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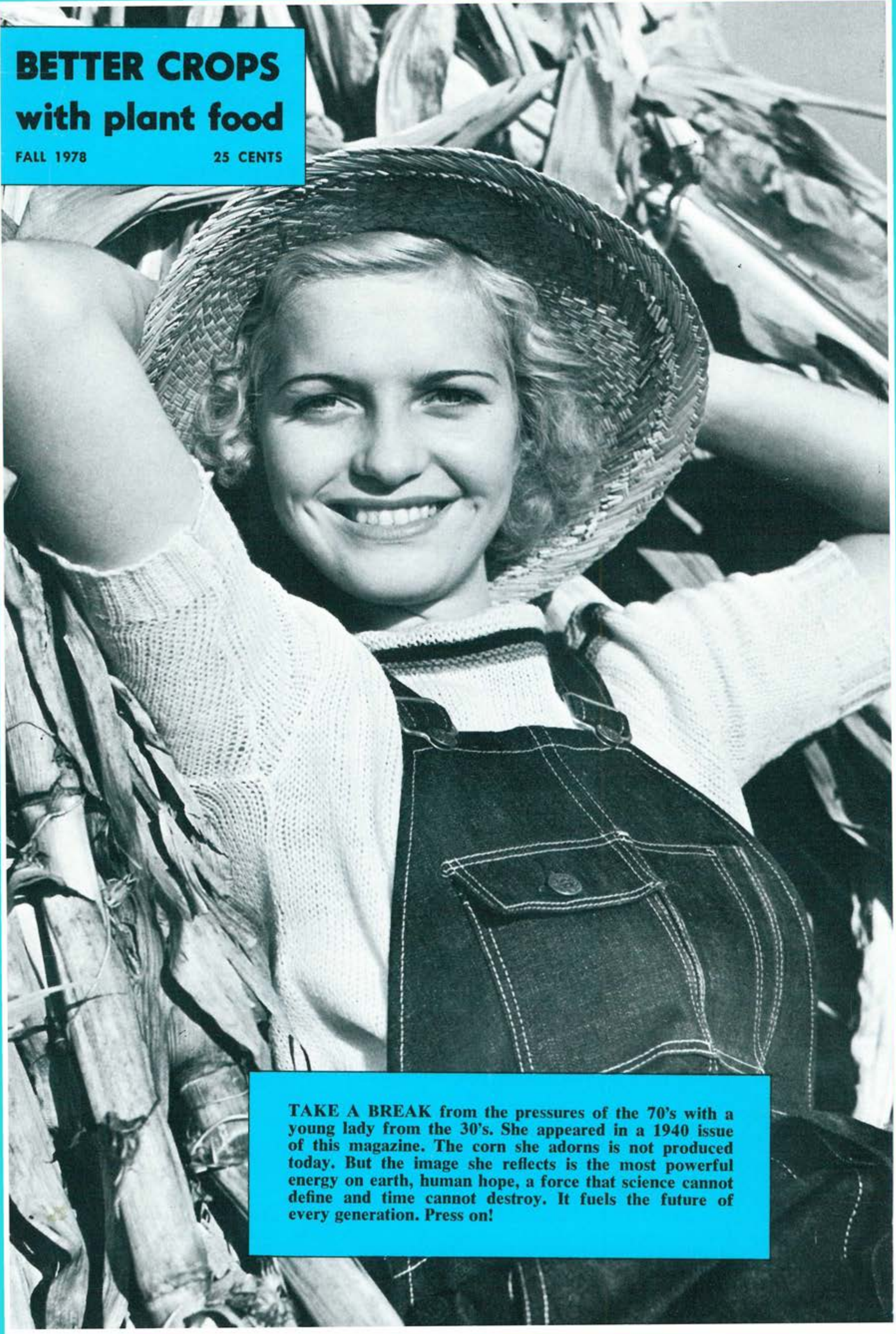

TAKE A BREAK from the pressures of the 70's with a young lady from the 30's. She appeared in a 1940 issue of this magazine. The corn she adorns is not produced today. But the image she reflects is the most powerful energy on earth, human hope, a force that science cannot define and time cannot destroy. It fuels the future of every generation. Press on!

BETTER CROPS with plant food

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Contents

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FERTILIZER USE

& HIGH YIELDS

THE 1979 FERTILIZER season looks promising . . . IF the weather cooperates . . . IF rail car shortages don't deny growers supplies when they need them. This article looks beyond a single season to usage challenges facing the industry and to high-yield needs facing agriculture. It shows why fertility research and education are equally needed in boom and bust years.

R. E. WAGNER
President
Potash & Phosphate Institute

A KEY FEATURE of American agriculture is generally considered to be its high yield character.

That's not true when we measure present productivity against potential . . . or when we examine recent progress toward that potential . . . or when we consider what is needed for a sustained profitable agriculture.

In fact, average yields of some crops have not increased appreciably in the past 10 years.

High yield farmers still are relatively few in number. Even some of our scientists are slow to accept the maximum yield concept and introduce it into their research. Fortunately, though, we do

From papers delivered to the 14th Latin American Food Production Conference and the American Society of Agronomy.

IT'S POOR BUSINESS TO LET PRODUCING POWER OF COSTLY LAND BE LIMITED BY LOW FERTILITY . . .

have some real innovators among researchers leading the way to maximum yields.

Few will argue with the great **need** ahead to produce the kinds of crop yields that will meet the world's food requirements. A high yield agriculture is fertilizer intensive.

If we can believe even the more conservative fertilizer projections, our own nation will consume more NPK in the next 15 to 20 years than it has in all previous history. And previous history has been impressive. Each successive 20-year period has seen more fertilizer used than the total consumed up to that time.

With that kind of outlook, little wonder there is continuing interest in new nitrogen plants—even though right now some are shutting down—and new phosphate and potash mines.

The outlook, bright as it seems, raises a key question. Are such projections more a reflection of the great and unquestioned **need** ahead than they are a realistic forecast of what farmers will actually **use**? The answer is not easy. For example, world-wide phosphate use was projected to rise 8-9% yearly over the past 10 years, but demand actually rose 6 to 6.5%.

The day is past when it just happens that actual consumption equals what is projected. From now on it must be made to happen. Putting it another way, the low apples have been picked—the higher ones are harder to get.

As we go, about the job of making it happen, we must remember that projections do not sell fertilizer. I share the concern of many—that future projections will not serve well UNLESS the industry invests more in agronomic research and education to develop tomorrow's markets.

MANY CHALLENGES face increased fertilizer use. These challenges make thoughtful leaders look with concern at today's projections for tomorrow's consumption. I do not believe increased fertilizer usage has ever faced as many challenges as it does today. Let's look at seven of them:

CHALLENGE 1: Fertilizer economies are maturing in some heavy using areas.

Fertilizer growth stops when maturity peaks. That peak has not been reached anywhere yet, though Japan is coming close. In several areas, crops don't respond as dramatically as they once did to applied nutrients. This makes increased fertilizer use seem less convincing. It makes even maintenance tonnage a challenge to research and education.

CHALLENGE 2: Maturity in fertilizer use in a few areas is causing talk of over-fertilization.

We hear it in America, western Europe, and other nations. This distorts the total picture. It causes the farmer to think how little he can get by with rather than how much he needs to get best plant growth for best profits.

Years of heavy fertilization can build up some soils. In Michigan soil tests, 59% averaged medium or less P in 1967, 31% in 1977. This indicated buildup. But in Missouri 68% averaged medium or less P in 1964, 70% in 1976. In Kansas, 67% in 1968, 71% in 1977.

Where there is buildup, we say so. To do otherwise is to deny scientific fact. But we must be sure it is truly over-fertilization and not under-production! Low yields from under-production is far

RESEARCH FOR FACTS ON HIGH YIELDS WILL MAKE NEARLY EVERYTHING WE STUDY NEW . . .

more common than over-fertilization in most of the world.

CHALLENGE 3: Some crop yields have reached a plateau.

The skyrocketing trends of the 1950's and 60's topped out about 10 years ago. U. S. corn yields averaged 38 bushels/A in 1950 and reached 86 bushels/A in 1969. The average corn yield for the past five years (including 1978's 101-bushel record) is 87 bushels, same as the 1969-73 five-year average.

CHALLENGE 4: The farmer's production costs are increasing faster than his yields.

This is not a new story. History is full of farmers troubled by the cost-price squeeze. But today little long-term relief is in sight, except for farmers who produce those high yields.

CHALLENGE 5: Research support is eroding.

A recent PPI study of five important states—Kansas, Nebraska, Oklahoma, Missouri, and Iowa—showed a decline in funding of soil fertility research.

Such funds are now only 2% of the total state and federal support for agricultural research.

Scientist years assigned to soil fertility research declined nearly one-third over the past decade.

Federal funding alone actually declined 7.4% during this decade and is expected to decline further through 1981. This can do nothing but further hamper soil fertility research that has seen scientist years decline and operating funds to some of the best remaining researchers greatly reduced.

