RESEARCH
PPI
EDUCATION

BETTER CROPS
with plant food

FALL 1984

INSIDE THIS ISSUE:

- Fall-Winter Fertilization: Here's What the Experts Say
- European Wheat Systems Seek Higher Yields and Profits
- Narrow Row Spacings Increase Soybean Yields and Nutrient Removal
- The Next Agricultural Revolution...and much more

BETTER CROPS with plant food

Editors: Don Armstrong, Bill Agerton, and Santford Martin
Assistant Editor: Selma Bushman
Circulation Mgr.: Barbara Martin

Vol. LXVIII (68) Fall 1984

BETTER CROPS (USPS 396850) is published quarterly by the Potash & Phosphate Institute. Subscription price is $5.00 per year or $1.25 per copy. Second Class Postage Paid at Atlanta, GA. **Postmaster:** Send address changes to Potash & Phosphate Institute, 2801 Buford Hwy., N.E., Suite 401, Atlanta, GA 30329.

Contents

European Wheat Systems Seek Higher Yields and Profits — 3
Larry Murphy

The Next Agricultural Revolution — 6
Arthur Wallace

Choosing a Crop Yield Goal — 8
W.C. Dahnke, L.J. Swenson, R.J. Goos, and A.G. Leholm

P and K Effects on Root Growth and Nutrient Uptake — 10
W.B. Hallmark and S.A. Barber

Fall-Winter Fertilization: Here's What the Experts Say — 12

PPI Fellowships Available to Deserving Graduate Students — 15

Apply Lime Anytime — 15
Emmett E. Schulte

Narrow Row Spacings Increase Soybean Yields and Nutrient Removal — 16
Larry G. Bundy and Edward S. Oplinger

Compaction, Tillage, PK Fertilization and PK Soil Test Interpretation — 18
J.F. Moncrief, W.E. Fenster, and G.W. Rehm

Foundation for Agronomic Research Gains Support of New Contributors — 21

Potassium in Agriculture An International Symposium — 22

Will We Starve? — 24
J. Fielding Reed

Cover photos by J.C. Allen and Son, Inc.

European Wheat Systems Seek Higher Yields and Profits

By Larry Murphy

THE FACT that higher yields lead to increased crop profitability has been demonstrated repeatedly. Wheat shows the same dramatic improvement in profits when yields are improved through better management. Production economies can save money but the only way of generating more income and higher profits is through higher yields.

Wheat yields in the U.S. and Canada have been increasing but on the average, those increases have not kept pace with increased costs. With higher yields as a goal for all of us, we need to be ready to examine any management practices that show signs of promise.

Success in Research

U.S. and Canadian researchers are attempting to learn more about higher and more profitable yields. Yields over 100 bu/A have been produced frequently in research projects in Virginia, Maryland, Michigan, Indiana, Arkansas, Wyoming, Idaho and Oregon. Many of those yields have been obtained under dryland conditions. The most consistent characteristic of these research projects is the adaptation of management practices far beyond the scope of current wheat production techniques. Specifically, these researchers are looking at such variables as improved varieties and hybrids, narrower row spacing, higher seeding rates, higher rates of fertilization, split applications of nitrogen (N), use of plant growth regulators, excellent weed and insect control, and use of fungicides and other plant disease suppression techniques.

High Yields in Europe

The use of improved wheat management practices in England, France, Holland, Denmark and Germany have led to significant improvement of wheat yields in the past 20 years. Top producers in those countries, particularly England and West Germany, frequently produce 8 to 9 metric tons per hectare (120-135 bu/A). High-yield clubs are now aiming for 10 metric tons per hectare and higher (150 bu/A). The fact that these yields are produced under European climatic conditions does not automatically mean that they can be achieved in the U.S. and Canada, but it does not mean, either, that many of their management practices will not work here.

Some European Management Practices

Selection to top varieties and the use of high quality certified seed is high on the priority list for top European wheat producers. That is a practice that can be easily adapted in the U.S. and Canada. For example, Lowell Burchett, Secretary of the Kansas Crop Improvement Association, cites the use of certified seed as the single most important factor that can be used to improve wheat yields immediately in Kansas.

European producers and researchers have also determined that a high population of single-headed plants is desirable for high yields rather than a large number of tillers. Velcourt Ltd., a highly successful farming company in England, indicates that they would like to have 600 heads per square meter (520 heads per square yard). They are paying more attention to precision seeding, calculating

(continued on next page)

Dr. Murphy is Great Plains Director of the Potash & Phosphate Institute. He recently visited wheat research sites in England, France, Holland, Denmark, and Germany. This article reports some of his observations.

numbers of seeds per acre rather than just weight, and seeding in narrow 10 to 11 centimeter (4 inch) rows.

Fertilization practices in the production program of top European producers are substantially different than those used in the U.S. and Canada. Higher yields require higher amounts of nutrients. Nitrogen (N) applications commonly range from around 190 to 250 kilograms of N per hectare (170-225 lb N/A). One of the most interesting aspects of European N applications is the timing. Relatively little N is applied preplant but a topdressing of about 40 kilograms per hectare (36 lb N/A) is made shortly after seeding. The remainder of the N is split between topdress applications just before the initiation of spring growth, usually about the same magnitude as the fall application, 2 or more applications during the rapid growth phase (usually in combination with pesticides) and a final application at heading of about 40 kilograms of N per hectare (36 lb N/A).

Tramlines

All of these split nitrogen applications require the use of a unique system known as tramlines. Tramlines are merely a system of marking the applicator path through the field so that the same tracks are covered with each application of fertilizer or pesticide without destroying more plants.

Tramlines are laid out depending upon the swath width of the applicator to be used. Frequently, the tramlines are determined by stopping-up openers in the drill. English and German farmers point out that the presence of those tramlines allows them to apply chemicals at night (when there is less wind) without having to be concerned for uniform coverage or use of a marking system.

Nitrogen recommendations are sharpened by taking into account soil tests for easily oxidized organic nitrogen and in some cases by tests for residual nitrate nitrogen such are commonly used in the drier areas of the U.S. and western Canada.

Phosphorus, potassium and other nutrient applications are based on soil analysis. Rates of application commonly reflect the higher yields and are either calculated to increase soil test analysis to higher levels or else replace removed nutrients when soil tests are already high.

TRAMLINES mark applicator paths through fields so the same paths are used during each application.

THESE research plots are located at Rothamsted Experimental Station in England.

