BETTER CROPS

with plant food

Spring 1985

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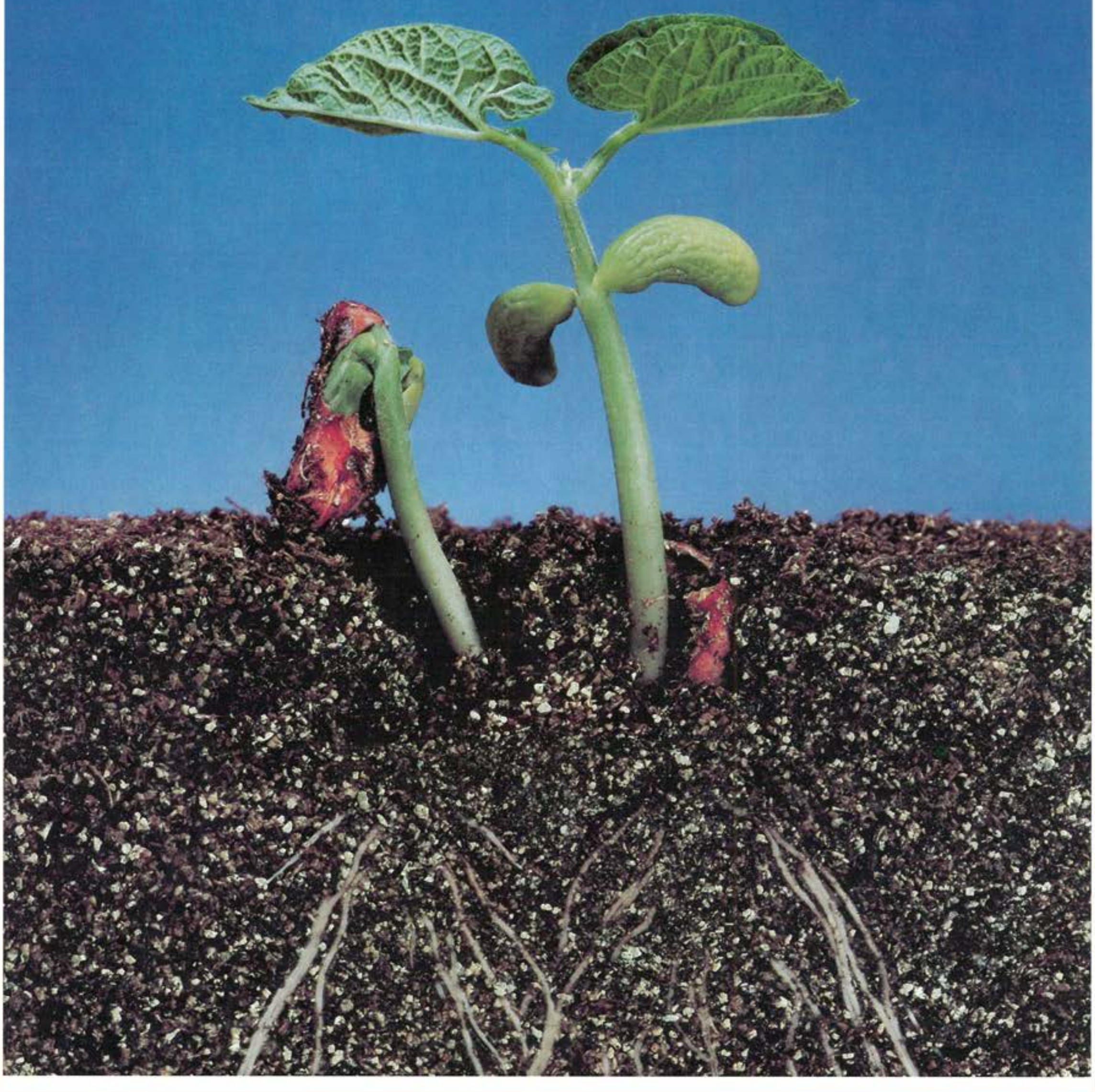

BETTER CROPS with plant food

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Our cover photo features an emerging bean seedling, courtesy of New York Agricultural Experiment Station.

A Farmer's Experience with Integrated Crop Management (ICM)

by J.E. Peill

Mr. J. E. Peill

IMPROVED, INTENSIVE, INTEGRATED crop management (ICM) is here to stay. Economics will force us to manage our crops for maximum economic yield, which we are convinced cannot be achieved with the conventional approach.

Over the past 10 years, we have gradually developed on our farm intensive management systems based on European high yield technology for wheat. We have managed to nearly double traditional yields of winter wheat, from 3 to 6 tonnes per hectare (45 to 90 bu/A). This yield increase has multiplied the profit margin by a factor of 5. While the bulk of our field trial work was with winter wheat, we also achieved 112 bu/A, with winter barley, and managed to increase our spring cereal yields substantially. Attempts to apply the same technology to soybeans and corn indicate they will also respond to intensive management.

While we are fully aware that much remains to be learned, we can now, based on our own experience, fully identify with the ICM principles responsible for the yield explosion in Europe over the past 10 to 15 years.

In addition to sound husbandry practices, such as proper drainage, pH adjustment, crop rotations, and soil-saving and compaction-avoiding land preparation methods, we place special emphasis on the following.

1. Establishment of a Good Stand

That involves location, variety and date-specific seeding rates, placing the seed as evenly as possible within the drill row, and the drill rows as close as possible in a well prepared, firm seed bed. Ideally, each plant should have symmetrical spacing for a maximum yield. Since the technology for such precision planting is not yet available, we are presently using a drill spacing of 10.5 cm (4 inches) and calibrate the seeder to achieve the specific planting rate in terms of viable kernels per unit area.

The goal is for a final head count of 550 heads per square meter (about 450 per square yard), with a large percentage of primary heads, depending on the genotype.

2. Weed Control

As in all crops, weeds must be controlled. Under Nova Scotia conditions, fall-applied Glean herbicide appears to be the most promising. Spring applications of herbicides often conflict with the ability to travel before the crop canopy protects the weeds.

3. Lodging Control with Plant Growth Regulators (PGR's)

The genetic yield potential of the presently available varieties is greater than the strength of the straw. Lodging, with the associated yield and quality reduction and increase in harvest costs, is a major threat which can be reduced or eliminated through diligent use of PGR's and tramlines assisted with appropriate timing of N applications.

