinal tract.

While this NO_2 is absorbed into the blood stream, it converts hemoglobin (the oxygen-transporting pigment of the blood cells) into methemoglobin, which will not transport oxygen. Then cyanosis or "blueing" occurs from oxygen deficiency.

Among livestock, ruminants are very sensitive, particularly bovines. But most short gut, monogastric creatures—swine, poultry, dogs, and man—generally avoid this condition, **Dr. White-Stevens** explains. Why? Because they don't ingest massive volumes of raw vegetation and their gastrointestinal tract is not populated with what **Dr. White-Stevens** calls a "suitable conversion flora." Human infants are very sensitive to declining oxygen in their blood because their "gastrointestinal flora have not yet settled into the normal spectrum," as **Dr. White-Stevens** expressed it.



Do farm fertilizers load our rivers with nitrate?

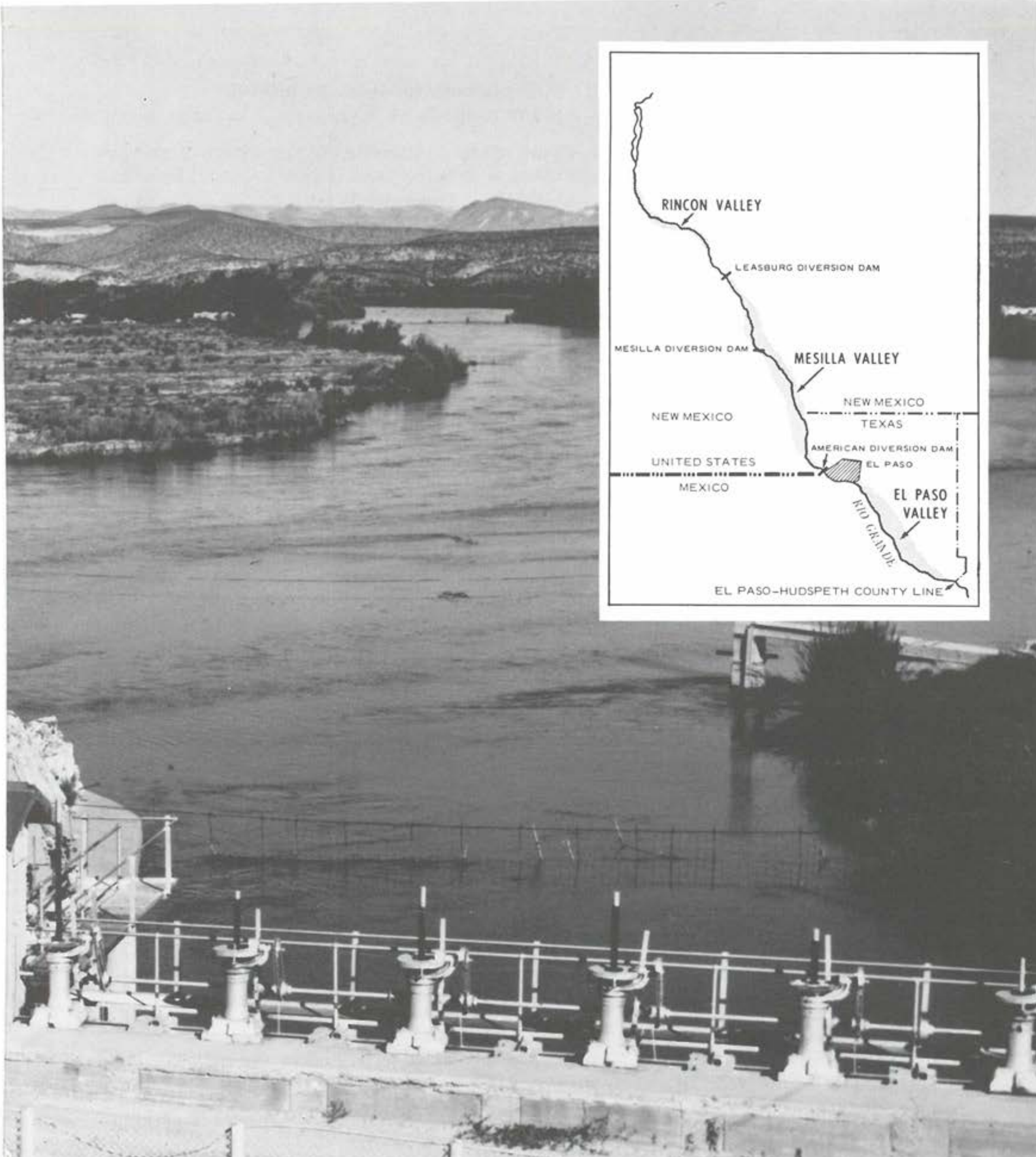
The U. S. Department of Agriculture has reported the most conclusive agricultural nitrogen study to date —a 30-year record of salt-balance conditions along 3 valleys of the Rio Grande, made by **Agricultural Research Scientists C. A. Bower and L. V. Wilcox.** It shows four interesting facts:

1—While fertilizer use has increased greatly (35 to 100 times) during the past 30 years, the nitrate load of the Upper Rio Grande has NOT increased —in an area not heavy with population and industry but busy with big farming valleys heavily irrigated.

2—At each monitoring station, the river's average annual flow "lessened with time while nitrate-nitrogen concentration remained stable or decreased, except during the last 10 years at the El Paso-Hudspeth County line." This station lies at the bottom of all 3 valleys (the Rincon, Mesilla, and El Paso Valleys) and below El Paso city's treated sewage plant. This station recorded highest nitrate concentration of all stations—0.68 parts per million (ppm), far below the 10.0 ppm limit for safe drinking water set by health officials.

3—Most of the rise in nitrate at the county line station can be traced to the marked decline of irrigation water returning to the river as drainage water.

4—Whatever nitrate increases El Paso's treated sewage water may have caused at the county line station, it was LESS than the nitrate observed in the water diverted to Rincon Valley (far above El Paso) BACK WHEN ALMOST NO NITROGEN FERTILIZER WAS USED.



What caused the relatively high nitrate concentration in Rio Grande water drained for Rincon Valley BACK WHEN ALMOST NO FERTILIZER WAS USED?

The report mentions two possibilities: A natural source of nitrate-nitrogen or mineralizing organic nitrogen.

The ARS report explains, "Recorded levels were 2.31 ppm the first 10 years (of little fertilizer use), 2.84 ppm the second, 1.61 ppm the last 10 years (of higher fertilizer use).

"In the first 10 years when little fertilizer was used there, the nitrate-nitrogen concentration in the irrigation water showed 0.15 ppm while the drainage water (from the river) was showing 2.31."