These large nutrient applications, particularly nitrogen, would tend to spell trouble for many varieties (even semidwarfs) if plant growth regulators were not commonly used as a part of the management program. Plant growth regulators have been researched to some degree in North America and have shown promise on barley through a chemical-induced shortening of the plant, increased straw strength and resistance to lodging. However, North American research has not been as extensive with the use of plant growth regulators on wheat. European farmers and researchers feel that the use of plant growth regulators allows them to utilize larger amounts of nitrogen without lodging, grain shriveling and yield loss.

In the European system, nothing is left to chance in the control of weeds, insects and plant diseases. All that means careful scouting, and knowing when supplemental applications are necessary for pest control. A particularly interesting point is the control of leaf fungus diseases through the liberal use of fungicides. Damp, European spring weather is conducive to greater leaf infection, particularly with the thick leaf canopy and the humid micro-climate produced by the plants. The same type of problems probably exist in the more humid regions of the U.S. and Canada and under irrigated conditions in the West.

Pick and Choose

The Europeans certainly aren't satisfied with a lower modest yield wheat crop, and neither should we. One Velcourt manager, James Townsend, points out that soil compaction is the next major problem that they plan to attack to continue to increase yields. Managing large amounts of straw and reduced tillage seeding are other systems that will be examined.

Obviously, the more humid climate in Europe is ideal for wheat growth and some of the systems they are using may not be readily translated to North American conditions. Still, we have much to learn from these outstanding producers and you may wish to start thinking about some of their ideas in conjunction with your production system.

As Anthony Forsyth, Kineton, Warwickshire, England and Peter Klinkhamer, Schlesweig-Holstein, West Germany put it, **"I am applying the best management I know how for higher yields and higher profits."** So can you. ■

The Next Agricultural Revolution

By Arthur Wallace

A MULTIDISCIPLINARY REVOLUTION in agriculture with greatly increased crop productivity is just around the corner. A large potential for increased food production exists. If farmers of a still-hungry world wish to integrate various independent pieces of know-how which already exist on how to improve crop yields, substantial increases in food production are possible.

This new revolution based on overcoming many limiting factors to crop production follows the recent Green Revolution and will precede the coming Genetic Engineering Revolution in agriculture. The Genetic Engineering Revolution will yet take many years to fully materialize.

Most investigators and leaders in agriculture expect the Genetic Engineering Revolution to occur in agriculture in the next decade or two. Many recognize the difficulties and call for a mobilization of resources to achieve it. Several breakthroughs are needed. It may take 10 or 20 years to materialize, however. High-yielding new varieties of plants with resistance to many of the environmental and nutrient problems that face present-day agriculture are expected.

Hoped for are breakthroughs from Genetic Engineering in three important biological processes:

(1) The first is adding the symbiotic nitrogen-fixing relationship, which occurs in legumes such as soybeans and alfalfa, to other major crop species.

(2) The second is transmission of the efficient C-4 mechanism of photosynthesis (which occurs in crops like corn and sugarcane) to other crops. This could greatly increase yields.

(3) The third involves discoveries that will make it possible to inhibit the dark photorespiration process through which some crops lose considerable amounts of the carbon fixed as carbon dioxide in the photosynthetic process.

Breakthroughs in these three areas could lead to phenomenal yield increases. Plant cell culture will enhance progress with each. Such achievement would require a massive research effort, but could bring on a major new agricultural revolution resulting in abundant food supplies.

The Genetic Engineering Revolution will be very gradual in coming and as yet cannot even be guaranteed to happen. Success may be many years away. In the meantime, all world agencies can and should right now work on the viable alternative, the Multidisciplinary Revolution. The know-how is essentially available and needs only to be used.

The Multidisciplinary Revolution is exactly as the name implies. Agricultural science is fragmented into a number of disciplines. Some disciplines involved in crop production include crop breeding and variety selection and management, land reclamation, soil fertility and plant nutrition, weed control, irrigation, plant physiology, entomology, soil microbiology, plant pathology, and farm machinery. Each of the disciplines has developed procedures which can improve crop yields, but seldom do all of the disciplines work together to achieve the maximum potential. Putting them all together into a unified or integrated system is the basis of the Multidisciplinary Revolution.

Dr. Wallace is with the Laboratory of Biomedical and Environmental Sciences, University of California, Los Angeles.

Some Examples

Remarkable achievements have been obtained by some innovative researchers and farmers. In England, for example, a whole new concept of growing wheat is developing. Timely use of fertilizers, fungicides and growth regulators is causing yields of 10 to 11 metric tonnes per hectare (t/ha) — 1 metric tonne per hectare equals 0.45 tons per acre — or 150 to 160 bu/A.

The management system in England is sophisticated. A growth regulator is applied two to three times to a crop to regulate the balance between shoot and root growth. Nitrogen (N), phosphorus (P), and potassium (K) nutrients are never allowed to become limiting. Control of diseases is essential for maximizing the use of nutrients that are available in soil. High plant populations are necessary. All other components of the system are likewise optimal.

Similar situations exist for many other crops, including corn, soybeans, and potatoes. Big gaps exist between average farm yields, yields on well-managed farms, and yields that have been produced in top research experiments. Much of the difference is merely the result of using the available knowledge which can be had by those who want and are willing to use it to improve farm yields. It takes more than knowledge, too, for there are inputs which require investing more money to achieve highest yields.

The exciting aspect of simultaneously overcoming several limiting factors to crop production is that additive or synergistic effects are experienced. Correcting two limiting factors alone may result in a 20% yield increase for each. When both are corrected together, the combined yield increase is more than 40%. When 6, 8, 10 or more limiting factors can be corrected simultaneously, the total effect can be staggering. Often the combined effect of two corrected limiting factors is a synergism. The combined effect then is much greater than the sum of the parts. Yields go up very rapidly with synergistic or interactive responses.

Are there obstacles to this Multidisciplinary Revolution in agriculture and can it be achieved? Economics is considered as the leading barrier to a new yield revolution in agriculture. Input costs are high, and most persons believe that additional inputs give smaller and smaller increment returns. However, this need not be the case if the inputs are adjusted according to computer calculated requirements considering rainfall, wind, temperature, light intensity, days to harvest, etc.

With correct adjustments, the last increment of fertilizer nutrients can give as much return as the first, if fertilizer requirements are not exceeded.

Even though agriculture in the U.S.A. is remarkably productive, yields for most major crops can still be at least doubled. Yields have not plateaued. Much improvement is still possible, especially if the disciplines work together to eliminate more of the limiting factors. This is the crucial aspect: the approach must be multidisciplinary. There are many examples of recent works to improve yields by overcoming multiple limiting factors.