In practice, we're not looking for yield increase from PGR per se. We find the use

(continued on next page)

Mr. Peill is a farmer located in the Annapolis Valley of Nova Scotia, Canada. He has also conducted research for Agriculture Canada, and has been a leader in introducing European high-yield technology for wheat into Eastern Canada.

economically justified if lodging is prevented only once in three years, through combine cost savings alone. Of course, quality and yield reduction are also usually associated with a lodged crop.

4. Disease Control

Unfortunately, conditions favoring high yields also provide a better environment for diseases. In our climate, mildew and septoria occur every year, albeit at varying degrees. *Fusarium, Cercosporella,* may occur in some; rust has, so far, not been a problem.

Most chemicals seem to do the job for which they are recommended. Timing and rates are critical, as is good coverage of the target area. Adequate volume of spray mixture is recommended, as well as sufficient pressure to penetrate the crop canopy. **Tramlines are a must for accurate application.**

Since fungus diseases usually occur in mixtures, it follows that broad-spectrum, preferably systemic fungicides, would be ideal. Europeans tend to use "cocktails" of fungicides to broaden the spectrum.

Research permits, however, did not allow us to use mixtures or even sequential treatments with different fungicides on a field scale, thus our experience with "cocktails" or sequential treatment with different materials is still very limited.

Fertility Program

The facts are that the plant requires a certain amount of nutrients at certain times. It matters not whether these nutrients come from the soil, from manure, or from the bag, as long as they are available when required.

Many present day fertility recommendations and resulting practices may not only perpetuate the mining process on some of our soils with dire long-term consequences, but simultaneously impose yield barriers which usually result in higher unit costs, thus impairing our competitive position.

Those of us having worked with ICM realize by now that nitrogen (N) is the primary engine which drives yield. Critical is not only the total amount, but the N availability at certain growth stages. If soil and climate do not provide the conditions for sufficient N storage and release at critical stages, carefully timed splitting of the total amount is advantageous, but only local research can provide that answer. Soil types, existing fertility levels and climate, as well as target yield, are the great variables.

The total amount of N for wheat can be calculated:

2.2 lb N = 12.5 lb protein in milling wheat, or 13.75 lb in feed grain.

Thus a 104 bu/A crop at 13.5% protein requires:

148 lb N/A for the grain
Assuming a 50/50 Harvest Index =
104 bu/A × .48 lb N/bu =
50, lb N/A for the straw

Total = 198 lb N/A (222 Kg N/ha)

N management requires special attention. We calculate the total N on the basis of the target yield requirements, grain plus straw, assuming that the N supply from the soil equals N loss.

For hard, red winter wheat, the yield target is 104 bu/A at 13.5% protein; the calculated N is then split into four applications.

71 lb N/A as soon as possible as vegetation begins.
27 lb N/A (approximately) at growth stage 30 (Zadok Scale)
27 lb N/A (approximately) at growth stage 37 to 39
71 lb N/A (approximately) at growth stage 55 to 57 (ear emergence)

General European experience with which we tend to agree allocates the different N applications approximately as follows:

1st N 100% yield oriented
2nd N 75% yield oriented, 25% protein oriented
3rd N 50% yield oriented, 50% protein oriented
4th N 25% yield oriented, 75% protein oriented

Table 1. Fertility requirements to produce targeted yields and provide for maintenance of soil fertility in the specified four-year rotations.

Crop Rotation	$N-P_2O_5-K_2O$ Crop Requirements* lb/A	–	Previous Crop Straw Credit lb/A	=	$N-P_2O_5-K_2O$ Soil Removal lb/A	×	Soil Depletion Factor 1.4	=	Balance Requirements
Wheat 109 bu/A	N: 176	–	31 (Soy)	=	145				
	P_2O_5: 75	–	11 (Soy)	=	64	×	1.4	=	90
	K_2O: 135	–	42 (Soy)	=	93	×	1.4	=	130
Barley 111 bu/A	N: 144	–	51 (Wheat)	=	93				
	P_2O_5: 59	–	13 (Wheat)	=	46	×	1.4	=	65
	K_2O: 111	–	93 (Wheat)	=	18	×	1.4	=	25
Corn 127 bu/A	N: 210	–	45 (Barley)	=	165				
	P_2O_5: 77	–	14 (Barley)	=	63	×	1.4	=	88
	K_2O: 152	–	84 (Barley)	=	68	×	1.4	=	95
Soybeans 52 bu/A	N: 260	–	82 (Corn)	=	178				
	P_2O_5: 83	–	26 (Corn)	=	57	×	1.4	=	80
	K_2O: 125	–	121 (Corn)	=	4	×	1.4	=	6

*Source: Doane's Facts and Figures. Note: Annual adjustments are made where target yields were not obtained or where plant residue was removed.

The best form of N is still to be debated. We use urea if incorporation is possible; ammonium nitrate, 34% for the first application; calcium ammonium nitrate, 27.5% for the subsequent treatments.

Table 1 is based on the European management system. It is an attempt to establish a nutrient balance for a four-year rotation for soils which have high-plus soil test readings for P and K. Fertility practices for P and K are based on targeted yield goals. Estimated crop removal is multiplied times 1.3 to 1.4, to determine P and K requirements for four-year rotation for corn, soybeans, wheat and spring grains. ■

Roger P. Humbert: 1916-1984

DR. ROGER P. HUMBERT, who served as Western Director of the American Potash Institute (now Potash & Phosphate Institute) died November 11, 1984. Dr. Humbert joined the Institute staff in 1960 and worked to further programs in the western region until 1968.

Dr. Roger P. Humbert

A native of Wooster, Ohio, Dr. Humbert earned degrees from Ohio State University and the University of Missouri. He was an internationally known soil scientist and specialist in sugarcane production. His many honors include the selection as ASA Fellow, the highest award given by the American Society of Agronomy.

Dr. Humbert is survived by his wife, Alice Cecelia Lutkey Humbert, of Los Gatos, California; their five children; and eight grandchildren. ■

Long-term U.S. Crop Yields Teach Lessons

By Werner L. Nelson

AVERAGE U.S. CROP YIELDS for corn, soybeans, wheat and alfalfa over the years show interesting upward trends. There are some lessons to be learned.

Corn. Yields continued to increase rather consistently up to 1972, except for the blight year of 1970. Since then they have been quite erratic because of greater weather variability. We all remember the very dry and hot year of 1983. However, the highs have tended to increase.