High-yield agriculture of recent years is apparently doing a good job of TAKING UP and USING much nitrogen to give the super yields the nation must have.

Is the Rio Grande the only evidence of no nitrogen fertilizer pollution?
No. Many studies in many areas point to insignificant levels. . .

- **In A New England Study, Dr. Frink** (Conn.) estimated the percentage of nitrogen pollution in Connecticut's environment coming from these sources: Industrial Smoke 33% . . . Auto Exhausts 29% . . . Domestic Wastes 12.5% . . . Animal Wastes 10% . . . Animal Feeds 9.8% . . . Agricultural Fertilizer 3.5% . . . Non-Ag Fertilizer 2%.

- **In Midwest Contour Cultivation Studies,** only 3 lbs of nitrogen per year leached through tile drains . . . slightly more in Illinois but still insignificant . . . and even negative nitrogen balance in Michigan where corn plants actually took more than the soil received.

- **In A California Lysimeter Study,** only 10% of very high nitrogen rate (420 lbs/A) leached from sandy soils, 17% from clayey soils—in a heavily irrigated area where nitrate levels test well below health department safety limits.

- **In a 15-year Illinois Study,** nitrate content climbed from 10.5 to 18.5 ppm in the heavily populated, industrial Illinois River watershed . . . from 5 to only 7.2 ppm in the relatively lightly populated Kaskaskia River watershed using at least as much fertilizer as the Illinois River area.

- **In a Purdue Erosive Conditions Study,** about 6.6 lbs soluble nitrate N/A ran off under a cloudburst (2½ inches rainfall IN ONE HOUR) when the nitrogen (150 lbs N/A) was PLOWED DOWN before the downpour. (This may be why most Indiana farmers apply their fertilizer N deep in the soil.)

- **In A North Carolina Neuse River Study** through farmland, nitrate content did not change significantly (from 0.54 to 0.56 ppm in 14 years), while Tar Heel farmers were increasing their nitrogen fertilizer use from 116,000 in the mid-50's to 165,000 tons in the late 1960's.

Do RECOMMENDED N rates cause nitrate leaching below root zones?
Very little, according to several university tests where RECOMMENDED N rates were applied to continuous corn.

Can we predict what will happen to all the fertilizer N we apply?
No. But research has traced 50 to 80% of applied N recovered by the crop . . . 10 to 20% denitrified or volatilized into the atmosphere . . . the balance left in the soil for the next crop and sometimes subject to leaching.

Can a farmer cause his crop to USE more nitrogen?
A better farming job will always increase the possibility of more nitrogen uptake by the crop. **N. C. State University agronomist, Dr. E. J. Kampreth,** advises growers to keep a good eye on plant STAND and fertilizer TIMING for crop, soil, weather. He emphasizes the importance of corn population.

- **A LOW STAND (14,000 plants/A)** may use in the grain 23 lbs LESS N than a grower applies in 100 lbs N/A, 49 lbs LESS N than he applies in 150 lbs N/A.

- **A GOOD STAND (21,000 plants/A)** may use in the grain 7 lbs MORE N than he applies in 100 lbs N/A, just 29 lbs LESS N than he applies in 150 lbs N/A.

Does high soil fertility actually reduce pollution?

It seems to. At 7 Experiment Stations in several North Central states, runoff declined as corn yields increased in extended trials. **Dr. C. J. Overdahl,** widely known **University of Minnesota soil scientist,** explains organic residues build up on well fertilized soils. In relatively high rainfall area of Minnesota, about 4 tons of corn stalks were returned to the soil when yields ran 130 to 160 bushels per acre, BUT only 2 tons per acre when yields ran 50 to 60 bushels per acre, **Dr. Overdahl** reports.

He warns against excessive amounts of nitrogen or all of it socked on before planting or in fall. The best bet is nitrogen added in increments as needed on **sandy soils** and wise application schedule and rates on **all other soils.**

Does chemical fertilizer harm soil microbes—bacteria and earthworms?

No. It tends to increase the numbers of bacteria and earthworms. Even after applying commercial fertilizer at the ridiculously high rates of 100,000 lbs per acre in lab tests, **Iowa State University agronomist L. R. Frederick** found little difference—slight decline in numbers and activity of soil microbes, perhaps, but total weight actually increasing some. Some alarmists may accuse commercial fertilizer of "sterilizing the soil" of its microbial content. But when 100,000 lbs PER ACRE won't "sterilize or corrode" it, you can bet sound fertilizer management improves it.

Long-term experiments in Illinois, Missouri, Pennsylvania, and England have shown 3 things: (1) Soil depleted of organic matter and tilth because of no fertilizer during a century of tests will respond immediately to fertilizer and restore crop yields to normal. (2) Plots fertilized during the century maintain their yielding ability, with no difference between inorganic and organic fertilizers. (3) Quality of wheat or corn shows no difference between organic and inorganic fertilizer so long as the amounts are the same.

Would nitrates from farmland to waterways be less if the SAME AMOUNT of food was produced from compost, nitrogen-fixing legumes, or animal and human wastes instead of fertilizer?

No. At least, not one expert appearing before the Illinois Pollution Control Board hearings would predict any less nitrates from the organic sources, including **Dr. Barry Commoner and Dr. Daniel Kohl of Washington University.**

In testing nitrate content of waterways, can scientists readily tell which nitrates come from fertilizer and which from soil, manure, and sewage?

No—not readily. There is no accurate way of separating the two forms of nitrogen without using isotopically-labeled fertilizer (enriching fertilizer with isotope nitrogen-15) in a very detailed, expensive experiment, according to **Dr. A. P. Edwards, noted TVA soil scientist** and pioneer in this work.

Dr. Edwards cites two problems: (1) The difficulty of getting soil samples to represent the organic N being mineralized over a drainage area of any real size. (2) The impossibly narrow margin for error between the (nitrogen-15) contents of applied fertilizer and the (nitrate nitrogen) from soil organic materials.

Dr. Roland D. Hauck (TVA), one of the first to use nitrogen isotope technique to study denitrification in soils and an advisor on nitrogen-15 to the International Atomic Energy Commission, cites two problems: (1) It uses a trace material (fertilizer nitrogen) very similar in nitrogen isotope composition to other constituents in the system under study—meaning the fertilizer nitrogen is soon diluted out of its detection range. (2) There are too many soil entities with almost identical nitrogen isotope contents which undergo the same kind of soil reactions as the tracer material.

Would farmers welcome the government regulating their fertilizer use?

