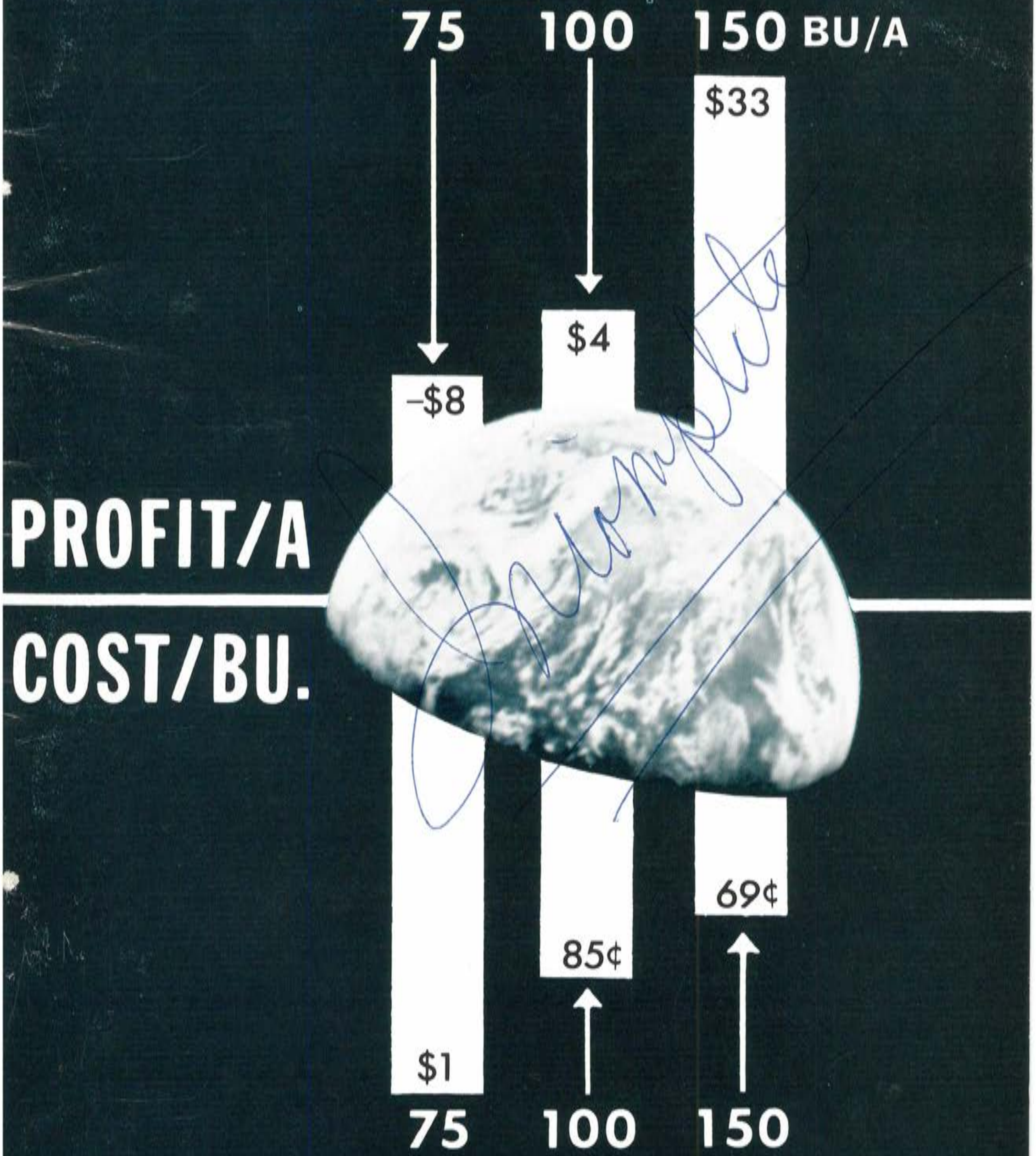
Better Crops WITH PLANT FOOD

NUMBER 3—1969 25 CENTS



CORN TRUTHS STAY DOWN TO EARTH

HUMANITY and MONEY!

EVER TRIED TO TALK higher yields to folks who have seen "extra corn" depress their market? It takes guts. Why do scientists, top growers, and industry specialists keep talking it?

Humanity and money! Humanity grows by the hour, and average yields just don't make money for the farmer.

Population experts say the U. S. will have **344 MILLION** people to feed in just 30 years . . . **ONE BILLION** people in barely 100 years . . . if our current population continues to grow at present rates.

"By 1980, we can feed the U. S. with no more acres under plow than we have now, if our farm skills keep growing . . . and by 2000, farmers could still keep the U. S. population of 344 million fairly well fed," Donald Murphy predicts in **Wallaces Farmer.**

IF our farm skills keep growing—that's the key: **SKILLS** to keep the farmer in business and to keep an increasing population well fed on limited land.

An excellent guide to greater corn profits, issued by **Indiana Farm Bureau** specialists, shows how higher yields lead to more profit per acre and less cost per bushel. Their table of costs and returns, shown below, are general figures. The picture may vary in your area and situation. But the point is clear: 70 to 80-bushel yields may be needed to break even and pay costs. So, profits must come from **EXTRA** bushels **PER ACRE.**

What do those **EXTRA** bushels demand? Top management—including season-sure nutrition. And to maintain **SURE** nutrition, the grower should know what today's high-yield crops take away. Pages 26-30 feature removal pictures of four leading crops, ranging from just above breakeven yields right up to the stars—300-bushel corn, 120-bushel soybeans, etc. They were featured in a recent issue of AGRICULTURAL NITROGEN NEWS magazine.

They tell the farmer one thing: Mine your soil and go out of business. Build it and stay in.

Estimated Per Acre Costs & Returns of Corn

	75 bu. yield	100 bu. yield	150 bu. yield
Land Charge (Interest & Taxes)	$35.00	$35.00	$35.00
Power & Equipment	12.00	13.50	15.25
Labor	9.00	10.25	12.00
Overhead & Miscellaneous	4.00	4.30	4.80
Seed	2.50	3.20	4.25
Sub Total	$62.50	$66.25	$71.30
Pesticides	2.00	3.00	5.00
Limestone (Annual Costs)	1.50	1.50	1.75
Plant Food	9.70	14.75	23.50
Total Costs	$75.70	$85.50	$101.55
Value of Corn @ .90¢	$67.50	$90.00	$135.00
Profit per acre	−$ 8.20	$ 4.50	$ 33.45
Cost per bushel	$ 1.01	$ .85	$ .69

Better Crops
WITH PLANT FOOD

The Whole Truth—Not Selected Truth

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CONTENTS

What is a farmer's

THE MODERN FARMER must skillfully combine land, labor, capital, and management to produce the different raw products he sells. He is a self-employed businessman controlling an investment often greater than the main street businesses of his community.

Farmers are quick to substitute capital for labor, to use herbicides, insecticides, fertilizers, improved hybrids, etc. But many do not recognize the value of timeliness in production and marketing.

RIGHT TIMING of production and sales is important! Selling near seasonal high price can make a big difference in profit.

Weather influences crop production. Farmers have the same number of days to plant 1,000 acres as they had when they were planting 400 acres or only 100 acres.

TIMELY PLANTING boosts corn and soybean yields. Delayed planting—from May 2 until May 30—decreased a full season corn hybrid 19 bushels per acre average for 5 years at the Northwest Iowa Experiment farm.

Best yields come from corn planted between April 25th and May 10th, Purdue studies showed. About this time loam soil reaches 50-52 degrees F at 4 inches deep between 7:00 and 8:00 A.M.

Corn planting delayed beyond May 10 reduces yields about one bushel per day for each day of delay until around May 20, about 2 bushels per day after May 20.

J. WILLIAM UHRIG
PURDUE UNIVERSITY

Early planted corn has other advantages: (1) Faster development under better moisture conditions, (2) Earlier harvesting before serious lodging, (3) Shorter height to stand better, (4) Highest shelling percentage and more grain per pound of stalk.

Simply saying a day's time is worth x dollars during the first part of May assumes away the real economic question. You can't change number of days suitable for field operations.

But you CAN CHANGE size of equipment, amount of equipment and type of tillage system used, number of operations performed, and timing of certain operations.

We are beginning to use computers to compare alternatives available in choosing tillage systems, size of equipment, and in planning the farm business.

IN TOP FARMER Conferences at Purdue in 1968, we developed a linear programming model:

(1) To analyze over 800 combinations of planting dates, harvesting dates, tillage methods, machinery sizes, soil types, technology packages, land rental, and irrigation options.

(2) To select various sets of machinery combinations (sizes and tillage systems)

TIME worth?

for planting *1,000 acres of corn* in a timely fashion.

(3) To analyze weather data of the past 17 years for suitable fieldwork days during 6 different planting and 3 harvesting periods.

With 6-row conventional tillage system and no extra land available for rent, an additional hour of planting time between April 26-May 2 would be worth $196, assuming no other changes were made. This included the entire component of labor and equipment, including 2 planters, 2 men, 2 tractors, etc.

Thus, an additional hour would be worth $100 per man and tractor outfit. Having the extra time would allow the computer to re-aim the entire schedule of land preparation and planting toward higher average yields.

Two full-time operators were employed. Part-time help was available as needed. Peak labor need came in fall, between September 16 and October 5, when 575 hours of labor were hired. If extra land were available, the operator could have paid a breakeven rental fee of $76 per acre for up to 40 acres.

Switching to 12-row conventional equipment (one planter) reduced labor 552 hours from 2,409 to 1,857. An extra hour of planting time before May 10 was worth $127 per hour with the 12-row conventional equipment.

No. 2 corn price was figured at $1.00 per bushel in the previous examples. Higher corn prices would have increased the value of extra time.

WHAT WILL YOU DO WITH IT—this extra planting time during the latter part of the planting period?

If you can buy or rent additional land, either on a crop-share or cash-rent basis, your additional revenue may be larger than the additional costs on the crops planted in late May. Substituting soybeans for late-May or early-June corn is a very good question on most Indiana farms.

When extra land was available for cash rent at $45 per acre, we found 1,552 acres of corn (rather than 1,000 acres) could be planted with the 6-row equipment selected (two planters). An extra hour of field time during early planting period was worth nearly $318 with the larger acreage.

At this rate, 11⅓ extra hours would increase net farm income more than $3,600.

With the extra acreage, an extra hour of time for land preparation was worth $25 per hour. It was worth $31 at harvest, compared to $8 with just 1,000 acres of corn to harvest.

Under the 12-row conventional system, total corn acreage differed little: 1,582 vs. 1,555 with the 6-row system. But the 12-row system increased farm income

$3,860. How? Through higher yields from more timely operations.

An extra hour at planting time was worth $286, but only 2 extra hours could be used at this rate. The bottleneck occurred at harvest. An extra hour in October harvest was worth nearly $100 per acre, and 12½ extra hours could have been profitably used at that rate.

Big dividends could have come from boosting harvest capacity with larger combines, an extra combine, or custom-harvesting part of the crop. Hired labor still peaked in early fall when 535 hours of extra labor was used.

GAIN MORE SPRING TIME: Work longer hours during planting season . . . Hire additional labor . . . Custom hire additional services . . . Increase machinery capacity—either in size or number . . . Use minimum tillage practices . . . Perform as many operations in fall as possible —plowing and spreading fertilizer.

USE THIS TIME BEST:

1. Do everything possible outside this short critical time period—spreading fertilizer, preparing seedbed, etc, as much as possible during fall and early spring before corn planting. . .

2. Use large equipment to accomplish much during the time.

3. Hire much extra labor to use expensive power and equipment fully.

4. Work longer hours during the critical period.

5. Switch to a tillage system that takes less time per acre during critical time period.

6. Expand operations by renting or buying more land to use larger equipment more effectively.

7. Hire some jobs done on custom basis.

THE END

Potash Helps Fight Disease

AN OPPORTUNITY to study relationships between insect attack and nursery trees occurred in N.-W. Germany after an unusually severe scale insect attack on certain plots.