Where are those scientist years going? Into efforts on pollution, food safety, energy, and other programs popular for the period. Many of these problems need researching, no doubt—but not at the expense of soil fertility.

CHALLENGE 6: Much research shoots for less than those important higher yields.

High yield research reduces the risk of duplicating what has already been done. High yield research helps insure new knowledge. Such research helps more than top farmers. It helps bring average and below average farmers along to higher yield plateaus.

The goal is to move all production systems to higher levels. Not with fertilization alone, but with the total package of production practices. Breakthroughs will come only from the total package.

CHALLENGE 7: The theme of pollution from fertilizer will be preached for a long time to come, no doubt.

Michigan State University's veteran and wise scientist, Dr. R. L. Cook, said it best: "The practices we perform to grow our top yields do the best job in conserving and building our soils."

That's important to 208 implications. Farmers struggling under regulatory over-kill may find some hope in that wisdom.

Serious thinking about all these challenges causes anyone to wonder about the future of the fertilizer industry. Not about its survival. It will survive fully, because man must have it. But what about the vigor of its future growth?

One thing is certain. Food crops will need nutrients from fertilizer to yield enough to feed tomorrow's growing

HIGH YIELD MEANS MORE NUTRIENTS INTO THE PLANT AND LESS INTO THE ENVIRONMENT . . .

population. And fertilizer will be needed to hold yield levels high enough—profitable enough—to keep farmers farming. To farm beyond their own needs, farmers need incentive. And in the free world incentive is profit.

The big question still remains: How much of the need will become usage?

MARKET DEVELOPMENT can make a difference. Especially market development through sound agronomics. And never has it been more needed than today.

We have said it many times before, but truly the "back to the basics" time has arrived. This is the day of the scientific approach.

At the Third World Conference, Dr. John Douglas projected NPK usage to increase 2.5% annually through 1990—1.8% for P, 2.5% for K, and 3% for N. This compares to 8% for NPK in the 1960's and 3.5% so far in the 1970's. Such predictions stimulate much talk, thought, and discouragement.

Of course, we must remember the tonnage base is getting bigger, which means a 3% increase in 1990 equals an 8% increase in 1960.

It will take vigorous market development to move above the Douglas projections. But I believe it can be done, if the industry cooperates closely with the universities in seeking true agronomic needs for fertilizer.

Actually the fertilizer industry, as a whole, never has promoted market development with the vigor of other industries—such as the major pharmaceutical firm that recently reported 16% of its gross invested in market development.

Many fertilizer producers invest $100 to $200 million in a plant or mine. Some put much effort on product development, but very little on product utilization.

Potassium has always been the "stepchild" of the "big three elements" in need of market development.

This is why the potash industry founded the American Potash Institute in 1935, later the Potash Institute, and now the Potash & Phosphate Institute—**to get fertilizer used in a way that is "scientifically sound and profitable to the farmer."**

This meant working closely with universities and the industry in support of solid soil fertility research and education.

The idea helped move potash consumption from 240,000 tons K_2O in 1935 to 5,833,000 tons in 1977. The same potash consumption trend has happened in other countries where the Institute has supported programs—increasing dramatically in Korea, for example, soon after the Institute initiated its program in 1962 following several static years.

The Institute and university colleagues do not take major credit for these trends, but many detached observers say their influence was important.

Fertilizer history occurred in the U.S. in the seventies. Potash, the "stepchild" on the NPK team, caught and passed phosphate use for the first time. This strengthened the phosphate industry's decision to join the potash industry to make phosphate promotion a form of scientific education.

On July 1, 1977, the Potash Institute became the Potash & Phosphate Institute.

TRUE RESEARCH IS NOT KNOWING, BUT BEING WILLING TO FIND OUT AND THEN ACT . . .

HIGH YIELD RESEARCH is fundamental to sustaining a profitable agriculture and developing new fertilizer markets. The Institute is increasing its traditional commitment to such research.

What is "high yield"? It varies with climate, soil type, etc.

1. High Yield Means a goal of maximizing yield for any given set of conditions by optimizing the use of controllable inputs. It is poor business to allow the producing power of costly land to be limited by any factor as controllable as fertilizer.

It is very easy to conclude fertilizer will not increase yield when some other practice is inadequate and holds down the yield.

2. High Yield Means crops with full capacity to absorb all inputs profitably. High yields generate a highly charged system of interactions among nutrients in the soil and in the plant. We know little about these interactions and their influence on higher production.

Top farmers want to move to still higher yields. When they can't, they get uneasy over how little is known about what they are already doing.

3. High Yield Means more use of plant nutrients in right balance. More into the plant and less into the environment. The answer is not to reduce nutrients going into the plant to save the environment. The answer is to find ways the plant can make better use of more nutrients.

High fertilization rates can be justified only when they help the plant use other inputs and its total environment to reach its full growth potential.

4. High Yield Means fertilizer usually generates 30 to 40% of the yield while costing only 15 to 20% of the total production expenses in most crops.

5. High Yield Means upgrading the total production system to build soil productivity, not just fertility. This means more residues properly used, chiseling or subsoiling in some soils, pest control, drainage or irrigation, adequate nutrients, etc.

6. High Yield Means more and more emphasis on efficient use of water and energy.

RESEARCH MUST HELP farmers reach new levels. The Wall Street Journal recently reported the importance of high yield research this way:

"Farmers say higher yields are the only way they can make money. Extra cash from extra bushels provides the edge over fixed production costs that keeps successful growers in business while others flounder."

In the same article, Iowa State University economist, Arnold Paulsen, explained, **"More broadly, those extra bushels represent national economic development. If we get more soybeans out of each resource unit, we've got a choice between using more soybeans or using newly freed resources to meet other needs."**

Research that produces yesterday's yields or even today's **average** yields does not reach the high yields our economy now demands for the farmer to pay his bills and make some profit.

Let's illustrate the problem this way:

U.S. corn averaged 91 bu/A from 1975 to 78. The USDA projected 1978 corn production cost to be \$248.92/A in the Lake States and Corn Belt.

With 91 bu/A, the average farmer would lose money unless he got about \$2.75 for his corn. Pushing to 150 bu would lower his breakeven point to \$1.70 corn. The leaders getting 200 bu/A can cover those costs with \$1.25 corn. So if they get \$2.00 for their corn, they can net between \$100 and \$125/A, depending on extra fertilizer and harvest costs.

The point is clear: Average yields will not keep farmers in business.

Illinois farmer, Herman Warsaw, is a prime witness to what can be done. Charting his yields over the past 8 years is like charting fertilizer sales or prices—a roller coaster. BUT never did his yield drop below 200 bushels/A during those 8 years, even in two dry years.

The point is clear: He had the full package of sound practices IN PLACE to get full potential out of the good years when they came.

In one good year, 1975, that potential exploded into 338 bu/A. Full fertility was prominent on his list of practices.

The kind of research that made American agriculture the envy of the world has had its day. We must now move on.

RESEARCH NEEDS A FACE-LIFT —to bring modern farmers modern facts on high yields. Such a goal will make nearly everything we study new.

How do nutrients—major, secondary, micro—interact at high yield levels?

What do new research findings do economically for farmers who adopt them?

Do high yields change the crop's quality factor?

How effectively will high yields improve water and energy use efficiency?

What changes will high yields bring to soil test correlations?

Many exciting questions are out there in high yields—waiting to be answered.

While the industry is primarily interested in applied research—for use as soon as practical—there is recognition of the great importance of basic long-term studies to build market strength on a continuing basis.

Water will grow more scarce in the future. Someone said it right: "H and O in a 2:1 ratio are our most important nutrients."

Pest systems need basic research. A recent study showed 33% of U.S. crop production lost to pests—13% to insects, 12% to diseases, and 8% to weeds.

TRUE RESEARCH IS NOT KNOWING, but being willing to find out. Strong scientists point to challenging yield goals and include them in their project proposals—in their willingness to find out.

They don't believe working with top-profit yields is non-scientific. They know their whole system of research programs was conceived in the land-grant spirit of helping the farmer reap the best economic returns he possibly could under his circumstances.

That's why strong scientists are willing to apply practical economics to scientific or agronomic responses. They deserve more support from the industry. And that is why a cooperative industry and land-grant university program in soil fertility research is now being discussed.

If the talks are successful—and we hope they are—the program will probably start in the 5-state area of Kansas, Nebraska, Oklahoma, Missouri, and Iowa. This effort can be a great help to deserving researchers and to all agriculture.

It would be a major effort of land-grant university researchers cooperating with an industry that knows fertilizer programs must be based squarely on scientific truth.

There is no better way to build markets—not for just a season, but for decades ahead. There is no better way to represent the best interests of the farmer, the universities, and the industry.

The End

REPRINTS

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POTASSIUM Combats Shipping Stress

From FEEDSTUFFS
Weekly Newspaper of Agribusiness

INCREASING POTASSIUM concentration from 1 to 1.5% in diets of steers that were stressed by shipping increased weight gain 11 lb. per head in the first 28 days in a feedlot in Texas tests.