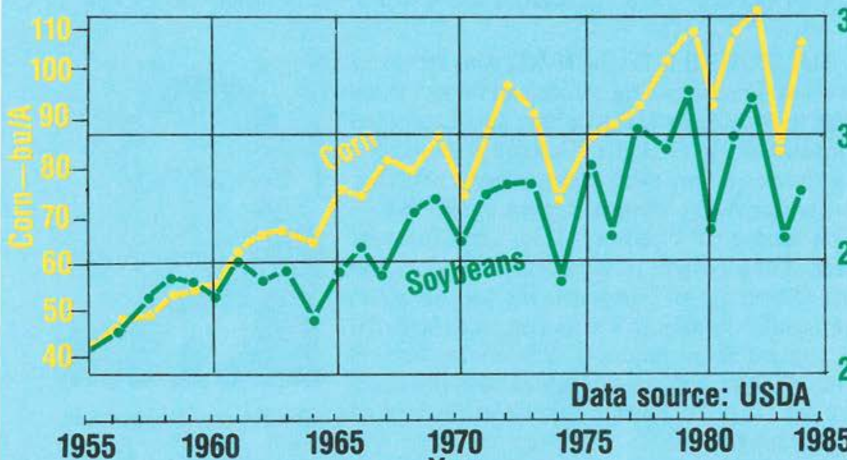
Are yields becoming more vulnerable to weather after reaching 100 bu? Not necessarily, because when "good" years come, yields tend to reach new highs. In "bad" years the lows tend to increase. **This shows farmers are doing a better job of putting the management package together to make the most out of the good years and to reduce the effects of weather in the poor years.**

Gross returns were only about $260/A in 1982 and 1983 (yield x average price). However, in 1984 farmers had the inputs in place to get a gross return of about $270/A. It takes faith, nerve and continually improving execution for farmers to keep coming back.

Soybeans. Yields continued to increase rather consistently up to about 1973. Since then, they have been erratic, but with highs and lows increasing up to about 1980. We could make the same comments as for corn.

Gross returns varied from about $175/A in 1982 to $200/A in 1983. In 1984, gross return was only about $165/A. Yield was increased but price was lower.

Figure 1. U.S. Average Yields, 1955-1984. Corn and Soybeans



Dr. Nelson is Senior Vice President of the Potash & Phosphate Institute (PPI).

Wheat. This shows a different picture. Since 1968, yields have not fallen below 30 bu except for 1974 because of a freeze. Based on the last four years, 1981 to 1984, yields are definitely moving up.

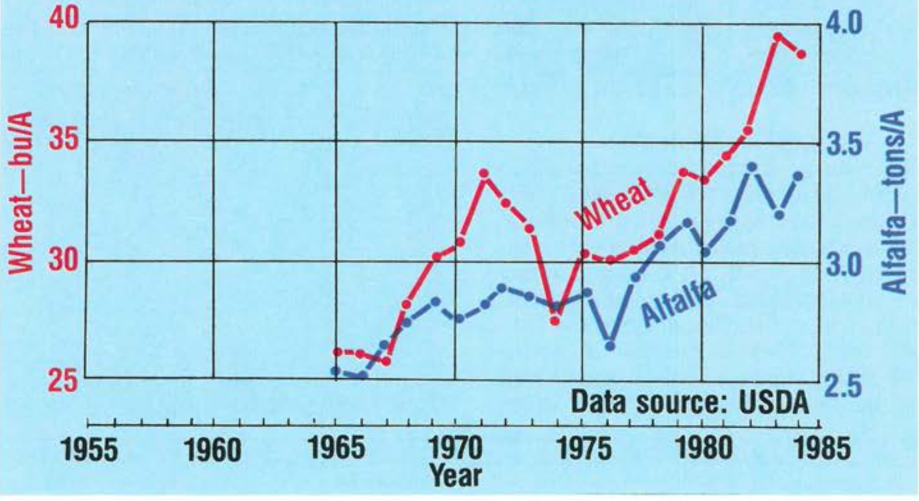
Implementation of variety, fertilization and other management practice information is relatively more limiting than with corn and soybeans. Are the yields there for the asking as management is improved? Agronomists think so.

Alfalfa. Yields have continued to increase even more consistently than wheat. Implementation of known production practices—cutting management, fertilization, liming, varieties and pest control is lower than for corn and soybeans. Weather has not been a dominant factor in average yields.

Some Lessons

- **Crop yields will continue to increase.**
- Farmers are further along in overall improved management systems (level of expertise) on corn and soybeans than with wheat and alfalfa.
- We can do much to make better use of the water and seasons we get.
- Improved management practices to increase yields result in higher water use efficiency—more pounds or bushels per inch of water.
- Yields are tending to reach new highs in "good" years and be higher in "poor" years.
- Farmers should manage their crops and soils for high yields each year.
- Scientists must continue to uncover yield limiting factors through maximum yield research.
- Since the potential increases for highs in a good year are greater than increases for lows in a poor year, loss of stability-of-yield is to be expected as yield levels increase.
- Farmers are more vulnerable financially as production input cost increases steadily and yield variability is greater from one year to the next.
- Plotting and studying yields on a state, province or marketing area could uncover helpful facts and stimulate new thinking on improved crop production practices and their implementation. ■

Figure 2. U.S. Average Yields, 1965-1984. Wheat and Alfalfa



In Arkansas

Breaking the 100 bu/A Yield Barrier in Soft Red Winter Wheat

By Robert Bacon, Bobby Wells, and Fred Collins

ALTHOUGH average yields of soft red winter wheat in Arkansas and the Mid-South are generally below 50 bu/A, current research has shown that yields as high as 118 bu/A are possible (**Table 1**). These high yields were accomplished with proper variety selection, pest protection, and high levels of fertility.

The studies were conducted at four locations in Arkansas and included the following factors: varieties, seed fungicidal treatment, systemic foliar fungicide, systemic insecticide, surface drainage by bedding, P fertilization, K fertilization, N rates and N application time. Different variables were chosen for each site to fit the unique conditions at that location.

Table 1. Maximum Wheat Yields Obtained by Various Management Inputs.

		Grain Yield (bu/A)		
Site*	Soil Texture	1982	1983	1984
1	Silty clay	97	100	104
2	Silt loam	89	118	117
3	Silt loam	86	101	101
4	Sandy loam	93	94	97

*see Table 5.

Fungicide Protection

The use of fungicides was found to consistently increase yields (**Table 2**). The full fungicide treatment, a combination of a seed treatment and a foliar spray, increased yields 7.3 bu/A averaged over 3 years at 4 locations. The use of a systemic foliar spray of Bayleton† (1982) or Tilt† (1983 and 1984) accounted for about 71% of this increase while Baytan† seed treatment was responsible for the other 29% of the increase. There was often an interaction between varieties and fungicide protection. Varieties that are genetically more susceptible to diseases, particularly powdery mildew, showed a larger yield increase with the use of fungicides.