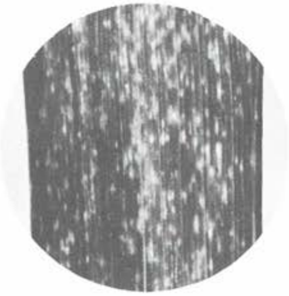
The plots most severely attacked were those fed with high nitrogen and those with potash shortage. Foliage from the plots was used as feed material for scale insect nymphs in Petri dish tests. The nymphs migrating to the leaves were counted after four days. The number was significantly greater for leaves from the NPMg plots—but there were no significant differences for leaves from the KMg, NPKMg and Mg plots. These laboratory experiments indicated that NP feeding made the foliage preferable to scale insects, **but this NP effect was eliminated if potash was also given.**

The results were then confirmed in the field. The KMg plots had the smallest insect infestation. However, this was not much increased when NP was added—on the NPKMg plots. **If NP was given without potash, the number of scale insects was doubled.** These results were for Red Oak. Similar field results were obtained 130 km distance with Robina. At this second centre, Robina resistance to scale insect infestation was also reduced by PCa fertilizing, but it was reduced to a minimum only when potash was given.

At both centres the number of insects per 10 cm of stem was significantly larger on the plots not given potash. Even when N was also given, K greatly reduced the insect infestation. Numbers of young tree seedlings died, the attack of the insects debilitating plants which were primarily weakened by potash shortage. One measurement taken showed that there were 122 more dead stems per 0.1 hectare on the PCa plots than on the PCaK plots.

From Fertilizer, Feed, and Pesticide Journal.

PUT K MUSCLE TO WORK IN THE FIGHT AGAINST PLANT DISEASE



MOST DISEASES have a sweet tooth for lush, soft crops, the kind that come from pouring on plenty of nitrogen but forgetting to add enough of the other nutrients to keep normal balance in the plant. Potash-hungry plants accumulate too much sugars and nitrates that can't be converted to proteins.

Such potash-hungry plants run down early—their cells die, their tissues deteriorate, **inviting open house to disease lurking at the door.** That door may be weak or injured roots. It may be mechanical or insect-injured tissue, thin cell walls or epidermal layers, dead tissue, sluggish stomata, etc.

Once inside, the infection can spread like wildfire when chemical compounds become unbalanced in the cells, when food flow (translocation) to or from roots declines, and when the plant cannot form (photosynthesize) new tissue. Adequate potassium helps the plant resist such conditions. In fact, USDA Yearbook on Plant Diseases says **potash has been responsible for retarding more plant diseases than any other substance—"perhaps because it is so essential for catalyzing cell activities."**

Potash strengthens stalks and stems against invading organisms and lodging . . . thickens cereal cuticles against mildew and other infections . . . helps prevent iron from accumulating in corn nodes and interfering with nutrient flow to and from roots . . . insures larger, more evenly distributed food-carrying vessels for alfalfa, less subject to clogging from vascular diseases.

It helps insure normal balance of chemical compounds in the plant—no excess of non-protein nitrogen and carbohydrates, adequate amino acids, starch, and cellulose. It makes plant cells more turgid, less suitable for certain diseases to invade after heavy rainfall.

It affects the number and size of plant stomata—the little mouthlike openings for transpiration and gas exchanges—and insures far less sluggish closing of the stomata.

It helps delay plant senility which comes too soon in potash-hungry plants, with its dead leaf tissues inviting even weak parasites to enter. It helps activate 25 or more enzymes vital to the normal function of a plant's chemical system.

MANY trials of the past 10 years have shown potash helping REDUCE . . .

- **Leaf blight** and **stalk rot** in corn.
- **Black spot** and **stem end rot** in potatoes.
- **Wilt** and **damping off** of cotton.
- **Leafspot** and **dollarspot** in grasses.
- **Wildfire** in tobacco.
- **Stem rot** in tomatoes.
- **Black leaf** in grapes.
- **Mildew** in many crops.

DIAGNOSE

N P K

PROBLEMS WITH SOIL TESTS

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USING SOIL TESTS to help solve soil fertility problems is a well-established practice in the United States. Let's look at some additional ways to use soil tests in diagnosing and solving problems that occur rather frequently with nitrogen, phosphorus and potassium.

WHAT ABOUT NITROGEN? The usual excuse for not emphasizing nitrogen soil tests is that they are not very reliable. Actually, they are quite reliable if used and interpreted correctly.

Organic matter content, for example, is run millions of times every year and then almost completely ignored. If, in addition to percent organic matter, a general idea of the organic matter distribution with depth is known, it is a fairly good guide to nitrogen mineralization from the soil.

The easiest way to find organic matter distribution with depth—without determining it—is to know the soil name. Lacking that, the topographic position on the landscape is helpful.

For example, many upland soils in the Southeast have about 2% organic matter in the surface 6 inches and drop off to very low values below that point.

Other soils, such as the Maury in Kentucky and Tennessee, maintain this percentage for 12 inches. River bottom soils often have 2% organic matter for 2 feet or more.

Despite these differences, we use 2% as an unvarying figure for all three groups of soils. **TABLE 1** shows how the nitrogen contribution from organic matter can be used when we have some knowledge of the soil. The estimates of availability are arbitrary. But organic matter below the top 6 inches probably delivers only about half the nitrogen surface soil does.

Another aid in finding nitrogen need is to determine nitrate nitrogen in a soil profile at any time of interest. You must sample "effective" soil profile explored by the plant roots. Surface samples alone are not always proportional to the total nitrate in the root zone. **FIGURE 1** shows results of this kind of sampling. Both soils received 160 lbs. of nitrogen in the fall in a time of nitrogen application study by Harold Miller in Kentucky.

The soil shown by black circles has lost more than half the nitrogen by May. The soil shown by open circles has retained most of the nitrogen in the root zone. Surface sampling of these soils would have shown about the same level of nitrate in each.

Sampling for nitrate and determination in a soil and water slurry, using a nitrate electrode is a rapid and efficient way to determine whether additional nitrogen

TABLE 1. CALCULATIONS OF NITROGEN DERIVED FROM ORGANIC MATTER

1% × 6 inches depth = 10 lbs N/acre

2% × 6 inches depth = 20 lbs N/acre

2% × 12 inches depth = 20 lbs N/acre + 10 lbs for second 6 inches.
Total = 30 lbs N/acre

2% × 24 inches depth = 20 lbs N/acre + 10 lbs for each 6 inches.
Total = 50 lbs N/acre

is needed. This test helps check on fall-applied nitrogen or after heavy rains have left an uncertain amount of nitrate nitrogen in the soil.

A final need in making nitrogen recommendations is to have an idea of how much nitrogen a given crop requires. This varies from soil to soil. Yet, in the author's experience, it is quite consistent from year to year on a given soil type.

Table 2. Amount of nitrogen needed to produce bushel of corn (calculated at 100 lb. N/a)

	lbs N/bu corn increase	
Soil	**1967**	**1968**
Captina	**4.54**	**4.54**
Zanesville	**2.50**	**2.08**
Stendall	**——**	**4.35**

TABLE 2 shows this for corn receiving 100 lbs. N/acre. The data are taken from Kentucky work of D. E. Peaslee and H. F. Miller. The Captina and Stendall soils turn nitrogen into corn about half as efficiently as Zanesville soil does it.

All state experiment stations have this kind of data which can be generalized and used in recommending nitrogen rates.

WHAT ABOUT PHOSPHORUS? The basis of most sound soil test programs is a calibration curve for phosphorus content of the soil vs. percent of maximum yield, **FIGURE 2** shows. A sandy soil usually requires a higher level of soil test phosphorus for maximum yields than a clay soil does. Two questions are largely unanswered by such a calibration curve: (1) If a soil test reads low, such as point 1, how much fertilizer phosphorus is needed to bring the soil test phosphorus up to where maximum yields can be obtained? (2) If the soil test reads very high, such as point 2, how many years can it be cropped before the soil test level declines to where a yield response can be obtained?

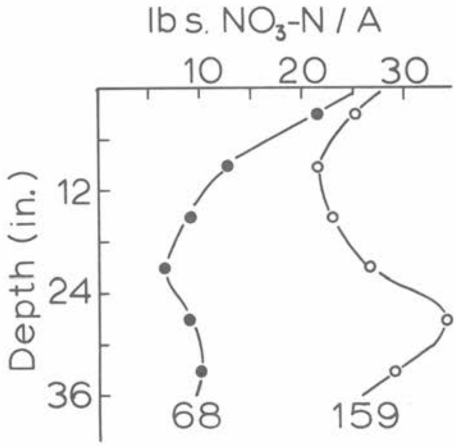


FIGURE 2

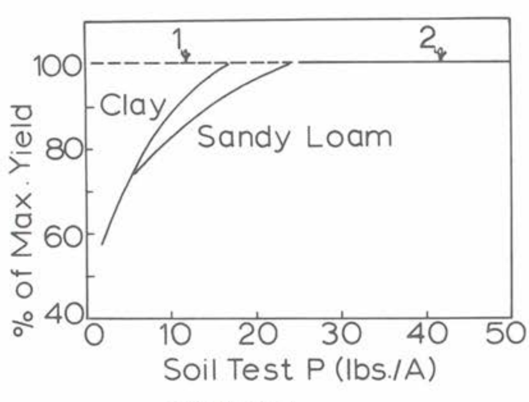


FIGURE 1

The answer to question 1 can be obtained by determining the increase in soil test phosphorus as a function of added fertilizer phosphorus. This is usually related to the soil texture, being higher for a sandy soil than a clay soil. **FIGURE 3** shows examples taken from a sandy soil (Sassafras) and a clay soil (Davidson).

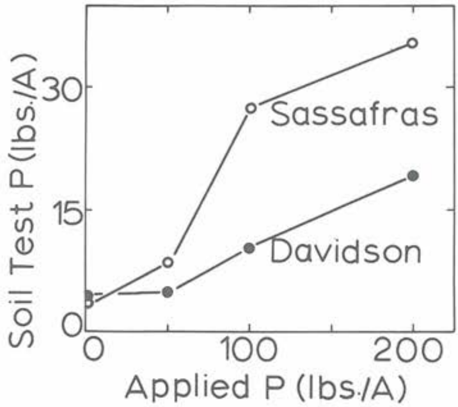


FIGURE 3

Note how 50 lbs. of added P does not affect the soil test of Davidson at all.

Such results have convinced many people, particularly in North Carolina and Virginia, that massive doses of phosphorus are needed to make a significant change in red clay soils such as the Davidson.

Data needed to answer question 2 are not available in any quantity. What information is available suggests that once a soil test level of phosphorus reaches a very high point, it requires a long time to lower it to the danger point.

This "long time" depends on the crop and soil, but may extend from 5 to more than 10 years. Obviously, research on this matter is urgently needed.

WHAT ABOUT POTASSIUM? A 30-year debate has taken place over soil testing for potassium. On one side are those who believe a simple "pounds per acre" test is adequate. On the other, are those who believe a certain portion of the cation-exchange capacity should contain potassium for best plant growth.

Actually, both groups are partly wrong. A "pounds per acre" test is not satisfactory for grouping soils with great differences in cation-exchange capacity. A certain percentage of potassium saturation is not adequate for all soils, either.

FIGURE 4 shows plots of exchangeable vs. solution potassium for three soils

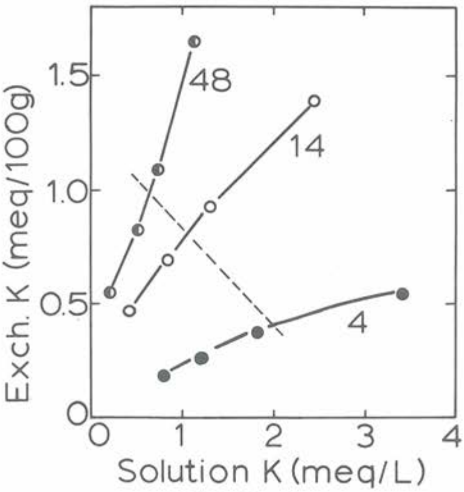


FIGURE 4

with cation-exchange capacities of 4, 14 and 48 meq per 100 grams. It is easy to get potassium into the soil solution when the cation-exchange capacity is low, but difficult when it is high.

Work by B. W. Hipp and the author in Texas convinced us that the amount of exchangeable potassium needed for good crop growth varied as the dashed line is drawn. This indicates a high cation-exchange capacity soil requires two-and-a-half times as much exchangeable potassium as a low exchange capacity soil.

At the same time, the percent potassium saturation for the high exchange capacity soil is about 2% and for the low exchange capacity soil is 10%. Graphs such as **FIGURE 4** could be used in making potassium recommendations, using soil data from the areas involved.