This should become a great world goal. Multiple, interdisciplinary approaches to yield problems are suggested, but the integrated approach is often ignored.

It is very apparent that yield-limiting factors such as plant nutrients and soil conditions need to be eliminated, along with others in order to maximize yields. This points up the important role of soil and plant analyses. Several different nutrients can be limiting simultaneously. But correction of one or more of them may give little response, unless all of them and other limiting factors that are present are also corrected.

Dramatically different yield results can be obtained when all limiting factors are eliminated, and the economic rewards will come to those farmers that make the effort to apply such management. ■

Choosing a Crop Yield Goal

By W.C. Dahnke, L.J. Swenson, R.J. Goos and A.G. Leholm

CHOOSING A YIELD GOAL for each field is one of the more important decisions you make. Since fixed costs per acre are the same with low or high yields, profits in relation to fixed cost increase as yields increase. Variable costs increase as potential yields increase, so it becomes important to choose a realistic yield goal so your average returns from variable costs, in this case fertilizer, are greater than your costs.

What is a yield goal?

A yield goal is the yield per acre you hope to grow. As you already know, what you hope to grow and what you end up with are two different things. Yields are largely determined by your management, the soil, and weather conditions during each growing season. Management is directly under your control. The soil is a constant factor but can be improved through good management. Weather conditions are not under your control and are unpredictable for the coming growing season. For this reason you do not always reach your goal. However, this should not be an excuse to have a low yield goal.

What should your yield goal be?

A yield goal could vary all the way from past average yield to potential yield. Potential yield is the highest possible yield obtainable with ideal management, soil, and

The authors are with the Department of Soil Science and Extension Agricultural Economics, North Dakota State University. Reprinted from Ext. Circular SF-822 with permission of North Dakota Extension Service.

weather. It would probably be too high as a practical goal. On the other hand, average yield is a goal that is too low. In fact, if you fertilize according to soil test for your average yield, the maximum yield obtained would be the same as your past average yield and your new average yield would actually decline.

Practical range for a yield goal should be somewhere between above average to near past maximum yield obtained by you or a nearby neighbor on a similar type of soil. Just what your yield goal should be in this range can depend on many factors. Availability of capital, a one-year lease, etc., are some factors that could influence the amount you would invest for variable costs, such as for fertilizer. The one thing that is certain is that your yield goal should be above average yield. In fact, it should probably be close to the past maximum yield obtained in your area on the same or a similar soil type.

The key reason for this is that when sufficient nutrients are applied for a specific yield and that yield goal is not reached because of poor growing season conditions, the nutrients will carry over and be available to future crops. In this case the added cost to the grower is the cost for one year's interest on the money used to purchase nutrients that were not used in the year of application. This could amount to 50¢ to $1/A when your yield goal for wheat was 10 bushels per acre above actual yield. On the other hand, if your yield goal was 10 bushels per acre low, the unrealized yield would be worth $30/A when wheat is worth $3/bu.

While it is not economical to have a yield goal that is too low, it is not wise to have an unrealistically high yield goal. Fertilizing for an unrealistically high yield ties up capital that could more profitably be used in other ways and can increase the chances of losing significant amounts of nutrient during years of above average rainfall.

Management for higher yields

The management factors that influence yields are tillage, rotations, drainage, soil fertility, crop variety, seed quality, planting date, row spacing, plant population, weed, insect and disease control, and harvesting time and method. Many of these have little or no influence on costs but can significantly increase returns. Other factors, like soil fertility, result in higher variable costs per acre since higher yields require more nutrients than low yields. Although the cost for fertilizer on a per acre basis can be significant, returns can be greatly increased when soil tests indicate a need for nutrients. For example, it costs $5/A for enough nitrogen (15¢/lb of N) and phosphorus (25¢/lb of P_2O_5) to supply nutrients for an extra 10 bu/A of wheat. With wheat at $3.50/bu the extra yield returns $7 for each dollar invested in fertilizers.

Important factors to consider in choosing a yield goal

- Your yield goal has to be practical, feasible and achievable. However, if you achieve your yield goal more often than one or two years out of five, then your goal is probably too low.

- A yield goal should be well above the past average yield to near or slightly above the past maximum yield for a particular field.

- Nutrients not used in years with poor growing conditions will normally be available in following years. Although soil testing sometimes cannot quantitatively account for all of these nutrients, most will still be in the soil system and available to future crops.

- A low yield goal in a good growing season can easily mean a lost income of $30 to $40/A while a high yield goal in a poor growing season will mean a loss of 50¢ to $1 in interest cost on unused nutrients.

- Never fertilize for a poor yield because then you will be sure to have one. ■

P and K Interaction Effects on Root Growth and Nutrient Uptake

By W.B. Hallmark and S.A. Barber

PHOSPHORUS (P) and potassium (K) increases soybean yields, and a **positive yield interaction** frequently occurs when P and K are added together to the soil.

This raises a question: How do P and K additions interact to influence the growth, nutrition and yield of soybeans?

Our research shows that increasing amounts of soil P and K have a beneficial effect on root growth and morphology and nutrient uptake by soybean seedlings.

PxK interactions were observed for several parameters which may be responsible for the yield interactions of field grown soybeans.

Table 1 shows that increasing soil **P and K increased the weight of roots and shoots.** P and K also decreased the root/shoot ratio showing that with good nutrition the plant devoted less of its dry weight to roots and more to shoots. P and K added together resulted in the lowest root/shoot ratio.

Table 1. Effect of Adding P and K to Soil on Plant Weight of Soybean Seedlings.

Treatment		Plant Weight		
P Added	K Added	Roots	Shoots	Root/ Shoot Ratio
-------- lb/A --------		---- grams/pot ----		
0	0	1.01	2.43	0.416
0	200	1.08	2.62	0.412
200	0	1.13	3.60	0.314
200	200	1.11	3.96	0.280

Secondary root radius was decreased when P and K were both added resulting in a significant PxK interaction. See **Table 2. A smaller root radius is desirable since it provides the plant with more root surface area per gram of root to absorb nutrients.**

P addition also increased the weight of primary and secondary roots.

Table 2. Effect of Adding P and K to Soil on Root Radius and Weight.

