BETTER CROPS with plant food

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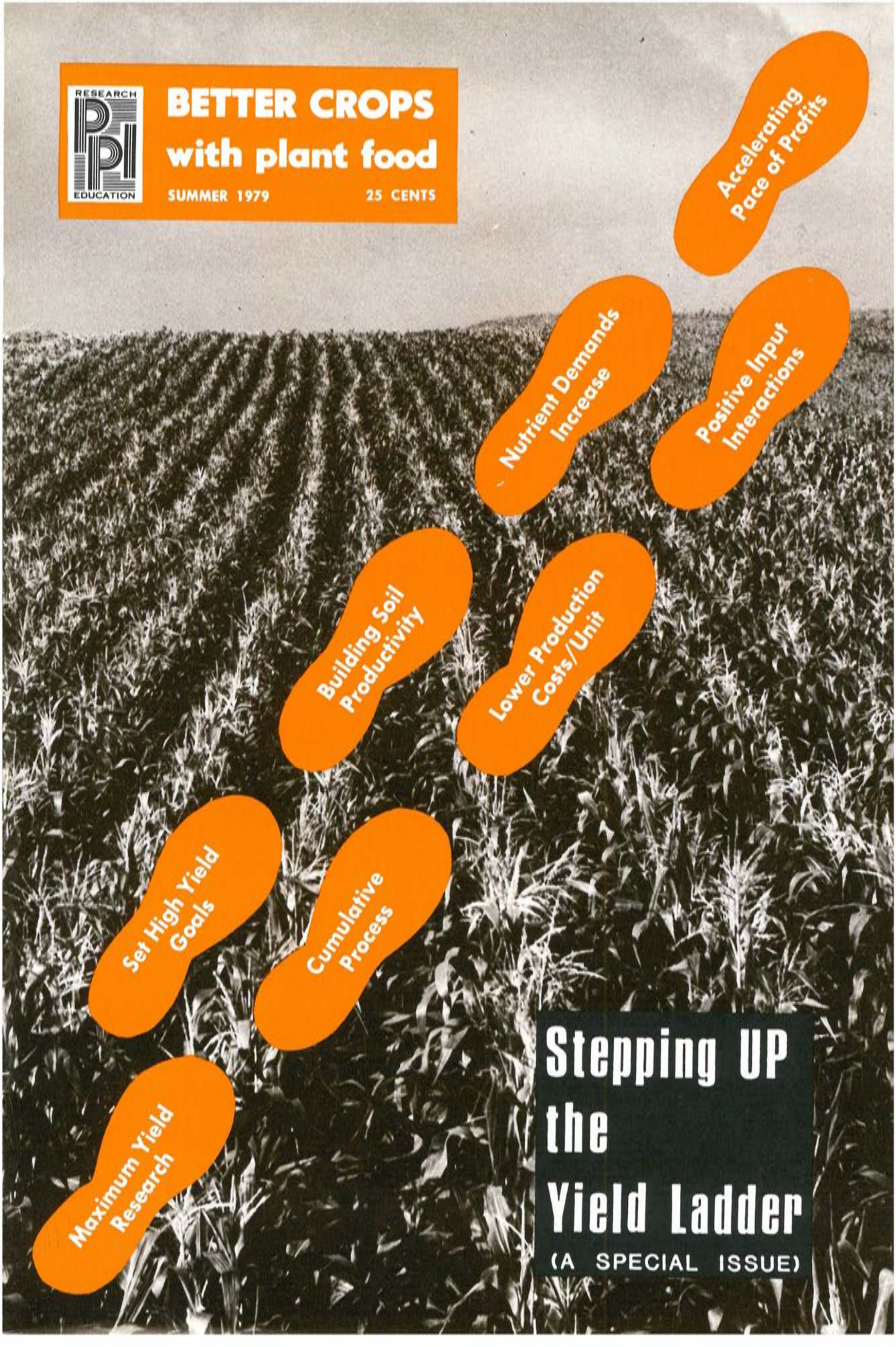

Stepping UP the Yield Ladder

(A SPECIAL ISSUE)

BETTER CROPS with plant food

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Where The Action Is...

MOVING UP to maximum economic yields is the best way—and about the only way—farmers can control their profit margins today.

The goal is to maximize production for any given set of conditions by optimizing use of controllable inputs. There are several inputs. None are more controllable than fertilizer.

It is poor business to allow the producing power of costly land to be limited by any factor as controllable as fertilizer.

This special issue of BETTER CROPS focuses on high yields.

You will find a report on how stepping up the yield ladder increases plant food needs. You will find frequent reference to interactions, to economics of high yields, to maximum yield research.

But you will not find many answers on how best to fit the pieces and parts that go into making high yields.

RESEARCH HAS given us good components or parts—**high yielding varieties and hybrids, improved fertilizer practices, new pest control methods, better tillage and residue management practices,** and **many others.**

We can expect research to turn out still better individual components. But greater strides toward high yields will likely come through **fitting those parts into combinations that produce positive interactions.**

This means two or more parts working together can produce a better result than the total of the individual actions.

Let's assume P alone gives a 15-bushel increase and K alone gives the same increase.

If yield climbs above 30-bushel increase when BOTH are applied TOGETHER, a positive interaction has occurred.

WE KNOW HOW to move **average** yields higher. But what about moving **high** yields **higher.**

At higher yield levels, what are the relationships among rates and ratios of major, secondary, and micronutrients? How do all these relate to all other components?

The search for positive interactions that build maximum yields is where the action is in research today. And it's likely to be there for many years to come.

It's where research transcends the routine. It's where the unknown is explored. It's where the answers will come from the maximum **economic** yields that keep farmers in business and help them feed the world.

Researchers face an exciting challenge—**to catalog full yield potentials of soils. These potentials will always be a moving target because research** will make them so. Research seems to be readying itself to make a major move.

The following articles address some of these issues. We invite you to read them and let us know your thinking.

R. E. Wagner

PRESIDENT
POTASH & PHOSPHATE INSTITUTE

Stepping Up The Yield Ladder Increases Plant Food Needs...

EACH SOIL TYPE has the capacity to produce at certain levels. A successful farmer sets target yields at the optimum for each of his soil resources. He then applies the necessary production inputs to achieve this target yield.

M. L. Vitosh of Michigan State University put it this way: "Selecting the appropriate yield goal for each soil or field is very important. Remember the yield goal should challenge each grower and also be realistic."

Nutrient demands increase as yields increase. The chart shows nine important crops. Plant nutrients are controllable production inputs and should not limit achieving target yields.

J. R. Miller of the University of Maryland says, "A good soil fertility program is essential for top yields and maximum profits. As we aim for higher crop yields, we cannot overlook the importance of providing adequate plant food."

IT IS THE ERA of high-yield farming. Profit potential increases as yields increase. There are few other choices available to farmers to beat rising fixed costs.

Richard Rominger, a California farmer, says, "The ability to produce higher yields has kept farmers in business over the years."

Total production costs vary only 10 to 20 percent among top, average, or below average farmers. Farmers setting and achieving optimum target yields net more because, unlike costs, gross returns are in direct proportion to yield.

For example, 150 bushels of corn grosses 50 percent more than 100 bushels. High yields spread costs across more units of production, reduce cost per unit, and reduce the risk from fluctuating product prices.

Fertilizer has been credited with 30 to 50 percent of crop yield. It is a relatively small investment in the total production package.

To achieve target yields, adequate plant food must be available **from seeding to harvest.** Shortchanging plant nutrients lowers yield, quality, and profit potential.

Dr. John Marten, Staff Economist of the Farm Journal, says, "The sharp, profit-oriented farmer is going to use adequate fertilizer as one of his main cost-cutting tools. To cut costs and increase efficiency, concentrate on lowering cost per unit—not cost per acre. High yields are still the key to efficient production."

REGARDLESS OF region or crop, the high yield era in agriculture is here. Farmers need high yields to assure an adequate return on their investment. Mankind needs high yields to maintain food, feed, and fiber levels.

Our modern agricultural system requires huge supplies of plant nutrients, **in place and available.**

For example, the total U.S. corn and soybean crop removes over 2.3 million tons K_2O in the grain annually.

As more and more of our production is utilized in food, feed, fiber, or for export, more and more plant food is removed from our soils. U. S. farmers still remove more N, P_2O_5, or K_2O from soils than they return.

Know the plant food requirements of your crop and set the stage for optimum production.

"Regardless of region or crop, the high yield era is here. Farmers need high yields to assure adequate return on their investment."

PLANT FOOD UTILIZATION

(At various yield levels)

LB/A	CORN			SOYBEANS			WHEAT		
	125	200	250 bu	40	60	80 bu	40	80	100 bu
N	155	266	350	216	324	432	67	134	168
P_2O_5	58	114	150	43	64	85	27	54	68
K_2O	165	266	350	95	142	189	81	162	203
Mg	41	65	81	18	27	36	12	24	30
S	21	33	41	17	25	33	10	20	25
	COTTON (LINT)			**GRAIN SORGHUM**			**POTATOES**		
	750	1125	1500 lb	6,000	8,000	10,000 lb	200	350	500 cwt
N	105	143	180	188	250	313	108	188	269
P_2O_5	45	54	63	68	90	113	36	63	90
K_2O	65	96	126	150	200	250	218	382	546
Mg	17	26	35	33	44	55	20	35	50
S	15	23	30	29	38	47	9	15	22
	ALFALFA			**CLOVER-GRASS**			**CTL. BERMUDAGRASS**		
	4	8	10 tons	3	6	7 tons	6	10	12 tons
N	225	450	600	150	300	350	300	500	600
P_2O_5	40	80	120	45	90	105	84	140	168
K_2O	200	480	600	180	360	420	252	420	504
Mg	20	40	53	15	30	35	27	45	54
S	20	40	51	15	30	35	27	45	54

Figures are total nutrients taken up by the crop in harvested and unharvested portions.

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Good yields increase profit potential.
Set optimum yield goals for each soil type.
Fertilize so plant nutrients are not limiting.
Multiple cropping increases annual plant food use.