Prior to this discovery, livestock nutritionists had determined that 0.80% potassium in the diet was adequate for maximum gains of unstressed cattle. Dr. Dave Hutcheson, Texas Agricultural Experiment Station clinical nutritionist of the Texas A&M Center at Amarillo, conducted the research at the USDA Center in Bushland. Dr. Andy Cole, USDA animal scientist, and Dr. J. B. McLaren, with the University of Tennessee, helped with the study.

The research was conducted in September and October of 1977. Cattle were purchased from 7 farms in Tennessee, weaned and moved to an auction barn for one day and then to an order buyer barn for three days. While at the order buyers, one half of the 107 steers were fed a 50% concentrate diet with antibiotics and the others received hay free choice.

After a 26-hour truck ride from Tennessee to Texas, calves were put in a feedlot and received a normal diet adjusted to either 1.0 or 1.5% potassium. There were four treatments. One-half of the steers fed hay received high potassium and the other half a normal potassium diet.

The same was done for steers that got a concentrate diet for three days in the order buyer barn. After two weeks, all steers received the same diet with 0.80% potassium for two more weeks. Diets were formulated from flaked corn and milo, alfalfa cubes, corn silage, and supplement.

The steers averaged 400 lb. per head on arrival at Bushland. All steers were weighed prior to loading in Tennessee, on arrival in Texas and at 7, 14 and 28 days. Steers that became sick were isolated and treated with antibiotics for 3 days.

It took the steers 7 days to regain the 9% weight loss from the trip. During the 28 days, calves that received extra potassium made the best gain. Receiving a high concentrate diet for 3 days in the order buyer's barn also improved gains. With normal and high potassium, these calves gained 86 and 91 lb. in 28 days. Calves that got hay at the order buyers gained 75 and 86 lb. in 28 days.

Because most calves get no feed or only a little hay from weaning until arrival at a feedlot, feeding a diet containing 1.5% potassium for two weeks makes good sense according to scientists. Gains will be markedly increased the first few weeks after arrival.

Hutcheson said results of the experiment are logical and fall into place with other knowledge about potassium metabolism in animals. Other scientists have shown that potassium plays a big part in maintenance of water balance in the body.

Cattle subjected to shipping stress have many metabolic changes including decreased weight from water loss in cells and the digestive tract.

When this happens, potassium moves out of cells with the water and growth stops or slows down. Growth starts again after cells have the proper water and potassium concentration.

Hutcheson said the economics of the treatment is right. Trading 20 cents worth of potassium for 11 lb. of beef selling for $5.50 is a good swap. The End

EXCHANGEABLE POTASSIUM
Some Problems

G. W. THOMAS
University of Kentucky

THE USE OF ammonium acetate to extract "exchangeable" potassium from soils is nearly universal throughout the world.

Ammonium acts very much like potassium in soils and it is of minor importance as an exchangeable cation in most soils. Both of these factors have made its use popular. In addition, ammonium acetate leaves no residue on the burner of a flame photometer.

Monroe Rasnake and I recently looked at the exchangeable potassium in six bottomland soils representing a huge acreage in the Ohio and Mississippi river watersheds. The results of our study are shown in the table below.

THE NUMBERS in the table show the problem quite clearly. Before cropping, the exchangeable potassium was a rather good guide to potassium availability except in the Nolin soil using % potassium in the first cutting as a measure of potassium availability.

After cropping (judging from the % potassium in the sixth cutting), there was a generally poor relationship between exchangeable and plant-available potassium.

To show the problem in a practical way, take the Melvin si.l. which had 130 ppm of potassium **after** cropping. This value corresponds to a "high" soil test and, using Kentucky recommendations, no potassium would be applied.

Despite this, the bermudagrass growing on this soil (sixth cutting) was potassium-deficient, using 1.5% potassium as a standard of adequacy. The same soil before cropping would have received the same recommendation and, in this case, it would have been correct, judging from the potassium content in the first cutting.

The Nolin soil, on the other hand, would call for potassium after cropping. Yet it needs none, since the potassium content was high in the sixth cutting.

It is somewhat comforting to see that the very low potassium content of the

	Exchangeable K			K in plant tissue		
Soil	Before crop	After crop	Yields	1st cutting	6th cutting	Total K uptake
	ppm		g/kg soil	%		mg/kg soil
Commerce sil	264	220	13.24	2.58	1.53	247
Collins sil	36	35	6.58	1.44	0.41	50
Melvin sil	140	130	13.24	2.11	1.05	189
Huntington sil (I)	93	70	13.57	2.07	0.83	167
Huntington sicl (II)	142	120	12.44	2.39	1.35	210
Nolin sil	139	100	17.93	2.71	1.61	354

Collins was correct. A value of 35 ppm gave plants with only 0.41% potassium.

THE INSENSITIVITY of exchangeable potassium to crop removal is one of the problems in its use. The other problem is that the potassium status of the soil is not accurately reflected by the exchangeable potassium level.

It also is apparent that the problem does not only exist after sustained cropping. When potassium fertilizer was added to these soils, the "efficiency" ranged between 1.3 and 70%. This means that in one case, 100 lbs. of fertilizer potassium would increase the soil test by 1.3 lbs. and in another by 70 lbs. Mineralogy of the soils was not helpful in predicting this.

In conclusion, the reader might wonder where we stand with a potassium test. It is evident from our data that very low testing soils really are very low and very high testing soils really are very high.

In the medium-to-high range there is some uncertainty. When we checked earlier work in Indiana, Alabama, Mississippi, Iowa, Oregon and Kentucky, we found that it agrees with this assessment.

It appears that to make intelligent potassium fertilizer recommendations we will need **good** fertilization and cropping histories along with the ammonium acetate exchangeable potassium. Even with these, the recommendations will not be entirely correct. **The End**

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CAN ANYONE explain to me how Abe Lincoln ever made it to the White House?

A man with as many failures and mistakes as he had before he got to 1600 Pennsylvania Avenue?

A man who ran such a cluttered desk after he got there that he kept an envelope in his top drawer with a little note on it: "If you can't find it anywhere else, it's in here."

I laugh when I think of old Abe walking into today's world of buffet dandies **without** his White House pass.

They'd take one look at him and boot him, as a loser.

Not unlike the rejection Billy Graham suggested today's world might give the Teacher he has represented ever since Billy walked through some sawdust to shake the hand of a man they called Cyclone Mack back in the Great Depression.

Abe, **without** his White House pass, would have a friend here. He has been a hero to me. And his failures, like Churchill's foibles as Ike put it, are part of the mixture that made him so great, in my mind.

Indeed, the two men are much alike in the way they were down, rejected many more times than they were up, accepted. But I look at the time they **were** up! **How God Almighty used them in that hour!**

The H-V Formula

I don't think constant colleague acceptance and mistakeless careers make much impression upon the tapestry of time.

Such men are basically weak —when they need to be praised and hailed at every turn, when then need to run in little packs seeking an illusion called prestige, when they are so afraid of the pack they can't stand alone to make a decision.

There is no greater myth than prestige. Visit the hospitals and the last beds I have sat beside through many sunsets over the past 7 years and you will laugh at the word.

If you do laugh, be prepared never to be preeminent among the brethren, as a wise man used to say to me.

BUT—frankly, most of us want to be preeminent among the brethren, the colleagues, the world. Even mavericks desire it, in their way. Even I have felt the urge in recent months. So much so that I went looking for a formula, for a shortcut, at my age.

The urge was strong enough to stir memories of two psychology studies reported in *Time* magazine several years ago. I dug into the old file box for two tearsheets of data.

I call the formula the H-V Formula.

The first half of this formula was stimulated by a study on persuasion.

Psychologists sat 90 students at one end of a table in a conference room.

Another student entered the room as the persuader. He took a seat and spoke 5 minutes on over-population. His job was to convince the listeners of the dangers of over-population.

He spoke from three distances: One to 2 feet, 5 to 6 feet, and 14 to 15 feet.

To measure his effectiveness, the listeners had questionnaires to answer before and after he spoke.

The scientists were surprised when the speaker proved **most persuasive at 14 to 15 feet.** They expected the greatest influence from 5 to 6 feet. They knew one to 2 feet violated that invisible ring most animals and man consider off limits to strangers.

So, here we have the H (horizontal) half of my H-V formula: Distance x persuasion.

The second half of the formula was stimulated by a study on titles.

A psychologist introduced a man called "England" to **five different audiences** as a Cambridge University (1) student, (2) demonstrator, (3) lecturer, (4) doctor, (5) professor.

When the stranger left, the psychologist asked each group to estimate the height of its visitor — same man, of same height, apparently in same suit carrying 5 different titles before five different audiences.

The 5 different audiences remembered him as follows: **As a student,** barely 5 ft. 9.8 in. **As a demonstrator,** 5 ft. 10.29 in. **As a lecturer,** 5 ft. 10.86 in. **As Dr. England,** 5 ft. 11.5 in. **As Professor England,** 6 ft. .32 in. — or 2.5 inches above his "undergraduate height."