Table 2. Effect of Fungicide Protection on Wheat Yields.

	Grain Yield* (bu/A)		
Site	Control	Foliar	Seed + Foliar
1	73	79	81
2	82	—	88
3	68	75	78
4	77	80	81

*3 year average (1982-1984)

Nitrogen Fertility

Nitrogen rates of 120 or 180 lb N/A were applied in the spring or 30 lb was applied in the fall with the remainder applied in the spring. The 180 N rate showed an average increase of 1.7 bu/A over the 120 N rate (**Table 3**). No difference between application times were seen.

Table 3. Effect of Nitrogen Rate and Application Time on Wheat Yields*.

		Application Time	
Site	N Rate	Fall/Spring	Spring Only
	(lb/A)	(bu/A)	
1	120	75	78
	180	79	79
2	120	84	82
	180	87	86
3	120	75	74
	180	73	72
4	120	78	78
	180	81	80

*3 year average (1982-84)

The authors have conducted wheat research in Arkansas during the past several years. Dr. Bacon is Assistant Professor and Dr. Wells is Professor, University of Arkansas. Dr. Collins is Senior Breeder, CR Seeds, Bay, Arkansas.

Phosphorus Fertility

Phosphorus was included at sites 2 and 3 because wheat grown on these silt loam soils has often shown visual responses to the addition of phosphorus fertilizers and because the soils tested medium to low in available phosphorus. Although there were some obvious vegetative growth responses to the addition of P at site 3, no increase in yield was seen **(Table 4)**.

The 3-year yield average from site 2 indicated a yield increase of 5.9 bu/A with the addition of 100 lb P_2O_5/A. However, this yield response was not consistent. An 11.5 bu/A yield increase was seen in 1982, while increases of 2.3 and 4.0 bu/A were indicated in 1983 and 1984, respectively. In 1982 at site 2 there was a strong interaction between P and time of N application. From those data it appears that under conditions of low P in the soil a fall application of N may be necessary for proper utilization of P fertilizers.

Table 4. Effect of Phosphorus on Wheat Yields with High Nitrogen Rates*.

Site	P_2O_5 Rate (lb/A)		
	0	50	100
	(bu/A)		
2	81	86	87
3	73	—	74

*3 year average (1982-84)

Other Factors

Variety selection was very important at all locations and years. As is generally true the "best" variety differed with locations and with years within locations. Variety performance also varied in response to fungicide use and time and rate of N application. Although there were little data on the use of the insecticide Furadan 4F†, preliminary information showed yield increases up to 12.7 bu/A. Little response of wheat yields was indicated by the use of beds for drainage or by the addition of potash fertilizer.

Producing Consistently High Yields

The maximum yields listed in **Table 1** were obtained from different combinations of input factors each year. Although some factors were obviously important for high yields, many interactions occurred among factors. The occurrence and magnitude of these interactions varied from year to year. However, there are certain combinations of inputs that gave consistently high yields **(Table 5)**. These management packages indicate that wheat yields close to 100 bu/A are possible on a regular basis.

Due to environmental differences, the proper management package for high wheat yields varies from field to field. In order to maximize yields, soil tests can be used to determine the need for phosphorus and potash. Selection of the proper variety, high nitrogen rates and fungicide protection, particularly with disease susceptible varieties, are necessary for high yields. ■

Table 5. Wheat Yields for Selected Management Packages over a 3-Year Period (bu/A).

Site	Management Inputs	1982	1983	1984	Mean
Keiser (1)	McNair 1003†, raised beds, full fungicide, 180 lb N using fall/spring application	94	90	97	94
Pine Tree (2)	McNair 1003†, full fungicide, 50 lb P_2O_5, 100 lb K_2O, 180 lb N using spring application	81	108	117	102
Jonesboro (3)	McNair 1003†, full fungicide, insecticide, 180 lb N using fall/spring application	80	94	93	89
Manila (4)	Nelson†, full fungicide, insecticide, 180 lb N using fall/spring application	91	83	97*	90

*Kibler replaced Manila as the 1984 site for this treatment.

†Mention of a trademark of a brand of a product does not constitute an endorsement nor an exclusion of similar products by the University of Arkansas Agricultural Experiment Station.

North Carolina

Multiple Cropping Boosts Silage Yields

By J.P. Mueller, J.R. Anderson, Jr. and J.T. Green, Jr.

ON MANY DAIRY FARMS in the mid- and upper-south, land is limited and the feed production goal is to produce a maximum of quality feed. Silage is usually the base forage in these enterprises. Although corn, sorghum and small grains are often used as silage crops, corn is preferred on the best soils because of its potential yield and quality. On less desirable soils, sorghum is frequently grown as the primary silage; sometimes sorghum is double-cropped following small grain for silage. Yields of corn planted behind small grain for silage have been poor because corn planting must be delayed beyond optimum planting periods.

In areas where corn is subject to periods of summer drought, farmers have sometimes resorted to planting mixtures of corn and sorghum as a hedge against dry weather since sorghum is more drought tolerant than corn. Previous studies have shown no advantage to using these mixtures over monocultures (one crop). If weather is favorable, corn alone will normally yield more digestible dry matter than the mixture; if severe drought stress occurs, a sorghum monoculture will usually yield more than mixture. Thus, replacing some of the corn stand with sorghum or vice versa is a simple one for one trade-off with little potential for synergism.

Nevertheless most previous work has not considered the potential of the sorghum component of a corn-sorghum mixture to regenerate after harvest. This means that a second, or ratoon crop of sorghum, could be harvested for silage if a sufficient population of sorghum plants remain viable after harvest. In the lower south where the frost-free period exceeds 225 days, grain sorghums are often ratooned successfully. Although the growing season in the midsouth is not sufficient to ratoon sorghum for grain, many areas have sufficient season (200-215 days) to ratoon a silage crop. **Therefore, our goal was to investigate the potential of multicrop silage systems involving corn-sorghum mixtures to be followed by small grains.**

From 1981 to 1984 we studied various aspects of the above concept in four separate tests at three locations. Three of the four tests were irrigated.

Our basic cropping plan was to:

1) Target planting corn and sorghum together on April 15 (this is a compromise between optimum dates for corn and sorghum).
2) Harvest the first silage crop about the first week in August.
3) Ratoon sorghum plants for a second harvest in mid to late October.
4) Plant small grain immediately after ratoon harvest.
5) Harvest small grain silage crop the following spring prior to April 15.