PLANT FOOD UTILIZATION BREAKDOWN

Crop	Yield	Pounds Per Acre				
		N	P_2O_5	K_2O	Mg	S
Corn grain	200 bu grain	150	87	57	18	15
	Stover	116	27	209	47	18
Cotton	1500 lb lint + seed	94	38	44	11	7
	Stalks, leaves, etc.	86	25	82	24	23
Wheat	80 bu grain	92	44	27	12	5
	Straw	42	10	135	12	15
Oats	100 bu grain	80	25	20	5	8
	Straw	35	15	125	15	11
Barley	100 bu grain	110	40	35	8	10
	Straw	40	15	115	9	10
Rapeseed	35 bu grain	66	32	16	—	12
	Straw	39	14	67	—	9
Rice	7000 lb grain	77	46	28	8	5
	Straw	35	14	120	6	7
Flax	20 bu grain	40	17	15	—	3
	Straw	14	5	30	—	3
Grain Sorghum	8000 lb grain	120	60	30	14	22
	Stover	130	30	170	30	16
Sugar Beets	30 ton roots	125	15	250	27	10
	tops	130	25	300	53	35
Sugarcane	100 ton stalks	160	90	335	40	54
	tops and trash	200	66	275	60	32
Tobacco (Flue)	3000 lb leaf	85	15	155	15	12
	Stalks, etc.	41	11	102	9	7
Tobacco (Burley)	4000 lb leaf	173	17	189	21	24
	Stalks, etc.	115	19	131	11	21
Soybeans	60 bu grain	240	48	84	17	12
	Leaves, stems, etc.	84	16	58	10	13
Peanuts	4000 lb nuts	140	22	35	5	10
	vines	100	17	150	20	11
Apples	250 cwt fruit	20	8	50	2	—
	Leaves, new wood, etc.	80	38	130	22	—
Peaches	600 bu fruit	35	10	65	12	—
	Leaves, new wood, etc.	60	30	55	10	—
Oranges	540 cwt fruit	90	23	162	10	7
	Leaves, stems, etc.	175	32	168	28	21
Tomatoes	600 cwt fruit	100	23	216	8	21
	vines	80	25	120	20	20
Potatoes	500 cwt	173	73	281	14	15
	vines	96	17	265	36	7
Sunflower	3500 lb seed	125	60	39	12	6
	Stover	51	10	89	30	10
Tall Fescue	3.5 tons	135	65	185	13	—

* Legumes can get most of their nitrogen from the air.
* Figures given are total amounts taken up by the crop in both the harvested and the above ground unharvested portions.

"Our modern agricultural system requires huge supplies of plant nutrients, in place and available. The total U. S. corn and soybean crop removes over 2.3 million tons K_2O in the grain annually."

Interactions At High Yield Levels . . .

R. E. WAGNER

"IN A HIGHLY DEVELOPED agriculture, large increases in yield potential will mostly come from interaction effects. Farmers must be ready to test all new advances that may raise yield potentials of their crops and be prepared to try combinations of two or more practices."

Dr. G. W. Cooke, Chief Scientific Officer of Britain's Agricultural Council, says this in his book, **Fertilizing for Maximum Yields.**

What are interactions in high yield agriculture? In a broad, simple sense, an interaction occurs when the response of one or a series of factors is modified by the effect of **one or more factors.**

Let's say phosphorus increases crop yield by 15 bushels and potassium independently gives a 15-bushel increase. If the two used **together** give **30 bushels,** the effect is **additive** and no interaction occurs.

Any divergence—plus or minus—from fully additive effects is interaction.

If together, they give **between 15 and 30 bushels,** there would be a partially additive effect, but a **negative** interaction is indicated. Although negative, it is an important interaction **because two or more factors produce a response greater than either alone.**

In the past, we have called this balanced fertility. It isn't really balanced until responses are **fully additive or even until positive interactions are achieved.**

Anything short of fully additive effects as a minimum indicates imbalance of the factors being considered or inadequacy or interference from unidentified factors.

We seek interactions with positive synergistic effects—where factors **together** produce an effect greater than the sum of their **independent** actions.

In the example just given (15 lb P and 15 lb K), **positive interaction** happens when the effect from P and K **used together totals more than 30 bushels.**

We can say $1 + 1 = 2$ when the action is independent. But $1 + 1 = 3$ or more when there is positive interaction. Such interactions can be substantial.

A "SYSTEM" WITH GOOD FIT of high yield components and positive interactions should be our goal.

Today's challenge to researchers is to identify interactions and characterize them. The day of single factor emphasis must give way to the systems approach—not just balanced nutrition, but the **total package.**

This includes hybrid or variety, insect and disease control, plant population, tillage practices, etc. Only a few can be considered in this limited space.

So, let's look at just a few examples of interactions of phosphorus with potassium. It's hard to find good examples for many crops, because such research at high yield levels is scarce. It's hard to cite results from lesser yields. It seems reasonable most interactions would be more significant at higher yield levels.

ADDITIVE EFFECTS stop short of maximum yields. Even when research is designed to study interactions, positive expression is often missed.

Table 1 shows how easy it is to stop research short of enough yield increases to produce a positive interaction. This is from an alfalfa study in New Jersey.

Table 1.

P_2O_5 lb/A	K_2O lb/A	Yield T/A	Increase over check
0	0	4.3	
150	0	5.8	1.5
0	300	6.7	2.4
150	300	7.2	2.9

The 7.2 tons is a respectable alfalfa yield. But it is not great enough in this study to conclude positive interaction has occurred. Both phosphorus and potassium gave a response. But when

the two were applied together, the response was less than the sum of the independent actions.

This should quickly alert the researcher to one fact—that the full yield potential had not been reached, though increase from check to the best treatment was substantial. What are the interfering factors?

POSITIVE P-K INTERACTIONS can stand out. **Table 2** shows the difference positive P-K interactions made in soybean yield and profit in Virginia.

Table 2.

P_2O_5 lb/A	K_2O lb/A	Yield bu/A	Profit $/A
0	0	24	−30.00
30	0	26	−26.40
0	120	37	21.60
30	120	45	54.00

In New York studies, members of a balanced P-K team interacted favorably to produce the best cabbage yields, shown in **Table 3.**

Table 3.

P_2O_5 lb/A	K_2O lb/A	Yield T/A
34	36	19.0
137	36	20.0
34	576	17.5
137	576	28.0

You will note K was so limiting at the 36 lb rate that response to P was small, but increased appreciably at the higher, more balanced rates. The 34 lbs of P_2O_5 with 576 lbs K_2O was inadequate and so far out of balance that it produced an unfavorable effect.

Table 4 shows the importance of a positive P-K interaction on corn in a Virginia study.

Table 4.

P_2O_5 lb/A	K_2O lb/A	Yield bu/A
0	0	42
120	0	45
0	120	117
120	120	142

Obviously, 120 lbs/A each of P_2O_5 and K_2O gave top yield. Again this study does not answer what the yield **could have been** with more P or K or both and what the best balance would be for maximum yield level.

Table 5 shows a positive P-K interaction on Coastal bermudagrass in Texas.

Table 5.

P_2O_5 lb/A	K_2O lb/A	Yield lb/A
0	0	5375
0	300	5294
100	0	6510
100	300	9146

Adding potash alone had no effect. P was more effective. But it took **both** to boost production substantially.

TO SUM UP, high yields are where the action is. Interactions are there, too.

The challenge to researchers is to learn more about interactions.

The challenge to farmers is to make better use of positive interactions, in order to maintain a reasonable profit capability in the expected high-cost years ahead.

More and more we can look for fertility balance and bank balance to be highly correlated. **The End**

"Today's challenge to researchers is to identify interactions and characterize them. The day of the single factor must give way to the systems approach — not just balanced nutrition, but the total package. This includes hybrid or variety, insect and disease control, plant population, tillage practices, etc."

Interactions For Top Corn Yields...

DAVID DIBB
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&

W. K. GRIFFITH
Great Falls, VA

U. S. FARMERS AVERAGED 101 bushels of corn per acre in 1978 setting a new high-yield record. But despite this record, the average corn farmer struggles to stay in business.

Economists estimate that the break-even corn yield ranges from 70 to 110 bushels per acre. Top growers have little problem because they recognize the profit advantages of high yields and adopt the newest technology to push yields even higher.

Farmers must keep production costs down and apply new technological advancements to produce these higher yields. Average yields are expected to reach 150 bushels by the year 2000. Top farmers are producing twice that average now—200 bushels per acre, and they will likely produce over 300 bushels by 2000.

HIGH YIELD FARMING is a dynamic system where many growth factors interact. Farmers can control some 50 growth factors in corn production. Cost, ease of modifying the system, and apparent yield effects vary with each growth factor.

Yet, all must be in place in a high yield environment. For example, a farmer now growing 100 bushels per acre cannot produce 200 bushels next year by changing fertilization rates alone.

SET THE STAGE FOR high yields with a challenging goal. Make a list of all management practices you use to produce current yields. Consider such practices as hybrid selection, planting date, harvest population, moisture availability and control, drainage, fertility levels, pesticides used, tillage, rotations, etc.

Compare these practices with those used by top researchers and farmers, on demonstration test strips and hybrid variety trials. This is the information you need to set meaningful yield goals.

Caution! You cannot make big jumps in yields initially. That takes time. Increasing soil fertility levels alone will take several years, and that is just part of the cumulative effects of good management.

IMPORTANT GROWTH FACTORS and their interactions. Hybrids must be carefully selected for top yields. University and seed company tests often show increased yields of 75 bushels per acre when the best hybrids are used. One seed company recently showed a 60-bushel difference with hybrids expected to produce in the 200-bushel range.