So, here we have the V (vertical) half of my H-V Formula: Title x height.

This H-V Formula is no laughing matter, folks. Not in this image building age. Anyone desiring to get ahead had better look at it carefully.

It may not serve me. I may be too far along. From here on in, for me, it may be the simple joys of selfless advice to young folks. I can see them now waiting eagerly for each senile syllable.

But for those in that striving, rising age of life, the H-V Formula may be helpful, even essential.

The formula? Oh! The formula! The formula is this:

The horizontal distance (H) between you and your audience is to your power of persuasion what the title you carry is to the vertical size (V) your audience perceives you to be.

In formulatic language that reads: Distance is to persuasion what title is to height.

So, watch yourselves, young peers. Don't let 'em stick you too close or introduce you too humbly. Press on!

ALFALFA

The Higher The Yield The Less Cost/Ton

F. R. ARBUCKLE and D. C. PETRITZ
Purdue University

PRODUCING ALFALFA may be costing you as much as \$63.22/ton while your neighbor produces it for as little as \$40.63/ton, shown in **Table 1.** Many factors go into obtaining these cost figures.

First, we must consider the direct or variable costs—such as fertilizer and lime, seed, twine, labor and fuel.

Second, we must consider the indirect or fixed costs—such as equipment and building investment.

DIRECT COSTS are the out-of-pocket expenses to meet when the enterprise is undertaken. Let's look at costs of producing 5 tons of alfalfa per acre in **Table 1.**

First, we need 75 lb P_2O_5 at 18¢ and 325 lb K_2O at 8.5¢ giving us a fertilizer cost of \$41.12.

Second, we need a half ton of lime at \$10/ton for a cost of \$5.00.

Third, we need 10 lb of seed at \$2/lb spread over the 5 years expected life of the stand for \$4.00. Then we pay for custom seeding at \$5/acre—spread over 5 years—that becomes \$1/acre.

Fourth, if we spray for weevils the spraying expense is \$20.60.

We calculated harvesting costs at \$4/ton or \$20/A. This was based on 74¢/ton for fuel and oil for two tractors and a mower-conditioner, \$1.90/ton for twine, and \$1.36/ton for repairs.

We calculated the interest on the operating capital at 9% plus a 0.5% allowance for miscellaneous costs, which comes to \$8.71.

IN MANY BUDGETS, labor is not considered a direct cost. But when producing hay, we hire much labor directly for hay harvest.

The amount of labor required to get the hay from seed to bale is about the same. But after the hay is in the bale, the labor requirements increase with the level of production.

Also, the labor figure in **Table 1** would be increased if seeding costs were added in this table. In **Table 1,** seeding was done on a custom basis.

The total direct (out of pocket) costs for 5 tons per acre of alfalfa is \$124.23/acre or \$24.85 per ton.

Lowering your inputs to lower direct costs will produce lower yields. Higher yields will require increased inputs at higher direct costs.

Yields below 3 tons may be obtained without spraying for weevils. So that cost may be eliminated at low yields. Also it may be eliminated if weevils are not a problem on your farm.

Higher yields require higher fertilizer and lime per ton, shown in **Table 1.** The amount of machine operation is related to yield, because increased yields require more cuttings and greater amounts of time to harvest. As a result, greater yields increase machinery operating costs and lower yields decrease them.

A LARGE INVESTMENT can be made in typical harvesting equipment. It includes a mower-conditioner, a rake, a baler, a couple of wagons, and often an elevator.

We won't discuss planting and incorporation equipment here, because this equipment is usually used for several cropping enterprises. So it would be nearly impossible to allocate a fair share of the cost for that equipment to the alfalfa enterprise.

Table 2 shows individual and total investment needed to purchase a typical set of harvest equipment.

When we spread the annual cost of $2,128 over 60 acres of alfalfa, it becomes $35.46/acre machinery and equipment investment.

Larger acreages lower this per acre cost considerably, while smaller acreages create a very large investment per acre. You can adjust these to suit your own acreage.

If you have your own equipment, you have this investment in machinery whether you produce 10 acres or 100 acres of alfalfa. These costs are a very large part of the total cost of producing alfalfa.

Once you've calculated these costs for your own farm, you may consider hiring your hay harvested or purchasing hay from someone else rather than maintaining your own equipment and producing your own hay.

THE HIGHER THE YIELD the lower the cost per ton.

Let's now add a $76/acre land charge. The resulting per ton costs are $63.22 @ 3 ton, $51.49 @ 5 ton, $46.67 @ 6 ton, and $40.63 @ 8 ton per acre yield, shown in **Table 1.**

These figures show total costs per acre increase with yield levels—from extra fertilizer and lime needed to produce these yields. BUT PER TON costs drop off rapidly.

This fact indicates higher yields are more economical and very desirable because they spread fixed costs over more tons. The End

Table 1. Alfalfa-costs of Production*

Direct Costs	3 Ton	5 Ton	6 Ton	8 Ton
Fertilizer[1]	24.68	41.12	49.35	65.80
Lime[2]	5.00	5.00	5.00	5.00
Seed	3.74	4.00	4.00	4.00
Pesticides[3]	—	20.60	20.60	20.60
Custom Seeding[4]	1.00	1.00	1.00	1.00
Mach. Op.[5]	12.00	20.00	24.00	32.00
Interest[6]	4.41	8.71	9.88	12.20
Labor @ $4/hr.	14.28	23.80	28.56	38.08
Total Direct Costs	65.11	124.23	142.39	178.68
Indirect Costs				
Mach. & Equip[7]	35.46	35.46	35.46	35.46
Storage	13.08	21.80	26.16	34.88
Total Indirect Costs	48.54	57.26	61.62	70.34
Land Cost[8]	76.00	76.00	76.00	76.00
Total W/Land Cost/Acre	189.65	257.49	280.01	325.02
Cost/Ton	63.22	51.49	46.67	40.63

*Based on Large Labor Oriented Operation (Mower-conditioner, rake, baler, 2 wagons, elevator-manually hauled and stored).

[1] Fertilizer use is not linear in reality, but is most often geometric, these figures are estimates based on removal.

[2] Spread cost including lime. Assumes the soil requires a 2½ ton/acre lime application to get desired pH.

[3] Includes cost of application.

[4] It is more economical to hire the seeding than to purchase the required equipment to seed, unless already on the farm.

[5] Fuel and oil, $.74/ton; twine, $1.90/ton; and repairs, $1.36/ton.

[6] Interest on operating capital @ 9% plus a 0.5% allowance for miscellaneous costs.

[7] Assumed minimum of 60 acres and same depreciation schedule for all equipment for all yields.

[8] Based on $800/acre land at an interest rate of 9.5%.

Table 2. The total and annual cost of the investment required for the production of alfalfa in conventional rectangular bales.

Item	Investment	Annual Cost[1]
Mower-Conditioner	$ 4700	$ 799
Baler	4119	700
2 Wagons	1500	255
Rake	1700	289
Elevator	500	85
TOTAL	$12519	$2128

[1] Annual cost based on depreciation at 10%, Interest at 4%, Taxes at 1.5%, Insurance at 0.5%, and Shelter at 1% of the investment. (Total 17%)

Applying N & P At The Same Time Into The Same Soil Shows Promise For Winter Wheat...

L. S. MURPHY,* D. R. KEIKAM
R. E. LAMOND, P. J. GALLAGHER
Kansas State University

A STUDY COMPARING methods of applying nitrogen and phosphorus for winter wheat in Kansas has indicated agronomic superiority for a technique involving dual knifed applications of nitrogen and phosphorus, preplant.

Knifed applications imply injecting ammonia and 11-37-0 simultaneously into the soil in the same retention zone. Each ammonia shank was equipped with two lines, one to deliver ammonia and the other to deliver liquid APP.

Treatments were injected on 18-inch centers at a depth of six inches. Before the 1976-77 crop, dual (simultaneous) application of ammonia and liquid ammonium polyphosphate (11-37-0) was the only combination evaluated as a knifed preplant treatment.

Figure 1. Nitrogen and phosphorus application methods produced significant differences in plant growth, composition and grain yields at this location in Harper County, Kansas. Knifed applications which placed anhydrous ammonia and liquid ammonium polyphosphate (10-34-0) in the same soil zone before seeding (lower picture) performed exceptionally well. "Surface" applications of nitrogen involved use of 28% N urea-ammonium nitrate solution disked into the soil immediately after application.


METHODS N-P
APPLICATION
N P2O5
75 50
SURFACE SURFACE
KSU HARPER COUNTY 1975


METHODS N-P
APPLICATION
N P2O5
75 50
KNIFE DRILL
KSU HARPER COUNTY 1975


METHODS N-P
APPLICATION
N P2O5
75 50
KNIFE KNIFE
HARPER COUNT

Table 1. N-P placement effects on wheat yields. Harper County, Kansas.