Another approach to using potassium soil tests for diagnosis involves a "balance sheet" obtained by taking yields and soil samples over a period of years. Such an approach can be used by any farmer or

Table 1. N and K_2O fertilizer affects crude protein consumption of orchardgrass hay[1]

Treatment N lbs/A	Treatment K_2O lbs/A	Crude Protein %	CP Consumption per Cow per Day lbs	Soybean Oil Meal Equivalent lbs/cow/day
0	0	10.14	1.34	3.0
0	200	10.81	1.37	3.1
100	0	16.31	2.23	5.1
100	200	15.96	1.92	4.4

[1] 200 lbs P_2O_5/A was applied to all plots.

Table 2. Effect of Nitrogen and Potassium Fertilizer on Hay Consumption and Milk Production of Dairy Cows

	Treatment N	P_2O_5	K_2O	Daily Forage Consumption	Cow Days Per Acre[2]	Fat Corrected Milk	Total Milk Per Acre[3]	Gross Value of Milk at $4/Cwt.	Value of Grain and Beet Pulp Fed[4]	Estimated Value of Milk Due to Forage Alone[5]
	lbs/A			lbs/Cow[1]		lbs/Cow/day	lbs	$/A	$/A of forage	$/A
P	0	200	0	13.2	151	25.2	3,805	$152.20	$45.30	$106.90
PK	0	200	200	12.7	183	23.8	4,355	174.20	54.90	119.30
NP	100	200	0	13.7	230	24.5	5,635	225.40	69.00	156.40
NPK	100	200	200	12.0	452	24.6	11,119	444.76	135.60	309.16

[1] Average cow weight of 1200 lbs.
[2] Based on hay consumption only. See text for details of grain and beet pulp fed.
[3] Estimated: Cow days per acre x fat corrected milk/cow/day.
[4] Estimated: Based on 10 lbs. of grain/cow/day and 4 lbs. of beet pulp/cow/day x cow days per acre. Grain valued at 2¢/lb and beet pulp at 2½¢/lb.
[5] Estimated: Gross value of milk—value of grain and beet pulp = estimated value of milk due to forage only.

Table 3. Spectrographic analysis of orchardgrass hay samples[1]

Treatment N lbs/A	Treatment K_2O lbs/A	K (%)	P (%)	Ca (%)	Mg (%)	Si (%)	Mn (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)
0	0	2.58	0.39	0.28	0.16	0.40	322	132	60	60
0	200	3.35	0.36	0.30	0.17	0.55	203	246	32	48
100	0	3.16	0.39	0.34	0.22	0.28	144	87	75	70
100	200	3.78	0.40	0.36	0.26	0.24	177	93	47	57

[1] 200 lbs. P_2O_5/A was applied to all plots.

Table 4. Nitrogen and potassium removed by one cutting of orchardgrass hay

Treatment Code	Nitrogen Content %	Nitrogen Applied lbs/A	Nitrogen Removal[1] lbs/A	Potassium Content %	Potassium Applied lbs/A	Potassium Removal[1] lbs/A
P	1.62	0	32.3	2.58	0	51.4
PK	1.73	0	40.1	3.35	166	77.6
NP	2.61	100	82.2	3.16	0	99.5
NPK	2.55	100	138.4	3.78	166	205.1

[1] Calculated: Forage content x dry matter production.

intake did not cause significantly higher daily milk production. **But total milk production, calculated as milk per acre on the basis of hay consumption, shows the benefit of proper NK balance. Total milk production from the NPK treatment nearly tripled P only, nearly doubled NP!**

Fixed production costs have not been calculated and yield data only represent first cutting hay yields. But dollar per acre calculations emphasize the additional profit potential derived from a sound, balanced fertility program.

TABLE 3 shows how spectrographic analysis of the various hays reveal mutual effects from NK balance. N-K teamwork gives better quality forage:

(1) P supply to the animal increases.

(2) Mg exceeds 0.2% which may be important in offsetting hypomagnesaemia tendencies (grass tetany).

(3) Si is lower for faster, more complete digestibility. Also note the NK forage carried the highest percentage of Ca and Mg.

TABLE 4 shows how important it is to keep an eye on nutrient removal, if you want to MAINTAIN top-yield-and-quality forage. **THE END**

[1] For a more extensive discussion of the trial see the Agronomy Journal, Vol. 59, pages 599-602.

How To Fail At Farming

HERE ARE FIVE simple rules that will help you to fail as a farmer. While you may know a few farmers who follow these rules and do all right, you'll know more who follow these rules and fail:

1) Stay out of debt. If you are in debt, get out as soon as you can. In reality, credit is a tool that can be used to make money. It is dangerous, as most good tools are. Axes and saws are dangerous. Learn to use them carefully to get work done. But if you want to fail, don't use credit to earn money.

2) Don't take chances. Suppose you can spend $10 per acre for more fertilizer, with a 50-50 chance of getting back $30 or more in increased yield. But if there is one chance in ten that you won't get your $10 back, don't take that chance.

3) Be independent. Don't get yourself tied up in rental agreements, partnerships, production and marketing contracts, and things like that. These are ways you can get the use of land, labor, capital—things you need to farm with. If you don't use them, you won't have enough money to do things you want to do.

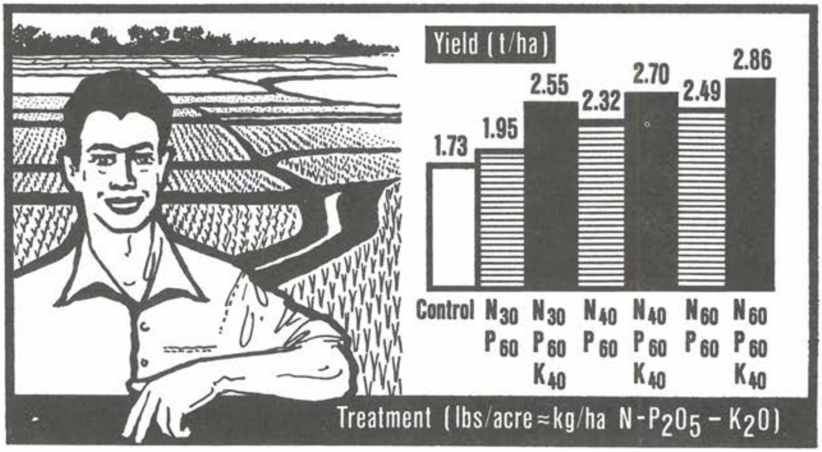
4) Stand pat. Wait until nearly every farmer you know is using the new variety, method, or idea. By then, most of the profit in it will have gone to them.

5) Work hard. If you do enough hard physical work, you won't have the time or energy to figure out how to make your farming operations pay.

Someone said: "But I was taught as a child that these five rules were virtues." But think them over. How do they apply to farming now as you know it?

E. P. Callahan in FARMER'S DIGEST.

Increasing yields of paddy by NPK in East Pakistan



208 FERTILIZER EXPERIMENTS conducted on paddy in various regions of East Pakistan were evaluated and statistically analyzed. They were carried out during the "Aman" season 1966 (transplanting in August/September) representing the major part of paddy grown in East Pakistan. N, P and K were tested at the following levels: 30, 40 and 60 lbs/acre N, 60 lbs/acre P_2O_5 and 40 lbs/acre K_2O. **In almost all cases NPK at the rate of 60-60-40 produced the highest yields.** Based on these results, it can be expected that the official fertilizer recommendations for paddy of 40-40-20 will be changed into 60-60-40.

Imbalance AGGRAVATES Disease

MANY DISEASES ATTACKING rice are aggravated when nitrogen and potassium are not in proper balance, Dr. H. R. von Uexkuell reports from Tokyo. Potash is highly effective with **Brown Spot, Stem Rot,** and **Bacterial Blight** among others.

Brown Spot, on "normal" plants with good potash status, may be limited to small spots. The disease stays close to the seat of infection. But on potash-deficient plants, the spots grow large, engulf more of the plant.

Stem Rot occurs most frequently on ill-drained or degraded paddy fields, with outbreak closely related to potash deficiency. Severe lodging follows the rot.

Bacterial Blight disease can be decreased by potash usage, especially if the plants are oversupplied with nitrogen. Today's high nitrogen levels, demanded by high yields, usually result in potash hunger and decreased disease resistance.

Blast Disease, most universal rice attacker, may increase without enough potash to balance high nitrogen. Reports from Italy, France, Portugal, Venezuela, Taiwan, and Japan indicate a positive role of potassium in reducing the problem.

Don't Surrender to the WEEVIL

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UNIVERSITY OF MARYLAND

ALFALFA is the most valuable forage crop you can grow on the farm.

In recent years, some livestock farmers have given it up because of the alfalfa weevil and no good pesticide. But they are returning to it, because they now realize what it can do for them when managed right:

- **Gives best yield of palatable hay.**
- **Insures richest protein of all forages, highest calcium of all home grown feeds.**
- **Excels in Vitamin A, is rich in Vitamin D and other vitamins.**
- **Increases yield and protein of any grass hay.**
- **Exceeds other legumes in annual production and return during life span, though it costs more to establish.**
- **Beats other legume forages in dry-year production.**
- **Helps maintain soil fertility.**

Most farmers agree alfalfa out-produces other common hay crops, particularly straight grass. Their animals eat more of it, reducing the amount and cost of concentrate feeds.

Hay	Acres Harvested 1961-1965	Yield Per Acre
Alfalfa	90 M	2.42 tons
Red clover—Timothy	205 M	1.47 tons
Lespedeza	29 M	1.15 tons
Grass	—	1.50 tons*
Corn Silage	95 M	11.3 tons

Source: Maryland Agricultural Statistics
* Author estimate

Much larger yields than these can be secured under favorable conditions, especially good management.

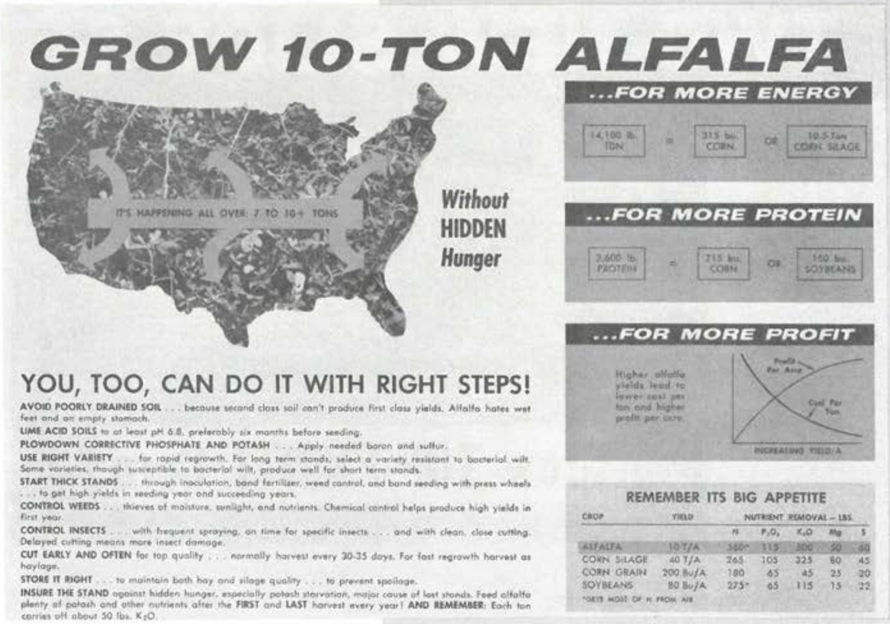
HAY QUALITY depends on maturity when cut, the color, leafiness, fineness of stem and freedom from foreign material.

Protein content is related to the maturity and leafiness; Vitamin A to the green color; fiber to the steminess and so forth. But alfalfa "stacks up" as the best.

Among forages, alfalfa hay is number one in protein, calcium, thiamine, and niacin. It is second high in carotene and riboflavin. So, alfalfa hay pays off when balancing a ration.

Crop	Digestible Protein %	Calcium %	Carotene mg/lb	Thiamine mg/lb	Riboflavin mg/lb	Niacin mg/lb
Alfalfa Hay (All analyses)	10.5	1.47	11.4	1.3	6.2	17.4
Red clover Hay (All analyses)	7.1	1.35	8.6	0.9	7.1	16.9
Red clover—Timothy Hay (high in clover)	5.5	.90	3.2	—	—	—
Lespedeza Hay	6.5	.98	22.4	—	4.0	—
Grass Hay	3.5	.48	5.3	0.6	4.1	15.5
Corn Silage (well matured—all analyses)	1.2	.10	6.4	—	—	5.7

(Source: Morrison, Feeds and Feeding, 21 ed.)