Illinois farmers have spoken eloquently at hearings all over their state. They seem to agree on 6 points: (1) Fertilizer application is already controlled by the pocketbook . . . few can afford to apply more nutrients than the crop can use . . . inefficiency of any kind cannot be tolerated in modern farming. (2) Enforcing regulations could make head hunters of everyone, for the only way to police farmers is to offer bounty to informers. (3) Money spent on regulations and policing could be spent on applied practices on a cost share basis. (4) Proposed regulations are really no more than good, sound practices many farmers already use. (5) Recommendations and education are better than regulations. (6) Soil erosion causes 95% of any farm pollution, and a fertile soil erodes much less than an infertile soil.

How bad is our soil erosion?

Water erosion on 179,000,000 acres and wind erosion on 55,000,000 acres dump 4,000,000,000 tons of SEDIMENT into U. S. lakes and streams EACH YEAR, the records show.

Are the "plodding professionals" doing anything NEW about this problem?

Many things, including no-till and minimum-till systems PLUS a NEW terracing system called PTO or parallel tile outlet terracing.

For years ag engineers have recommended terracing—long, low ridges of earth across sloping fields with a flat channel behind each ridge to hold water temporarily. The water eventually flows down the flat channel to a grass waterway and down the waterway to a ditch or stream. But the terraces were not parallel, making the crop rows uneven in length and hard for the grower to till. These uneven terraces, routing trapped water down surface drainage outlets, often let much sediment escape.

The new PTO system eliminates these problems, according to **University of Illinois Agricultural Engineer Ralph Hay.** The new terraces do two things: (1) Release flowing water so slowly through perforated pipes or gravel filters into underground drainage tile that solids "drop out" and remain in the field. (2) Run parallel, making it much easier to till with multi-row farm equipment, a real headache or impossibility in the old system.

Can fertilizer boost vegetative growth enough to reduce cornfield erosion?

It did in tests reported by **Dr. Smith.** A cornfield received a soaking rain of 4.5 inches. The area that got only 9 lbs nitrogen per acre lost 28 cu. ft. of water and 0.09 lbs of nitrate-N per acre. The area that got 177 lbs N/A lost only 7 cu. ft. of water and 0.01 lbs of nitrate N/A.

Do some really believe we can return to organic-rotation farming to get our food?

They believe it very sincerely. And they are dedicated, highly intelligent people, not crackpots. But let's look at what nearly a century of manure-legume farming has done to scientific plots. The famous University of Missouri Sanborn Field shows the problem. For 80 years, certain plots have been fertilized with only legumes and farm manures and carefully studied. The organic matter of their plow layer has declined about 50%, **Dr. Smith (Mo.)** reports. Legumes removed for hay drain hardest on mineral elements. Illinois, Kansas, and Iowa have experienced similar results.

How much nitrogen is lost in 50% of the organic matter?

A little arithmetic will tell us. A soil that loses 1% of its organic matter in the top 6 or 7 inches has lost about 1,000 lbs of nitrogen. So, 50% loss would mean about 50,000 lbs of nitrogen. Man was blessed, indeed, when Providence permitted him to learn how to get some nitrogen from the air.

Is there any need to try to convert ourselves to organic farming?

NOT IF WE ARE TRYING to seek a better form of plant nutrient. There is no difference in organic and inorganic materials . . . and no matter how nitrogen, phosphorus, potassium and other sources are applied to the soil, they enter the plant roots in an inorganic form, according to **Dr. S. C. Wiggans, chairman of the University of Vermont Plant and Soil Science Department, and Dr. Blair Williams, Professor of Human Nutrition.**

NOT IF WE ARE TRYING to gain a healthier form of food. A 25-year Cornell University test, summarized by **K. C. Beeson,** showed Vitamin C and carotene content of seedling rye the same on soil fertilized with huge quantities of manure and with chemical fertilizer . . . the Vitamin C, iron, and copper in potatoes the same on soil fertilized with manure and with chemical fertilizers.

NOT IF WE ARE TRYING to avoid "poisoned" diets. The Dutch, reported earlier in this series, use more commercial fertilizers than anyone on earth . . . and produce the highest food yields per acre and best public health records per person . . . all in a century during which America's life expectancy rose from 40 to above 70 years.

Potential Handbook

THIS PAGE completes the third part of a 4-part series on **FACTS FROM OUR ENVIRONMENT.** Many people have asked us to convert this series into popular booklet form. Demand will determine production. We do not claim this series has all answers, by any means, or that it probes every detail with scientific depth. But it does pull out and pinpoint many truths that get blown away in the winds of committee rhetoric and doomsday hearings.

Every effort is being made to capsule, to paraphrase, and to quote competent scientists without distorting the original content of their talks and reports. Some folks advised us to seek the thinking of leaders in different areas. Please advise us below. We will receive your YES or NO gratefully.

Please clip and mail today, so we can get your advice as soon as possible.

NAME____________________

ADDRESS____________________

CITY____________________

STATE________ **ZIP**________

ORGANIZATION____________________

____

1—The series, **FACTS FROM OUR ENVIRONMENT,** would make a useful handbook for general distribution.

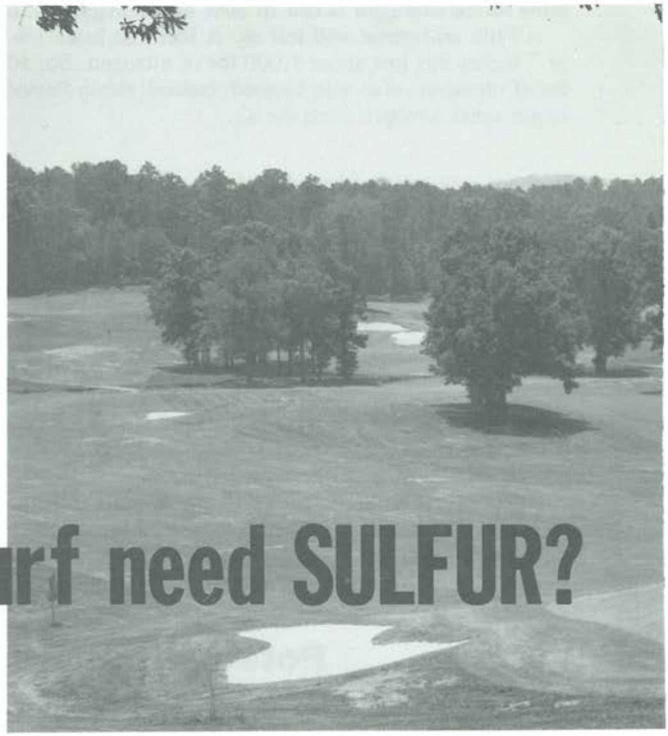
YES_____ **NO**_____

2—Please reserve the quantity below for us (7¢ per booklet) if demand warrants production of this series.