	1975 bu/A	Plant—1975 %N	Plant—1975 %P	1976 bu/A	Protein 1976 %
Control	22	2.62	.18	15	10.9
Knifed N	40	3.21	.22	34	12.3
Surface N	36	2.61	.20	25	11.0
Knifed N-P	45	3.14	.28	34	12.2
Surface N-P	40	2.74	.20	26	11.3
Knifed P	45	3.14	.28	34	12.2
Surface P	40	2.74	.20	26	11.3
Drilled P	38	2.72	.20	32	11.3
LSD .05	8	0.59	.03	6	0.7

N constant at 75 lb N/acre. P supplied at 25 and 50 lb P_2O_5/acre.

These knifed dual N-P treatments were compared to knifed preplant applications of ammonia and broadcast applications of phosphorus applied as separate treatments.

The phosphorus (APP) was sprayed on the soil surface and incorporated by disking. Broadcast, preplant nitrogen-phosphorus applications employed the use of a mixture of nitrogen solution (UAN) and APP.

This combination liquid treatment was sprayed on the soil surface preplant and incorporated by disking. Also included in the early studies were various methods of preplant nitrogen application and phosphorus banded with the seed at seeding.

Table 1 shows the simultaneous knifed nitrogen and phosphorus treatment produced consistently higher yields than either broadcast or band applications. Relative yield effects of the broadcast and band phosphorus treatments varied. **Figure 1** shows very striking growth differences existed before harvest in both 1975 and 1976. Soil P of that location where the 1975 and 1976 studies were conducted was low by weak-Bray P extraction, 3 ppm. Soil pH was 6.0.

SIMILAR STUDIES were established in the late summer of 1976 at locations in Labette, Reno, Harper, and Dickinson counties. While similar in design to the 1975 and 1976 investigations, these studies were more involved because they also utilized UAN and APP mixtures as knifed treatments preplant similar to the dual application of ammonia and APP.

A dribble technique was also employed for dual N-P applications of UAN and APP. This dribble application involved coarse streams of liquid fertilizer placed on the soil surface on 18-inch centers and incorporated by disking.

Band applications of phosphorus were also employed in 1976 combined with all methods of nitrogen application. Nitrogen was constant at 75 lb N/A, P_2O_5 was constant at 40 lb P_2O_5/A. The same source of P (11-37-0) was used in all studies.

One additional treatment was added in 1976-77—a knifed application of ammonia and APP which involved 0.5 pounds active ingredient **N-SERVE** per acre. **N-SERVE** is a nitrification inhibitor produced by the Dow Chemical Company.

Figure 2. Methods of N-P application significantly affected plant growth, tissue composition and yield at this location in Ellsworth County, Kansas. Knifed, preplant placement of ammonia plus liquid ammonium polyphosphate or knifed placement of a mixture of nitrogen solution (UAN) and ammonium polyphosphate was superior to separate N and P applications, broadcast applications, and band placement of P.


N-P METHODS
75 N UAN KNIFED
0 P_2O_5 40
KNIFED
ELLSWORTH CO APRIL 15, 1977


N-P METHODS
75 N UAN KNIFED
40
KNIFED P_2O_5 B'CAST
ELLSWORTH CO APRIL 15, 1977


N-P METHODS
75 N UAN KNIFED
KNIFED 40 BAND
P_2O_5
ELLSWORTH CO APRIL 15, 1977


N-P METHODS
75N KNIFED
UAN NH_3
40 P_2O_5 KNIFED
ELLSWORTH CO APRIL 15, 1977

Table 2. Comparative effectiveness of methods of N-P application for wheat. Kansas, 1977.

	Reno Co.			Ellsworth Co.			Labette Co.	Dickinson Co.	
	bu/A	%N	%P	bu/A	%N	%P	bu/A	%N	%P
No N	21	3.80	.17	38	3.91	.20	26	3.58	.22
Knifed NH_3	22	3.44	.16	43	3.90	.16	38	4.14	.23
Knifed NH_3—Knifed APP	39	3.74	.25	58	4.74	.30	45	4.50	.28
Knifed NH_3—B'cast APP	38	3.78	.20	53	3.92	.19	43	4.06	.22
Knifed NH_3—Band APP	35	3.80	.19	50	4.18	.21	41	4.12	.24
Knifed UAN	25	3.84	.16	40	4.02	.19	37	4.07	.23
Knifed UAN—Knifed APP	43	3.87	.23	55	4.62	.29	45	4.02	.28
Knifed UAN—B'cast APP	39	3.82	.20	52	4.02	.20	45	3.92	.21
Knifed UAN—Band APP	35	3.84	.20	45	4.06	.21	45	4.07	.23
Knifed NH_3—Knifed APP	39	3.74	.25	58	4.74	.30	45	4.50	.28
Knifed NH_3—Knifed APP plus N-SERVE	47	4.02	.23	45	4.49	.30	49	4.36	.33
LSD .05	6	NS	.03	8	0.39	.02	4	0.29	.04
Soil pH		7.3			6.0		5.5	6.1	
Soil Test P, ppm		4			5		4	11	

THE GROWING SEASON during late fall, winter, and early spring of 1976-77 was anything but desirable. Plants did not produce much top growth until rains began in April. As soon as top growth began, differences which appeared in 1975 and 1976 began to show up on all locations.

Knifed, preplant treatments of ammonia and APP and similar knifed preplant treatments of UAN-APP combinations exhibited striking growth differences versus other methods of nitrogen and phosphorus application. In all cases, the dual applications were superior.

Dribble applications of UAN-APP combinations also produced good plant growth but were not as striking as the knifed, preplant treatments.

This excellent plant growth is shown in **Figures 2 and 3.** Plant tissue samples were collected from three of the four locations and analyzed for nitrogen, phosphorus and potassium content. **Table 2** shows the results of these analyses.

Rains continued in April and wheat yield prospects improved daily. Still, differences which had appeared early in the season were still quite evident late in the season (heading).

Table 2 shows preplant, knifed applications of nitrogen and phosphorus produced highest yields at all locations.

Broadcast and dribble applications improved dramatically as spring progressed and were second to knifed treatments in grain yield.

Phosphorus banded with the seed combined with various methods of nitrogen application produced the lowest mean yields of all techniques of N-P application.

ANALYSIS OF THE TISSUE indicated generally higher phosphorus concentrations in the dual N-P applications. Notable effects were produced by the treatment which involved N-SERVE. Throughout the growing season these plots had outstanding yield potential and were visibly superior to other treatments at several of the sites.

Analyzing the data and comparing knifed, N-P treatments as ammonia and APP versus the same treatments with

Figure 3. Superior performance of knifed N-P applications of ammonia plus liquid ammonium polyphosphate or knifed placement of mixtures of N solution and P solution were also noted at this site in Reno County, Kansas. Differences noted early in the spring (top) were visible until harvest. Note the magnitude of P response in the third picture.


N-P METHODS
75 N NH_3 KNIFED
40
KNIFED P_2O_5 BCAST
RENO CO. KANSAS APRIL 15, 1977


METHOD N-P
APPLICATION
75 N NH_3 KNIFED
40 P_2O_5
KNIFED BCAST
RENO CO. KANSAS 1977


METHOD N-P
APPLICATION
75 N UAN KNIFE
40 P_2O_5 0
KNIFE
RENO CO. KANSAS 1977
MAY 12


METHOD N-P
APPLICATION
BCAST 75 N KNIFE
BCAST 40 P_2O_5 KNIFE
UAN NH_3
RENO CO. KANSAS 1977
MAY 12

Table 3. Comparative performance of tillage implement applications of Nitrogen and Phosphorus for winter wheat. Kansas, USA.

Treatments	Sandyland Exp Field		McPherson County		Saline County	
	Yield bu/A	% Grain Protein	Yield bu/A	% Grain Protein	Yield bu/A	% Grain Protein
Control (0-N, 0-P)	37	10.6	34	10.8	36	12.8
30 lb N/A	45	10.8	42	10.6	42	12.8
60 lb N/A	46	11.4	46	10.9	42	13.5
LSD $_{05}$ N Rate	NS	0.4	2	NS	NS	0.4
0 lb P_2O_5/A	45	11.2	44	10.8	39	13.5
30 lb P_2O_5/A	46	11.0	44	10.7	45	12.9
LSD $_{05}$ P Rate	NS	NS	NS	NS	3	0.4
Undercutting Blade	48	11.8	47	10.9	44	13.4
Chisel Plow	46	10.4	43	10.6	41	13.2
Surface	46	11.1	42	10.8	42	12.9
LSD $_{05}$ Method	2	0.5	3	NS	NS	NS
LSD $_{05}$ Treatment	3	0.5	5	NS	6	1.0

N-SERVE, the latter gave superior yield performance at two of the three locations harvested. The fourth location (Dickinson county) exhibited the same trend but was lost to a late season hailstorm after plant tissue analyses had been collected.