CROP	YIELD	NUTRIENT REMOVAL – LBS.				
		N	P_2O_5	K_2O	Mg	S
ALFALFA	10 T/A	560*	115	500	50	60
CORN SILAGE	40 T/A	265	105	325	80	45
CORN GRAIN	200 Bu/A	180	65	45	25	20
SOYBEANS	80 Bu/A	275*	65	115	15	22

*GETS MOST OF N FROM AIR

FARMERS REALIZE alfalfa not only puts more milk and meat profits in their pocketbooks, but also RETURNS GOOD CROP FOR MANY YEARS WITHOUT RESEEDING. With roots deep in the subsoil, alfalfa can draw on deeper moisture than other crops in dry years.

Management is a big key to alfalfa profits. Time the first cutting right, spray the stubble immediately, and you may get up to four or five cuttings a season. Keep the crop healthy with yearly topdressings of an 0-15-30+ Br or similar fertilizer.

Potash is the key element in an alfalfa fertilizer—not only for top production, but also for long-lived stands. Each ton of alfalfa carries off about 50 lbs. of K_2O.

The 70's promise new alfalfa resistant varieties and new pesticides. The Queen is returning with more productive varieties: Saranac, Cayuga, Iroquois, Team, WL 303, WL 202, Syn W, etc.

Seed movement last spring exhausted the supply of Williamsburg at many points in the mid-Atlantic area. Dealers were hard pressed to meet demands for the August planting.

Start planning NOW for the spring of 1970.

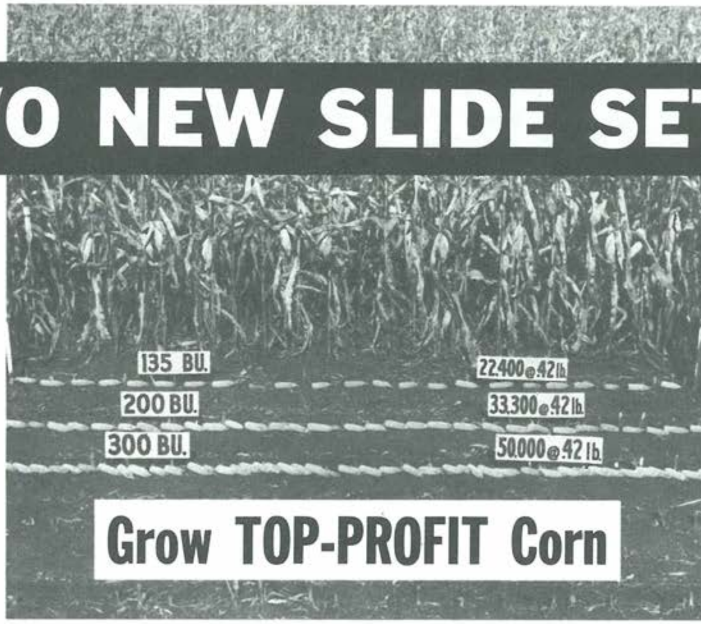
THE END

- **ALFALFA HATES wet feet and an empty stomach.**
- **LIME SOILS to at least pH 6.8, preferably 6 months before seeding.**
- **PLOWDOWN CORRECTIVE phosphate and potash.**
- **USE RIGHT VARIETY . . . for rapid regrowth . . . for long term stands.**
- **CONTROL WEEDS and insects with chemicals . . . and clean close cutting.**
- **CUT EARLY and often . . . normally harvest every 30-35 days . . . as haylage for fast regrowth.**
- **STORE RIGHT . . . to maintain hay and silage quality . . . to prevent spoilage.**
- **INSURE against hidden hunger.**

Order Alfalfa Mat on Page 21

TWO NEW SLIDE SETS S

44 SLIDES AND SCRIPT



ORDER ON PAGE 21

1—We are always shooting for higher corn yields from an acre of work. Why?
Money! Average yields don't make money. Take highest state corn average—100 bushels per acre! Crop value for past few years would vary from \$90 to \$120 per acre. Costs would run \$80 to \$120 per acre. Not much profit, if any, for AVERAGE yields. Farmers hitting 150 to 200 bushels may reach \$40 to \$90 profit per acre. Higher yields mean more profit per BUSHEL—say 25¢ for 120-bu. corn, 34¢ for 160 bushels, 40¢ for 200 bushels, Illinois work showed. Breakeven yields move up with rising costs. You have to get above breakeven yields to make money. That's why yield goals keep rising.

2—Some folks take a lot of pains selecting their hybrids. Is it worth it?
You bet it is. High-yield capacity, disease resistance, maturity time, etc. They mean much to yield. In one study, 30 days difference in maturity time meant 73 bu./A MORE corn. Hybrid can be the key to fertilizer profits. Take different hybrids receiving the same amount of potash—330 lbs. K_2O per acre. The potash increased Hybrid-A 43 bu. per acre—a respectable increase but barely profitable since the final yield was 101 bu./A. The same amount of potash increased Hybrid-B 57 bu. per acre, *to a profitable 162 bu. level!* Figure \$100 per acre production costs and dollar corn. Fertilizer clearly added \$43.80 per acre to the farmer's returns with the RIGHT HYBRID.

3—How much nutrition will my corn crop need? I'm talking about top-profit yields.
Most expert advisers and farmers will tell you top-profit yields range from 150 to over 200 bushels per acre. May be higher in the future. Such yields take up huge amounts of NPK. Take 200-bu. corn. A whopping 645 lbs.—260 lbs. N, 125 lbs. P_2O_5, and 260 lbs. K_2O PER ACRE! In the first two months of rapid growth, the corn takes up about 75% of its potassium, about 58% of the nitrogen, 46% of the phosphorus. Be sure your crop has plenty for all periods of heavy demand.

4—Which helps yields most—proper plant population or proper fertilizer rate?
They work together. In Kentucky trials, P boosted yields 2 bu./A, K 22 bu./A at 15,700 plants per acre. But at 24,500 plants, the P boosted yields 22 bu./A, potash 39 bu./A. Higher populations can profitably use more fertilizer. For example, Illinois increased yields only 21 bu./A by increasing population without additional N. But the combination

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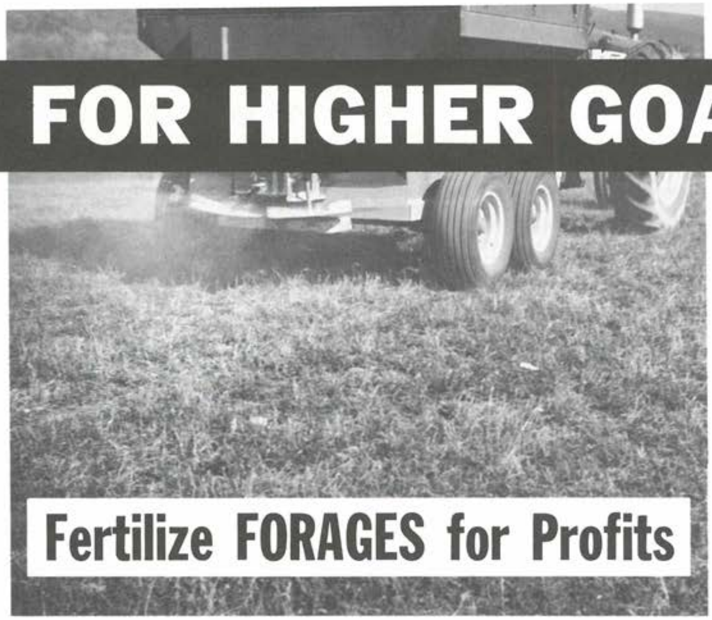
HOOT FOR HIGHER GOALS



FOR LOAN OR PURCHASE

Fertilize FORAGES for Profits

43 SLIDES AND SCRIPT

1—How can I cut cost . . . make more profits from forage?

You can shoot for a higher yield from each acre. In Pennsylvania a 4-ton hay yield cost around $19 per ton to produce. But the 6-ton yield cost only $12—or $7 LESS per ton when the yield increased 2 tons per acre.

2—I know many folks who swear by potash in producing forage crops. Why?

Profit is their biggest reason. When 240 lb. K_2O per acre were added yearly to maintain a 3-year alfalfa stand in Minnesota, hay value increased $63.30 above the cost of the potash. Adequate potash insured THREE good alfalfa cuttings in Michigan, raising feed value 75% per acre. True protein N of orchardgrass climbed from a low 1.6% with no potash to more than 2.5% with 400 lbs. K_2O in Indiana. High true protein N is vital to top quality feed.

These influences—plus K's role in helping crops resist disease and survive rough weather—make many folks believe K is O.K. for their forage programs.

3—How important is QUALITY in forage, really?

Quality means the difference between profit and loss. It affects the performance of your animal PLUS the amount of grain you must purchase. Take an alfalfa-brome hay, for example. With GOOD quality, a farmer had to add only 3 lbs. grain per day to insure 41 lbs. milk per day. With POOR quality hay, he had to add 18 lbs. grain to get only 20 lbs. milk—OR 50% LESS MILK WITH 6 TIMES THE GRAIN. That clearly says one thing: "Profit depends on quality."

4—How does forage stack up with grain as a quality feed?

Great! Take alfalfa, for example. A 10-ton yield gives the energy (TDN) found in 315 bu. of corn or 10.5 tons of corn silage PLUS the protein in 715 bu. of corn or 150 bu. of soybeans. That means even a 5 ton alfalfa yield adds up to a lot of corn and soybeans!

5—How big a difference can fertilizer make?

A big difference! It takes just as much money and labor to plow, plant, spray and fence for low yields as for high yields—and just as much land! It costs about $55-$65 per acre

TO PAGE 19

—higher population PLUS higher N—boosted yields an impressive 88 bu./A. Yes, they work together.

5—Many of my neighbors plow down lime, phosphorus, and potassium in fall. Why?

It makes 'em more flexible. Reduces next spring's work load when they're sweating to plant early for higher yields. Also, when they do it in fall, they're SURE it's on, not delayed or prevented by a soggy spring. It also reduces soil packing by heavy equipment on soft spring soils. And they have fewer delivery problems or delays. Look out your window on a decent day this winter. You may see that leading neighbor broadcasting his P and K—on level land, of course, or 4% slope with light residue cover, 8% slope with heavy residue cover. But he won't do it on deep sandy soils, excessive slopes, in deep snow, or on flood-subject land.

6—Why does deeper plowing require more fertilizer and lime?

Because you are creating a greater plow layer. When you gradually plow from 6 to 11 inches deep, you should increase your nutrient rate about 50%. The extra soil you are "turning" into your new plow layer dilutes the nutrients you once applied to the more shallow layer. Also the newly turned soil may be (and often is) nutrient poor.

7—Much has been said about closer rows. Are they really important?

Profit is the best answer. Some growers have increased yields and profits up to 60% by selecting right row width and proper population. Going to closer rows with some hybrids —say from 40 to 30 inches—improves plant distribution and yields. Profits rose \$6 per acre by going from 40″ to 30″ rows and 16,000 to 24,000 plants per acre, in Illinois trials.

8—I believe my corn stands better when I apply extra potassium—even on soil testing high K! Why?

This comment comes from more and more farmers these days. They often farm dark heavy soils with perhaps a 7.0 pH or above. They are usually shooting for 150+ bu. yields with high population and 200+ lbs. N. Often soil tests are not calibrated to such demands, and the needs for extra potash contradicts our earlier ideas. Try test strips of less and more fertilizer to determine top-profit yield on your farm. Use your best management on the strips. They should tell whether potassium is needed to insure better-standing corn.

9—Can just one nutrient influence my profits? That is, push 'em UP or DOWN?

It surely can. Get 'em out of "balance" (right proportion to each other) and you'll soon pay for it! You might ask how much potash you need to "balance" a given nitrogen rate. That depends on the N rate. When Illinois added N to K-deficient soil, the best N rates boosted yields to only 100 bushels with 50 lbs. K_2O. But when 150 lbs. K_2O was applied, 240 lbs. nitrogen was profitable—getting 150 bu./A and still going up. More nitrogen calls for more potassium to get the most out of today's high-yield crops. Keep a close eye on your nutrient balance and needs. Your profit may well be in the balance.

10—I'm averaging a little over 115 bushels corn per acre on all my land. What can I do to approach 200 bushels?

Iowa State University, serving one of the greatest corn states, advises growers shooting for 200-bushel corn to ADD the following to what they already do for 100-125 bushels: An EXTRA 9,000 plants . . . An EXTRA 210 lbs. N . . . An EXTRA 125 lbs. P_2O_5 . . . An EXTRA 150 lbs. K_2O. Check with local advisors.