Hybrids interact with other production factors in this dynamic system. A potassium and hybrid research test showed a 60-bushel per acre increase when K_2O was teamed with an adapted hybrid **(Table 1).**

TABLE 1. Differential hybrid response to K

K_2O rate lbs/A	Corn yield - Bu./A	
	Hybrid A	Hybrid B
0	58	101
330	105	162

Some hybrids cannot tolerate crowding (dense population). Illinois research shows yield differences between two hybrids planted at a population of 24,000 plants per acre but with different spacing within the row **(Table 2).**

TABLE 2. Comparison of the effect of crowding in the row on yields of two hybrids

Hybrid	Yield—Bushels per Acre	
	Four stalks grouped every 34.8 inches	One stalk every 8.7 inches
A	169	195
B	190	209

A 200 bushel per acre yield could not have been reached in this experiment without the right combination of hybrid and spacing within the row.

AVERAGE CORN PLANTING DATES

FIGURE 1

Commercial and public corn breeders will continue to develop even better hybrids for the future.

RESEARCH RESULTS have clearly supported early planting as a recommended practice for several years. In fact, research in nine states shows an average yield loss of 1.3 bushels per acre for each day planting is delayed past the optimum planting date.

A Potash & Phosphate Institute survey indicates just how critical planting date for high yields can be. **Figure 1** shows the average planting date for several states for 200+ bushel corn. The survey (published in the Winter 1978/79 issue of **Better Crops)** shows that planting date is more critical as you move from south to north.

In the traditional Corn Belt, 51 planting date observations in Illinois showed that April 13 was the earliest planting date by farmers and May 17 the latest (34 days).

In Georgia, 35 observations were made revealing the earliest planting date as March 1 and the latest May 10, a period of 70 days.

Maximum corn production is believed to result when tasseling and silking occur about the time of maximum solar radiation in late June. Because the drop-off from this radiation peak is much more rapid as you move northward, earlier planting dates become more critical.

A farmer should know that timeliness of operation is important for maximizing profits regardless of location. A 1.3 bushel per acre per day can result in great losses to the farmer even with only 100 acres of corn **(Table 3).**

TABLE 3. Estimated losses on 100 acres of corn due to delayed planting past optimum planting date

Corn price $/Bu.	Losses $/100 acres per day
$2.00	$260
2.50	325
3.00	390

PLANT POPULATION should not limit yields. There are three population factors of prime importance—**total number of plants; row spacing;** and **spacing within the row.**

1. **Total number of plants.** The total number of plants per acre must be sufficient to maximize use of other available inputs. A Tennessee study showed that a positive interaction still occurred when plant population exceeded 22,000 plants per acre **(Table 4).**

TABLE 4. Effect of population on yield in Tennessee.

Population Plants/A	Yield Bu./A
18,000	203
22,000	217
26,000	231

The same effect at higher populations but at a lower yield level was shown in a Nebraska study **(Table 5).**

TABLE 5. Effect of population on yield in Nebraska.

Population Plants/A	Yield Bu./A
19,000	132
23,000	147
28,000	156
35,000	183

2. **Row spacing.** Generally, narrower rows have a greater yield potential. In the Tennessee study **(Table 4),** the 231-bushel yield at 26,000 plants per acre was attached in 24-inch rows. Other tests with the same population yielded 211 bushels on 30-inch rows and 200 bushels with 40-inch rows. Narrower rows yielded a 31-bushel advantage.

3. **Spacing within the row.** The spacing within and between the rows has a considerable effect on yields. In a Florida study, plant population at 29,000 but with different spacings showed higher yields with closer row spacing **(Table 6).** Stands were uniform.

TABLE 6. Yield effects of plant spacing in Florida

Row width inches	Plant spacing in row - inches	Yield Bu./A
18"	12"	204
24	9	180
36	6	178

Previous discussion has shown interactions between population and hybrids or other factors. Population and fertility interaction is important, too. **Table 7** shows the increased yields when population and fertilization are combined.

High yield goals require relatively high plant population or larger ears of corn. **Table 8** shows these requirements.

TABLE 8. Projected corn yields at different ear weights and plant population combinations.

Harvest population (ears harvested/A)	Average ear wt. - lbs @ 15.5% moisture .5	.6	.7	.8
	Yield - bu/A			
18,000	129	154	180	206
20,000	143	171	200	228
22,000	157	189	220	252
24,000	171	206	240	274
26,000	186	223	260	297
28,000	200	240	280	320
30,000	214	267	300	342
32,000	228	274	320	360

SOIL MOISTURE can be a limiting factor in top yield corn production. Short-term moisture stress that reduces yield can be minimized by the use of sound practices for tillage, population, timeliness, fertility and rotation. **Table 9** shows the relationship between fertility and moisture.

TABLE 9. Moisture efficiency is improved with higher fertility rates.

Fertility rate	Corn yield—Bu./A Poor seasonal moisture	Good seasonal moisture
High	111	205
Low	53	127

High fertility and good soil moisture were required to produce 200+ bushel yields. Yields were well below profit level in the dry year only at low fertility levels. Irrigation serves as an in-

TABLE 7. Interaction of population and fertility and its effect on corn yield.

Population	*Increased yields at indicated fertilizer rates — Bu/A 160 lb N	100 lb P_2O_5	200 lb K_2O
Low	48	2	21
High	67	22	39

*Yields at the higher population ranged from 180 to 200 bushels per acre (high yields). These data have been summarized from separate fertilizer and population tests—N work was done at Illinois; P & K work was done at Kentucky.

TABLE 10. Higher yields increase nutrient needs in corn

	Pounds taken up in above ground portion		
	125 bu/A	200 bu/A	250 bu/A
N	155	266	350
P_2O_5	58	114	150
K_2O	165	266	350
Mg	41	65	81
S	21	33	41

surance factor against moisture stress for the high-yield farmer.

HIGHER YIELDS demand higher fertility (Table 10). The farmer must utilize a fertility program that builds the soil productivity and maintains that level of fertility year after year. Research clearly shows that fertility accounts for 30 to 50 percent of the corn yield.

Yields decline lowering profit when the fertility program is not balanced. A 5-year Maryland study shows long-term effects on yield **(Table 11).**

The farmer who wanted to "just get by" without phosphorus or potassium would have lost over $16,000 on 100 acres of corn at $2.25 per bushel during the 5-year period. And that is after fertilizer costs are deducted.

So, you can see how important it is to properly manage the controllable factors for high yield corn production. With the yield goal approach, you can tailor applications of nitrogen to meet the requirements for your yield goal.

TABLE 11. Long-term effects of inadequate fertility on yield

Fertilizer rate per year	1974	1975	1976	1977	1978	5-yr average
lb/A			corn yield - bu/A			
160-160-160	151	149	159	153	134	149
160- 0 - 0	146	139	116	80	104	117
Difference	5	10	43	73	30	32

TABLE 12. Corn prices have only a slight effect on optimum N and K rates.

Corn	Optimum N rate 12¢ N	Optimum N rate 18¢ N	Optimum K_2O rate 9¢ K_2O-LM soil test
$/bu	$/bu		lb/A
3.00	192	184	145
2.50	189	180	135
2.00	182	174	125

TABLE 13. Summary of Fayette County, Ohio Corn Club Yields and Practices.

Factor	Low yield farmers	High yield farmers
Yield (bu/a)	110	165
Ave. planting date	5/12	5/5
Ave. population (000)	21.7	23.8
Ave. nitrogen rate (lb/A)	147	178
Ave. P_2O_5 rate (lb/A)	86	100
Ave. K_2O rate (lb/A)	94	145
Ave. fertilizer cost ($/A)	55.00	68.65
Ave. net profit ($/A)	99.00	195.00

TABLE 14. Summary of Pennsylvania 5-acre Corn Club yields and practices

Factor*	Yield range (bu/A) 0-80	81-100	101-120	121-140	141-160	161-180
Ave. plant pop. (in thousands)	16.9	17.8	18.5	20.0	20.3	21.2
Ave. nitrogen rate (lb/A)	134	149	156	169	176	180
Ave. P_2O_5 rate (lb/A):						
Soil test level	84	106	154	180	186	189
Applied	100	114	107	117	118	129
Ave. K_2O rate (lb/A):						
Soil test level	241	275	360	348	386	405
Applied	85	99	83	98	104	103
Returns to labor & management ($/A)	37.61	112.26	158.18	195.45	225.65	289.85

*Manure and previous crop credit included in applied N, P_2O_5 and K_2O figures. Soil test levels are those preceding the crop grown and before fertilizer was added.

Sound management assures efficient and economical use of fertilizer applications. As a rule of thumb, apply 1.2 to 1.3 pounds of nitrogen for each bushel you expect to harvest. Thus, a 200-bushel corn yield goal will need 250 pounds of nitrogen.

Even when corn prices are down, it is still economical to supply adequate nitrogen for high production levels. Illinois and Iowa tests show that the optimum rate of N drops only about 5 percent (from 184 to 174) with 18 cent per pound N when corn prices drop from $3.00 to $2.00 per bushel (a 33 percent drop, **Table 12).**

The same is generally true for other nutrients that provide a yield response.

PUTTING IT ALL TOGETHER. Hundreds of farmers in Ohio and Pennsylvania have participated in successful corn clubs for several years. Ray Lockman, Agrico Chemical Company, and Joe McGahen, Pennsylvania State University, have provided summaries from the two clubs respectively. Note how the farmers are putting many of these production inputs to work to achieve a more profitable enterprise **(Tables 13** and **14).**

You can improve your corn yields, too. It will take the application of sound management and production practices.

The End.

Interactions For Top Soybean Yields . . .

WERNER L. NELSON
West Lafayette, Indiana

WILL THE AVERAGE soybean yield be 50 bu/A 25 years from now? Will the best farmers, who generally double the average, be reaching 100 bu/A then?

Why not, if many farmers have already reached 60 bushels, some 70 bushels? Why not, if some researchers have already hit 80 to 90+ bushels?

ESSENTIAL INTERACTIONS to increase yield potential and increase response from soil fertility and fertilizer include these:

Narrower Rows. Drilling in 7 to 10-inch rows will increase soybean yields 5 to 10 bu/A almost immediately. This applies to most soybean growing areas, except perhaps some of the South.