Quantity________

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

TO Turfgrass Managers:



Does your turf need SULFUR?

FRED V. GRAU
GRASSLYN

ADAPTED FROM WEEDS, TREES, AND TURF MAGAZINE

THE PRINCIPAL COMPONENTS of most turfgrass fertilizers are nitrogen, phosphorus, and potash: N-P-K. The P content has been gradually lowered because this element tends to accumulate in the soil. Excess P is associated with an increase in **Poa annua** and with a nullifying effect on arsenic, which is a helpful chemical in reducing Poa populations.

The nitrogen content of mixed turfgrass fertilizers has been greatly increased. Ureaforms have permitted this without increasing the chances of ugly burns. Fewer applications during a season are necessary due to the insolubility and long-lasting effect.

During this period of developing fertilizers with higher nitrogen and lower phosphorus, we have seen a growing recognition of the need for more potash in the mixes. Adequate potash builds greater winter hardiness, better resistance to diseases, and more stiffness to grass blades.

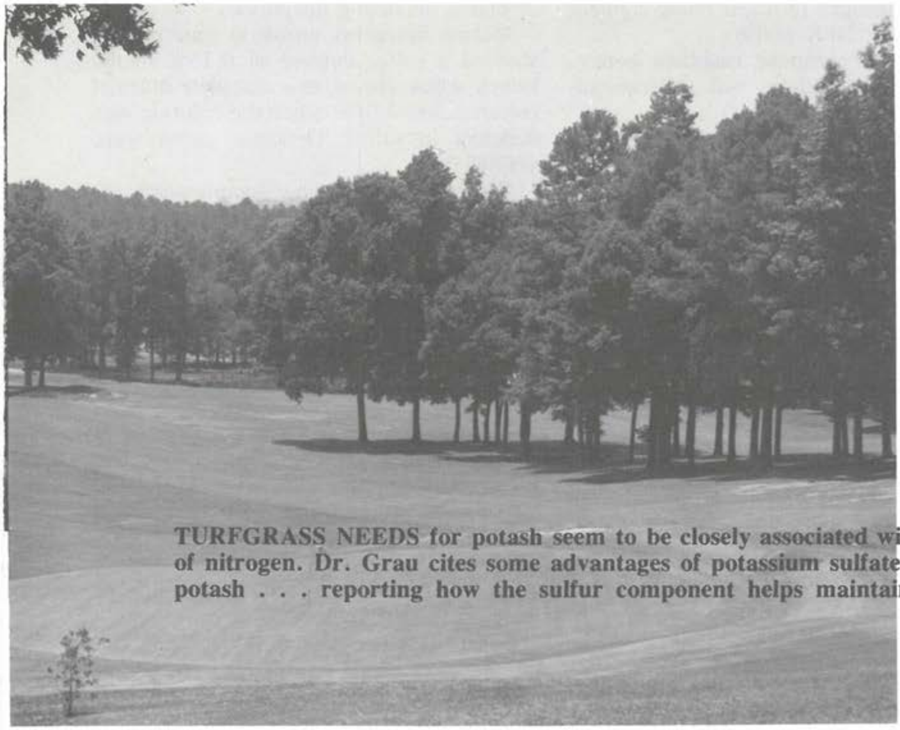
The need for potash seems to be closely associated with the quantity of nitrogen used. For maintenance, the amount of potash needed usually runs about half to two-thirds that of nitrogen. Where potash is low to very low, a 1:1 ratio may be used until balance is restored.

In developing a 16-4-8 fertilizer, for example, the general practice is to use potassium chloride, unless specifications require another potash carrier.

What are the other choices and why would they be specified? The first and most obvious alternate choice of a potash carrier would be potassium sulfate (K_2SO_4).

First, let's look at the nutrient content of the two materials.

	N-P-K- S
Potassium Chloride (KCl)	**0-0-60- 0**
Potassium Sulfate (K_2SO_4)	**0-0-53-18**



TURFGRASS NEEDS for potash seem to be closely associated with the quantity of nitrogen. Dr. Grau cites some advantages of potassium sulfate as a source of potash . . . reporting how the sulfur component helps maintain healthy turf.

Sulfur is the ADDED Ingredient.

The natural presence of sulfur in potassium sulfate makes this material a logical choice to supply potash to turfgrass. One big advantage of potassium sulfate is that the potash has less tendency to burn turf. It is somewhat less soluble, releasing more slowly and lasting longer. The big PLUS is the SULFUR, a major plant food element frequently neglected. Without sulfur, no living plant can thrive.

WHY IS SULFUR IMPORTANT? Without sulfur, turfgrasses exhibit a chlorosis that frequently occurs as an intense yellow color—in mild cases resembling nitrogen deficiency or even iron deficiency.

We know sulfur enhances color, density, and growth. There seems to be a direct relationship with nitrogen, because turfgrass fertilized with higher nitrogen quantities responded more to sulfur. It has been reported 12 lbs of nitrogen require 8 lbs of potassium oxide and 3.45 pounds of sulfur—remarkably close to the proportions of potassium and sulfur in potassium sulfate!

There are several advantages in having sulfur built into a potash system which is used in balance with nitrogen and phosphorus:

1—Sulfur helps produce chlorophyll (green color), though it does not occur in this substance.

2—Sulfur helps form several amino acids that are components of protein.

3—Sulfur activates several important enzymes.

4—Sulfur helps produce Vitamin B_1 (thiamin), biotia, coenzyme A, and glutathione.

5—Sulfur helps build protoplasm, helps increase cold and drought resistance in some plants.

6—Sulfur is involved with an enzyme that is necessary to nitrogen fixation by microorganisms.

It's important to remember the need for sulfur fertilization is closely related to the amount of nitrogen fertilizer being applied. Combined with NPK, sulfur . . .

1—Helps decompose residues better.

2—Helps stimulate soil microorganisms.

3—Helps improve color, density, and composition of turfgrass.

4—Helps build greater drought tolerance.

5—Helps improve winter hardiness.

6—Helps reduce diseases significantly.

WELL-DOCUMENTED STUDIES by Goss, Gould and others in the Pacific Northwest reveal some very convincing reasons for applying sulfur along with N, P, and K.

Adequate sulfur reduced **Fusarium** patch in turfgrass by 86%! The rates varied between 50 and 150 pounds of sulfur per acre. Fifty pounds of sulfur can be supplied with 300 pounds of potassium sulfate which would yield also about 150 pounds of K_2O which usually is sufficient to balance 7 to 8 pounds of N to 1,000 sq. ft.