(Order this Slide Set, GROW TOP-PROFIT CORN, on Page 21)

to establish alfalfa. Figure $20 for fertilizer and lime out of this: 50 lbs. P_2O_5 and 225 lbs. K_2O. The other costs are essentially fixed. So, it pays to fertilize enough to do a top-yield job with all the other costs involved.

6—What about fertilizing pastures? Will it pay me?

Yes. Leaders say the evidence is clear. For example, fertilizing Coastal Bermula-grass increased beef production from 259 lbs. to 684 lbs. per acre per year. In net profit, this meant $30 per acre, $300 every 10 acres, $3,000 on a 100-acre operation. In other words, the $35 spent for fertilizer produced an ADDITIONAL 425 lbs. of beef from each acre. This Georgia grass was fertilized with 200 lbs. of nitrogen and 500 lbs. of 0-10-20 yearly. In another study, $14 worth of fertilizer per acre on alfalfa-brome pasture returned $55.33 in additional beef gain—$3.69 return on every dollar invested.

In another trial, $21 worth of fertilizer boosted permanent pasture profit more than $77 per acre.

Fertilizing clover-grass pastures can produce big dividends. About $15 worth of fertilizer and lime per acre—sometimes more—can produce up to 2 tons EXTRA forage under many conditions. *COST:* $1,500 fertilizer bill each year on a 100-acre operation. *RETURN:* 300,000 EXTRA lbs. of milk or nearly $18,000 increase. This could happen IF the extra forage is properly used, experiment station agronomists say.

7—Can I get by with nitrogen alone on my pure grass stands?

Not for long. Nitrogen is the lifeblood of a strong grass program. But as N use increases, you'd better watch your fertility balance. New York trials showed first-year yields high with nitrogen only. But later yields declined steadily, until fourth-year production was little more than half the first year's yields. When phosphate and potash were brought in to help nitrogen the fifth year, the yield jumped almost to first-year levels.

8—Why do nitrogen-fed grasses demand right proportions of phosphate and potash?

A good answer was found when Timothy was fertilized up to 200 lbs. N per acre in Maine. Without nitrogen, the crop removed around 95 lbs. potash each year. But when the crop received 100 lbs. N per acre, it removed 180 lbs. potash per acre . . . 230 lbs. potash at 200 lbs. N . . . and 245 lbs. potash at 300 lbs. N. More N demands more K. We now know this from many trials in all parts of the country. They have shown nitrogen-gorging grasses rapidly draining the soil's K supply.

9—Some advisers tell me to use legumes where I can. Why?

Legumes not only improve feed quality, but also fix 200-300 lbs. N per acre from the atmosphere. And researchers say legumes stimulate the cow's hormone system. Legume-grass pastures have produced more gain or milk per head, often per acre—plus higher weaning percent, slightly heavier calves. Clover-grass pastures have produced beef about 40% more economically than all-grass pastures.

10—Will fertility balance help my crop production? How?

It will help yield. It will help quality. It will help profits. As the old saying goes, "You gotta show a Missourian." Well, Missouri trials showed balanced (NPK) fertility getting far more out of orchardgrass than the PK or NK trials—nearly 2,300 lbs. more yield, 400 lbs. more protein, and $175 more profits PER ACRE.

The same influence applies to corn silage. Wisconsin trials showed balanced (NPK) fertility increasing protein 600 lbs. per acre over the PK treatment and carotene content 48 mg per lb. of dry matter. It also reduced fermentation losses from 7.3% to only 2.1% of dry matter.

(Order this Slide Set, FERTILIZE FORAGES FOR PROFITS, on Page 21)

A tabloid newspaper, offering $1.00 each for "embarrassing moment" letters received the following epistle:

"I work on an early night shift in a steel plant. I got home an hour early last night and there I found another man with my wife. I was very much embarrassed. Please send me $2.00 as my wife was also embarrassed.

The editor, so we are told, sent a check for $3.00, admitting the possibility that the stranger, too, might have been embarrassed.—*Exchange.*

There is nothing more pathetic than a horse fly perched on an auto radiator.

An old lady kept a parrot which was always swearing. She put up with this but on Sunday she kept a cover over the cage—removing it on Monday morning.

One Monday afternoon she saw her minister coming toward the house, so she again placed the cover over the cage. As the reverend gentleman was about to step into the parlor, the parrot remarked: "This has been a d—— short week."

A lady was riding on the train with her son. The conductor came by and she said, "A fare for me and a half fare for the boy."

The conductor looked at the boy and said, "Lady, that boy's got long pants on."

"In that case," said the lady, "a full fare for the boy, and a half fare for me."

A fly was walking with her daughter on the head of a man who was very bald. "How things change, my dear," she said. "When I was your age, this was only a footpath."

Greatly agitated, a woman carrying an infant dashed into a drug store.

"My baby has swallowed a bullet," she cried. "What shall I do?"

"Give him the contents of this bottle of castor oil," replied the druggist calmly. "And then be sure you don't point him at anyone!"

Oldtime Mosquito (to young mosquito): "And to think that when I was your age I could bite girls only on the face and hands."

A man driving through the country noticed a farmer with a bull hitched to the plow. Stopping his car, he said to the farmer: "You have a beautiful farm here and everything looks prosperous and I am wondering why you don't have a tractor to do your farm work."

"We have two tractors in the barn," replied the farmer.

"Then why in the world have you got your cultivator hitched to a bull!" exclaimed the man.

"Well, friend, I'll tell you," explained the farmer. "I'm just trying to teach this bull there is something in life besides romance."

A stout cedar shingle makes a pretty effective board of education.

Pep Up Your MEETINGS With Slides

NEW SLIDE SETS	10-Day Loan (Date)	Purchase
1969:		
Grow TOP-PROFIT Corn, 44 Slides	______	______$6.60
Fertilize FORAGES For Profits, 43 slides	______	______$6.30
1968:		
Facts Favor Fall-Winter Fertilization, 41 slides	______	______$6.25
Fertilizer Time Is ANYTIME Down South, 35 slides	______	______$6.25
Build Quality Lawns For Beauty, 41 slides	______	______$8.00
Fertilize Those Soybeans, 36 slides	______	______$6.00
Keys To Cotton Profits, 41 slides	______	______$5.85
PROVEN FAVORITES		
Potassium For Agriculture, 66 slides	______	______$5.00
Alfalfa For Top Profits, 40 slides	______	______$5.85
Coastal Bermudagrass, 49 slides	______	______$7.20
Field Diagnosis & Tissue Testing, 51 slides	______	______$7.35
Fertilizer Application For Top Profits, 48 slides	______	______$7.05
Ten More Bushels of Soybeans, 51 slides	______	______$7.35
Potassium Hunger Symptoms, 40 slides	______	______$5.70

Also Place Mats

PLACE MATS (For Dinner Meetings)	Free Sample	Quantity 2¢ Ea.
You Can Grow 200-Bushel Corn	______	______
Aim For 80+ Bushels of Soybeans	______	______
Grow 10-Ton Alfalfa	______	______
Grow Healthy Lawn-Turf	______	______
Year-Round Fertility Starts TODAY	______	______

Name______________________ **Address**______________________

City______________________ **State**____________ **Zip Code**________

Organization____

American Potash Institute, 1649 Tullie Circle, N.E., Atlanta, Georgia 30329

Plan Your '70 CORN Campaign Now

NEWSLETTERS & FOLDERS
(To Reach Extra Thousands Through Fast-Mail Programs)

	Free Sample	Cost Each In Quantity
Will Your Crop Give You Its BEST? E-133	______	______ 3¢
Potassium Adds MUSCLE To Nitrogen Use, M-149	______	______ 3¢
Be A TOP-Yield Chaser Year-Round, N-1	______	______ 3¢
Add Extra DAYS To Spring, M-150	______	______ 3¢
Fertilize For FULL Water Use, M-151	______	______ 3¢
Potassium Builds Corn QUALITY, C-1-68	______	______ 2¢
Grow STRONG-Stalk Corn With Potash, S-W-66	______	______ 3¢
N-K Teamwork Means PROFIT-Corn, H-3-65	______	______ 3¢
Practice MODERN USE: Plenty Ahead of Peak Demands, M-137	______	______ 3¢
Use CROP ARITHMETIC To Figure Top Yields, M-142	______	______ 3¢

PLACE MATS
(To Pep Up Dinner Meetings With Top-Yield Techniques)

You Can Grow 200 BUSHELS Of Corn	______	______ 2¢
Year-Round Fertilization Starts NOW	______	______ 2¢

WALL CHARTS (16" x 21")
(To Display Hunger Signs & Plant Food Removal Trends)

N & K Hunger (True Color) On Corn Leaves & Ears		______10¢
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COLOR POST CARDS
(To Plant Helpful Ideas In A Personally Thoughtful Way)

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EDUCATIONAL KITS
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Catalog of Promotion Pictures & Ad Mats	______	______ 4¢
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FOOD FOR Future Forests

S. A. WILDE
UNIVERSITY OF WISCONSIN

KENNETH DERR
WISCONSIN CONSERVATION DEPT.

PRODUCING TREE nursery stock depends more on periodic additions of fertilizers than probably any other plant culture. Three factors cause this:

- **Tree seedlings are raised on artificially irrigated, usually sandy soils of high biological activity.**
- **The density of stock often approaches two million plants per acre.**
- **The harvest removes both tops and roots. And the roots carry precious fertility constituents of the soil, its mineral and organic fine particles.**

Let's look at the fate and cost of fertilizers applied during the 15-year existence of the Boscobel forest nursery of Wisconsin. Initial soil tests revealed about 4% of silt particles, less than 0.5% of organic matter, strongly acid reaction of pH 4.6, and a critically low supply of all nutrients. Soil building literally started "from scratch".

During the following 15 years, the 70-acre area was improved by peat, fermented sawdust compost, green manuring, and complete fertilizers applied broadcast as topdressing and solution.

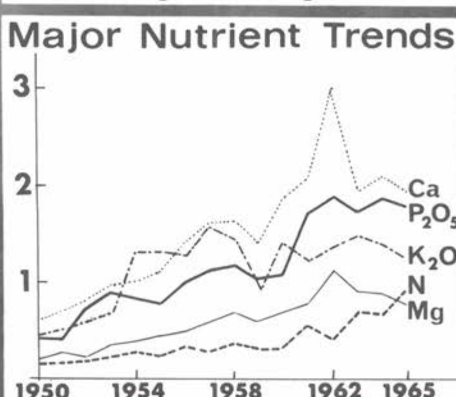
FIGURE 1 shows the trend of major nutrients reported in annual soil tests.

The hardest job with infertile nursery soil is to increase organic matter, chief source of total nitrogen and nutrient-adsorbing exchange material. It took about 10 years to raise soil organic matter to a 2% level, with corresponding content of total nitrogen about 0.08%.

This 18-ton gain of incorporated humus per acre came from adding some 350 cubic yards of organic remains. Nearly 80% of applied organic matter was decomposed by microorganisms and removed with roots of harvested seedlings. The cost per acre ran like this:

> **300 cu. yards peat in 6 applications, each constituting 6 truckloads of 8 cu. yards' volume; the cost of $3.20 per**

FIGURE 1. Dynamics of nutrients in the soil of the Boscobel State Nursery, Wisconsin. Figures of the ordinate refer to 0.10% (N), 100 lbs/a (P_2O_5 and K_2O), and m.e./100g (Ca and Mg).



cu. yard includes digging, loading, 60-mile delivery, and spreading by one man with suitable machinery.
Total cost $960

40 cu. yards of fermented hard maple sawdust compost, prepared with anhydrous ammonia, phosphoric acid, potassium sulfate, and *Coprinus ephemerus* inoculum for $2.60 per cu. yard $104

3 green manure or catch crops at $16 per seeding $48

$1,112

This expense covers 1.5% gain in soil humus content, equaling 72 cubic yards of organic remains per acre, worth about $230.

The supply of exchangeable bases was increased adjusting soil reaction from pH 4.6 to pH 5.9, by applying 3 tons of dolomitic limestone. The cost ran only $27 per acre: $2.00 per ton of material and $7.00 for delivery, spreading, and rototilling.

Tests show exchangeable calcium and magnesium preserved their normal ratio of 4 to 1.

Soluble nitrogen fertilizers, applied ahead of seeding and as topdressing or solutions, equaled 2.2 tons per acre of ammonium sulfate costing about $150. Tension lysimeters have shown liquid treatments of soluble fertilizers (ammonium sulfate, ammonium phosphate, potassium nitrate) applied directly on stock are entirely consumed by the growing plants.