In Tennessee, 36-inch rows produced 46 bu, 18-inch rows 57 bu/A, from 3 varieties over a 4-year average.

In Iowa, 30-inch rows required about 58 days for complete canopy, 10-inch rows only 36 days.

Weed Control. A key to making narrow rows work is weed control. More and more pieces of the weed control puzzle are falling into place. There is now very good control over annual grass weeds and more answers on broadleaf weeds.

Earlier Planting. A longtime Ohio study showed planting date greatly influences yield. In a 4-year average, yields from planting May 10 were 49.3 bu; May 25, 42.9 bu; and June 10, 34.3 bu.

While response to early planting may not be as great in other states, most have shown the advantage for earlier planting, except parts of the South.

Variety and planting date may interact. In Ohio, Williams variety was 3 bu better than Amsoy 71 at the early date, but no different at two later dates.

The key point is clear: It doesn't cost anything to plant earlier.

Rotation With Other Highly Fertilized Crops. In many states, corn yields are increased 15 to 30 bu/A when corn follows soybeans rather than continuous corn. Soybeans do the same—3 to 5 bu more when following corn rather than continuous soybeans.

Superior Variety. Varieties often differ 15 bushels in variety trials. Farmers should check results and try top varieties on their fields.

Adequate Lime. Soil acidity has increased from increased N use on corn over the years. This has caught many farmers unaware. Maintain a 6.0 pH or higher through soil tests every 2 or 3 years. Low pH is a frequent culprit agronomists identify on trouble shooting calls.

WHAT ABOUT SOIL FERTILITY AND FERTILIZERS? We often hear

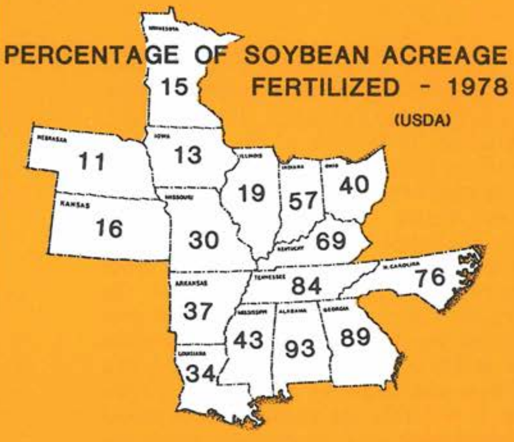


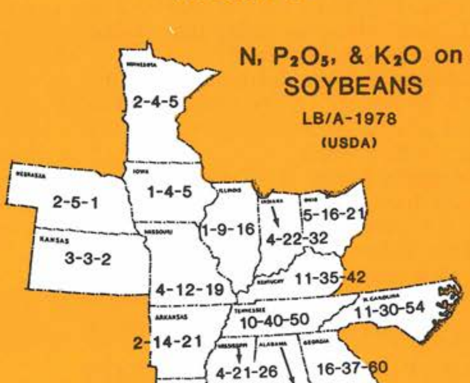
FIGURE 1

soybeans respond better to soil fertility than to fertilizer. Why is the soybean plant a bit unique?

The roots essentially stop growing after podding starts and N fixation slows. Also, the plant takes up about 50% of its P and 40% of its K in the last 40 days of the growing period. **So, the need for a high P-K soil is very real.**

Fertilizing the Rotation. Growing soybeans in rotation with another highly fertilized crop such as corn has been emphasized. But the corn usually receives too little to take care of the soybeans, also. The reason becomes clear when you look at the nutrients just in the grain:

FIGURE 2



	Amounts just in grain, lb/A				
	N	P_2O_5	K_2O	Mg	S
Corn 200 bu	150	87	57	18	15
Soybeans 60 bu	240	48	84	17	12
Total	390	135	141	35	27

It can be done IF enough is put on the other crop. But the surest way is to **fertilize soybeans directly.**

What About Present Fertilization? The percentage of soybean acreage fertilized and the average N, P_2O_5, and K_2O used is quite low in many states compared to some in the Southeast, shown in Figures 1 and 2.

What About Amounts To Apply? Soil tests are not calibrated for 60 bu or above, because very few fertility experiments have been conducted for such yields.

But, based on what is known, agricultural advisors can do quite well making suggestions that produce higher, more profitable yields.

If we are going to apply top management for soybeans as for corn, **the soils should test high.** Soil test values needed for high yields are still under study.

Preliminary work by J. W. Johnson in Ohio indicates K soil test should be about 450.

As the K soil test was increased from 272 to 448 by previous fertilization, soybean yields increased from 50 to 70 bu/A in an Illinois trial.

If a soil is medium or less in a specific element, buildup PLUS maintenance should be added over several years to bring the soil to high. Amounts needed to increase P and K one lb on the soil test vary greatly among soils and states. Illinois uses 9 lb P_2O_5 and 4 lb K_2O.

Check P and K soil tests every three or four years to make sure the test levels are building to high. Once there, they must be maintained at that level.

What About Placement? Broadcast is the simplest way to put on high amounts needed for high yields. But row applications, especially on low fertility soils and for such a nutrient as Mn, are often used **in addition to broadcast.**

Dr. L. D. Bailey got good response to placement on a low P soil with a pH of 7.5 in Manitoba, shown in Table 1.

What About Interactions? Soil pH influences response to such nutrients as Mo and P.

Table 2 shows how Tennessee got response to Mo at pH 5.7 and 6.0, but none at 6.2 and 6.4, Louisiana got response to P at pH 5.0 and 5.6, but none at pH 6.4 and 7.0, on a low P soil.

Tables 3 and 4 show how much K affects disease and yield. Either Benlate (a fungicide) or K reduced disease and increased yield, but TOGETHER their effect was even more striking, in Table 3.

Table 1. Effect of rate and placement of P_2O_5 on soybean yields (low P, pH 7.5).

P_2O_5	Broadcast	Drilled with seed	Side-band below seed	Drilled below seed
lb/A		bu/A		
0	35	35	35	35
26.8	35	57	57	58
53.5	39	13	59	63
107.0	40	5	61	64

Another positive effect is on germination and size of seed. Potassium and nematicide tend to work as a team, shown in Table 4.

Table 5 shows how P and K interact positively to increase number and weight of nodules, as well as increase yields and profits. Proper inoculation, pH, P and K levels can produce high yields. Under such conditions, N does not usually give an economic response.

The pH level affects Mn and Fe response. Wisconsin increased yields from 56 to 65 bu/A with row or foliar applied Mn.

Iron chlorosis on high pH soils under stress has been corrected about 80% of the time with Sequestrene 138 iron over the row.

Table 2. Soil pH and response of soybeans to Mo or P interact.

pH	No Mo	Mo	pH	No P	60 lb P_2O_5
	bu/A			bu/A	
5.7	34	43	5.0	21	24
6.0	37	40	5.6	27	32
6.2	40	42	6.4	34	35
6.4	42	41	7.0	40	40
	TN				low P soil — LA

Table 3. Interaction of K and Benlate on soybeans (TN).

	Disease rating pods, 10-8-77	Seed gm/100	Seed % Germ.	Yield bu/A
0	8.6	11.8	84	35
Benlate	5.0	12.6	90	41
K	7.2	12.3	95	38
K + Benlate	3.8	13.0	96	45

Table 4. Potassium and nematicide interact to help overcome nematodes (MO).

Variety	K	Yield increase — bu/A Nematicide	Yield increase — bu/A K+ Nematicide
Dare, SCN susceptible	6	0	13
Forrest, SCN Race 3 resistant	10	5	18
D72-C57, Race 3 and 4 resistant	14	4	14

Table 5. P and K interact to increase nodules, grain yield, protein yield and profits (VA).

P_2O_5	K_2O	Yield (2 yr avg.)	Nodules per plant	Nodule green wt.	Seed protein prod. (2 yr avg.)	Net return
lb/A/yr		bu/A	no.	g/cu ft soil	lb/A	$/A
0	0	25	35	5	640	—$81
120	0	26	59	10	660	— 97
0	120	47	79	14	1100	9
120	120	55	114	26	1290	61

Just PK fertilizer in a band beside the seed helps in marginal Mn deficient situations because of the acidifying effect of the fertilizer.

The Long Term Approach is necessary to reach 60 bushels or more. It may take 2 or 3 years to get the act together, to build fertility to adequate levels.

Some farmers may want to shoot for 70 to 100 bu/A range. Practices must interact to reach such yields. Select a small "laboratory" field to use the best practices for 5 years.

From this "lab field" you get yield potential, and best practices for maximum economic yield on your farm. **The End**

Shooting For Top Forage Yields...

JOHN E. BAYLOR
Pennsylvania State University

HIGH FORAGE YIELDS don't just happen. They are the result of your putting together all of the most advanced production know-how. And that is just as important for perennial forage crops as it is for corn or soybeans.

The steps to high yields are about the same regardless of crop or location. Consider these steps to high forage yields.

1. **Fit crop to the soil.** Soils vary widely in their acidity, fertility, topography and drainage characteristics. For most soils, you can improve the conditions. Proper liming will reduce acidity, and proper fertilization can supply ample plant food for the crop.

You must know your forage species and your soils to get those top yields. Some forages that produce high yields on a certain soil will not grow well on other soils. You must fit them properly.

2. **Choose quality seed of high performance varieties.** Variety makes little difference if you are shooting for average yields. But, shooting for top yields means carefully selecting your varieties. You could gain a ton or more of hay per acre per year by selecting high yielding, disease resistant varieties.

USDA has estimated that farmers lose 24 percent of their alfalfa crop for hay to diseases. Diseases reportedly take 35 percent of the red clover grown for hay. You must use resistant varieties and sound cultural practices to keep disease under control.

3. **Plant for adequate stands.** You need about 500,000 established forage plants per acre to have a productive stand. You can get that with improved seeding techniques. Yields of 3-4 tons of top quality alfalfa hay per acre are possible the seeding year. You can also improve existing stands by using new techniques of direct seeding (no-till seeding) of productive species. Recently cleared insecticides are now available to control soil borne or seedling insect pests. And herbicides are available to control grass and broadleaf weeds.