Treatment		Radius		Weight	
P Added	K Added	Secondary Roots	Primary Roots	Secondary[1] Roots	Primary Roots
--------lb/A--------		------- millimeters -------		----------- g/pot -----------	
0	0	0.090	0.71	0.835	0.178
0	200	0.095	0.92	0.900	0.180
200	0	0.090	0.70	0.925	0.214
200	200	0.085	0.73	0.885	0.226

[1]PxK interaction: Secondary root radius $p = 0.001$. (The "p" value indicates how confident one can be that there is a significant difference. For example, $p = 0.001$ means one can be 99.9% sure that the observed difference was not due to chance).

Increasing soil P increased the **root surface area** per pot and per gram of root. See **Table 3.** P also decreased the root surface area/g shoot indicating that at high P relatively less root surface was needed to meet the plant's needs. The **effect of P** on root surface area measurements **was greatest when K was also added** to the soil. This shows again the importance of having high levels of both P and K in the soil.

Dr. Hallmark is now with the Iberia Research Station at Jeanerette, Louisiana. Research referred to in this article was conducted while he was at Purdue University, West Lafayette, Indiana. Dr. Barber is Professor of Agronomy at Purdue.

Table 3. Effect of Adding P and K to Soil on Root Surface Area Measurements.

Treatment		Root Surface Area		
P Added	K Added	/pot	/g root	/g shoot
lb/A		cm[2]		
0	0	550	545	225
0	200	535	495	205
200	0	600	530	165
200	200	615	555	155

Nutrient influx was increased with P and K addition. P increased the influx of P, K, Ca and Mg while K increased P, K and Ca influx, but decreased Mg influx. See **Table 4.** There were significant positive PxK interactions for P and K influx and a negative interaction for Mg influx. These interactions may be partially responsible for the PxK yield interactions observed in the field.

Table 4. Effect of Adding P and K to Soil on Net Nutrient Influx of 9 to 21 Days Growth Stage of Soybean Seedlings.

Treatment		Net Nutrient Influx[1]			
P Added	K Added	P	K	Ca	Mg
lb/A		pmoles/cm^2·s			
0	0	0.08	2.35	4.15	2.80
0	200	0.10	3.20	4.55	2.85
200	0	0.59	4.30	5.85	5.60
200	200	0.88	7.35	6.35	4.30

[1]PxK interactions: $p = 0.003$ for P influx; $p = 0.001$ for K influx; and $p = 0.009$ for Mg influx.

Plant nutrient concentrations were significantly affected by P and K. See **Table 5.** The effect of P and K on nutrient concentration was similar to that for nutrient influx. P increased P and K concentrations of shoots as did K addition. The effect of P addition on P and K concentration was greatest when soil K was high. Likewise, the effect of K addition was greatest when soil P was high. **This resulted in positive PxK interactions for P and K concentrations** and a negative interaction for Mg concentration.

Table 5. Effect of Adding P and K to Soil on P, K, Ca and Mg Concentration of Soybean Seedlings.

Treatment		Shoot Concentration[1]			
P Added	K Added	P	K	Ca	Mg
lb/A		ppm			
0	0	45	430	510	345
0	200	45	490	485	305
200	0	70	490	485	450
200	200	85	650	465	320

[1]PxK interactions: $p = 0.041$ for P concentration; $p = 0.001$ for K concentration; and $p = 0.001$ for Mg concentration.

In summary, increasing soil P and K had a beneficial effect on many of the parameters measured. The PxK interactions resulted in higher P and K shoot concentrations. This could be part of the reason why PxK yield interactions occur with field grown soybeans. ■

Fall-Winter Fertilization: Here's What The Experts Say

APPLICATION of potash and phosphate in the fall and winter months is a sound and profitable agronomic practice in many areas. We asked the experts — agronomists from various agricultural areas — to share their ideas and observations. Following are some guidelines based on research and experience.

Ohio

"**Research in Ohio** has shown fall to be an excellent time to apply needed phosphate and potash. Our data show that the efficiency of P and K applied in the fall compares well with spring applications from the crop's standpoint.

"From the farmer's standpoint, fall applications can have several advantages. The most important advantage is having one less job to do in the spring. Yields and profits are often lost in Ohio from late planting. Wet weather is usually the reason for farmers not planting when they should. While fall fertilization does not prevent wet springs, it does allow more planting to occur in the dry periods that we usually have in late April and early May."

— Jay Johnson
Ohio State University

Maryland

"**A good soil fertility program** is an important key to high yields and greater profits per acre. On many farms no-tillage and other forms of conservation tillage are being used with excellent results. Conservation tillage farming offers a good opportunity for the application of phosphate and potash in the fall and winter seasons because of the plant residue that is left on the surface to protect the soil from excessive erosion. However, on very sandy soils where leaching is a problem potash should not be applied in the fall for crops to be planted in the spring. The application of fertilizers on frozen soil should also be avoided when there is the potential for excessive runoff.

"In recent years many excellent yields have been reported for corn grown under the no-tillage system. Research conducted cooperatively by the University of Maryland Department of Agronomy, TVA, and USDA has shown at optimum nitrogen rates no-tillage corn has a higher yield potential than corn grown under the conventional tillage system. In research plots on a Mattapex silt loam soil corn grain yields over an 11-year-period at the optimum nitrogen rate of 160 lb/A have remained at about 140 bu/A for corn grown by the conventional tillage method whereas no-tillage corn yields have increased over time and are now outyielding the conventionally tilled corn by approximately 25 bu/A. No-tillage corn not only has the advantage of a higher yield potential on many soils in Maryland, but this practice also reduces soil erosion, fuel, time, and labor requirements.

"Don't overlook the use of phosphate and potash in the fall and winter seasons. This practice will help to spread your workload and you will have the insurance that the needed phosphorus and potassium will be in the soil to give top yields for next year. Be sure to have your soils tested to determine the quantities of nutrients needed for the crops to be grown."

— J.R. Miller
University of Maryland

Indiana

"Timeliness is one of the keys to producing Maximum Economic Yields in Indiana. With our weather, any way we can reduce spring work will result in more timely planting. It can also result in less soil compaction, since soils are normally drier in the fall. Thus fall fertilization can both improve timeliness and reduce compaction – both important to successful crop production.

"Research has shown fall application of N, P and K can be done safely and effectively on most soils in Indiana. And with the improved harvesting and drying equipment being used today, many farmers have more time available for fall field work today than in previous years. When coupled with normally good soil conditions in October in Indiana, fall fertilization is definitely a tool which can be used to improve the overall efficiency of a farm operation. Applying fertilizer in the fall also minimizes compaction risks by moving one more field operation off wet soils in the spring and substituting drier conditions most falls.