Increase in available phosphorus caused no particular problem. Today's average supply of about 200 lbs. P_2O_5 per acre constitutes nearly 50% of all applied phosphate fertilizer. Phosphate fertilization cost $60 per acre for the period.

POTASSIUM PLAYS a big part in developing vigorous tree planting stock, especially in stock hardening. Both broadcast and liquid treatments of potassium sulphate (50% K_2O) approached 4,000 lbs. per acre, costing around $120. The low exchange capacity of the soil demanded this high potash rate to maintain available K_2O above 100 lbs. per acre.

Red pine tests best show nutrient uptake by nursery stock. In 3-years growth, this tree species consumed 220 lbs. of elemental nitrogen, 40 lbs. of phosphorus, 100 lbs. of potassium, 75 lbs. of calcium, and 30 lbs. of magnesium. The plants used about 70 percent of this nutrient supply during the third growing season.

IN FERTILIZER TERMS, how much plant food did the 5 crops of this planting stock remove from the soil? About 5,500 lbs. of ammonium sulphate, 1,000 lbs. of 20% superphosphate, 1,000 lbs. of 50% potassium sulphate, and small amounts of calcium and magnesium during the 15 years.

The fertilizers applied during this time equaled 4,400 lbs. of ammonium sulphate, 2,400 lbs. of 20% superphosphate, and 4,000 lbs. of 50% potassium sulphate, in addition to 85 tons of organic remains and three tons of lime. So, the loss of commercial fertilizers by leaching constitutes 400 lbs. of superphosphate and 2,875 lbs. of potassium sulphate.

On the other hand, the stock extracted from organic equals 1,150 lbs. of ammonium sulphate in excess of the added soluble fertilizer.

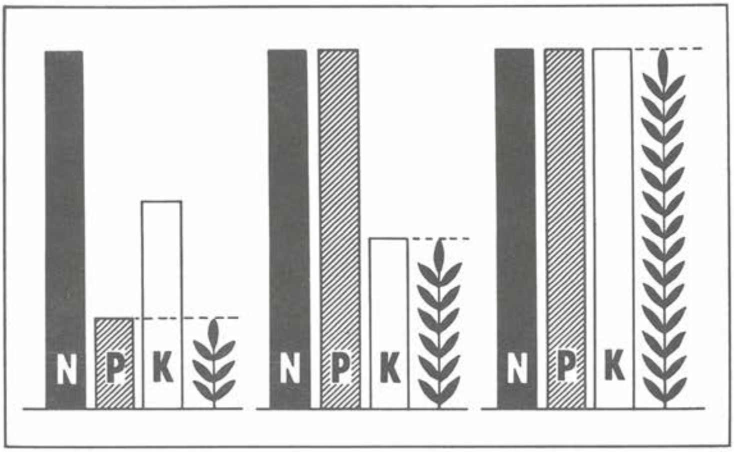
Mineral fertilizers, peat, fermented sawdust, and lime cost $1,400 per acre during the 15 years. Soil tests cost $250 per 100-acre nursery or about $40 per acre for the period.

The five crops of 3-year-old red pine, comprising 6½ million seedlings, with average cost of $12.50 per 1,000 ($10 in 1953 to $16 in 1961), yielded at least $80,000.

So, building and maintaining soil fertility, even on a very infertile soil, cost barely 1.9% of the crop's gross value. And this figure does not consider the financial gain represented by the enrichment of the soil in organic matter and nutrients.

THE END

NUTRIENT



BALANCE

MORE IMPORTANT THAN EVER

ERNEST L. BERGMAN **R. F. FLETCHER** **M. R. HEDDLESON**

PENNSYLVANIA STATE UNIVERSITY

MORE THAN 100 YEARS AGO, the German chemist, Liebig, coined the LAW OF MINIMUM. Based on his research in plant and soil sciences, the law shed a guiding light for all future research in soil fertility and plant nutrition.

THE LAW OF MINIMUM says: Crop yield is limited by that one factor which is least available to the plant in comparison to each of the other factors. Today this law becomes more important every season. WHY?

BECAUSE RESEARCH has progressed to a point where we now know there are at least 16 essential elements needed to grow higher plants.

BECAUSE INDUSTRY has done a tremendous job of making fertilizer available to growers. Yet, the big three (NITROGEN, PHOSPHORUS, POTASSIUM) were emphasized, while other elements went neglected.

BECAUSE RECOMMENDATIONS for yield and quality improvement are steadily being refined—thanks to better soil and plant testing methods as well as statistical procedures and computers that can tell scientists how a specific factor influenced production.

CASE IN POINT: Pennsylvania 1960-1968. Until 1967 the Pennsylvania Soil Testing Service analyzed soils for pH, lime requirements, organic matter, phosphorus and potassium—with calcium and magnesium as a special service to the growers.

Need for these two tests showed up in plant analyses and in visual symptoms on field and greenhouse vegetable crops. The initial soil test for Ca and Mg did not identify the problem. In some instances, magnesium spray applications cleared up the symptoms.

This system had a major drawback. It required a different test for each element, making it almost impossible to compare individual elements on a common basis, such as relative percent saturation. But it was an important step forward toward proper balance.

THE GOAL: A test where calcium, magnesium, and potassium could be related to each other on the basis of CEC and percent saturation.

This would make it possible to express the individual elements as percent of CEC with these guidelines: for calcium 60-80%, of CEC; for magnesium 10-15%; for potassium 2-5%. Furthermore a Mg/K ratio of at least two to one and a Ca/Mg ratio of about six to one.

This test became reality in 1967 and the above elements were included in the procedure. Since then, the Service has analyzed over 70,000 samples per year.

PRACTICAL EXAMPLES:

TABLE 1 shows soil test results of a 1963 greenhouse soil where tomato production was unsatisfactory. Plants showed magnesium hunger. But the old test would not identify the problem. In fact, the tests indicated adequate Mg present in the soil. The new test, then an infant, uncovered very high calcium, high potassium and a high Ca/Mg but good Mg/K ratio in the soil. Magnesium application removed the symptoms, increased production, and seemingly brought balance into the soil.

TABLE 1. GREENHOUSE SOIL ANALYSES DATA FOR A TOMATO PROBLEM SOIL.

	soil test exchangeable cations meq/100 g soil			cation percent of CEC			ratios	
Date	K	Mg	Ca	K	Mg	Ca	Mg/K	Ca/Mg
Fall '63	.7	1.3	11.9	4.3	8.1	73.9	1.9	9.1
	one meq magnesium applied *							
7/22/64	.4	2.5	15.2	1.9	11.4	69.4	6.0	6.1
	additional .66 meq magnesium applied							
10/29/64	.6	2.9	14.8	2.8	13.4	68.5	4.8	5.1

* in addition to nitrogen and phosphorus.

TABLE 2 show greenhouse lettuce production in 1967. Yield ran 202 baskets per bed. The crop was very spotty, though the old test showed all elements available in high amounts. But the new test indicated imbalance. After 475 lbs. magnesium per acre was applied before second planting, yield climbed 70% per bed. Spottiness declined. Why this increase? Probably due to applying fertilizer unevenly by hand in the beginning. Somebody might have been in a rush!

TABLE 2 GREENHOUSE LETTUCE PROBLEM IDENTIFICATION BY SOIL TEST.

	Best lettuce	Fair lettuce	Poor lettuce
K, meq/100 g soil	.82	.76	1.22
Mg, " "	1.8	1.5	1.9
Ca, " "	10.5	11.0	10.0
K, saturation %	5.4	5.0	8.0
Mg, " "	11.9	9.8	12.5
Ca, " "	69.4	72.1	66.2
Mg/K ratio	2.2	2.0	1.5
Ca/Mg "	5.8	7.4	5.3

TABLE 3 shows rise in melon field soil tests. Melon yield rose. And income from 1967 to 1968 on one half acre climbed \$600—from \$1000 to \$1600—by balancing fertilizer application. WHY? Because vines became healthier and held up longer, prolonging the harvest season.

After the first soil test, 1 ton dolomite, 1 ton ground limestone, and recommended N, P, and K were applied. In 1968, no lime was needed, but 120 lbs. Mg/acre was added.

TABLE 3. MELON FIELD SOIL TESTS.

	1967	1968
pH	6.1	6.7
K, saturation %	3.8	4.8
Mg, " "	3.8	6.4
Ca, " "	41.4	65.1
Mg/K ratio	1.0	1.3
Ca/Mg "	10.9	10.2

TABLE 4 Pennsylvania processing tomato production (10,000 acres in 1968) is under steady surveillance by vegetable crops extension and research.

On a major part of the acreage, fertilizer recommendations and what was actually applied by the grower have been correlated. These recommendations are based on soil tests, but far too many growers still do not follow them closely enough. They apply either not enough or too much of one or more of the elements.

Those who follow recommendations have done very well in the past. Close scrutiny of the table will show this.

Table 4. Examples of Pennsylvania soil test results, before planting, acre yield of processing tomatoes, fertilizer recommendations and applied fertilizer—1968.

	Processing Tomato Yield-Tons/Acre							
Soil Test	31.9	31.2	21.8	21.3	19.5	15.1	12.0	9.9
Soil pH	6.4	6.6	6.5	6.5	6.5	6.4	6.6	6.5
K-meq/100 g soil	.37	.26	.28	.18	.80	.60	.52	.55
Mg- " "	.70	.80	.40	.60	.70	.70	.70	1.00
Ca- " "	5.0	5.8	4.5	5.0	8.3	7.5	5.0	7.5
K-saturation %	4.1	2.9	3.8	2.1	6.8	5.2	6.4	4.9
Mg- " %	7.3	9.5	6.2	6.8	5.6	5.8	8.1	9.5
Ca- " %	55.4	65.0	62.3	56.9	70.5	63.6	61.1	67.6
Recommendation & Application*								
Applied N**	115	80	140	155	130	96	210	150
Recommended P_2O_5 lbs/acre	115	281	100	300	0	0	100	260
Applied P_2O_5 lbs/acre	115	160	180	313	0	216	156	150
Recommended K_2O lbs/acre	115	281	290	360	0	60	60	260
Applied K_2O lbs/acre	115	160	280	385	0	60	100	150

* All growers followed recommended magnesium and lime application when Mg/K ratio was less than 2:1 or Mg % saturation less than 10. (Pa. Agri. Ext. Serv. ST 3, 1968).

** Standard recommendation between 110 and 130 lbs/acre of actual N.

MAXIMUM YIELD AND QUALITY can only be produced by considering ALL the elements. The new Pennsylvania Soil Test seems to show this with phosphorus, potassium, magnesium, and calcium.

THE END

What do YOU  Recommend?

CONRAD KRESGE
COLUMBUS, OHIO

HOW MUCH FERTILIZER do YOU recommend for high yields? For 180 bushels of corn, 20 State Universities in the Midwest and Northeast say 225 pounds of N, 105 P_2O_5, and 130 K_2O per acre—on the average.

Through a 1968 survey of soil testing labs in these states, the American Potash Institute sought facts on 3 items:

(1) Extractants used for P and K.
(2) Top values in "low", "medium", and "high" ranges of soil test P and K levels.
(3) Recommended N, P_2O_5, and K_2O for certain high yields of 4 crops at a medium soil test level.

Only the third item is discussed here. Information on the others is available from your American Potash Institute agronomist.

TABLE 1 shows average fertilizer recommendations as well as range in recommendations for high yields of the 4 crops. The recommendations for wheat and soybeans are from only 11 and 12 states, respectively.

It is interesting to compare recommendations with conservative crop removal figures. Compare **TABLE 1** with **TABLE 2.**

TABLE 2

Crop/Yield Removed	Nutrients Removed (lb./A.) N	P_2O_5	K_2O
Corn grain—180 bu.	160	60	40
+stalks	240	90	235
Corn silage—36T.	240	95	295
Alfalfa hay—7 T.	390	100	315
Wheat—65 bu.	80	40	15
+straw	135	55	120
Soybeans—55 bu.	175	45	75
+straw	205	55	130

All nutrient recommendations compensate for removal in corn and wheat grain. Phosphate recommendations meet removal needs even when stalks or straw is removed. Potash recommendations are low when compared to uptake in the total above-ground plant parts for all 4 crops. Potash recommendations are also BELOW the amount of K removed by the beans alone in a soybean crop.