4. **Lime and fertilize for high yields.** It is said that the 100 most learned scientists in the world would include liming of the soil in a top ten priority list of things man must do to continue life on earth. Liming is especially important to high alfalfa yields.

Fertilizer is definitely one of the most important factors needed to achieve high yields. Here is how adequate fertilization based on soil tests can give forage crops a big boost:

Adequate fertilization (1) helps seedings get a fast start, (2) helps plants survive winter cold, (3) permits earlier, more frequent cutting for top quality and (4) helps plants recover from insect attacks.

But, the key purpose for fertilizing legumes and grasses (forages) is **to produce high yields of top quality forage.** That means more profitable feed.

5. Control insects. You can lose lots of hay from insect damage on forages, especially on legumes. But, you can control those insects by using sound cultural practices such as timely cutting combined with full use of biological control agents.

You can improve alfalfa hay yields 20 to 30 percent by controlling damage from the leafhopper alone. A sound insect control program can improve feed quality and extend the plant life, too.

6. Manage for top yields and quality. Management for top yields and stand maintenance must consider certain important factors. These include **(1) the location and amount of food reserves in the plant; (2) cold, heat and drought tolerance; (3) location of the growing point; and (4) the amount of leaf area.**

Take a closer look at food reserves. Perennial forages store energy as **total nonstructural carbohydrates (TNC).** These food reserves help the plant to live over winter by developing tolerance to the cold, and they initiate plant growth in the spring and after each cutting. Photosynthesis helps the plant to elaborate the TNC. That is as essential as the nitrogen, phosphorus and potassium the plant must have to survive and grow.

Food reserves are stored in different parts of the plant in different species. In alfalfa and birdsfoot trefoil, the reserves are stored in the roots and crowns. Reserves are stored in leaf sheaths and stem base in tall fescue and orchardgrass. Timothy grass stores reserves in its swelled basal stem internodes called haplocorms. TNC are stored in the underground creeping stems (rhizomes) in reed canarygrass and smooth bromegrass. They are stored in both the underground rhizomes and the above ground stolons in bermudagrass.

You must utilize proper cutting management to keep yields and quality high. The quality of perennial forages depends heavily on the stage of maturity at harvest. But, cutting too early or too often can reduce yields. Alfalfa research at several experiment stations has shown that increasing the number of harvests (from 2 to 3 or 3 to 4) can boost yields 10 to 30 percent when fertility and other factors are in balance.

How can you step up the yield ladder? Simply put the pieces together properly. A brief review of Pennsylvania's 10 top alfalfa growers can serve as an example.

These top 10 growers averaged 7.3 tons of hay equivalent per acre in 1978, and without supplemental irrigation. That's nearly 3,000 lbs of crude protein and over 8,100 lbs of TDN per acre. They used a total of 6 known high yielding varieties. Four of the top yields came from fields established in 1977, and another five from stands established in 1976. One field established in 1975 yielded 6.8 tons in 1977 and 6.9 tons in 1978.

All growers planted on well-drained soils well suited for alfalfa. Nine of the 10 had fields with soils derived from limestone. Lime and fertility programs for establishment and maintenance were based on soil tests. High applications of manure in the rotation before alfalfa produced generally high levels of potassium.

Each of the growers made four cuttings in 1978. Three of them used all of their crops for silage. Eight of them stored one or more cuts in the silo.

First cuttings were made in late May to early June at the pre-bud to bud growth stage. The average intervals between cuttings from first to last harvest were 36, 39, and 45 days respectively.

All 10 growers sprayed for leafhoppers and other insects at least once during the year. Seven growers sprayed two or more times. Insect control kept yields high.

In Summary. You can get top forage yields by putting production know-how to work. And all the steps to high yields are interrelated. You might say they interact—one factor affects the response of another. **The End**

"It is said the 100 most learned scientists in the world would include liming of the soil in a top ten priority list of things man must do to continue life on earth."

RESEARCH BRIEFS

Breeding Maize In A High Yield Environment...

R. J. LAMBERT
University of Illinois

MAIZE BREEDERS DEVELOP inbreds under contemporary agronomic practices that can suddenly change to narrower rows, higher plant populations, etc.

But they have not before tried to produce an ideal production environment for selecting superior genotypes.

One object of this program has been to eliminate some of the year-to-year variation and the problem it presents by managing for the production of consistently high yields. In such a high yield environment, plant selection should be more effective. The results, hopefully, will be hybrids that will respond to higher yield management.

We began our efforts to reduce environmental effects in plots at Urbana, Illinois, in 1974. A corn and soybean rotation was established, one year in corn, one year in soybeans, etc.

Our plots are planted mid-to-late April in 20″ row spacing with a final population of 32,300 ppa. Pre-emergence herbicides (Sutan + Atrazine) were applied and plots were not cultivated. Supplemental irrigation was applied as needed.

CURRENT FERTILIZATION rates are 300 lb P_2O_5/A and 300 lb K_2O/A annually. Through the 1978 season, the plots received 200 lb N/A. In 1979 the N rate was increased to 400 lb N/A, because the 200 lb N was thought potentially limiting for the hybrid grain yields being obtained.

Soil fertility level has increased greatly since 1974. The P_1 test has been increased from 120 to 204 lb/A and K test from about 400 to 600 lb/A. And the soil pH is 6.2.

Table 1 shows grain yields for several hybrids. **The data indicate consistently high grain yields are possible under high yield management.** Many of the hybrids averaged over 200 bu/A.

There has also been a gradual increase in the average yield of all plots tested since 1974. Several synthetic varieties and their hybrids have also been evaluated for adaptability to a high yield environment.

BASED ON THE DATA in **Table**

Table 1. Grain yields (bu/A) of several maize hybrids grown in a high-yield environment. Urbana, Illinois, 1974-78.

Pedigree	1974	1975	1976	1977	1978	Mean
C123 x B14	163	193	225	172	—	188
C123 x R177	167	183	199	—	—	183
Mo17 x B73	170	225	245	176	190	201
Mo17 x N28	186	206	245	153	—	198
FR4A x Mo17	191	210	216	—	—	206
B73 x Oh545	—	234	272	195	244	236
B73 xVa26	—	234	245	205	223	227
C123 x B14 lg2	207	181	236	—	—	208
C123 x R177 lg2	181	226	230	—	—	212
C123 x Oh43 lg 2	179	206	219	—	180	196
(B14 x Oh43) x C123 lg2	205	238	222	—	250	229

Table 2. Grain yield (bu/A), barren and lodged plants of a diallel set involving 8 synthetic maize varieties (1976-77).

Parent	Bu/A		% Barren Plants		% Lodged Plants	
	Parent Mean	Hybrid Mean †	Parent Mean	Hybrid Mean	Parent Mean	Hybrid Mean
RDAY	121	142	11	11	17	21
RDA	115	142	19	10	14	19
RDITE-CBS	119	145	10	8	25	27
BS16	126	141	9	9	23	24
BS3	148	145	14	11	17	23
RSSSC	**141**	**157**	**6**	**8**	**11**	**20**
BS10	**156**	**159**	**2**	**7**	**31**	**27**
Iowa Elite Line Syn.	132	138	13	12	23	24

† Mean of 7 synthetic variety hybrids involving the specific synthetic as one parent.

Table 3. Mean value of 200 testcross hybrids (RSSSC x B79) and 40 selected testcross grown in a high yield environment (1978).

	Mean Yield bu/A	Grain Moisture	% Lodged Plants
Testcrosses (200)	180	24.6	17.0
40 Selected	213	24.7	14.2

2, we have selected RSSSC and BS10 as the two synthetics with the best combining ability for grain yield and barren plants. We initiated a breeding program in 1978 to improve the performance of these two synthetic varieties in a high-yield environment.

Table 3 shows the results are very promising for RSSSC, based on 1978 data.

The increased grain yield of the 40 highest yielding testcrosses over the mean of the 200 was 18%, with no change in grain moisture and slight improvement in lodged plants.

Continued cycling of these two synthetic varieties should lead to better adaptability to high yield environment.

The 300/100 Challenge . . .

HAROLD REETZ, JR., KIM POLIZOTTO, DAVID B. MENGEL
Purdue University

AT LEAST 10 U. S. FARMERS have challenged researchers with corn yields above 300 bushels per acre in recent years.

It seems reasonable that crop production specialists at Corn Belt experiment stations should be able to develop a management package that could attain such yields. Yet, to date none have been reported.

About 20 Purdue agronomists met last October to establish a high management-high yield project. The production was set at 300 bushels for corn and 100 bushels for soybeans.

Being the three youngest members of the Purdue crop production team, we took on the challenge of putting the plan into action.

A 20-acre area was set aside at the Purdue Agronomy Farm for a long-term high management-high yield demonstration. Three management systems were outlined:

Continuous corn—5 acres. Continuous soybeans—5 acres. Corn/soybean

rotation—10 acres.

Initial efforts to increase soil fertility were begun, with total fertilizer **for corn at 450-350-600** and **for soybeans at 0-350-600.**

Throughout the growing season, plant growth and development measurements and plant tissue samples are being taken to monitor nutrient uptake and growth rates for the crops.

Detailed physical and nutritional characterization of the soil is also underway to provide benchmark information.

The complete management plan is being implemented gradually to be in full operation for the 1980 growing season. In 1979, a proven high production hybrid was planted at 37,700 plants per acre.

Other hybrids are being tested in nearby plots under high management and high population. Amsoy 71 was solid seeded.

Our intent is to maintain a high management system and monitor progress above and below ground in as many ways as possible over several years.

We are trying to meet the 300/100 challenge. It won't happen overnight. But it will never be met unless we try.

High Yield Soybean Research In Manitoba...

SOYBEANS MAY BE an attractive crop for Manitoba in the 1980's, thanks to work by the staff of the Brandon Research Station.