Hybrid Selection

During the course of our study we evaluated several different corn and sorghum hybrids for "fit" to our proposed system. We needed an early maturing corn, yet one with good yield potential. Important characteristics for the sor-

The authors are with North Carolina State University.

Table 1. Component yields of corn-sorghum mixtures and their monocultures in a multicrop silage system including rye.

Treatment (plants per acre)		First Crop			Sorghum		
Corn	Sorghum	Corn	Sorghum	Total	Sorghum Ratoon	Rye	Total
		Tons/A (65% moisture)					
1) 17,000	21,000	17.4	3.5	20.9	3.4	5.8	30.1
2) 22,000	19,000	17.7	2.6	20.3	3.3	5.8	29.4
3) 23,000	14,000	19.8	2.3	22.1	2.8	5.8	30.7
4) 23,000	21,000	20.0	2.9	22.9	4.2	5.8	32.9
5) 20,000	19,000	18.2	4.4	22.6	6.7	5.8	35.1
6) 26,000	—0—	25.9	—	25.9	—	5.8	31.7
7) —0—	80,000	—	17.4	17.4	5.7	5.8	28.9

Irrigated test in Wake County, NC, 1983. Corn and sorghum hybrids used were XL32aa and Savanna5 (treatments 1-4, 6, 7); treatment 5 was XL32aa corn + 102S sorghum.

ghum companion centered around ratooning ability.

The main advantage of this system was its potential to produce a respectable ratoon harvest. Mere persistence of sorghum is enough in the first crop because the goal is to produce an overwhelming corn dominance. This is desirable because most studies show that sorghum silage has only about 80% of the feed value of corn silage. We were able to produce a corn dominant first harvest in 3 of 4 studies. Probably the best type of sorghum for this system is an intermediate forage sorghum with good ratooning ability. Grain types, intermediate and giant types were evaluated in our studies.

Plant Populations

Target plant populations for corn-sorghum mixtures were near 40,000 plants per acre. Monocultures were planted at normal suggested populations for the hybrid; corn 24-28,000 plants per acre and sorghum 45 to 80,000 plants per acre. First-crop corn yields and ratoon sorghum yields were highest when corn populations were between 20 and 24,000 plants per acre, and sorghum populations at least 20,000 plants per acre. See **Table 1**.

Row Spacings

Several planting patterns were used during these studies. Corn and sorghum rows were planted separately to avoid excessive intrarow competition and also to facilitate measurements. The most practical pattern for the mixtures involved planting a twin row of corn and sorghum approximately 8 inches apart with 28 inches between each set of twin rows. We found that this pattern reduced competition and still could be harvested with a single row silage chopper. Other row spacings studied included alternative 18 inch rows of corn and sorghum and a single row containing both corn and sorghum. Usually, the standard monocultures were planted on standard 36 inch rows.

Soil Fertility

Obtaining proper levels of soil fertility is very important to an intensively managed system where two crops are removed in the same growing season. For this reason we tailored soil test recommendations to meet the demands of the system. In all cases, applications of fertilizer elements N, P, K, S and micronutrients were based on soil test results, but usually applied in excess of standard soil test recommendations. At all of our sites, soil tests revealed very high levels of P and moderate levels of K. Based on estimates of crop removal, basic rates of plant

(continued on next page)

nutrients applied were:

	N	P_2O_5	K_2O	S
	lb/A			
First Crop	200	100	280	50
Ratoon	150	0	150	0
Small Grain	120	50	100	0

Weed Control

In all our studies we used a seed safener on the sorghum seeds so that atrazine and alachlor or metolachlor could be used without damaging the sorghum seedlings. We found this to be a safe and very effective program. Any escaping weeds were controlled with a post-directed application of linuron. In addition, if germinating weeds were observed at the first harvest in August, they were eliminated by a stubble spray with paraquat. Weed control was excellent during these studies using the above system.

Ratooning Versus Planting a Second Crop of Sorghum After Corn Harvest

In the first year of our study we compared ratooning the sorghum from a corn-sorghum mixture with planting sorghum behind a corn monoculture. Ratooning has several apparent advantages over planting seed. A physiological advantage of the ratoon is that the plant is able to begin growth (regrowth) on the day of harvest; the plant is already established with a well developed root system and regenerative buds ready to produce tillers immediately. In contrast, when sorghum seeds are planted, the seeds must first germinate and then proceed through several physiological stages of development before they are able to accumulate significant amounts of dry matter yield. In our study the ratooned sorghum averaged over 70% more yield at the second harvest than sorghum that was planted immediately after the first harvest.

Another obvious advantage to ratooning is economic; the cost of an additional planting operation (which may include additional tillage) compared with a single planting operation ($10 to $20 per acre additional cost).

We found that ratoon crops were sometimes subject to heavy insect pressures. In 2 of 4 tests ratoon crops received some insect damage, mainly from fall armyworms. Thus, ratoon crops require intensified scouting during the initial regrowth periods so that insects can be eliminated before significant damage is inflicted.

Small Grains

During the first year of the study rye, oats, wheat and barley were planted following a ratoon harvest of sorghum. Because we wanted to keep the system continuous (i.e., cycling in precisely the same manner on the same land), rye was selected as the spring silage crop. Rye was the only small grain capable of accumulating 4-7 tons of forage by the first week in April; at this time it was in late-boot to early head emergence stage and could be cut and wilted for silage. In addition, quality of the forage was still acceptable. Wheat or barley could be used as the spring silage crop with an increase in the yield and quality of the silage; however, the harvest would be made too late to keep corn in the multicrop silage system. If wheat or barley are selected, monoculture sorghum could be planted behind the small grain harvest.

High Yields

Even though our tests were not always planted on the "best" soils and were subjected to various stress conditions, total system yields of the best treatments were above 35 tons/A. We believe that total system yields in excess of 45 tons/A are possible. The main yield advantage of the multicrop system is the ability of the sorghum component to produce a high yielding ratoon crop. We found no advantage of corn-sorghum mixtures over corn monoculture in a single cut system. In some cases a sorghum monoculture may yield as much or more as a corn-sorghum mixture, but quality is reduced when corn is excluded from the system.

Some "Trade-Offs"

Advances in planting and harvesting equipment may be necessary before multiple cropping systems such as reported here are practical for farm use.

Also, farmers should be aware of

This corn-sorghum mixture is planted in 18-inch alternating rows.

potential "trade-offs", such as reduced silage quality, compared with monocultures. Intensified management will be required for precise timing of planting and harvesting.