"All together, fall fertilization is an important tool available to our farmers, and is a good way to help minimize compaction problems and improve the overall timeliness of our crop production programs."

— Dave Mengel
Purdue University

Manitoba

"Many farmers in Manitoba choose to apply nitrogen and/or phosphorus fertilizers in fall to reduce labour requirements and time for planting in spring. Farmers should band fertilizers into the soil. Nitrogen and/or phosphorus fertilizers banded into the soil are more effective in increasing yields than broadcast applications and both the nitrogen and phosphorus fertilizer should be banded together when both are being applied. Farmers should also note that a small amount of phosphorus fertilizer (10 to 15 kg P_2O_5/ha) may be required with or near the seed at time of planting to satisfy the phosphorus requirements of the plant during the early growth period. Potassium fertilizers, when required, should be applied in a manner similar to that of phosphorus."

— G.J. Racz
University of Manitoba

Oregon

"Pastures, grass seed and winter wheat are the large acreages that benefit from fall fertilization in western Oregon.

"Many western Oregon livestock men ran out of winter feed last year with the colder than normal December and January temperatures. Fall is the best time for application of PKS on the large acreages of non-irrigated pasture in western Oregon. N application will stimulate fall grass growth. An optimum fall fertilizer program is a good hedge against winter feed shortages.

"Fertilization of grass seed crops starts with fall applications of part of the N (generally 30 to 40 lb) and fall is the optimum time to apply P and K. Grass seed is a major crop in western Oregon with over 250,000 acres harvested.

"Recent research has emphasized that plowing down big crops of straw for winter wheat production immobilizes significant amounts of N and results in N stress during the winter. Wheat plants are susceptible to take-all root rot invasion when nutrient stress is present.

"Banding an NPS Cl fertilizer with the seed at planting has reduced the susceptibility of winter wheat to take-all root rot in western Oregon."

— Tom Jackson
Oregon State University

Georgia

"On soils throughout Georgia, fall P and K applications are a sound agronomic practice. The only exception would be that a supplemental spring K application may be required if there has been excessive rainfall on deep sands with no cover crop."

— *Bill Segars*
University of Georgia

Washington

Washington State has three distinctly different soil, cropping and environmental systems to deal with. Thus, fertilization practices must be related to these conditions.

In the nonirrigated dryland cereal production area of eastern Washington most of the wheat is fall planted, so the practice has been to apply most of the nitrogen before the fall planting as shanked-in anhydrous ammonia. Soil moisture storage, together with the quantity of rainfall, is such that in general the soil profile (rooting zone) is no more than filled—consequently there is little or no leaching (a few areas excepted). All nonmobile nutrients can be (and are) fall applied because there is no serious nutrient tie-up. Spring grains are generally fertilized in the spring prior to seeding. For no-tillage seedings of spring grains it is particularly important for weed control and maximum availability of applied nutrients to band the fertilizer below the seed or below and between narrow seedrows (5-6 inch rows). Benefits from banding fertilizer with fall seeded grains are much less certain.

In the irrigated areas (annual precipitation about 6-8 inches per year) any and all nutrients are quite commonly fall applied, with good results.

In western Washington (high rainfall through the winter months and no frozen ground) little fall nitrogen fertilization is done except in those situations where the fall application can be made late (when the soil temperature is below 50°F) and for those crops (perennial or biannual) that need an early nitrogen supply—e.g. bulb crops.

Two precautions must be followed for fall application of nonmobile nutrients. On very sandy soils potassium can be lost by overwinter leaching, and on certain highly acid soils phosphorus availability is reduced if applied too far in advance of crop demands. This "tie-up" problem can be reduced if the soils are properly limed, but since lime is very expensive this is not always done.

— *A.R. Halvorson, C.F. Engle*
Washington State University

Idaho

Fall bedding is an increasingly popular practice in irrigated portions of southern Idaho for a number of commodities. It reduces the tillage required for seedbed preparation in the spring when time is short. If the need for P and K is indicated by the soil test, fall fertilization is necessary if the P and K is to be mixed in the seedbed. Otherwise, if annual P and K applications are desired for maintaining high soil test levels, application before fall bedding is frequently more convenient than spring applications.

The same is not necessarily true for fall N application. For N, fall fertilization should be avoided on soils prone to leach or denitrify nitrate-N. To enhance the effectiveness of fall N fertilization, application should be made when soil temperatures are below 50°F, ammonia sources should be used and when applied, fully incorporated. ■

— *Brad Brown*
University of Idaho

PPI Fellowships Available to Deserving Graduate Students

GRADUATE STUDENTS who are candidates for either the M.S. or Ph.D. degree in Soil and Plant Sciences are eligible to apply for Fellowship awards of $2,000 each to be awarded in April, 1985. Applications and supporting materials must be submitted by February 1, 1985.

The Committee to select Fellows consists of five members: Two from the staff of the Potash & Phosphate Institute (PPI) and three from the Advisory Council of PPI. Dr. J. Fielding Reed, President (Retired), of PPI serves as Chairman of the Committee.

The awards will be granted independent of any assistantship or scholarship that a deserving student already holds. Applications should include transcripts of all college courses, including cumulative and final GPA, and letters of support from three individuals (one of whom is the major professor). The problem description should be presented in a manner that will permit evaluation of originality of research, its depth and scope, innovative approaches, etc.

Application forms are available from Agronomy and Horticulture Department Heads at universities, from staff members of the Potash & Phosphate Institute, or by writing directly to:

Potash & Phosphate Institute
2801 Buford Hwy., Suite 401
Atlanta, GA 30329 U.S.A.

Apply Lime Anytime

By Emmett E. Schulte

REMEMBER that field you wanted to lime this spring but couldn't because it was too wet? When it finally dried out, county highway weight restrictions kept the lime trucks off the roads. Why wait until spring to lime?

For old hay fields that will be plowed up this fall or next spring, now is the **time to lime**. Apply lime after hay harvest in late summer or early fall. Soil moisture is usually low then, and lime trucks will do little damage to alfalfa crowns. There are no weight restrictions on highways, and lime vendors are in a slack period. Lime now and you won't have to rush around in winter or spring trying to get the job done.

Liming is best done when rotating from alfalfa rather than at seeding time. The reason is that lime takes about three years to react fully, owing to its low solubility. Only a small volume of soil surrounding each lime particle is neutralized. Everytime the soil is tilled, the lime particles come into contact with more acid soil and neutralize it. Several tillage operations are needed, therefore, to mix the lime thoroughly throughout the plow layer.