Development of the early maturing variety, Maple Presto, combined with the following crop management steps have produced encouraging results:

1. **Use of pre-plant, soil-incorporated herbicide.**
2. **Use of post-emergence herbicide to control weeds not destroyed by step 1.**
3. **Narrow row spacing, usually 7", or solid seeding instead of the traditional wider row crop spacings.**
4. **Planting of determinant type early soybeans (95 to 100-day maturity).**
5. **Application of suitable legume inoculant to seed.**
6. **Use of a floating cutterbar attached to either a swather or combine to facilitate harvesting.**

Dr. L. D. Bailey of Agriculture Canada, Research Station at Brandon, Manitoba, conducted a series of experiments during 1974-77 to determine soybean needs for P, K, S, Cu, and Mo on six soil types in western Manitoba.

In his 1977 trials, his maximum yields exceeded 60 bu/A. Dr. Bailey used the following management:

Soil Type: Assiniboine Clay (unresponsive to dressings of K, S, Cu, and Mo).

Variety: Portage (earliest maturing variety licensed at the time).

Maximum Yield: 63.5 bu/A, with check yield of 34.9 bu/A.

Fertilizer: 120 lbs P_2O_5/A placed below the seed.

Seeding: 7" rows.

Weed Control: Pre-plant incorporation of Treflan and post-emergence application of Basafram.

Seed Treatment: Inoculated with Nitragin Corporation's inoculum.

Average Planting Date: May 20.

Dr. Bailey showed some of the soils needed supplemental K and S for satisfactory yields. All six soils needed P additions for high production. Seed-placed P was beneficial at rates up to 27 lb P_2O_5/A, while higher rates depressed yields.

Germination damage, causing reduced emergence and lower plant populations, was responsible for these yield declines.

The most effective way to place P for soybeans was below the seed during planting. Differences between 36 and 108 lb P_2O_5/A were not large. Sideband placement was only slightly less effective than below-seed treatments.

Proper P placement is a key step toward maximum soybean yields in Manitoba conditions, Dr. Bailey's results clearlv show.

High Yield Corn Production Research...

FRED RHOADS and ROBERT STANLEY
University of Florida

HOW CAN FARMERS PRODUCE consistently high, more profitable corn yields? More specifically, how can they produce 300 bushels of corn per acre?

Florida began an irrigated corn research project in 1977 to develop a package of dependable production practices to achieve these high yields more profitably. The project included five fertility treatments applied to three different plant populations (12, 24 and 36 thousand plants per acre).

Nitrogen (N), phosphate (P_2O_5) and potash (K_2O) were applied as a 3-2-3 ratio fertilizer at rates of 0.5, 1.0, 2.0, 3.0 and 5.0 grams per plant.

The corn yielded 231 bushels of grain per acre with 36,000 plants **(Table 1)** receiving 240 pounds of N, 160 pounds of P_2O_5 and 240 pounds of K_2O per acre. Individual plots yielded over 250 bushels. The low population corn yielded more ears per plant while higher population corn produced larger ears.

Table 2 presents nutrient uptake by corn at maximum yield levels.

Table 1. Influence of corn yield by plant population and fertilizer (using Pioneer 3369-A corn)

Plant Population	Yield of grain—bu./A at rates of Fertilizer applied in grams/plant (3-2-3 ratio)				
	0.5	1.0	2.0	3.0	5.0
	- - - - - - - - Yield - - - - - - - -				
12,000	103	118	138	155	159
24,000	119	150	178	202	196
36,000	125	164	210	231	231

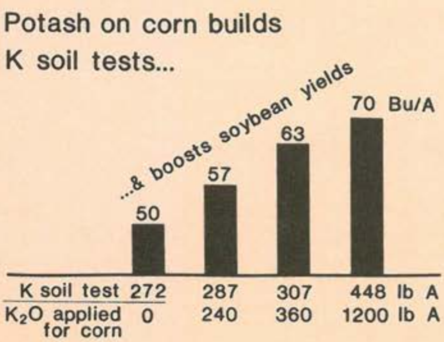
Table 2. The influence of plant population on nutrient uptake for maximum yields

Plant Population	Nutrient uptake in lbs/A N	P_2O_5	K_2O
12,000	122	62	178
24,000	180	85	266
36,000	214	92	305

These data suggest that fertilizer rates should increase with plant population on irrigated corn for maximum efficiency of nutrients.

Buildup Potassium In Soil Boosts Soybean Yields...

L. F. WELCH
University of Illinois



RATES OF POTASH (K_2O) were applied to corn over a 4-year period on a soil testing 280 in K.

Total amounts of K_2O applied in the 4-year period for various treatments is shown here. Also note how the soil test was increased. Adequate N & P were applied. Corn's response to potash averaged 25 bu per year.

The fifth year soybeans were grown with no additional potash. Yields were increased from 50 bu on the no potash plot to 70 bu at the highest K rate. Note how much unharvested K was still left in the soil.

Improving Corn Yields On Group 4 Soils...

GEORGE D. JONES
Virginia Polytechnic Institute and State University

TWO MAJOR FACTORS hold back top yields consistently in the Piedmont Region—inadequate rain and a low percentage of Group 1 and Group 2 (high productivity) soils.

Tatum silt loam (Group 4) is an important Piedmont soil used in this study.*

PEANUT HULLS were applied to plots and then plowed under. This variable was also studied with and without fertilizer.

The first year of the study (1975) had very good moisture growing conditions, 32 inches of rain during the growing season. But 1976 was relatively dry with several severe stress periods. Yields are shown in **Table 1.**

Peanut hulls increased corn yields—very significantly on the no fertilizer plots. Very high yields were produced on a Group 4 Tatum soil—266 bu/A—when the peanut hulls were teamed with adequate moisture and good fertilizer rates.

Chemical analysis of the corn at silage stage showed potassium content of the total plant was increased significantly by peanut hull applications and by applied fertilizer, shown in **Table 2.**

The potassium content correlated closely with increased yields. This indicates in a better moisture regime the plant was able to take up this nutrient.

A similar, though less dramatic, increase was found for njtrogen uptake.

Table 1.

	1975		1976	
	No fertilizer	Fertilizer (100-40-80)	No fertilizer	Fertilizer (100-40-80)
	corn yields bu/a		corn yields bu/a	
No hulls	126	205	53	111
Hulls	231	266	136	157

Table 2. Chemical Composition of Corn Silage as Affected by Peanut Hulls and Fertilizer.

	% N		% P		% K		% Mg	
	No fert.	Fert.	No fert.	Fert.	No fert.	Fert.	No fert.	Fert.
No hulls	.76	.78	.04	.05	.99	1.32	.43	.35
Hulls	.85	.91	.04	.04	1.77	2.04	.34	.29

* More details of this study are available in Agronomy Journal 70: 784-86, 1978.

Maximum Yield Test For Soybeans...

DR. DICK COOPER of the Ohio Agricultural Research Development Center in Wooster has set up two one-acre fields to evaluate the maximum yield potential of semidwarf soybean varieties and experimental lines in a long-term corn-soybean rotation.

The soil is a well drained Wooster silt loam with previous high corn and soybean yields. In spring, 1978, soil tests were as follows:

	pH	P	K
Field A	7.0	107	305
Field B	7.1	110	257

Starting in 1978, the following annual applications of spring, plow-down fertilizer were begun:

	Soybeans	Corn
Lb N/A	200	400
Lb P_2O_5/A	180	180
Lb K_2O/A	360	360

Irrigation, a solid set system, minimizes moisture stress. The target moisture runs 2 inches per week, irrigation plus rainfall.

Early planting (first week of May) and solid seeding are used to maximize soybean yields. In addition to chemical control, hand weeding is used where necessary to give weed-free plots.

In 1977, before the long-term rotation was established, field A was fertilized with 198 lb N/A, 115 lb P_2O_5/A, and 225 lb K_2O/A in spring and plowed down. Abundant rain made irrigation unnecessary.

Yields from the top two semidwarf lines and the check varieties are shown in **Table 1** for 1977 and **Table 2** for 1978.

The lower 1978 yields came partly from thinner stands and delayed early irrigation. This brought shorter plants and less lodging than 1977. The results suggest early moisture is vital for maximum yield of semidwarf varieties.

The data in **Tables 1 and 2** show a 60 bu/A barrier in 30-inch rows. Only in the 7-inch rows was the 70 and 80 bu/A barrier broken.

The importance of early planting and adequate moisture is well documented. High soil test levels for P and K are important to high yield, it is generally agreed. Less certain is the role of N fertilization.

But preliminary results suggest nitrogen may limit soybean yields at very high yields. Until this is documented, the 200 lb N/A will be used in the maximum yield field as insurance against a possible nitrogen limitation.

Table 1. Semidwarf soybean lines in maximum yield test, Wooster, Ohio, 1977.

Entry	Yield 30" (bu/A)	Yield 7" (bu/A)	Maturity date	Lodging score[1]	Height inches
Beeson	46.6	64.5	9-22	5.0	42
Williams	57.1	72.1	10-3	3.0	41
Elf	53.7	71.2	10-3	2.5	24
Gnome	55.0	74.6	9-24	1.5	21
3384	64.4	79.6	9-28	1.5	26
3385	64.0	85.2	9-28	1.5	28

[1] Lodging score is 1 erect to 5 prostrate.

Table 2. Semidwarf soybean lines in maximum yield test, Wooster, Ohio, 1978.

Entry	Yield 30" (bu/A)	Yield 7" (bu/A)	Maturity date	Lodging score[1]	Height Inches
Beeson	57.0	53.3*	9-23	2.5	34
Williams	59.7	62.7	9-30	1.8	38
Elf	58.3	60.9	10-2	1.2	24
Gnome	61.9	67.4	9-26	1.0	24
3384	68.3	73.3	9-28	1.2	26
3385	59.8	76.8	9-28	1.0	21

* Poor stand.

10 Tons Hay: Yield Goal For Michigan...

M. B. TESAR
Michigan State University

ALFALFA PRODUCED over 9.1 tons hay per year for a 5-year period in Michigan when cut four times (June 1-October 15) and fertilized with 0+98+294 each year on an excellently drained Conover loam soil.