This property of controlling disease really should cause no great surprise because we have known this about sulfur for a long time. The surprising thing is that so many of us have forgotten it or have not put the knowledge to use.

Another turfgrass disease sulfur has helped check and control is **Ophiobolus** patch. When Merion Kentucky bluegrass is short of sulfur, it is much more susceptible to powdery mildew. Sulfur has also helped reduce dollar-spot fungus in Florida's warm-season grasses.

This may be hard to believe but data from the Pacific N.W. show adequate sulfur prevented **Poa annua** from infesting bentgrass turf. At the same time the blue-green algae was reduced significantly. Sulfur apparently helps build a more vigorous turf, an obvious sign of healthier grass. Healthy turf resists injuries and recovers faster when injury occurs.

Mr. J. D. Beaton, Director of Agricultural Research for the Sulphur Institute in Washington, D. C., has thoroughly reviewed the literature showing interaction between turfgrass and sulfur. Previously we have named some of the advantages of keeping sulfur in balance with N, P, and K—but Mr. Beaton adds some appropriate points:

"Sulfur deficiencies retard the growth of plants, including turfgrasses," he noted.

Merion bluegrass grown in sand culture showed a sulfur content of 0.15% in the leaves when grown in a complete nutrient culture; only 0.04% when the solution was deficient in sulfur. Deficient leaves were yellow.

"Nitrogen and sulphur requirements are closely linked because both are required for protein synthesis. Plant protein contains about 17% N and 1% S. Fertilization at high rates, particularly with N, will greatly increase the need for sulfur and may induce a serious sulfur deficiency."

IT WAS EVIDENT that a deficiency of sulfur restricted the crop response to N fertilization, from data submitted. Also, crop response to sulfur occurred only when N was applied and maximum response to N occurred only when sulfur was applied. Turfgrass managers should find it difficult to ignore these signals.

Sulfur deficiency symptoms in grass can be confused with those of N, iron, and K shortages, making visual detection unreliable. Tissue (plant) analysis can be most helpful. Specific data on the influence of sulfur on turfgrasses are limited, but all the evidence points in one direction—that sulfur plays an important role in turfgrass management.

Goss reports sulfur appears to improve turfgrass growth on soils deficient in phosphorus. This is very important to those managers who have succeeded in creating a P-deficiency in their efforts to reduce infestations of annual bluegrass.

Under wet cool conditions in the spring, turfgrasses in some areas (western Washington, for one) develop a yellowish mottled appearance which sulfur fertilization can reduce or eliminate.

When N carriers were compared on fescue, bent, and bluegrass turf at the University of British Columbia (200 lbs of N per acre or 4½ lbs per 1,000 sq. ft.), the ammonium sulfate increased turf density, created deeper green color, and lengthened duration of response. The other carriers (no sulfur) were urea and ammonium nitrate. Response to N was poor.

Beaton has discussed several materials other than potassium sulfate as sulfur carriers, but none seems as adaptable to turfgrass management as K_2SO_4. The proportions of K to S appear to be almost perfectly balanced when considering any level of N fertilization.

True, not every soil under turfgrass will be sulfur-deficient. But as the use of N continues, we can expect to see a response to sulfur sooner or later.

Beaton has drawn on some 50 references for his exhaustive review. It leads this writer to sound a warning:

Every turfgrass manager will do well to look to his possible need for Sulfur on his turfgrass. THE END

Response of HYV wheat to potash

Average of 617 trials on 7 different soil groups in 11 districts - 1967/68

Varieties:
Sona – 227 Kalyan – 68
NP – 824 S – 308

Treatment	Yield
NP 120 - 60 - 0	2.936 kg/ha
NPK_1 120 - 60 - 30	3.031 kg/ha
NPK_2 120 - 60 - 60	3.173 kg/ha

Net av. profit due to 60 kg/ha K_2O

Rs 123.75
US $ 16.49

A FEW YEARS ago when the new "Mexican" varieties of fertilizer-responsive wheat were introduced to some major developing countries, their breeders recommended only the application of nitrogen and phosphorus for maximum production.

But the Indian Council of Agricultural Research, in hundreds of fertilizer trials, found that potassium applied in addition to 120 kg/ha N and 60 kg/ha P_2O_5 increased wheat yields profitably.

These experiments covered 7 different soil groups in 11 districts with different climatic conditions.

The yield increase due to 30 and 60 kg/ha K_2O was clearly linear and the response to 60 kg/ha K_2O highly significant indicating that larger potash dressings could result in still higher net profits per hectare. (Calculated on the basis of rupee 0.75/kg wheat and rupee 0.90/kg K_2O.) From International Fertilizer Correspondent.

Do you have any idea . . .

. . . how many reprints of this magazine's current series on **FACTS from OUR ENVIRONMENT** can be used by your school or company or state at a cost not to exceed 7¢ per booklet?

If demand warrants, the Potash Institute will compress the 4-part series into a multi-purpose brochure—for local mailings, meeting handouts, teaching and talk plans, radio and press use, and as a handy guide when facing alarmed urban friends. **Let us hear from you. We will appreciate your advice.**

Can YOU pinpoint the problem?

JOHN C. SHICKLUNA
L. S. ROBERTSON
MICHIGAN STATE UNIVERSITY

PINPOINTING field crop problems takes much skill and experience. Most agronomists today are highly specialized. They often work as a team with an entomologist and a pathologist.

Identifying field problems usually involves much more than looking at the crop or the soil. To be certain, scientists often need supportive work from a laboratory.

Visual symptoms frequently show up as (1) slow growth rates, (2) stunted growth, (3) off-colored vegetation, (4) average or low crop yields, (5) poor crop quality, or (6) as a delay in maturity of the crop.

After recognizing a problem exists, the scientists must be able to describe in specific terms the affected parts of the plant. A symptoms inventory is incomplete if all plant parts are not considered—roots, stalks, leaves, flowers, and fruits.

It pays to be able to relate the symptoms to the stage of plant growth—germination, seedling, rapid growth silking, heading or flowering, and grain fill, podding, fruiting, or maturation.

When pinpointing field problems, it pays to remember the many factors that can cause abnormal growth characteristics in field crops: (1) soil conditions, (2) air temperature, (3) light intensity and quality, (4) day length, (5) plant diseases, (6) plant insects, (7) animal activity, (8) weeds, (9) floods, (10) violent winds, (11) toxic agents.

And in the soil, it pays to keep an eye on many factors that can cause abnormal crop growth: (1) soil reaction, (2) available nutrient supply, (3) toxic materials, (4) compaction, (5) erosion, (6) water supply, (7) soil temperatures.