To know how much lime is needed, the soil should be sampled and tested. Take at least five cores or borings from every 5 acres to make a composite sample for testing.

Check with your local extension office for state guidelines on soil testing. ■

Dr. Schulte is Extension Soil Scientist, University of Wisconsin-Madison.

Narrow Row Spacings Increase Soybean Yields and Nutrient Removal

By Larry G. Bundy and Edward S. Oplinger

SOYBEAN YIELDS in northern production areas are often increased by use of narrow row spacings. However, the fertility requirements of soybeans at the higher yield levels obtained in narrow rows have not been determined.

Field experiments were conducted in southern Wisconsin on a Plano silt loam soil to study soybean fertility requirements at yield levels produced with narrow and conventional row spacings. Initial soil test values at the experimental location were pH, 6.2; organic matter, 3.8%; available P, 88 lb/A; exchangeable K, 221 lb/A. Duplicate experimental sites were established to allow annual rotation with corn and soybeans, and broadcast potassium (K) was applied to establish a range in soil K levels.

Corsoy 79 soybeans were planted in early May using 8-inch (narrow) and 30-inch (conventional) row spacings. Plant populations were approximately 195,000 plants/A in narrow rows and 155,000 plants/A in conventional rows. The effects of row spacing, soil K level, and maintenance K fertilization (100 lb K_2O/A) on soybean yield were determined.

Data obtained in 1981, 1982, and 1983 **(Table 1)** show that soybean yields were consistently increased by use of the narrow row spacing. The yield advantage with narrow rows averaged 16 bu/A in the 3-year study. Yield difference due to row spacing was greatest in 1982 when yields were increased by 22 bu/A (35%) by use of narrow rows. Data in **Table 1** suggest that the yield advantage from narrow row spacings increases with increasing soybean yield levels. Soybean yields were not increased by soil K or maintenance K treatments.

Table 1. Soybean yields with narrow and conventional row spacings.

	Yield, bu/A			
Row width	1981	1982	1983	Mean
8 inches	56	85	77	73
30 inches	46	63	61	57
Yield increase	10	22	16	16

Grain samples from unfertilized check plots at the initial soil K level were collected in 1982 to determine nutrient concentrations and removals in grain. Average yields in these plots were 87 bu/A in narrow rows and 66 bu/A in conventional rows. Data in **Table 2** show that yield differences due to row spacing had little or no effect on the concentrations of eleven nutrients in soybean grain. **Similar grain nutrient concentrations found at varying yield levels indicate that higher soybean yields produced with narrow row spacings are likely to increase crop nutrient removal in direct proportion to the yield increase obtained.**

Dr. Bundy is Assistant Professor of Soil Science and Dr. Oplinger is Professor of Agronomy, University of Wisconsin-Madison.

Table 2. Nutrient concentrations in soybean grain at two yield levels.

Yield bu/A	Row spacing inches	Grain composition % N	P	K	Ca	Mg	S	ppm Zn	B	Mn	Fe	Cu
87	8	5.85	0.60	1.79	0.19	0.24	0.31	41	26	25	113	10
66	30	5.83	0.60	1.80	0.20	0.23	0.30	43	27	25	126	11

The amounts of nutrients removed in grain at the yield levels obtained with the two row spacings in 1982 are shown in **Table 3**. It is apparent that greater amounts of all nutrients were removed in grain at the higher yield levels produced in narrow rows.

In summary, soybean yields were consistently increased by use of narrow row spacings. Yield increases of up to 35% were obtained by using 8-inch rows instead of 30-inch rows. Nutrient concentrations in soybean grain were not affected by yield differences due to row spacing.

Higher yields in narrow rows increased per acre nutrient removal. At the highest yield obtained in narrow rows (87 bu/A), 265 lb N, 62 lb P_2O_5 and 98 lb K_2O per acre were removed in grain. ■

Table 3. Amounts of nutrients removed in soybean grain at two yield levels.

Yield bu/A	Row spacing inches	Nutrients removed, lb/A N	P*	K**	Ca	Mg	S	Zn	B	Mn	Fe	Cu
87	8	265	27	81	8.7	10.7	14	0.19	0.12	0.11	0.51	0.05
66	30	199	21	62	6.7	7.9	10	0.15	0.09	0.09	0.43	0.04

*Multiply by 2.3 to convert to P_2O_5. **Multiply by 1.2 to convert to K_2O.

Compaction, Tillage, PK Fertilization and PK Soil Test Interpretation

By J.F. Moncrief, W.E. Fenster, and G.W. Rehm

ON MANY SOILS, primary tillage in the fall is necessary because of soil moisture conditions in the spring. These soils have poor drainage and finer textures. On better drained soils which permit spring tillage there can also be compaction which can affect yields. This compaction occurs if the soils are worked when too wet.

Tractors have increased in weight from about 3 tons in the 1940's to around 20 tons today. Also large harvesting equipment often carries several tons of grain in addition to its own weight. The depth of compaction increases as the soil moisture increases and can persist for years.

Research at Southern Experiment Station (Minnesota) on a Webster clay loam showed compaction can occur as deep as 24-30 inches under axle loads between 10 and 20 tons. The compaction treatments were applied in 1981, and then the plots were moldboard plowed. The subsoil compaction (30 in. deep) decreased internal drainage, kept the soil wet and cool during the spring and led to a nutrient deficiency problem even though nitrogen was applied at 60% above recommended levels. The corn yields were 170, 155, and 125 bu/A for the check, 10 ton/axle, and 20 ton/axle compactions, respectively. That's a 50 bu/A reduction due to compaction.

On a better drained soil (Nicollet silt loam) at the Southwest Experiment Station similar compaction treatments had little effect on corn yields. This was likely due to lower soil moisture conditions, at the time of traffic. Soil moisture level at the time of tillage is the most important factor influencing surface and subsoil compaction. Farmers with dual tires sometimes will get on their fields under higher moisture conditions. This may result in significant subsoil compaction which is primarily a function of axle weight and not tire size. This should also be kept in mind when fertilizer is spread with the so-called "floaters".

The message is simple. **Avoid traffic and tillage when soil moisture is high.** Soil moisture is likely to be lower in the fall, so get tillage done then if possible. If the fall is wet, opt for shallow, light tillage to incorporate crop residue in the spring if you are growing a crop sensitive to temperature after a high residue crop, such as corn or small grain. If you are following a low residue crop with corn, little or no tillage is necessary. Soybeans are relatively insensitive to the cooler temperatures, less aerated soil conditions, and higher density conditions of no-till. If this crop is grown, less tillage is acceptable.