Results of these investigations have been relatively consistent despite variation in soil available phosphorus content. This, as well as other data shown in **Table 3,** suggests a possible yield advantage of simultaneous, deep N-P placement for wheat, which needs more study for verification.

These results raise two questions:

1. Is this apparent P response improvement due simply to deep placement in more moist soil, enhancing P availability, as many have suggested?

2. Is there an actual chemical effect caused by the close association of high concentration of $PO_4^{=}$ and NH_3?

WE NOW SUBMIT the effects which we observed earlier were due not only to the deeper position in moist soil but also to a possible change in phosphorus chemistry produced by high concentrations of ammonium nitrogen in the phosphorus retention zone.

This particular point or theory is not new. Other researchers in the United States and Canada have reported ammonium effects on phosphorus absorption for the last 20 years. But this technique does have certain unique features in that the ammonium concentrations in the phosphorus retention zone are much higher than would be achieved if ammonium phosphate had been placed in a restricted band in the soil.

We further submit that evidence of ammonium modification of phosphorus chemistry exists from the effects of N-SERVE which were noted.

Delaying nitrification and thus maintaining nitrogen in the ammoniacal form for an extended period would tend to accentuate changes in phosphorus soil chemistry, changes which we think are substantiated by the increased plant absorption of phosphorus.

We have not conducted recent research in this area with row crops, although earlier research did involve grain sorghum as a test crop. Where responses to nitrogen and phosphorus were recorded, blade or chisel applications of nitrogen and phosphorus as ammonia-APP combinations were superior to broadcast applications of UAN-APP combinations, shown in **Table 4. End**

*Dr. L. S. Murphy is now Great Plains Director of the Potash & Phosphate Institute.

Table 4. Comparative performance of tillage implement applications of Nitrogen and Phosphorus for Grain Sorghum. Kansas—USA.

Treatments	North Central Exp. Field				Brown County—1972				Brown County—1973			Brown County—1974		
	Yield,	% Grain	Leaf[1]		Yield,	% Grain	Leaf		Yield,	Leaf		Yield,	Leaf	
	lb/A	Protein	%N	%P	lb/A	Protein	%N	%P	lb/A	%N	%P	lb/A	%N	%P
Control (0-N, 0-P)	6046	10.6	2.89	0.36	6270	6.5	2.28	0.27	2744	1.66	0.20	1736	2.69	0.31
60 lb N/A	5999	10.9	3.00	0.38	6699	8.0	2.73	0.31	3640	2.04	0.21	2856	2.83	0.29
120 lb N/A	5729	11.3	3.04	0.38	6456	8.5	2.88	0.32	4592	2.50	0.25	3197	2.97	0.29
LSD $_{.05}$ N Rate	NS	0.3	NS	NS	NS	0.3	0.08	0.01	224	0.11	0.01	235	0.09	NS
0 lb P_2O_5/A	5645	11.1	3.01	0.38	6540	8.2	2.82	0.31	4144	2.30	0.22	3030	2.91	0.29
30 lb P_2O_5/A	6083	11.1	3.04	0.38	6615	8.3	2.80	0.31	4144	2.25	0.24	3046	2.90	0.29
LSD $_{.05}$ P Rate	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.01	NS	NS	NS
Undercutting Blade	5626	11.2	3.08	0.38	6494	8.0	2.76	0.31	4368	2.32	0.24	3180	2.90	0.27
Chisel Plow	6004	11.4	3.10	0.38	6494	8.7	2.85	0.31	4144	2.44	0.24	3550	3.08	0.29
Surface	5934	10.8	2.88	0.37	6746	8.1	2.81	0.31	3864	2.06	0.22	2380	2.73	0.31
LSD $_{.05}$ Method	NS	0.3	0.09	NS	NS	0.3	NS	NS	224	0.14	0.01	291	0.12	NS
LSD $_{.05}$ Treatment	NS	0.7	0.20	NS	NS	0.6	0.08	0.01	672	0.38	0.03	571	0.21	NS

[1]Plants sampled at heading, youngest fully-emerged leaf.

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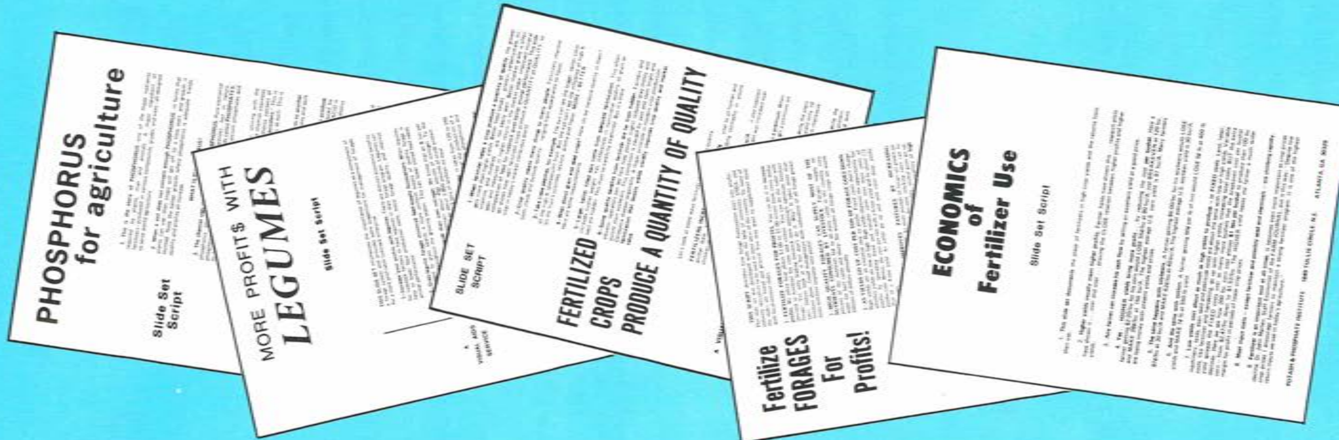

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Residual Fertilizer P BENEFITS Wheat & Oilseed Production

E. D. SPRATT
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MOST CHERNOZEMIC SOILS of the Canadian prairies are considered marginally deficient in phosphorus.

In the past 25 years, about 240 million tons of grain have been exported from Western Canada, removing about 1 million tons of P from these prairie soils. Only half of this loss was replaced by fertilizer P.

In recent years, sales of fertilizer P have risen to about 120,000 tons per year. But this replaces only the P exported in grain each year, leaving the soils in their deficient state.

Agriculturists are thinking about "soil building" by applying extra large amounts of fertilizer P to increase soil reserves. This can be done by increasing the rate of annual applications or by applying very large amounts of P occasionally.

RESEARCH AT THREE Agriculture Canada stations has shown how residual fertilizer P benefits wheat.

Starting in 1945, an experiment at Indian Head, Saskatchewan, tested various rates of monoammonium phosphate (MAP) and barnyard manure (BYM) applied in a 3-year crop rotation.

Over the years, MAP and BYM applications increased yields progressively, shown in **Figure 1.** Apparently, the accumulated residual P complemented the indigenous and freshly applied P to further enhance yields.

The sodium bicarbonate extractable P levels in soils receiving O, 44.8 and 112 MPA were 11, 13 and 22 ppm respectively in 1964 and 8, 13 and 18 ppm in 1977. This means the moderate MAP rate was still maintaining fertility status of the soil but the higher rate gave better yields.

WHEAT AND FLAX rotated over 8 years used P quite efficiently from large applications of P fertilizer at Brandon. For example, 21% was recovered from the 100 kg P/ha broadcast in 1966, while 22.5% was recovered from 10 kg P/ha applied with the seed annually.

The recoveries from the 200 and 400 kg P/ha broadcast applications were 15 and 9%, respectively, but the benefits of the residual P were by no means exhausted over the 8 years of cropping.

Over 8 years, annual applications of 20 kg P/ha to wheat gave about the same yields as 100 kg P/ha applied once, the averages being 2370 and 2450 kg/ha of grain respectively, shown in **Figure 2.** Without P fertilizer, wheat averaged 1717 kg/ha. With adequate P, wheat yields increased 50%.

Broadcast P also benefited flax. Without P, flax averaged 970 kg/ha. With adequate P, flax yield increased to 1185 kg/ha.

Wheat removed 11.2 kg P/ha/yr and flax removed 7 kg P/ha/yr from the 100 kg/ha of P broadcast treatment.

THE HIGHEST UPTAKE of P for wheat was 14.8 kg/ha/yr from the 400 kg P/ha broadcast treatment. Uptake of P from the soil without added fertilizer P was about 4.5 kg P/ha/yr, shown in **Figure 3.** As the plant took up P, available P in the soil declined, as measured by the $NaHCO_3$ soil test.