SOIL MINING or Soil Building? Following the average P recommendations would build up the soil or maintain P levels, the comparison shows. But following average K recommendations would possibly mine the soil when the total above-ground plant is removed.

And who wants his soil test level to decline below "medium", the level for which these recommendations were made?

It is encouraging to note from Table 1 that some of the labs do recognize the possibility. The high level in the range of K recommendations always exceeds or approaches the highest uptake figures used in **TABLE 2.**

HIGH YIELDS? Some would say 180-bushel corn, 7-ton alfalfa, 65-bushel

TABLE 1.

Crop and Yield Goal	Fertilizer Recommendations (lb./A.) Average N	Average P_2O_5	Average K_2O	Range N	Range P_2O_5	Range K_2O
Corn—180 bu.	225	105	130	160–320	20–200	20–280
Alfalfa—7 T.	0	100	215	0–20	30–260	40–360
Wheat—65 bu.	80	60	50	40–150	20–100	10–90
Soybeans—55 bu.	10	50	65	0–40	0–80	20–120

wheat, and 55-bushel soybeans are not such high yields.

This is true, and removal figures would run even larger when higher yields are achieved.

N/K BALANCE. The University labs clearly recognize the importance of N/K balance in applied fertilizer for growing the crop.

The average recommendations for K exceed that removed in the corn or wheat grain.

They know that sufficient K must be present in the applied fertilizer to build soil fertility and to help these crops stand up and resist disease.

HOW TO TELL—plant analysis. Are your fertilizer recommendations and applications in line with your yield goals?

Don't let too little fertilizer or imbalance of nutrients keep you from achieving your goal.

But how will you know? Plant analysis is a useful tool to help you decide. Indiana and Ohio summaries of plant analyses on crops grown during the 1968 season are quite revealing:

TABLE 3 % Samples Testing Deficient

Crop	N	P	K
	Indiana		
Corn	27	5	27
Soybeans	18	3	18
Alfalfa	33	10	33
	Ohio*		
Corn	48	5	29
Soybeans	35	1	45

*based on samples testing low or deficient in 1 or more elements.

TABLE 3 shows a high percentage of samples testing low in N and K. In 1968, 17% of the corn samples from Ohio came from abnormal-looking plants.

But the analyses indicated 56% of the samples were deficient in one or more elements. This is a good example of Hidden Hunger.

What happened? Were recommendations too low? Were recommendations being followed? What do YOU recommend? **THE END**

We Know...

200-Bushel Corn Removes:
260 lbs. Nitrogen/A
125 lbs. Phosphate
260 lbs. Potash

80-Bushel Soybeans Remove:
300 lbs. Nitrogen/A
80 lbs. Phosphate
190 lbs. Potash

1,250-lb. Lint Cotton Removes:
125 lbs. Nitrogen/A
45 lbs. Phosphate
90 lbs. Potash

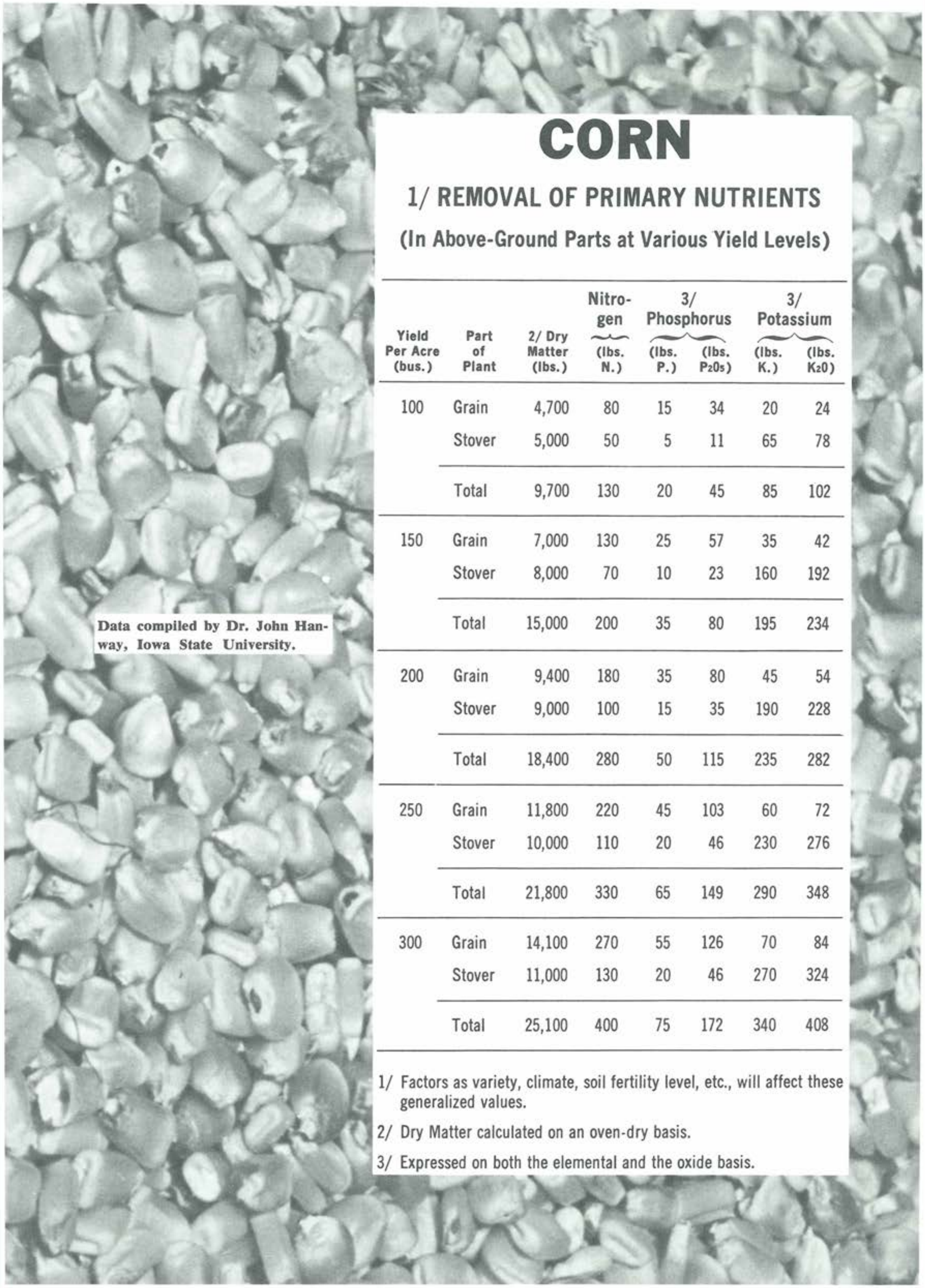
8,000-lb. Grain Sorghum Removes:
255 lbs. Nitrogen/A
88 lbs. Phosphate
184 lbs. Potash

BUT WHAT ABOUT . . .

300 Bushel Corn?
120-Bushel Soybeans ?
6,250-lb. Lint Cotton?
16,000-lb. Grain Sorghum?

ON THE NEXT FOUR PAGES, you will find plant nutrient removal projections that meet today's high yield goals. They show the removal of Primary Plant Nutrients in the above-ground parts of four leading row crops: corn, grain sorghum, cotton, and soybeans. They were featured in a recent issue of AGRICULTURAL NITROGEN NEWS magazine of the Agricultural Nitrogen Institute. They were compiled for the NEWS by four prominent agronomists of America.

They emphasize one thing: the more we take out of our soil the more we must put back in. Mine it and go out of business. Build it and stay in.



CORN

1/ REMOVAL OF PRIMARY NUTRIENTS

(In Above-Ground Parts at Various Yield Levels)

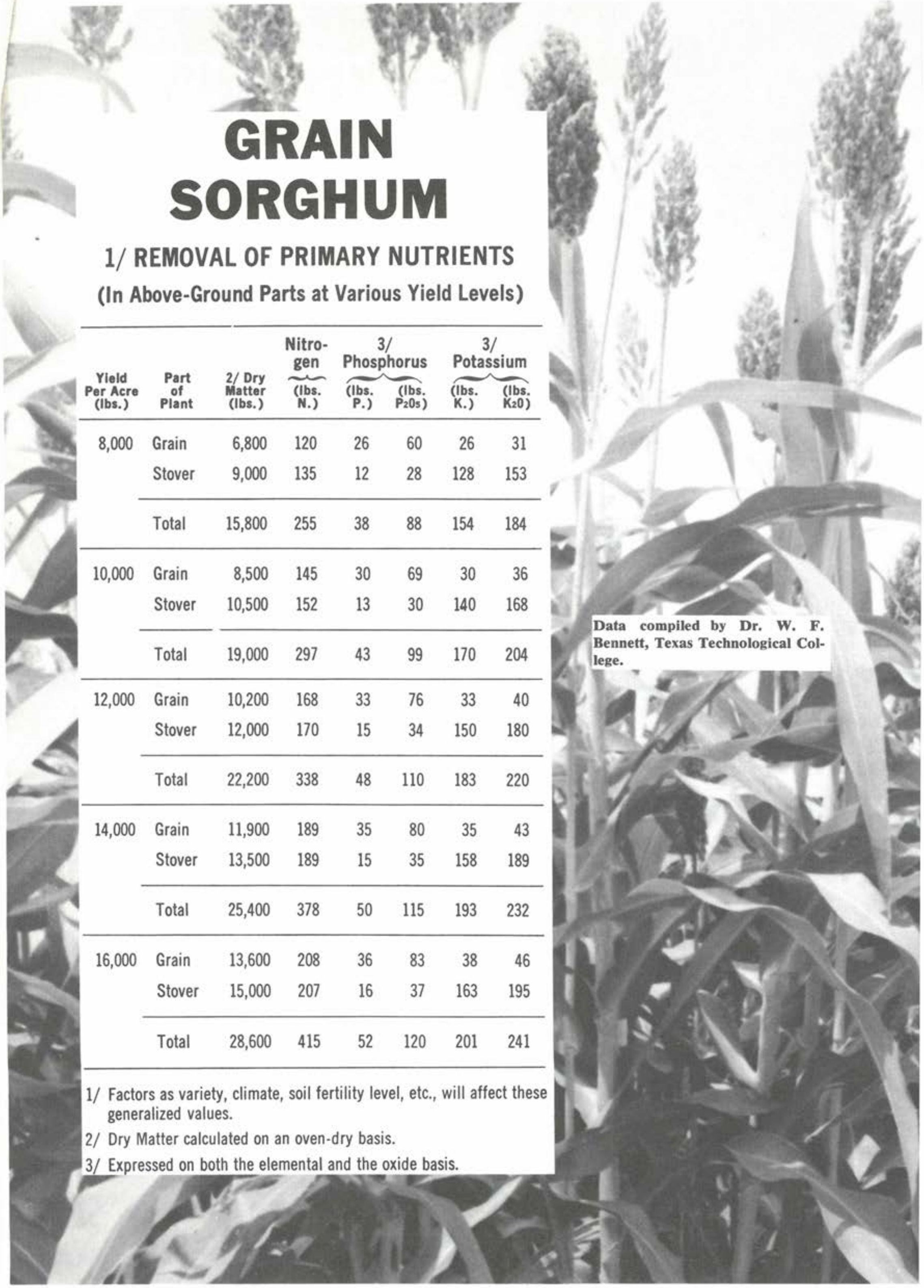
Yield Per Acre (bus.)	Part of Plant	2/ Dry Matter (lbs.)	Nitrogen (lbs. N.)	3/ Phosphorus (lbs. P.)		3/ Potassium (lbs. K.)	
				(lbs. P.)	(lbs. P_2O_5)	(lbs. K.)	(lbs. K_2O)
100	Grain	4,700	80	15	34	20	24
	Stover	5,000	50	5	11	65	78
	Total	9,700	130	20	45	85	102
150	Grain	7,000	130	25	57	35	42
	Stover	8,000	70	10	23	160	192
	Total	15,000	200	35	80	195	234
200	Grain	9,400	180	35	80	45	54
	Stover	9,000	100	15	35	190	228
	Total	18,400	280	50	115	235	282
250	Grain	11,800	220	45	103	60	72
	Stover	10,000	110	20	46	230	276
	Total	21,800	330	65	149	290	348
300	Grain	14,100	270	55	126	70	84
	Stover	11,000	130	20	46	270	324
	Total	25,100	400	75	172	340	408

1/ Factors as variety, climate, soil fertility level, etc., will affect these generalized values.

2/ Dry Matter calculated on an oven-dry basis.