If any of these soil factors are extreme—too high or too low—you can look for problems. When checking out soil factors, competent scientists never neglect non-soil factors.

Let's look at some problems an agronomist may face. In our case, they will be Michigan problems. **But if you can pinpoint the problem, can you make recommendations to solve it?**

PROBLEM 1?

Wheat growing in a field in Huron County was much higher over the tile lines than between the tiles. Why?

First, look below the soil surface. The soil between the tile had a sand lens about 20 inches below the surface. But sand lens directly over the tile line was completely destroyed when the area was disturbed for emplacing the tiles.

The difference in wheat growth was directly related to difference in available water but was indirectly related to the presence or absence of the sand lenses in the profile. The only way to correct the problem permanently is to eliminate the sand lenses by deep plowing. This was done at a later date.

The yield of beans, sugar beets, corn, and small grains rose substantially. And today you cannot locate the tile lines by the crop growth.

PROBLEM 2?

Bean leaves that show a general yellowing over the entire leaf, with the veins remaining green, are a typical problem in Michigan's bean growing area.

The problem first appeared as a mottled effect on the new leaves. The pH of the soil (loam texture) was 7.5 and the soil tested high P, K, and Mg levels.

Adequate NPK fertilizer was applied and 4 lbs of Zn per acre was applied in the row fertilizer. Then, what is the problem?

To diagnose this problem correctly one must remember an earlier suggestion: associate **plant part** and **stage of development** with **plant symptoms.** No apparent soil physical problems existed. Soil tests and fertilizer application rates showed adequate N, P, K, Mg and Zn.

The symptoms—yellowing with green veins—showed first on the relatively new leaves. Relate these symptoms to the soil pH (7.5) and the responsive nature of the crop and you uncover manganese deficiency.

The problem was corrected by using 8 to 10 pounds of manganese in the row fertilizer on the next bean crop. These symptoms have not shown up since, because manganese is used each time beans are grown.

PROBLEM 3?

In a relatively small spot of a Tuscola County beet field, beets wilted even with ample soil moisture. The stand does not equal the rest of the field.

The farmer's son saw lightning strike the ground at this spot. Was lightning the culprit? An interesting problem. But lightning was not the cause. A close look at the root of a beet dug from the soil showed the cause: **nematode damage.**

This is a hard problem to solve on large acreages, because chemicals are expensive. Treating a small area is not difficult. Good sanitation helps control nematodes PLUS long rotations that put several years between beet crops.

PROBLEM 4?

A grower had cropped his alfalfa field intensively for 2 years. The lower plant leaves showed fading color and "white dots" appeared on the leaf tissue.

The chlorosis (white dots) first appeared on the outer edge of the leaves. As deficiency became severe, the entire leaf margins appeared chlorotic. The problem?

The logical place to start, when a plant is in the deficiency syndrome, is to check out insects or disease. This may require a trained entomologist and plant pathologist.

Don't forget adverse weather conditions as a possible cause.

If these two factors cannot be pinned to the problem, then look for nutritional causes.

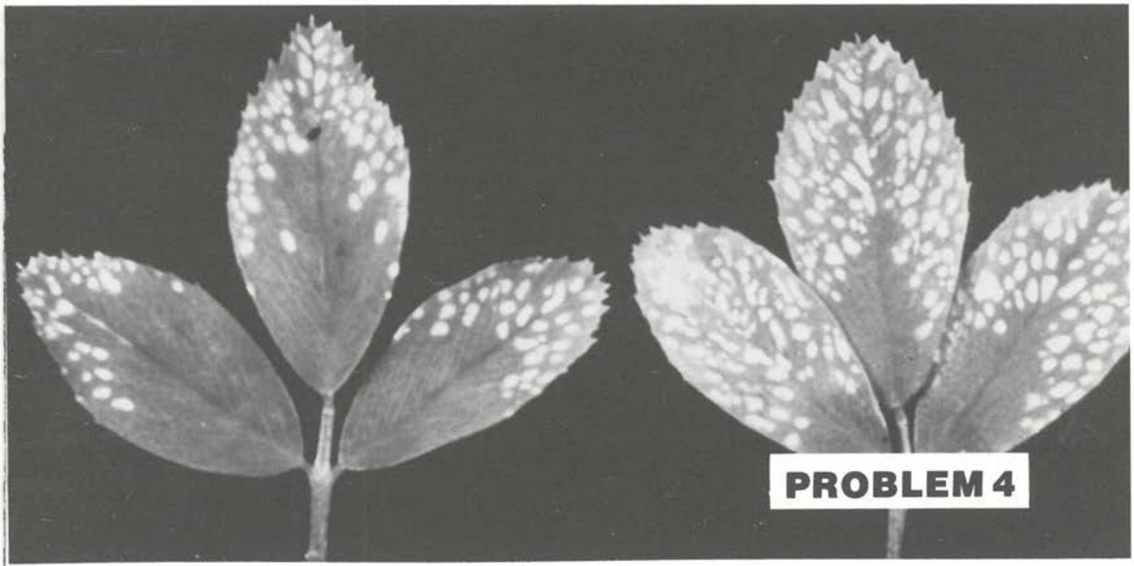
Tissue testing combined with soil testing will help show two things: a nutrient that is too low or a plant unable to take up adequate nutrients.

When a plant's uptake powers seem thwarted, check the plant roots for insect damage, disease or perhaps toxic conditions of some other nutrient or nutrients in the soil.

Excessive water, too little water or cold soil temperatures will also contribute to nutritional problems.

Problem 4 was solved by a tissue test that was confirmed by soil tests—potassium deficient alfalfa. The plant was low in K. The soil was low in K. Corrective potash applications and a long range program solved the problem.

Look over these trouble shooting notes. They are designed to help you **identify** and **solve** crop production problems. Design a sheet like this and use your name and your organization's name. Anyone willing to put his recommendations in writing shows he has confidence in himself and his company.