Phosphate and Potash Fertilization

There is much more flexibility with time of application for P and K. If soil tests indicate that P and/or K are needed, application can be made in the fall. Soils are generally drier and fall is a good time to apply larger buildup and maintenance amounts.

Farmers generally are trying to apply more of their P and K with the planter in the spring to improve efficiency and the amounts recovered by the plant. This is more important with conservation tillage systems, but is also advisable with any tillage approach.

P and K Recommendations for Conservation Tillage

1. Row applied P and K are necessary.

The authors are Extension Soil Scientists, University of Minnesota.

The benefits of fertilizer applied with the drill or planter increase as residue levels increase and tillage decreases.

2. In drier areas place the starter or row fertilizer as deeply as possible (2-4 inches).

Interpretation of P and K Soil Tests

When applied P and K are not uniformly mixed within the surface soil, special considerations are necessary when interpreting soil tests. The distribution of soil K due to tillage from a study in Goodhue County, Minnesota, is shown in **Table 1**. These values reflect K distribution after two years of potash application at the rates indicated.

Table 1. Effect of tillage on K (ppm) distribution.*

Tillage System	Soil Depth (inches)	Soil Test K - ppm, Applied K_2O - lb/A: 0	200	400
No-till	0 - 2	86	255	350
	2 - 4	65	88	135
	4 - 6	59	65	82
Chisel	0 - 2	87	167	249
	2 - 4	77	123	179
	4 - 6	70	70	102

*Goodhue County, MN. Moncrief and Swan, 1983.

The K distribution in the control plots reflects the past tillage history (chisel plowing). With chisel plowing K is fairly well distributed in the top 4 inches. Most of the K is in the top 2 inches without tillage. **Soil K appears to be increasing below 2 inches without tillage, suggesting some mobility.** Other researchers have also shown K movement on fine textured soils. This movement over time will tend to overcome potential positional availability problems.

Table 2. Effect of tillage on the change in soil test K after potassium application.*

Tillage System	Time of sampling	Soil Test K - ppm, Applied K_2O - lb/A: 0	200	400
No-till	Before application	71	80	102
	After application	65	124	176
	Change	−6	+44	+74
Chisel	Before application	69	76	108
	After application	72	112	153
	Change	+3	+36	+45

*Goodhue County, MN. Moncrief and Swan, 1983.

Tillage effects on soil fixation of applied potash are shown in **Table 2**. With a given application of potash the K soil test (0-6 inch sample) is higher without tillage. With soils that fix K it would appear that there could be an advantage with reduced mixing of applied fertilizer. This could serve to minimize fixation and increase potential recovery. A major factor which would determine the benefit of this is timeliness of rain. If the topsoil is

(continued on next page)

Soil Sampling Recommendations for Conservation Tillage

1. Continue to take soil samples from 0 to 6 inches deep for P and K soil test analysis. A shallow sample (0 to 2 inches) may be best for determining soil pH for herbicide recommendations.
2. Anticipate a greater increase in soil test P or K values per unit of nutrient added when using conservation tillage. This will vary according to degree of reduced mixing and the soil type but, the differences can be substantial (twofold) between no-till and moldboard plow on a high fixing soil.
3. If a ridge-till system is used, take soil samples after planting but before cultivation. For other times of the year sample half way up the ridge only.

moist enough to permit plant uptake of soil K, conservation tillage is a benefit with respect to recovery of applied K. In drier regions getting it down into the soil will be important.

With a ridge-till system a unique problem of interpretation is encountered. During cultivation to build ridges, soil surface P and K are moved into the row area. During planting the ridge is scalped and thrown between the rows. When and where does one then take the soil sample with this system? If samples are taken between the row after ridging, soil test P and K values may be misleadingly low. If the row area is sampled, values are high. Essentially one would be sampling the top 3 inches twice (3 inches of soil moved into ridge and 3 inches below). Sampling between the row at this time is actually the 3-9 inch layer. Results from a sampling study with this system are shown in **Tables 3 and 4** for soil P and K, respectively. Large differences due to position relative to the row are apparent after ridging or after planting but before ridging. If soil sampling cannot be done at this time, it is recommended that the samples be taken halfway up the ridge. ■

Table 3. Effect of time and place of soil sampling on distribution of soil P in a ridge-till system.*

Soil Depth (inches)	Soil Test P - ppm, Time of Sampling: After Ridging		After Planting	
	In Row	Between	In Row	Between
0 - 2	68	33	49	40
2 - 4	42	19	22	24
4 - 6	20	13	13	17
6 - 9	12	7	8	10

*Randall, 1983.

Table 4. Effect of time and place of sampling on distribution of soil K in a ridge-till system.*

Soil Depth (inches)	Soil Test K - ppm, Time of Sampling: After Ridging		After Planting	
	In Row	Between	In Row	Between
0 - 2	295	241	337	341
2 - 4	216	157	190	221
4 - 6	154	125	151	150
6 - 9	118	115	124	139

*Randall, 1983.

New Slide Set Features High Forage Yields

A NEW SLIDE PROGRAM, "How to Grow High Forage Yields," is available for loan to vocational agriculture classes, adult farmer night schools, dairy or beef producer meetings, and other interested groups. Brillion Iron Works, Brillion, Wisconsin has gathered the latest information on producing 10-ton legume-grass yields from U.S. forage specialists and produced the 7-minute slide program.

The 25-slide presentation is available for free loan by writing on school or business letterhead to:

Brillion Iron Works, Inc.
200 Park Avenue
Brillion, WI 54110

Foundation for Agronomic Research Gains Support of New Contributors

TWO NEW CONTRIBUTORS have joined the growing number of supporters of the Foundation for Agronomic Research. The contributors are Terra Chemicals International, Inc., and the Far West Fertilizer Association.

Terra Chemicals International, Inc.

Terra Chemicals, with headquarters at Sioux City, Iowa, markets fertilizers, feed ingredients, crop-protection chemicals, seeds and other farm supply products directly to farmers through more than 100 retail farm service centers in the Midwest, South, and Southwest. The company also sells nitrogen products, phosphates and potash to wholesale customers throughout the United States. Terra produces nitrogen-based fertilizers and feed ingredients and is a net purchaser of most of the products it markets.

Far West Fertilizer Association

The Far West Fertilizer Association, with headquarters at Pasco, Washington, primarily serves dealers and fertilizer industry suppliers in Washington, Oregon, and Idaho. "But we recognize the increasing need for agronomic research geared for the future," notes Mr. Bob Bell of Toppenish, Washington, President of the Far West Fertilizer Association.