Weevils and leafhoppers were controlled by spraying.

What inputs are needed to increase yield without irrigation to over 10 tons hay (12% H_2O) per acre for a 2 to 3-year period?

An experiment was started in 1978 beside the trials above on a similar soil to learn some answers to these questions:

1. Is the 294 lb K_2O and 98 lb P_2O_5 annually adequate for a 10-ton yield? Or will it take 480 lb of K_2O and 123 lb P_2O_5 for 10 tons, according to uptake data in an 8.2-ton yield in 1975?

2. Is splitting K between fall and spring necessary at high K rates?

3. Should K_2SO_4 be used instead of KCl at high K rates to reduce chlorine toxicity?

4. Will irrigation increase yields?

5. Will sulfur and foliar NPK increase yields?

There are 16 treatments involving P_2O_5 at 100 or 200 lb and K_2O at 0, 100, 200, 300, 400, 800, 1200, and 1600 lb/A in the experiment.

P is applied in spring. K is applied in the fall or spring or in the fall, spring, and after each cutting in the high application treatments.

Other treatments are irrigation and addition of sulfur, foliar NPK, or K_2SO_4 instead of KCl at a K_2O rate of 1200 lb/A.

The 1978 results produced a maximum yield of 9.84 tons hay (12% moisture) without irrigation—at a level of 200 lb P_2O_5 and 1200 lb K_2O. Yields of over 9 tons were reached with 100 lb P_2O_5 and 400 lb K_2O. More detailed results will be available in the future.

Hybrid Forage Bermudagrasses...

BERMUDAGRASSES are known as high yielders. Coastal is now being joined by new, improved hybrid bermudagrasses with high yield capacity.

Many states report high yields—from fields and research plots that are highly fertilized, well managed, and harvested several times a year (5 or more harvests).

The areas are managed and fertilized to produce high yields, to reduce disease, and to improve winter survival, so the bermudagrass is always growing at high-yielding growth rates.

Louisiana researchers managed Coastal bermudagrass to produce 9.66 tons dry forage per acre containing 6.29 tons digestible dry matter.

Many high yields have been reported with improved bermudagrasses. This table lists just a few:

State	Bermudagrass	(A) Dry matter	(B) Forage at 12% moisture
		tons per acre	
LA	OSU 66	10.69	11.98
LA	Tifton 44	9.93	11.12
LA	Tifton 44	11.71	13.11
LA	Coastal	10.75	12.04
LA	Coastal	11.75	13.16
TX	Coastal	9.28	10.39
AL	Coastal	10.31	11.55
AL	Coastal	10.45	11.70
AL	Coastal	11.01	12.33
AL	Coastal	9.70	10.86
GA	Coastal		10.3
GA	Coastal		10.2

High Yield Alfalfa Study In Oklahoma . . .

BILLY B. TUCKER
Oklahoma State University

ALFALFA IS an important cash crop in Oklahoma, when grown for hay.

More than 500,000 acres were harvested here in 1978. But yields are not as high as they could be—just slightly above 3 tons/A in the 3-year average from 1976 through 1978.

Moisture stress is the main yield-limiting factor, though inadequate nutrition and poor disease and insect control also limit potential yields. Only about 15% of Oklahoma's alfalfa is irrigated.

To learn what potential alfalfa production would be under adequate moisture, Oklahoma State University conducted a 3-year irrigation study at the Southwestern Substation at Tipton.

Yields ranged from a good 6.38 to 7.68 T/A the year of establishment, 1969, and continued to increase. The 1970 yields ranged from 9.07 to 10.69 T/A. And 1971 was even higher, shown in the table:

Alfalfa Hay Yields Produced at the O.S.U. Southwestern Substation, Tipton, OK, 1971

N-P_2O_5-K_2O Treatments, Lb/A	Hay Yield T/A*
0-0-0	11.93
0-40-240	14.09
Average of all other treatments**	13.38

* Calculated on the basis of 13.6% moisture.
** Treatment ranges: N 0-40 lb/A; P_2O_5 40-320 lb/A; K_2O 60-480 lb/A

Variables in the study were N, P_2O_5, K_2O, S, and micronutrients. There was no response to N, S, or micronutrients.

Responses to P_2O_5 and K_2O varied in various combinations. The most consistent came from the 0-40-240 treatment.

Sulfur was applied as potassium-magnesium sulfate. The micronutrients were applied as a mix.

Irrigated Alfalfa: Top Management Produces Top Yields . . .

IRRIGATED ALFALFA in the Great Plains has proven to be a highly profitable crop, IF top yields are achieved. And proper fertilization is highly important to top yields, researchers point out.

Jim Ball and George TenEyck, agronomist and ag engineer at the Sandyland Experiment Field of Kansas State University, report yields of 11.6 tons per acre in 1978. The study involved three cutting stages, two varieties, and several fertilization rates.

Initial soil test values for the Sandyland Field study were pH 7.2, 9 ppm P-1 phosphorus and 129 ppm exchangeable potassium. Response to phosphorus has been excellent. Annual applications to 120 lb P_2O_5/A have produced highest yields and increased the soil test P slightly.

Heavy pre-plant applications of P have raised yields but not as effectively as annual P applications.

Despite medium K soil test values at this location, additional K has not increased yields BUT annual soil tests on plots not receiving K have shown **gradual decline in exchangeable K.**

Herb Sunderman at the Colby Branch Experiment Station reported even higher irrigated alfalfa yields—in 1978, a mean yield of 11.7 tons across 19 varieties with one new line yielding a whopping 13.4 tons per acre.

The Kansas researchers summarize

Fertilization Effects on High Yield Alfalfa—Sandyland Experiment Field, Kansas State University
Jim Ball and George TenEyck

Fertility treatment lbs/a			Yield, t/a*		Yield, crude protein lbs/a		Nutrient Removal: Phosphorus lbs/a		Nutrient Removal: Potassium lbs/a	
P_2O_5	K_2O									
Preplant	Annually		1977	1978	1977	1978	1977	1978	1977	1978
0	0	0	8.08	7.73	3040	2718	33	27	363	341
0	40	80	9.32	9.33	3585	3266	44	35	426	415
0	80	80	9.34	9.73	3566	3466	49	42	429	449
0	120	80	9.63	10.57	3732	3858	53	49	452	479
0	120	0	9.62	10.53	3779	3907	54	53	429	472
0	120	160	9.96	10.62	3752	3799	54	49	451	491
320	0	80	9.39	9.88	3613	3623	46	40	432	466
320	120	80	9.81	10.60	3723	3803	59	51	460	485
320	120	80**	9.64	11.57	3635	4081	57	57	437	506
LSD .05***			0.72 t		276 lbs		4 lbs		45 lbs	

* Adjusted to 15% moisture
** Additional late fall cutting when regrowth permitted
*** LSD for comparing the same or different treatments in different years

High Yield Alfalfa Variety Trials—Colby Branch Experiment Station, Kansas State University
Herb Sunderman

Variety	Total Yield, Tons per acre, 12.5% H_2O 1975	1976	1977	1978	4-year mean
Aztec	8.48	10.31	8.84	12.35	10.00
Cody	5.46	10.46	9.36	12.04	9.33
Dawson	6.63	10.58	8.70	11.12	9.26
Kanza	5.86	10.32	9.41	12.01	9.40
Riley	7.33	13.12	10.80	12.28	10.88
KS-38	7.39	12.62	10.83	12.28	10.88
KS-49	6.96	12.18	10.10	11.88	10.28
KS-50	7.14	11.63	10.35	12.89	10.50
KS-51	6.26	12.53	9.66	13.42	10.47
Means, 19 varieties	6.67	11.44	9.46	11.69	

their management tips for top alfalfa yields into the following steps: (1) Selecting a variety with high yield potential, (2) harvesting at the proper time, (3) minimizing harvest losses, (4) irrigating when needed, and (5) fertilizing adequately.

"Irrigated alfalfa in the Great Plains has proven to be a highly profitable crop, IF top yields are achieved. And proper fertilization is highly important to top yields."

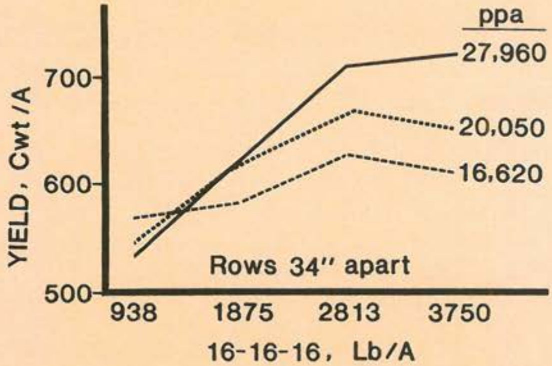


FIGURE 1

High Yield Potato Research...

DR. KUNKEL, Professor Emeritus, Department of Horticulture, Washington State University, conducted research in the Columbia Basin, Washington. He found maximum yields of high quality potatoes were due to the direct and indirect effects of at least 18 factors, not the result of one factor alone.

YIELD POTENTIAL FACTORS: Frost free period. Air temperature. Soil temperature. Light intensity. Daylight. Humidity. Wind.

MODIFYING FACTORS: Moisture. Insects. Diseases. Days Grown. Fertilizers. Seed Quality. Seed Piece Size. Number of Plants. Timely Operations. Variety. Soil Compaction.

When all 18 factors are optimum, it's possible to reach 800 cwt/acre or even higher.

Improper plant spacing within or between rows or improper fertilization can cause leaf area not to cover soil surface quickly enough. Then solar energy reaching the field will not be fully used.

Soil fertility is one potato growing condition growers can readily adjust. Plant nutrients must be adequate for early growth AND active growth late in the season.

Up to 1962, the top yield of late potatoes grown by Dr. Kunkel was 560 cwt/A. This yield was produced with 400 lb N, 230 lb P_2O_5, and 320 lb K_2O/A.