Summary Points

In these studies:

- There was no yield advantage of corn-sorghum mixtures over corn monoculture in a single-cut system.
- In 3 of 4 tests, corn was the dominant species in the first crop, comprising 60-80% of the forage yield.
- Rye was the most compatible small grain with the continuous multicrop silage system used in these studies due to its early spring production of herbage.
- In the mid-south, total corn-sorghum-small grain system yield potential should be in excess of 45 tons/A even though highest yields obtained have been 35 to 37 tons/A.
- Sorghum population in the first crop should probably be no less than 20,000 plants per acre; desirable corn population appears to be in the range of 20 to 24,000 plants per acre.
- Ratooning sorghum from corn-sorghum mixtures yielded over 70% more herbage than sorghum planted immediately following corn harvest.
- Selection of compatible corn and sorghum hybrids appears to be important to high yields. Vigorous, intermediate forage sorghums with rapid recovery after harvest and high yielding ability in the ratoon crop are essential to the system.
- Multicropping silage systems similar to the ones used in these studies have potential for improving silage yields in many areas of the southeast where land resources are limited and intensive management is practiced. ■

Studies Indicate Aluminum Not a Cause of Grass Tetany

By D.L. Robinson and J.H. Cherney

IN TEMPERATE REGIONS of the world ruminant animals commonly suffer from grass tetany, or hypomagnesemic tetany, when grazing cool-season grasses during cold, wet conditions. The tetany results from a deficiency of available magnesium (Mg) in the diet and frequently causes death of the animals.

Research conducted in Louisiana revealed very high aluminum (Al) levels in grass and rumen content samples and implicated Al involvement in the development of grass tetany.* Subsequent research was initiated to determine the source of Al in forage and rumen content samples. The basic approach was to compare mineral analysis of grazed and ungrazed or washed and unwashed forage samples to determine if soil contamination on the forage surface was the Al source.

In Louisiana an annual ryegrass pasture was sampled throughout the winter season to identify changes in forage mineral analysis as related to grazing and climatic changes. Samples were collected from the grazed pasture and from fenced areas that were ungrazed but were hand clipped periodically to simulate grazing. Samples from both areas were divided and half of each sample was washed to remove soil contamination while the other half was not washed. Titanium (Ti) was analyzed along with other minerals since plants are not known to absorb Ti, and it was therefore used as a soil indicator.

Figure 1 shows very high Al levels in grazed, unwashed forage samples during the tetany season. At the same time samples from the ungrazed areas remained very low in Al concentration. The Ti levels very closely paralleled the Al levels indicating the Al source was soil contamination on the forage rather than Al uptake by the plants. The Ti analysis also showed that the washing procedure did not remove all the soil contamination from the forage.

A similar study was conducted at Wageningen, The Netherlands, with 9 perennial ryegrass pastures that were rotationally grazed by 60 Friesian cows. The pastures averaged about 4.5 acres and were effectively grazed in 4 days. Cages were placed in each pasture to provide ungrazed areas. Forage samples were collected from grazed and ungrazed areas before and after the cows were allowed into each pasture. Furthermore, samples were collected from the rumen of 2 fistulated cows on the last day of grazing in each pasture.[1]

Forage Al levels remained low throughout the sampling period in the pastures and in the cages before grazing occurred. Levels of Al were usually below 100 ppm. After grazing occurred, the Al levels remained low in the cages but were as high as 400 ppm in the grazed areas during most of the study. However, during the grass tetany season

***Editor's note: A related article on grass tetany appeared in the Spring 1981 issue of *Better Crops with Plant Food*.**

[1]Robinson, D.L., O.J. Hemkes, and A. Kemp. 1984. Relationships among forage aluminum levels, soil contamination on forages, and availability of elements to dairy cows. Neth. J. Agric. Sci. 32:73-80.

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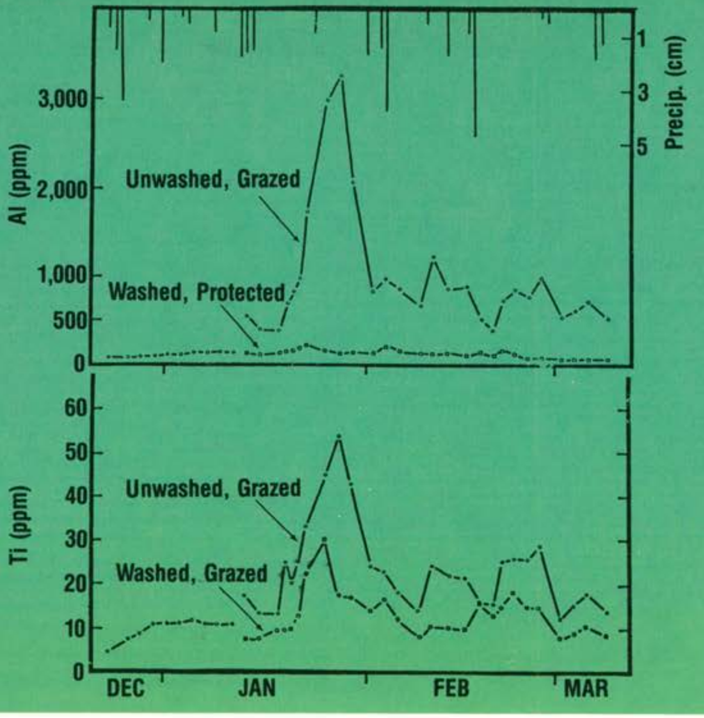
in October, Al levels exceeded 1,600 ppm after grazing occurred. Rumen content samples contained about 400 to 1,000 ppm Al prior to the grass tetany season but exceeded 2,200 ppm during October.

In both studies the high Al levels in forage samples occurred in association with cold, wet weather conditions when forage growth occurred slowly and grazing pressure was very high. This combination of conditions caused increased soil contamination on the forage and resulted in high Al values. The same conditions are also associated with the occurrence of grass tetany.

To determine if soil ingestion was involved in the incidence of grass tetany, a nutrient balance study was conducted with 6 Friesian cows in digestion stalls at Wageningen. All feed, drinking water, feces, and urine was analyzed to measure total intake and excretion of mineral elements. Mineral balance in the cows receiving a basic ration was compared to mineral balance when the cows were fed the same ration plus 2.2 lb of soil per day.