The Foundation for Agronomic Research (FAR) is a tax-exempt organization which sponsors research in total crop management systems for maximum economic yields. It is affiliated with the Potash & Phosphate Institute (PPI), with headquarters in Atlanta, Georgia.

"We are pleased to welcome these new contributors and are quite appreciative of the support they have pledged," emphasized Dr. R.E. Wagner, President of PPI and FAR. "While FAR is a young organization, founded only in 1980, it offers great promise and potential as a strong positive influence in agronomic research."

FAR now supports more than 50 agronomic research projects in the U.S., Canada, and other nations. The Foundation encourages all segments of the fertilizer, seed, pesticide, farm equipment, and other industries to invest in multidisciplinary crop production research.

Other organizations supporting FAR's program include: Agrico Chemical Company; AMAX Inc.; Chemical Enterprises, Inc.; C-I-L Inc.; Cominco American Incorporated; Dow Chemical U.S.A.; Duval Corporation; Estech, Inc.; Freeport Minerals Company; Frit Industries, Inc.; Great Salt Lake Minerals & Chemicals Corporation; International Minerals & Chemical Corporation; Kalium Chemicals—PPG Industries, Inc.; Mississippi Chemical Corporation; Potash Company of America; Potash Corporation of Saskatchewan; Royster Company; Sherritt Gordon Mines, Limited; Texasgulf Inc.; and The Sulphur Institute. ■

RESEARCH FAR EDUCATION

Potassium in Agriculture An International Symposium

POTASSIUM IN AGRICULTURE, An International Symposium, will be held July 7-10, 1985, at the Westin Peachtree Plaza Hotel, Atlanta, Georgia, USA. Cosponsors of the event are the Potash & Phosphate Institute (PPI), American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, National Fertilizer Development Center (NFDC-TVA), International Fertilizer Development Center (IFDC), and the Foundation for Agronomic Research (FAR).

More than 50 authorities from around the world will present papers on potassium production and marketing, potassium's role in plants, the behavior of potassium in soils, and potassium nutrition of the major crops grown throughout the world. Each speaker has authored a chapter for a book which is being published by the American Society of Agronomy. The book will be available at the symposium.

Participants in the symposium will have a choice of two post-conference tours. One will be to South Georgia, where visitors will see irrigated agricultural areas, the Coastal Plain Experiment Station at Tifton, Agrirama, Radium Springs, and general farming operations. The second tour will visit the National and International Fertilizer Development Centers, farming operations in the area, and Wilson Dam.

A banquet on Tuesday evening, July 9, will celebrate the 50th anniversary of the Potash & Phosphate Institute and honor member companies who have provided support through the years.

Numerous sightseeing, shopping, entertainment and dining attractions are available in the Atlanta area for participants, their spouses and guests.

Registration

The symposium registration fee will be \$140. This includes the proceedings, "Potassium in Agriculture," and planned events (a social hour on July 7 and a reception and banquet on July 9). Tour costs will be separate and optional.

To obtain an official registration form, accommodation information, a detailed program, and other facts about the symposium, write to: Potash & Phosphate Institute, 2801 Buford Hwy., NE, Suite 401, Atlanta, Georgia, USA, 30329. Ask for the Potassium in Agriculture Symposium packet. ■

Fall-Winter Fertilization Information

THERE IS A YEAR-ROUND need for practical, reliable agronomic information on fertilization practices. Listed here are some materials now available from the Potash & Phosphate Institute (PPI).

Quantity | **Cost**

"Facts Favor Fall-Winter Fertilization" tells of the advantages fall-winter fertilization offers for reducing soil compaction, planting earlier in the spring, building soil fertility, and saving on taxes. **Copies of the folder are 25¢ each (15¢ MC*).**

________ $ ________

"Fall-Winter: It's Time to Build Soil Fertility" tells why you should build soil fertility, how much P and K it takes and why fall-winter is a good time to do it. **Copies of the folder are 25¢ each (15¢ MC*).**

________ $ ________

"Invest in Productivity". This looks like "folding money" or an investment certificate with a message: Optimum fertilization returns dividends with *Maximum Economic Yields.* **Copies of this item are 10¢ each (5¢ MC*).**

________ $ ________

*The **MC*** symbol indicates Member Cost: For members of PPI, contributors to FAR, to university and government agencies.

Total cost $ ________

20% discount on orders of 1,000 or more copies of a single item

☐ **Payment enclosed**
☐ **Bill me, add shipping to invoice**

Name ________________

Address ________________

City ________ **State** ________ **Zip Code** ________

Organization or Firm ________________

Send to: Potash & Phosphate Institute, 2801 Buford Hwy., NE, Suite 401, Atlanta, GA 30329 (404) 634-4274

Will We Starve?

THIS INSTITUTE soon will celebrate 50 years of service to world agriculture. During those 50 years two issues have repeatedly surfaced – issues that seemingly conflict with one another:

(1) Surplus crop production in the U.S. The productive capacity of the U.S. farmer is awesome and often embarrassing. Congress wrestles with this "problem(?)".

(2) Impending world food crisis. The experts warn it is some 20 years away. Indeed, the National Academy of Science estimates that, today, more than 450 million people in the world are hungry and undernourished.

What an enigma! The average American lives amidst food surpluses, while much of the world experiences shortages. Will the world face massive starvation 20 years hence? 40 years hence? Ever?

We've heard all the terms – population explosion, green revolution, biotechnology, genetic engineering. Do they have the answer? Maybe.

The solution is intertwined with social, political, and biological environments. Much of the world faces the barriers of (a) senseless wars, (b) inept and corrupt government, (c) lack of incentives, and (d) economic constraints.

The U.S. farmer will become more involved with the world food picture. Whatever farm programs evolve, the concept of MAXIMUM ECONOMIC YIELD is a sound principle to follow – both domestically and worldwide – producing at the yield level that results in the least cost per unit of production.

Many experts warn that the future is bleak – in terms of population, resources, and environment. Others argue that this need not be – that the world CAN feed itself if it uses the marvelous tools science has given it to feed itself rather than to blow itself up.

Let's throw our resources behind the hopeful planners.

— J. Fielding Reed

Better Crops
WITH PLANT FOOD
Potash & Phosphate Institute
2801 Buford Hwy., N.E., Suite 401, Atlanta, GA 30329

Second-Class postage paid at Atlanta, GA