After 1962 he started using the best known production practices along with higher fertilizer rates. His investigations showed maximum yield needed up to 600 lb/A each of N, P_2O_5, and K_2O. Figure 1 shows how these heavy fertilizer rates needed high plant populations to be most effective.

Even higher yields than those in this brief may be possible with such varieties as A503-42. Figure 2 compares yields of this variety with several commonly grown varieties in Dr. Kunkel's high yield research.

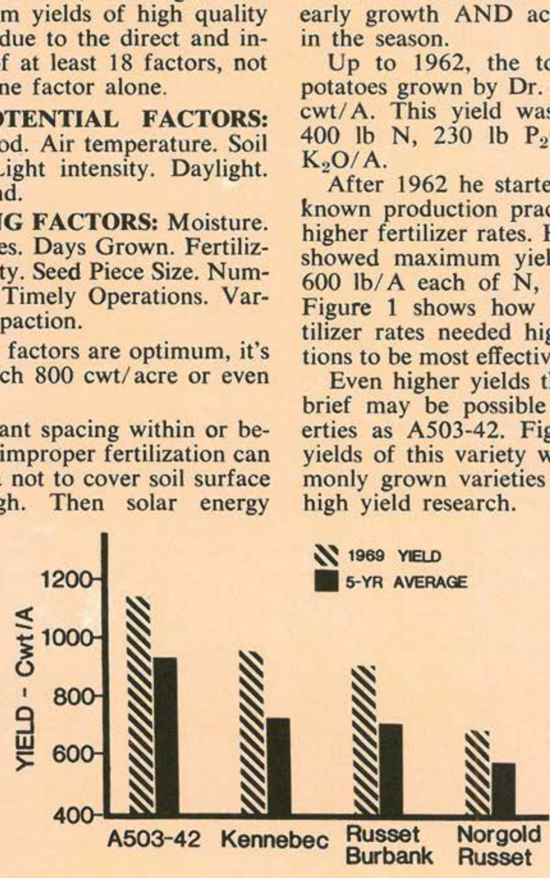


FIGURE 2

High Yield Wheat Research In Washington...

THE VERY HIGH winter wheat yields reached by Washington growers in the 1960's came through a strong program of high yield research in that state.

Washington's record yield of 209 bu/A of winter wheat was reached in 1965 by a grower near Ellensburg in Kittitas County. Dr. F. E. Koehler of Washington State University's Department of Agronomy and Soils provided this information on cropping conditions for this record-setting crop:

Previous crop: Sweet corn

Variety: Gaines

Fertilizer applied for wheat: 120 lb N, 50 lb P_2O_5, and 60 lb K_2O/A. Sulphur was also provided, but amount is not definitely known. As much as 43.8 lb S/A may have been supplied through 16-20-0.

Irrigated: Surface irrigation.

Size of field: 2.2 acres.

The record yield of winter wheat under dryland conditions is a very respectable 132 bu/A, grown on a farmer's field.

Irrigated spring wheat has yielded a high of 152 bu/A in experimental plots. The best yield reached by farmers is 110 bu/A. Yields of 65 bu/A are considered typical of dryland production by farmers.

Growers aiming for top yields are expected to pay more attention to seed size since Dr. Kenneth Morrison reports larger seed size produced higher yields than medium or small seed. The End

High Yield Wheat Growing In Southern England...

JOHN H. M. EDWARDS
Cleanacres, Ltd., Pewesy, Wilts
England

A WHOLE NEW CONCEPT of growing wheat is developing in Southern England where the timely use of fertilizers, fungicides, and growth regulators is causing yields of 150-160 bushels per acre.

The main stem produces the largest head with the greatest number of fertile grain bearing florets. Our aim is to establish high plant populations, planted as evenly as possible, to limit primary tillers and eliminate secondary and tertiary tillers.

These populations vary with moisture availability from 350 to 400 plants per square metre on light soils to 500-550 plants on deep, moist soils. Higher populations encourage deeper rooting and less susceptibility to drought.

TO MAXIMIZE GRAIN WEIGHT, seed quality, and yield it is necessary to keep the plant growing for as long as possible with a large healthy flag leaf, no disease on the plant, and the plant generally in a complete state of nutritional sufficiency.

We apply a total of 120-150 lb N/A. Research has clearly shown a heavy nitrogen application (we use 70-90 lb N/A) just before initiation of the primordia will enable the plant to form a head with a very large number of spikelets.

An additional 50-60 lbs of N are applied when the flag leaf emerges and the head appears. If good moisture exists, it is worthwhile to split this application and apply half after the ear has emerged and anthesis has occurred.

Phosphorus and potassium must not be limiting. Upwards of 100-120 lb/A of each are common applications, with 25-30 lb of each applied as a band dressing at planting.

There is little point in applying fertilizer in these quantities if the ability of the plant to photosynthesize is then destroyed by disease or if the plant does not have an adequate root system to enable it to utilize the fertilizer.

THE GROWTH REGULATOR, Chlormequat, is applied two to three times. The bulk is applied as tillers are forming and the leaf sheath lengthening. This slows leaf development and encourages root growth.

A second application of Chlormequat is made as the leaf sheath becomes strongly erect and first stem node appears for the purpose of continuing improved rooting and to strengthen the standing power of the plant. Some varieties receive a third application when the second node becomes visible.

A FUNGICIDE PROGRAM is integrated with the growth regulator to control diseases. Benomyle or carbendazim is used with the first and/or second growth regulator application.

If Septoria Tritici is a problem, captifol and maneb will be applied with the second growth regulator application. From this stage on, other fungicides may be used, but only to control certain diseases as they first appear.

A complex mixture of fungicides and growth regulators is applied between ear emergence and flowering to prevent ear diseases and to delay aging of the flag leaf. The flag leaf must function long enough to use the final nitrogen applications.

THE VERY HIGHEST YIELDS go hand in hand with the very best quality grain, these sophisticated systems have taught us. Forward looking farmers are adopting these practices to get 150-160 bu yields. And we hope shortly to be able to announce the best of our farmers are beginning to reach 200 bu per acre.

The Economics Of High Yield Agriculture . . .

W. K. GRIFFITH
Great Falls, Virginia

HOW OFTEN have you heard it said farmers can't afford to manage for high yields—the inputs are too expensive?

Not true if the farmer has management skills to reach higher yield goals. The key to profits in corn, soybeans, small grains, alfalfa, or any agricultural crop is cost PER UNIT of production, not total cost per acre.

At a recent North Carolina workshop, farmers and agri-businessmen calculated costs and returns for corn in North Carolina at various yield levels, shown in **Table 1.**

Table 1. Estimated Corn Production Costs in North Carolina

Yield Goal	Total Production Costs	Costs/bu
bu/A	$/A	$
70	188	2.69
125	233	1.86
180 (irrigated)	333	1.85

The 70 bu/A (North Carolina average) would not be profitable any time corn sold for less than $2.69/bu.

At the highest yield level, cost per bushel declined to $1.85/bu and the farmer would have 110 more bushels to sell. And the price of corn could fall well below $2.00 before he would lose money.

MOST PRODUCTION costs occur before final yields are known. Most of the best farmers set a target yield and then apply production inputs to meet this goal.

During these weeks, a combination of two things can go wrong: **(1) Yields can fall below the goal. (2) The market price can run less than expected.**

Farmers have more control over yield than price. So let's use lower yields and $3.00/bu corn in our example.

IN FIGURE 1, we see what happens to profit zones when lower yields than expected occur, using the 70 bu/A and 180 bu/A data from the North Carolina workshop.

The 70 bu/A farmer could tolerate only 7 bu/A reduction and still break even when corn was $3.00/bu. Market price for this low yield farmer could drop only 31¢/bu.

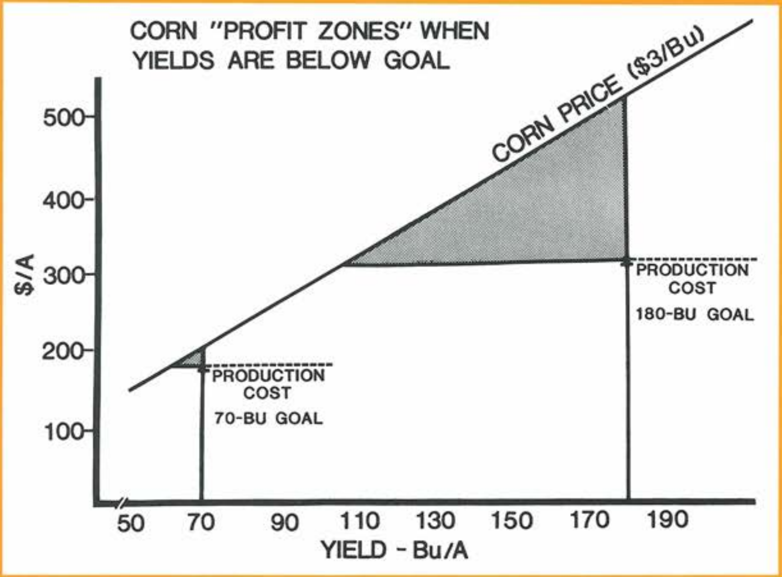


FIGURE 1

The 180 bu/A farmer could make money even though yields were 69 bushels below the target. The high yield farmer could also tolerate a $1.15 drop in market price.

Profit zones or potentials expand as yields expand.

Farmers know optimum growing conditions don't always exist. Stress creeps into the best seasons.

Stress "costs" the optimist less than the pessimist, because the optimist has managed to prepare for it. The only time a pessimist is right is in a total disaster year.

In all other years pessimistic strategy costs farmers money. **Table 2** shows how well optimism pays off. Note the accelerated pace of profits at the higher yield levels. **The End**

Table 2. Profits as affected by corn yield and price*

Corn Price $/bu	70 bu/A	125 bu/A $/A	180 bu/A
2.00	$—48	$ 17	$ 27
2.50	—13	80	117
3.00	22	142	207
4.00	92	267	387

* Based on figures from North Carolina Workshop.

"Farmers have more control over yield than price. Most of the best farmers set a target yield and then apply production inputs to meet this goal."

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