TROUBLE SHOOTING NOTES

Lynn Robertson Dept. of Crop and Soil Sciences
East Lansing, Michigan 48823 Telephone 517-355-0213

Date____________________

Farmer ____________________

Address ____________________

Field number________ Crop____________ Acres________

Crop history & yields 19____ ____ ____ 19____ ____ ____

Variety or Hybrid________ #Seed/Acre________ Rowspacing________

Yield Goal____________ Planting date____________

Population____________ General Appearance of Crop________

Insects____________ Diseases____________

Symptoms of Nutrient Problems____________

Soil Series____________

Soil Conditions____________ Erosion________

Tillage Depth____________ Tillage Tool________

Tillage Time (Date)____________ Number of times________

Soil Test Results Available? ____________

Weather Conditions ____________

Fertilizer Used—Rate, Date, Placement, Material____________

Manure Used—Kind, Date, Rate____________

Lime Used—Kind, Rate, Date____________

Micronutrients Material—Rate, Date____________

Disease Control—Rate, Date, Placement, Material____________

Insect Control—Rate, Date, Placement, Material____________

Weed Control—Rate, Date, Placement, Material____________

Water Control—Rates, Dates____________

Tissue Test Results____________

Recommendations—Now ____________

Recommendations—Next year____________

THE END

FROM PAGE 9

Table 1. K content and deficiency symptom development of tobacco leaves that received various K fertilizer.[1]

K applied lb/acre	K deficiency symptoms	K composition, % lower leaves	mid leaves	upper leaves
0	V. severe	0.6	0.6	1.3
20	severe	1.0	1.6	2.2
40	moderate	2.4	2.5	2.8
100	none	5.3	4.4	3.1
150	none	6.2	5.4	4.7

[1]Bowling and Brown, 1947.

K applied, and exceeded the composition of the tops at the higher K rates.

SUPPORTING EVIDENCE. Thus it is proposed that the K status of a plant can be evaluated without knowledge of **(1) a critical K nutrient level, (2) a minimum percent K value, or (3) the precise age of the plant.**

California researchers found a greater range of percent K between early and late season potato petiole samples than existed between sufficient and deficient K tissue at any one sampling.

Using a specific K level in the tissue relating to K status requires plant age be properly assessed or the K status could easily be misinterpreted.

A plant's potassium status can be evaluated by the occurrence of K deficiency symptoms, which indicates K is a seriously limiting factor. The diagnosis is usually refined by analysis of the plant or some index tissue.

Analyzing leaves from different positions on a single plant can detect K differences. With the mobility of K and its function in metabolism, the usual consensus is that higher concentrations of K occur in younger leaves than in older leaves.

Table 1 shows values for K content in lower, middle, and upper leaves of field-grown tobacco, with severity of K deficiency symptoms on the plants as a whole. With applied K levels at which no K hunger was observed, the percent K of the lower leaves was higher than the upper leaves.

W. C. Liebhardt and J. T. Murdock found percent K of corn tissue grown on soil containing 132 lbs exchangeable K/A was higher in the immature tip than in the mature tissue. But when 133 lbs K/A was added, the lower mature tissue contained a higher concentration of K than the upper immature tissue.

K. H. Fong and Albert Ulrich found the percent K higher in the immature leaf than in the mature leaves of potatoes through the range of growth response to increasing K rates. At optimum K rates and above, the K concentration of the mature leaves was equal or above that of the immature leaves.

THE THEORY RESTATED. On the basis of the reported K analysis and response data, it appears K status of the plant can be reliably determined by **comparative samplings of the mature and immature tissue.**

If the mature tissue contains a percentage K equal or above that of the immature tissue, the K status of the plant is optimum. But if the mature tissue contains a lower percentage K than the immature tissue, the K status is less than optimum. **THE END**

LOOKING FOR A HANDY ANSWER BOOKLET? SEE PAGE 21.

Is Potash THIS Important?

What is their secret?

Holland uses more potash per acre to grow food than most other nations on earth . . . and enjoys the world's best health standards . . . highest birth and lowest mortality rates. Is this due to the potash in their fertility program? Of course not! But science has observed . . .

- **THAT** potash is very important for regulating heart beat and strengthening heart muscles.
- **THAT** growth stops, paralysis develops, and death follows when potash is completely withheld from animal diets.
- **THAT** low-potash diets produce muscular weakness, poor calcification of bones, slow-down of nervous system, malfunction of adrenal glands and nervous system, and degeneration of heart and kidneys.
- **THAT** severe heat exhaustion can accompany potassium deficits, even in a person taking salt tablets (sodium chloride), then vanish when he increases potassium and stops sodium-chloride intake.
- **THAT** much of the needed potash from vegetables and fruit can be lost in their preparation, especially by draining off liquid after boiling or processing.
- **THAT** the potash content of fruit and vegetables (and other crops) can be helped by using enough potassium fertilizer in today's high-yield fertility programs.

Is potash really this important—or is much of this just myth?

It wasn't myth to astronauts **James Irwin and David Scott on Apollo 15 flight.** Both men lost 15% of their normal potassium, with Irwin suffering serious irregularity in heart rhythm (cardiac arrhythmia) after returning to the command ship following the 66-hour job on the moon. Had it continued, Irwin's heart could have gone into fibrillation, a potentially fatal series of muscle spasms preventing the heart from pumping blood properly. Scott suffered less problems (heart contractions) later in the flight home.

What caused their irregular heart beats? Reduced potassium levels in their bodies, apparently, according to their physician, **Dr. Charles Berry, Director of Life Science for NASA.**

What caused their potassium loss? Fatigue from the long stay on the moon was a big factor, Dr. Berry explained. **Astronaut Alan Worden,** working the command ship, lost 10% of his potassium.

What can NASA do to counter potassium loss in space? Maybe dose astronauts with extra potassium before a flight. Or add greater amounts of potash to their food. Their fruit drinks already carry extra potassium. NASA is working on it. The problem spotlights one thing: The life-saving necessity for plenty of potash in the food we eat.

How can we insure plenty of potash in our food supply?

By insuring a right balanced fertility program for our crops. Right balanced fertility does not mean equal amounts of all nutrient elements. It means **ENOUGH** of **EACH** nutrient to satisfy a high-yield crop's need. Nitrogen is usually the lead horse, so to speak—the vigorous booster. The more it boosts growth the more the crop takes up (or **WOULD** take up) **OTHER** nutrients, if they are there. Reports from such varied places as Florida, Michigan, Nebraska, and Illinois show corn takes up about the same amounts of nitrogen and potassium—with six hybrids containing an average of 24.2 nitrogen and 26.2 lb potassium per ton of dry matter produced. Our food cannot get what isn't there. So a strong potash program must go with the nitrogen and other elements.

MORE STARVED THAN

ALL FIVE stood close together in the corner of the hospital lobby, clearly three generations from the same family—and from what Norman Borlaug might call "the country."

Grandparents in their late 60's, parents in their early 40's, and a daughter in her late teens. The country was not in their dress, but in their faces, especially the men, lines only sun and wind and weather can carve.

Someone close to them was near death. It was written all over their sun-wrinkled faces. Deep grief. I watched quietly, without staring, but sharing their sorrow. I tried to think of something else, but failed. Only this thought would come:

"Salt of the earth. If these people ever give up, if they ever say 'to hell with it all,' we can hang a CLOSED sign on this old globe. If these folks ever quit being their solid, working, tax-paying, law-abiding selves, the radicals at both ends of the street will devour each other —in their own stews of hate and laziness at one end, of greed and luxuries at the other end."