Magnesium and Calcium (Ca) retention by cows receiving the basic ration was 0.3 and 2.4 grams per day, respectively, but increased to 2.5 and 7.4 grams per day when soil was added to the ration. Addition of soil to the ration had no significant effect on phosphorus (P) or potassium (K) retention by the cows. These results indicate that the soil provided supplemental Mg and Ca to the ration and did not adversely affect mineral nutrition in the animals. Because soil contamination on the surface of forages was the source of high Al levels associated with the incidence of grass tetany, and since soil ingestion had no adverse affect on Mg or Ca balance in the animals, it appears that Al does not contribute to the development of grass tetany. ■

Figure 1. Seasonal Variation in Aluminum (Al) and Titanium (Ti) Concentrations in Annual Ryegrass Pastures and Daily Precipitation (Louisiana).



Soil Test Summary for P and K

SOIL TEST summaries call attention to broad nutrient needs and help underline the need for samples on a field basis to identify specific needs.

The summary maps show the approximate percentage of soils analyzing medium or less in phosphorus (P) and potassium (K) as tested by university laboratories. Exceptions are Wisconsin, where a combination of samples from state and private labs was used; and California and Illinois, where data from private labs were used. The most recent summary available was obtained. "Medium" was selected as an arbitrary break point realizing that interpretation varies among crops, soils and states.

Note the relatively high percentage of soils west of and along the Mississippi River as well as in the South which test medium or less in P. Conversely, a relatively high percentage of soils along or east of the Mississippi River test medium or less in K. This, of course, is related to soils, climate and cropping patterns.

PHOSPHORUS SOIL TEST SUMMARY
Percent Testing Medium or Less

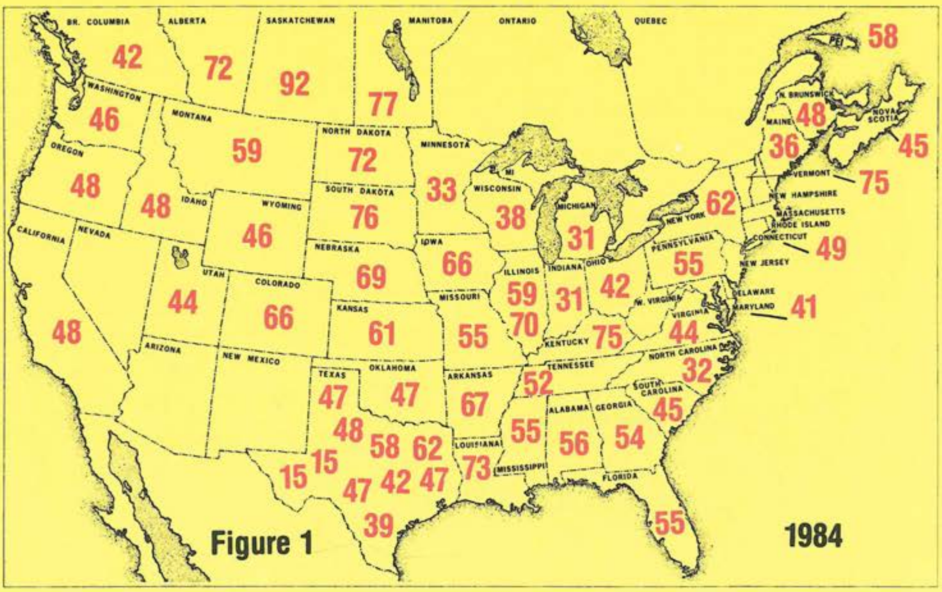


Figure 1

If 50% of the people in North America had inadequate vitamin C, we would get excited and do something about it. Should not we feel the same urgency about the relatively high percentages of soils testing medium or less in P and K?

High soil tests. It is generally recognized that as we strive for high yields, soils should test in the high range for P and K.

Crop production entails considerable risk because of such factors as economics, floods, droughts, and pests. Soil fertility is easily controlled and having the soil test level high in P and K helps reduce the risk of fertility limiting yields and profits.

A high soil test gives greater flexibility in fertilizer placement, soil sampling, time of application and rates. The main need is to get the replacement nutrients on somewhere in the rotation.

Field variability. When a field tests medium in P or K, parts of the field test low, medium or high. Hence, yield is being limited in some areas. Spot sampling and spot treatment is one possibility. Another is to fertilize to bring the field soil test up to high so there will be fewer spots testing low and medium.

In today's climate a farmer must apply nutrients where they will be used most effectively. Soil tests are a tool to help in his decision. ■