3/ Expressed on both the elemental and the oxide basis.

Data compiled by Dr. John Hanway, Iowa State University.



GRAIN SORGHUM

1/ REMOVAL OF PRIMARY NUTRIENTS

(In Above-Ground Parts at Various Yield Levels)

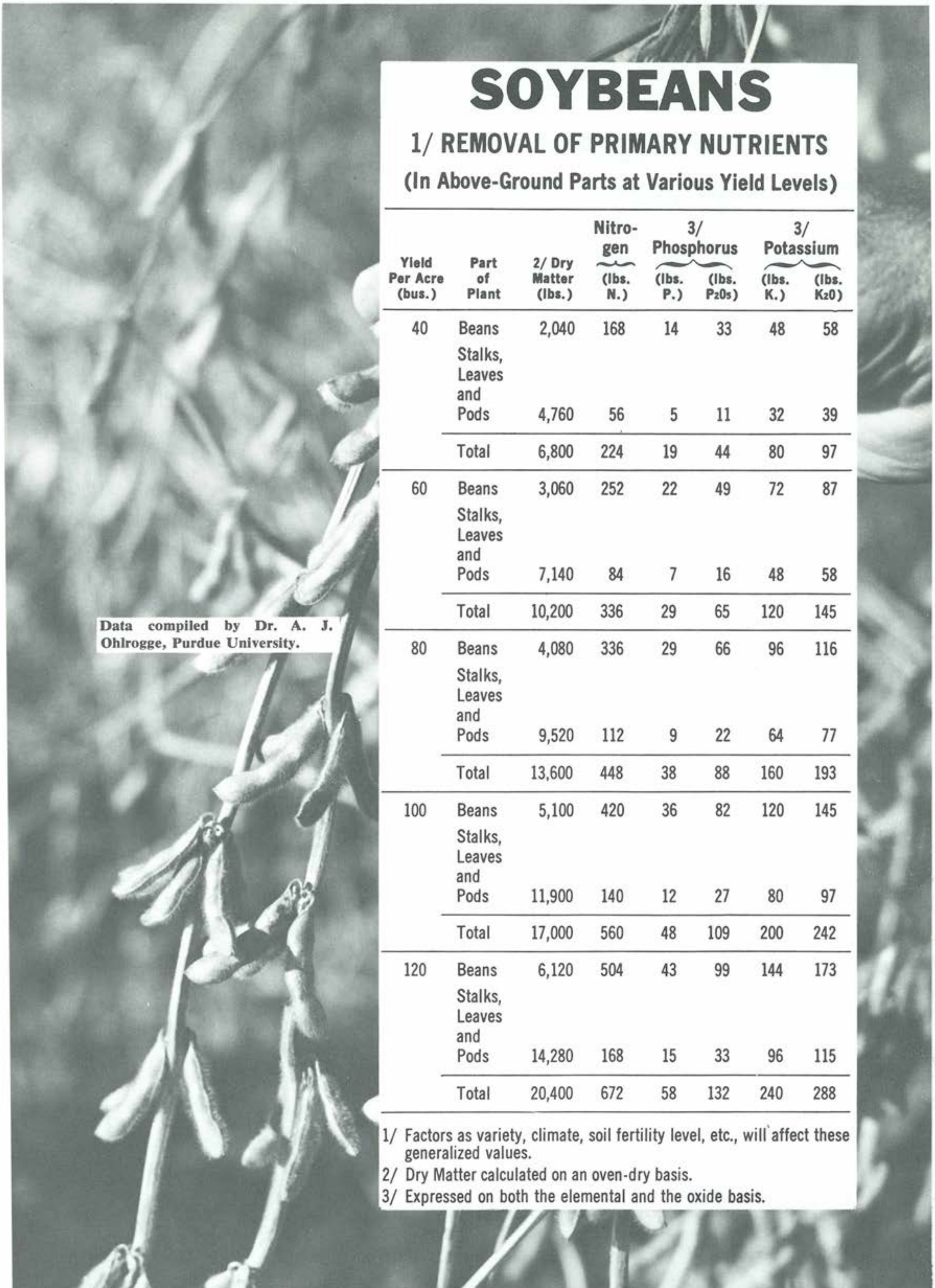
Yield Per Acre (lbs.)	Part of Plant	2/ Dry Matter (lbs.)	Nitrogen (lbs. N.)	3/ Phosphorus (lbs. P.)	3/ Phosphorus (lbs. P_2O_5)	3/ Potassium (lbs. K.)	3/ Potassium (lbs. K_2O)
8,000	Grain	6,800	120	26	60	26	31
	Stover	9,000	135	12	28	128	153
	Total	15,800	255	38	88	154	184
10,000	Grain	8,500	145	30	69	30	36
	Stover	10,500	152	13	30	140	168
	Total	19,000	297	43	99	170	204
12,000	Grain	10,200	168	33	76	33	40
	Stover	12,000	170	15	34	150	180
	Total	22,200	338	48	110	183	220
14,000	Grain	11,900	189	35	80	35	43
	Stover	13,500	189	15	35	158	189
	Total	25,400	378	50	115	193	232
16,000	Grain	13,600	208	36	83	38	46
	Stover	15,000	207	16	37	163	195
	Total	28,600	415	52	120	201	241

1/ Factors as variety, climate, soil fertility level, etc., will affect these generalized values.

2/ Dry Matter calculated on an oven-dry basis.

3/ Expressed on both the elemental and the oxide basis.

Data compiled by Dr. W. F. Bennett, Texas Technological College.



Data compiled by Dr. A. J. Ohlrogge, Purdue University.

SOYBEANS

1/ REMOVAL OF PRIMARY NUTRIENTS

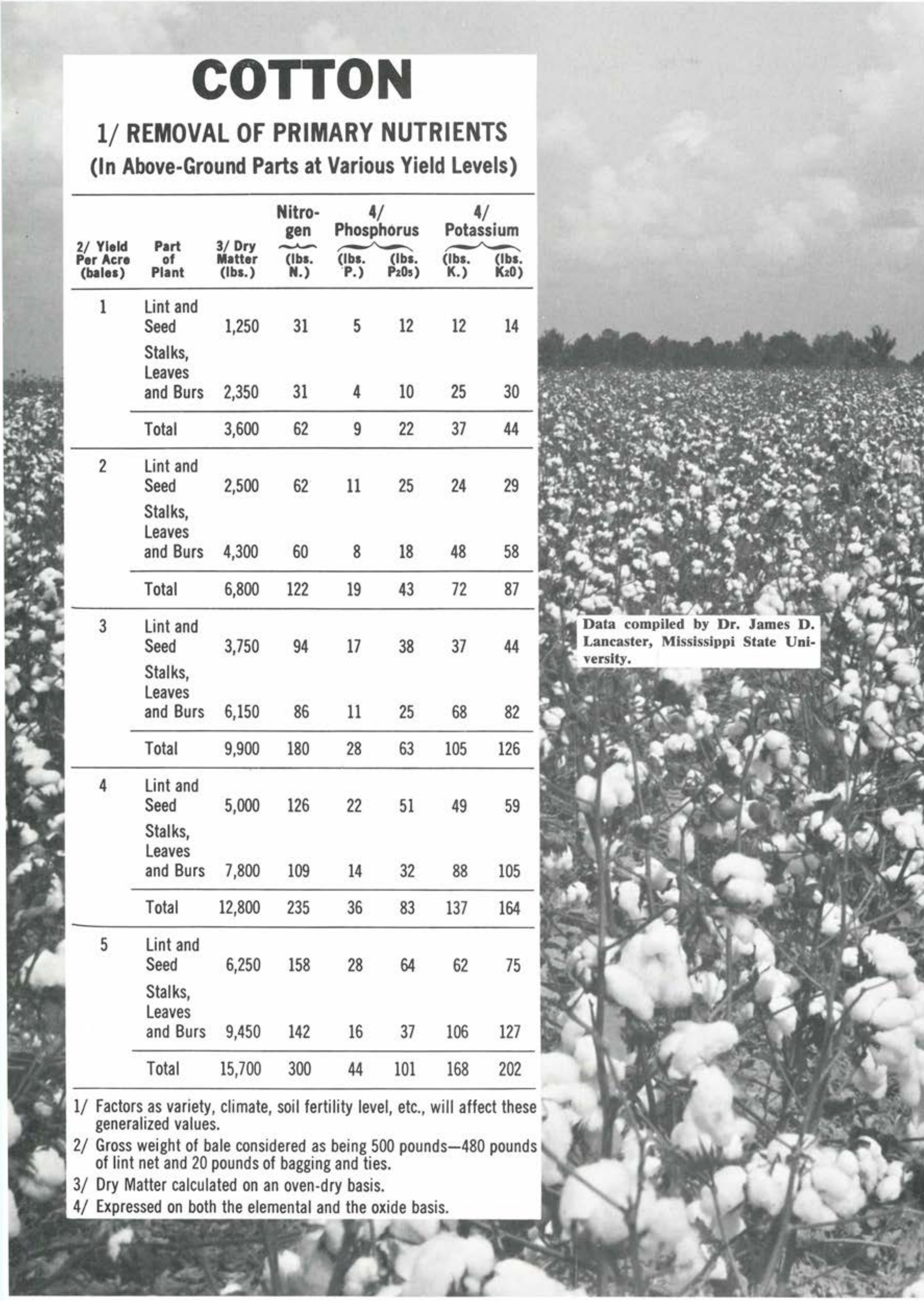
(In Above-Ground Parts at Various Yield Levels)

Yield Per Acre (bus.)	Part of Plant	2/ Dry Matter (lbs.)	Nitrogen (lbs. N.)	3/ Phosphorus (lbs. P.)	3/ Phosphorus (lbs. P_2O_5)	3/ Potassium (lbs. K.)	3/ Potassium (lbs. K_2O)
40	Beans	2,040	168	14	33	48	58
	Stalks, Leaves and Pods	4,760	56	5	11	32	39
	Total	6,800	224	19	44	80	97
60	Beans	3,060	252	22	49	72	87
	Stalks, Leaves and Pods	7,140	84	7	16	48	58
	Total	10,200	336	29	65	120	145
80	Beans	4,080	336	29	66	96	116
	Stalks, Leaves and Pods	9,520	112	9	22	64	77
	Total	13,600	448	38	88	160	193
100	Beans	5,100	420	36	82	120	145
	Stalks, Leaves and Pods	11,900	140	12	27	80	97
	Total	17,000	560	48	109	200	242
120	Beans	6,120	504	43	99	144	173
	Stalks, Leaves and Pods	14,280	168	15	33	96	115
	Total	20,400	672	58	132	240	288

1/ Factors as variety, climate, soil fertility level, etc., will affect these generalized values.

2/ Dry Matter calculated on an oven-dry basis.

3/ Expressed on both the elemental and the oxide basis.



COTTON

1/ REMOVAL OF PRIMARY NUTRIENTS
(In Above-Ground Parts at Various Yield Levels)

2/ Yield Per Acre (bales)	Part of Plant	3/ Dry Matter (lbs.)	Nitrogen (lbs. N.)	4/ Phosphorus (lbs. P.)	4/ Phosphorus (lbs. P_2O_5)	4/ Potassium (lbs. K.)	4/ Potassium (lbs. K_2O)
1	Lint and Seed	1,250	31	5	12	12	14
	Stalks, Leaves and Burs	2,350	31	4	10	25	30
	Total	3,600	62	9	22	37	44
2	Lint and Seed	2,500	62	11	25	24	29
	Stalks, Leaves and Burs	4,300	60	8	18	48	58
	Total	6,800	122	19	43	72	87
3	Lint and Seed	3,750	94	17	38	37	44
	Stalks, Leaves and Burs	6,150	86	11	25	68	82
	Total	9,900	180	28	63	105	126
4	Lint and Seed	5,000	126	22	51	49	59
	Stalks, Leaves and Burs	7,800	109	14	32	88	105
	Total	12,800	235	36	83	137	164
5	Lint and Seed	6,250	158	28	64	62	75
	Stalks, Leaves and Burs	9,450	142	16	37	106	127
	Total	15,700	300	44	101	168	202

1/ Factors as variety, climate, soil fertility level, etc., will affect these generalized values.

2/ Gross weight of bale considered as being 500 pounds—480 pounds of lint net and 20 pounds of bagging and ties.

3/ Dry Matter calculated on an oven-dry basis.

4/ Expressed on both the elemental and the oxide basis.

Data compiled by Dr. James D. Lancaster, Mississippi State University.

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