The large applications of P initially increased available P to high levels—

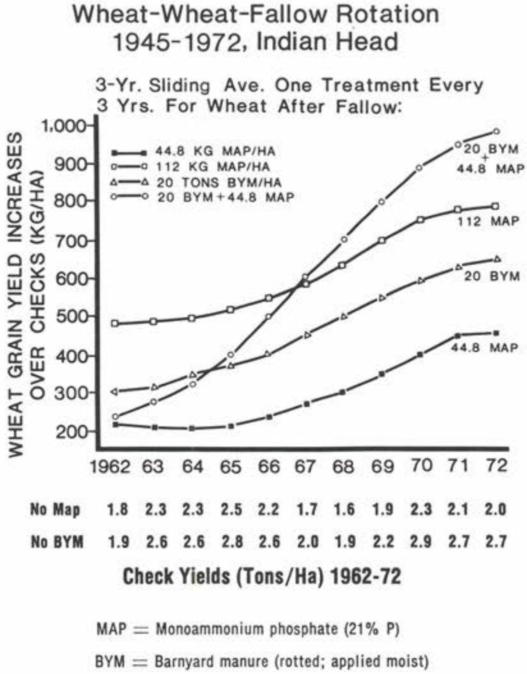

Figure 1. The effect of repeated applications of monoammonium phosphate (MAP) and barnyard manure (BYM) within a three-year wheat-wheat fallow rotation, from 1945-72, on the yield of wheat after fallow.

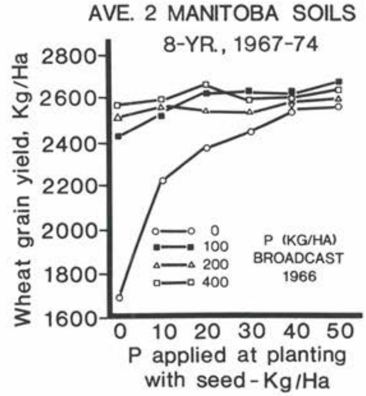

Figure 2. The effect of single amounts of fertilizer P broadcast once in 1966 and P applied annually at planting with the seed on yield of wheat grain, averaged over 8 years.

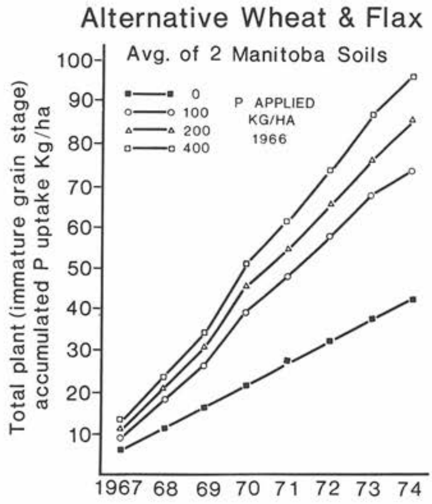

Figure 3. The effect of single broadcast applications of P in 1966 on the accumulative uptake of P by wheat and flax grown alternately from 1967 to 1974.

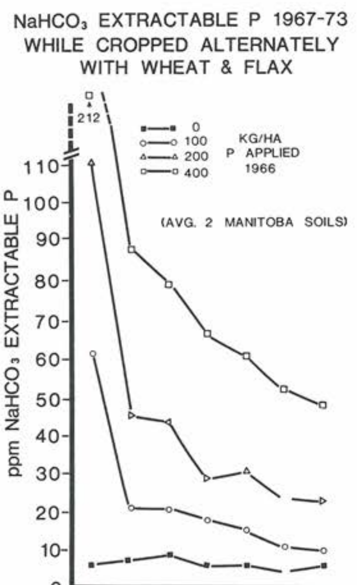

Figure 4. The effect of single applications of P in 1966 on the $NaHCO_3$ extractable P levels in the soils while being cropped alternately with wheat and flax from 1967 to 1973.

that is, 100 kg/ha of P increased available P by 50 ppm. There was a rapid decline within the first year, and then available P decreased by about 5 to 8 ppm per year shown in **Figure 4.**

Phosphate fertilizers usually benefit crops when the soil test **falls below 15 ppm and is definitely needed (and economical) when the soil tests are below 10 ppm.** So, an application of 100 kg P/ha kept these soils adequately supplied with available P for about 5 years.

It appears from the rate of decline of available P, in Figure 4, that 400 kg P/ha would supply enough available P for optimal yields for about 20 years.

IN THESE CALCIUM saturated soils, the fertilizer P changes rather rapidly to dicalcium phosphate dihydrate and then slowly converts to octacalcium phosphate. These forms contribute to the steady release of plant available P over time.

When $NaHCO_3$ extractable P levels in Manitoba soils are below 15 ppm, the most efficient method of applying fertilizer P is with or near the seed.

But no more than 200 kg/ha of mixed fertilizer can be placed with the seed of cereals (less if it contains some urea) and no more than 7 kg N/ha plus 9 kg P/ha can be placed near the seed of flax or rapeseed.

So more farmers are considering broadcasting and incorporating the complete NPKS fertilizers needed. Labor is saved, discount prices can be negotiated and sowing time is decreased.

When broadcasting, higher P rates are needed to get equivalent yield responses to those possible with near seed placement. But the residual P remains valuable.

FROM THE RESEARCH reported here, farmers are proceeding with confidence to build the P reserves of their deficient soils. They may add extra P annually or occasionally broadcast larger amounts knowing that residual fertilizer P adds significantly to wheat and oilseed production. **The End**

PHOSPHORUS & POTASSIUM
Increase Quality
Reduce Diseases
OF SOYBEANS

HOUSTON CAMPER, GEORGE JONES, and J. A. LUTZ, JR.
Virginia Polytechnic Institute and State University

MUCH MONEY is lost on soybeans each year because of poor seed quality and diseases.

Experiments conducted the last several years at VPI & SU Research Stations at Warsaw and Orange show an adequate, balanced soil fertility program can reduce the incidence of soybean disease and increase seed quality.

EASTERN VIRGINIA RESEARCH STATION, WARSAW:

One-time applications (1969 of P_2O_5 and K_2O were applied to a Sassafras sandy loam soil testing 124 (VH) in P_2O_5 and 59 (L) in K_2O.

Table 1 shows pod and stem blight and purple stain quite severe in 1971 on plots that did not receive the 1969 fertilizer application.

Potash (K_2O) application reduced pod and stem blight over 90 percent and purple stain more than 40 percent.

The effects of phosphate (P_2O_5) on this high P testing soil were not as dramatic as K_2O, but there was a general tendency for less disease.

The greatest reduction for both diseases in 1971 and 1972 occurred when a combination of P_2O_5 and K_2O had been applied, shown in Table 1.

Purple stain was more severe in the

Table 1. The effect of fertility treatments on the disease of soybeans at Warsaw, Virginia.

Fertilizer Applied*		Pod and Stem Blight			Purple Stain			2-Year Ave. Yields
P_2O_5	K_2O	1971	1972	Ave.	1971	1972	Ave.	
Lbs/A				%				Bu/A
0	0	20.8b	3.2b	12.0b	21.6b	6.2b	13.9b	23.1
400	0	12.5b	3.3b	7.9b	16.2b	6.0b	11.1b	26.2
0	400	1.8a	0.1a	1.0a	9.6a	0.7a	5.2a	35.9
400	400	1.3a	0.0a	0.7a	8.4a	0.8a	4.5a	38.8

*All fertilizer applied in 1969.

Table 2. Purple seed stain of soybeans as affected by fertility treatments and position on the plant at Warsaw, Virginia, 1971.

Fertilizer applied		Purple seed stain	
P_2O_5	K_2O	%	
Lbs/Ac		Top†	Bottom‡
0	0	26.9c	8.3a
400	0	22.1bc	11.7b
0	400	17.0b	7.7a
400	400	10.9a	6.0a

†Top one-third of plants.
‡Bottom two-thirds of plants.

top third of the plant when P_2O_5 and K_2O were omitted, shown in Table 2. When 400 lb/A of P_2O_5 and K_2O had been applied, purple stain was reduced in the top portion of the plant, with K_2O having the greater effect. K_2O had only a slight effect on reducing the incidence of purple stain in the bottom two-thirds of the plant.

Best results came when both P_2O_5 and K_2O had been applied, shown in Table 2.

PIEDMONT RESEARCH STATION, ORANGE:

Two experiments were conducted on a Davidson clay loam soil. Annual applications of the treatments were applied to soybeans over a five-year period (1972-1976). The treatments, five-year average yields, and the 1976 soil test levels for the two experiments are shown in Table 3.

Visual quality ratings were made in 1976 and the percent of sound seed

Table 3. The 5-year average yield and the 1976 soil test levels for two soybean experiments on a Davidson clay loam soil at Orange, Va.