Who invented the labels of "hayseed" and "rube" for people who make their living in the country—labels still alive in some minds, Nobel Peace Prize winner Norman Borlaug believes. What a con man that inventor was—to sell such a myth to so many generations.

No man stripped this myth more naked than the late Clarence Poe when he said, "There is just as much culture in the sweat of horny hands and the smell of plowed ground as there is in black-tie concerts and intellectual seminars."

Dr. Poe might have added that agriculture was man's first culture and it will be his last culture here because it is the one culture that keeps him alive to enjoy all other cultures.

For nearly a century, we Americans have fallen all over ourselves to get off the farm and out of the country into town. But today the weekend exodus to the countryside is something to behold. Why do we rush to the country?

To escape our smogs and noise and crowding and crime and stinking sewers, rivers and harbors, Dr. Borlaug contends. To absorb the fresh air, blue skies, and clean water from distant streams . . . to relish the trees and flowers, the song of the meadow lark and oriole, and the whistle of the bobwhite.

And with our beer cans and garbage, we have brought little, if any, understanding of the farmer and how he must get the food we need to survive.

In the summer of '32, a city lad mounted his new bike before dawn and pedaled out of a soft suburb 38 miles into the foothills of the great Blue Ridge —to a widowed grandmother some called "an humble old country woman" because (to them) she didn't have the sheen of hostesses they called "mother" whenever they were home.

Time will not erase the memory of those summer visits nor the love a young lad received from a country grandmother.

True, she could not play bridge or swing a golf club or balance a martini glass in one hand and menopause nerves in the other at country club receptions. Nor could she afford private treatment for "depression and nerves."

She didn't oppose "the good life." She was just too busy to seek it. Busy raising some grandchildren who had lost their parents . . . and some grain and vegetables and fruit and livestock for food . . . and a "cash crop" for bills and taxes.

True, she did not understand that phenomenon some ladies call STYLE. She had one bun knotting the back of her gray hair and untouched wrinkles noble in the sun, on her knees digging potatoes from the cool loam, singing to a helping grandson about something she called

NAIVE . . .

"blessed assurance" and "amazing grace."

Yes, "humble" she was—but not in the sense many sophisticates have catalogued rural people through the years.

There was nothing humble about her strength of body— to fire up three washpots on Monday morning, to hoe long rows of corn she enjoyed, to return from every Sunday visit "by milking time," to haul heavy buckets of cool well water to "convicts" patching the road, and to set three meals a day from a wood-burning stove.

There was nothing humble about her strength of mind— to devour newspapers and magazines and even Congressional bulletins, to hypnotize a grandson with tales of Andy Jackson and Abe Lincoln and General Lee and Woodrow Wilson at the pasture gate calling "soo cow" at sundown.

She was too aware of events beyond her hills to believe the world could stay the same and too wise to doubt some values must stay the same if man is to survive. Much more aware than most neighbors her grandson knew.

A hayseed? A rube? How naive urban minds of the 30's. Maybe they were more starved than naive—starved for a country grandmother to send them to the crossroads store on Saturday afternoon for peppermint candy out of the big glass jar.

And there to see the women in the back seat of the big black car at the handcrank gas pump, on their way to open summer homes with pools on top of the mountain in the Great Depression.

To see what looked like sadness or boredom or fear in those ashen faces, the unforgettable faces on that back seat—costly wives of cunning men, ingenious at acquiring a farmer's product for rock-bargain prices and selling it for luxury-building profits.

Some of the profits were on the fingers, wrists, necks, and backs of the women in the big back seat of the Great Depression. The lad felt sorry for those ladies—but did not know why.

Maybe because they didn't have a scrumptious piece of golden cornbread to crumble into a glass of cellar-chilled sweet milk waiting for them on a blue plate . . . and from the backporch well another song being hummed by a lady too busy to be sad or bored or afraid.

Maybe because they didn't have oil lamps to play rook by at night or crazy quilts to lie on and look up at the stars through giant country trees or a dipper of cool well water waiting in the hands of a country grandmother after helping an uncle lead the mules in for the night.

Maybe because they didn't have a house close to the road where men walking back to their native hills from city jobs lost in the Great Depression could find free food and a night's lodging, even on clean pallets spread along the porch by a country grandmother after the extra room was filled.

She was never tempted by the lights and sounds and people and culture of the city. She had her own lights and sounds and people and culture—and God-given variety she called fall, winter, spring, summer. Each one carried a blessing for her—the NECESSITY to prepare for it. Drudgery sometimes, yes. But no sleeping pills. Sweat and discomfort sometimes, yes. But no tranquilizers. Just strength to do what had to be done and never boredom or sadness or fear in her face for a lad who learned the proudest heritage a man can claim is a country grandmother.

A homemaker long before home demonstration became a profession—and ALWAYS THERE, at home when she was needed. She never sought liberation from the duties of womanhood, probably because the devotion of nine children did not seem like slavery to her.

Thrifty. Systematic. So self-reliant that several successful sons could not interest her in many new "comforts." How shallow for sophisticated minds to consider anyone like that a "rube" in 1932, how incredible in 1972.

If she were living today, she might tell weekend guests to her countryside to bring one thing with them—reverence, not for her, of course, but for the blue sky and clean air and open land and the soil, the priceless soil, entrusted to a noble people.

She might also tell them man must HELP that soil grow food. It would pay her weekend guests to listen to a hostess very sophisticated in the art of survival.

It Is The ONE DEMAND We Must Meet

MAN CAN NEGLECT many things and still survive . . . but not the nutrients in his soil. What goes up and out in our annual struggle for food must be returned by nature and man. For three decades, the Potash Institute has emphasized this principle through a teaching aid known around the world—a PFU (Plant Food Utilization) chart-pamphlet story first created by Institute scientist J. D. Romaine, now retired.

For a scientific theme, it has gone like "hot cakes"—nearly 1,000,000 copies used around the world. It has been updated twice with increasing yields. And in this issue, the Potash Institute updates it a third time.

This time the tabular chart on cover two features 40 crops and 5 nutrients, instead of the 20 crops and 3 nutrients on the earlier charts. And the story on page 1 shows why we must be **UPTAKE** conscious today—to insure future food for man, to insure richer residues and organic matter for the environment. If you can use this story in popular color-folder form, write **New PFU Folder** at the address below.

Better Crops
WITH PLANT FOOD

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

Controlled circulation postage paid at Washington, D. C.