EXPERIMENT 1					EXPERIMENT 2				
Fertilizer Applied		5-Year Ave. Yields	1976 Soil Test Level		Fertilizer Applied		5-Year Ave. Yields	1976 Soil Test Level	
P_2O_5	K_2O		P_2O_5	K_2O	P_2O_5	K_2O		lb/a	
lb/a		bu/a	lb/a		lb/a		bu/a	P_2O_5	K_2O
0	0	19.2	35	71	0	0	20.4	33	85
0	30	28.5	34	108	30	0	22.6	35	73
0	60	29.2	32	149	60	0	19.8	46	73
0	120	30.8	29	259	120	0	21.9	64	70
120	0	21.7	73	67	0	120	33.3	29	188
120	30	34.0	64	97	30	120	39.9	34	172
120	60	37.1	60	108	60	120	40.2	45	143
120	120	41.0	53	224	120	120	40.5	60	140

Table 4. The effects of P_2O_5 and K_2O on the quality of soybeans grown in 1976 on a Davidson Clay loam soil. Orange, Va.

EXPERIMENT 1					EXPERIMENT 2				
Fertilizer Applied		Visual Rating* (1-5)	Sound Seed		Fertilizer Applied		Visual Rating* (1-5)	Sound Seed	
P_2O_5	K_2O		Number	Weight	P_2O_5	K_2O		Number	Weight
lb/a			%		lb/a			%	
0	0	5.0	46.1	49.8	0	0	3.9	52.9	55.3
0	30	3.8	60.4	62.3	30	0	4.3	58.6	59.7
0	60	2.9	64.6	65.4	60	0	4.0	49.2	52.4
0	120	1.2	70.3	69.7	120	0	4.1	51.8	54.9
120	0	5.0	49.4	53.7	0	120	1.1	96.3	97.8
120	30	3.9	54.8	56.2	30	120	1.2	97.4	98.3
120	60	2.4	76.0	69.7	60	120	1.0	95.9	97.9
120	120	1.0	80.1	81.8	120	120	1.0	95.9	97.9

*1 = best; 5 = very poor

(both by number and by weight) were determined. The results for the two experiments are shown in Table 4.

A visual rating of the soybeans indicated K_2O was having a big effect on quality. A much higher number of discolored and shriveled seeds were observed at low K_2O levels. This observation was much less noticeable with P_2O_5 treatments.

A measurement of the percent of sound seed by number and weight confirmed the visual observations. The percent of sound seed in both experiments increased with K_2O applications and was the highest at the high K_2O rate.

P_2O_5 had less dramatic effect on quality. But in Experiment One P_2O_5 showed a trend toward improved sound seed.

In Experiment One, the highest P_2O_5 and K_2O rate produced highest number and weight of seed, 80 percent.

We were interested in how fertilization might affect germination. Soybeans from selected common treatments in the two experiments were combined and a germination test was conducted.

Table 5 shows 62% germination with no phosphorus or potassium application. P_2O_5 application alone increased germination to 70% and K_2O alone increased germination to 85%. Germination was highest (95%) when both P_2O_5 and K_2O were applied. **The End**

Table 5. Germination of soybeans as affected by rates of P_2O_5 and K_2O at Orange, Virginia. Ave. of 16 reps.

Fertilizer applied		
P_2O_5	K_2O	Germination
Lbs/Ac		%
0	0	62
120	0	70
0	120	85
120	120	95

Double Cropped Soybeans And Wheat Work

TOM McCUTCHEN
Superintendent, Milan Field Station
Milan, Tennessee

DOUBLE CROPPED soybeans and wheat may give West Tennessee farmers a chance to increase land efficiency and farm profits and help reduce erosion.

Six years of work at the Milan Field Station show this. The trials began in 1971 with Dare soybeans planted into wheat stubble with an Allis-Chalmers (A.C.) no-till planter.

Wheat yielded about 40 to 45 bu/A under the doublecrop system, but soybeans yielded 7 to 23% less than the station's average soybean yield, except in 1971 and 72 when the beans produced 14 to 16% better than station average. **Table 1** shows this.

Dare soybeans were planted in 40-inch rows at 70 lbs seed per acre in 1971, 30-inch rows at 60 lbs seed per acre in 1972. In 1973 thru 76, 20-inch row spacing was used to plant either Dare or Essex soybeans.

Table 2 shows 20-inch rows averaging 5 bushels more per acre than 40-inch rows. These plots were planted in wheat stubble with the A.C. planter. Essex variety yielded more than other varieties at the 20-inch row spacing.

All double cropped soybeans were planted right after combining the wheat, usually the same day. Over the six years, planting dates ranged from June 14 to June 21.

Year in and out, soybeans planted on land that grew cotton the year before outyielded soybeans following soybeans. This is due, of course, to cotton soils being more productive and usually more fertile. **Table 3** shows how the preceding crop influenced soybean yields.

AERIAL SEEDING SOYBEANS into standing wheat about a month before combining the wheat may succeed if certain steps are taken and some problems avoided. For many years, wheat has been successfully aerial seeded into standing soybeans at leaf shed.

We aerial seeded Essex soybeans at Milan about a month before normal wheat harvests, May 12-16, following a good rain of about 1 inch. Moisture is very important to aerial seeding soybeans. Our best results have come from a 3-bushel seeding rate.

Aerial seeding doesn't work when weeds are a serious problem, especially if Johnsongrass, bermudagrass or other perennial grasses are present. Annual grasses reduce yields because control practices are not fully developed for this seeding method. Cockleburs do not hinder this system because they can be controlled.

Aerial seeding was simulated in 1975 by broadcasting Essex soybeans into wheat at 2 bu/A on May 27. The wheat yielded 52 bu/A on June 16, the soybeans 32.6 bu/A on October 22. Essex double cropped on 20-inch rows planted June 18 and harvested October 22 produced 43.3 bu/A.

The 1975 aerial seeded stand was sparse. So in 1976, the seeding rate was increased to 3 bushels. After being aerial seeded on a 12-acre field in standing wheat on May 10, Essex soybeans yielded 46 bu/A. Airplane seeding at Milan cost $1/bu plus $1.50/A. In 1976 double cropped Essex, planted June 14-21, yielded 27 bu/A.

So, the aerial seeded Essex yielded 19 bu/A more than the no-till planted. The earlier planting in moist soil helps increase aerial seeded yields. Farmers are often delayed to mid-July for planting of soybeans following wheat harvests.

Table 4 compares aerial seeding of soybeans and grain sorghum to conventional systems and double cropping in 1976. The first planting single crop soybeans were lost to the weather but were replanted on June 14. The aerial seeded soybeans did well, but not the grain sorghum. Double cropped grain sorghum produced well, but not when aerial seeded.

In 1977, soybeans aerial seeded April 26 were lost to dry weather. Soil moisture was excellent, but dry weather persisted and the seedlings died.

Two more bushels seeded by plane also died. Poor seed quality may have been a factor in loss of the first seeding. Weeds invaded and the plots were abandoned.

The 1977 results from aerial seeding show what weather change can do. Instead of outyielding conventional planting systems, the crop was lost. It also shows the need for high quality seed, good soil moisture, and quick weed control in this planting system.

Farmers in Tennessee, north Mississippi, and west Kentucky can increase land use efficiency, reduce erosion, and make more money with double cropping.

Work at Milan found double cropping of wheat and soybeans to be a good system, with soybean yield losses well below those reported from other areas.

Aerial seeding of the soybeans into standing wheat moves the planting date of the soybeans to the recommended time for best yields but is very risky. This system produced good yields in 1976 at Milan. **The End**

Table 1. Double cropped soybean yields, 1971-1976 SOYBEAN Yield.

Year	Station[1] Average	Double Crop	Difference Bushels	Difference Percent
1971	31	36	+5	+16
1972	21	24	+3	+14
1973	44	41	−3	−7
1974	34	28	−6	−18
1975	37	30	−7	−19
1976	35	27	−8	−23
Average	34	31	−3	−9

[1]STATION AVERAGE—Average soybean yield from all soybeans grown on station—research plots, production fields, etc.

Table 2. Soybean varieties and row spacings for double-cropping, 3-yr. average (1974-1976).

Variety	Row Spacing 40 inch	Row Spacing 20 inch	Difference
		Bu/A	
Pickett 71	22	27	+5
Essex	25	31	+6
York	25	28	+3
Dare	23	28	+5
Forrest	21	27	+6
		Average	+5

Table 3. Double cropped soybean yields following cotton or soybeans the preceding year.

Year	Cotton	Soybeans Bu/A
1972	32	18
1975	40	25
Average	36	22

Table 4. Yields of soybeans and grain sorghum seeded in conventional and double-crop systems. 1976.

Cropping System	Planting Date	Planting Method	Yield, Bu/A Soybeans	Yield, Bu/A Grain Sorghum
Single	May 21	Conventional	26.7[1]	113.9
Double	May 12	Aerial[2]	38.7	42.2
Double	June 14	A.C. Planter[2]	35.6	89.5
Double	June 14	Conventional[2]	26.9	97.7

[1]Rain and poor stand eliminated the first planting of this treatment. Replanted on June 14.

[2]Seeded during or after wheat crop. Conventional planting included disking in wheat straw then planting.

[3]1976 Station Average Yield, Soybeans, was 35 bu/A.

ECONOMICS OF FERTILIZER USE

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