POTASSIUM SOIL TEST SUMMARY
Percent Testing Medium or Less

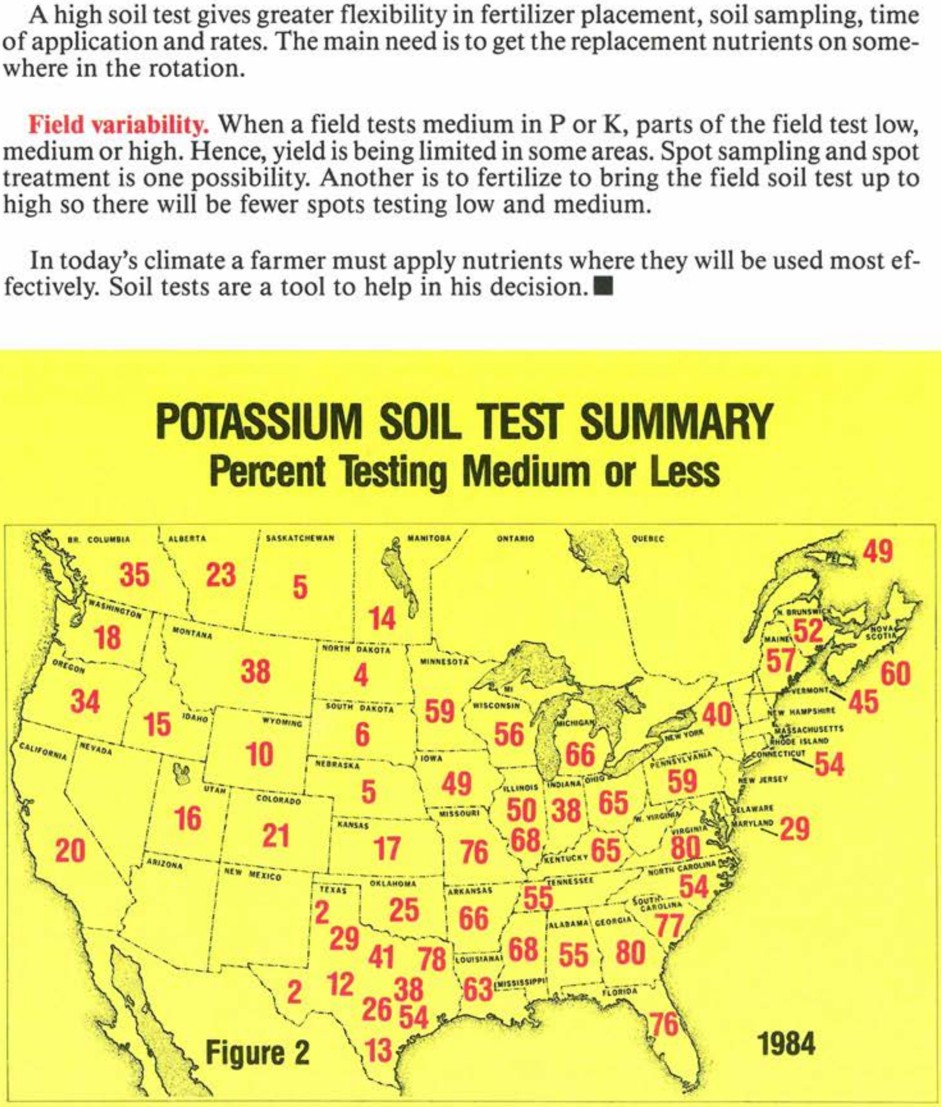


Figure 2

Soil Test Summary for pH

A SOIL pH satisfactory for plant growth varies with crop and soil. An arbitrary break point below pH 6.0 was selected for use in this survey. The data were obtained in the same manner as for P and K.

Note the relatively high percentage of soils east of the Mississippi River which test less than pH 6.0. This is related to lack of liming as well as to climate and soils. However, there are wheat fields in the Great Plains where N fertilizers have been applied for many years and yield limiting acidity has developed.

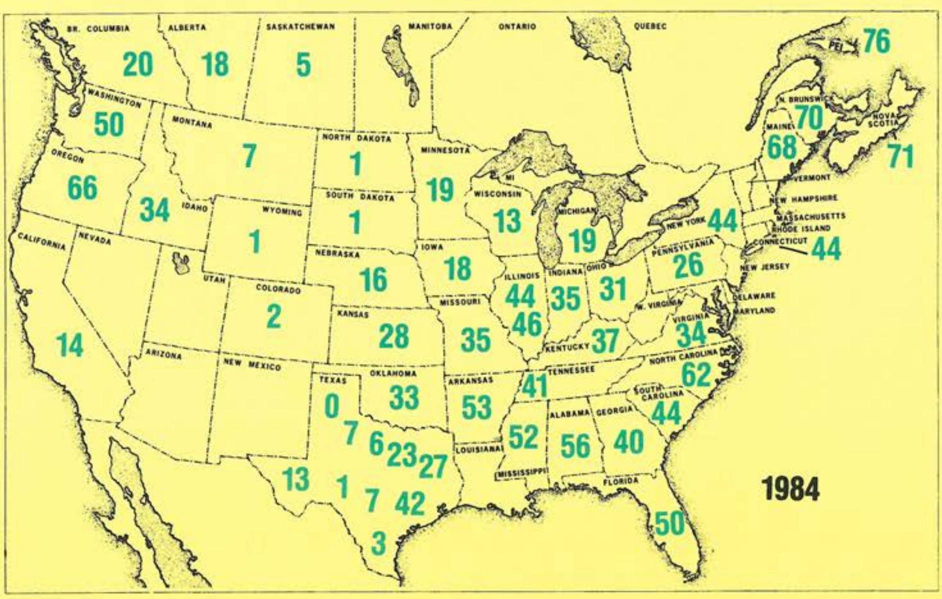
Lime is called the **"Foundation of crop production" or "workhorse in the soil".** Acid soils:

- Limit crop growth, yield and quality.
- Reduce availability of such nutrients as P, Mo.
- Permit elements such as Mn, Fe and Al to be in toxic levels.
- Reduce effectiveness of certain herbicides.
- Reduce return from other inputs such as seed, fertilizer, labor, land, machinery, pest control, tillage, water.

There may be considerable variation within a field and one testing pH 5.8 may have spots testing 5.0 to 5.5. Too, when a band of fertilizer is applied, the pH may drop a whole unit around the band.

Conservation tillage. With N applied on or near the surface, acidity can develop rapidly, affecting herbicide performance and crop yield. Hence, soil sampling every two or three years to a depth of two to four inches is particularly essential in determining lime needs in this special situation. ■

pH SOIL TEST SUMMARY
Percent Testing Below pH 6.0



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 prior to June 10, and $175 after June 10, 1985. 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. ■

For Western Canada?
Intensive Management of Winter Wheat

By D.R.S. Rourke and E.H. Stobbe

INTENSIVE cereal management (ICM) is a management philosophy where the objectives are to reduce unit production cost by optimizing production inputs. Crop yields will be maximized with the net effect of increasing profits.

Sounds great, but is ICM a reasonable, reliable approach in the Prairie Provinces of Canada, where many successful farming operations have relied on being extensive rather than intensive? While Prairie farmers are among the most efficient in terms of grain production per unit of labour, they are relatively inefficient in terms of grain production per unit land area. Perhaps it is time to reevaluate Western Canadian grain production potentials.

Environmental Constraints

Are the Prairies too dry for ICM?

Moisture availability is probably one of the most important environmental constraints on the Prairies. Annual precipitation is quite variable over the Prairie region, from a high of 550 mm (22 inches) in southeastern Manitoba to a low of 300 mm (12 inches) west of Swift Current.

Soil moisture status maps developed by Dunlop & Shaykewich illustrate the poorest soil water status (mm) which can occur with a 25% risk. (**Figure 1**). In one out of four years, 50 mm (2 inches) of irrigation water would be required to eliminate water stress in spring wheat in the majority of the province. It is estimated that winter wheat due to its early spring growth, early maturity, and extra moisture available from snow trap may have as much as 50 mm more moisture available. The 50 mm moisture advantage winter wheat has compared to spring wheat would allow winter wheat to grow in three out of four years without moisture stress.

Are the Prairies too dry for ICM?

Not necessarily.

Suitability of Winter Wheat for ICM in the Prairies

Besides improved moisture utilization, winter wheat also has other attributes which make it the ideal crop for production using ICM. For example, winter wheat has a longer growing season than spring wheat which can increase reproductive capacity. Early growth in the spring allows winter wheat to better utilize the long days of May and June to maximize the assimilation rate. While winter wheat can still suffer from heat stress, due to its earlier maturity, the period of heat stress is shorter and often coincides with less critical stages of development than normally found with spring wheat.

Until recently the production of winter wheat has been limited to the more moderate climates of southern Alberta and the southwest corner of Saskatchewan. However, advances in the agronomy of winter wheat, primarily by using

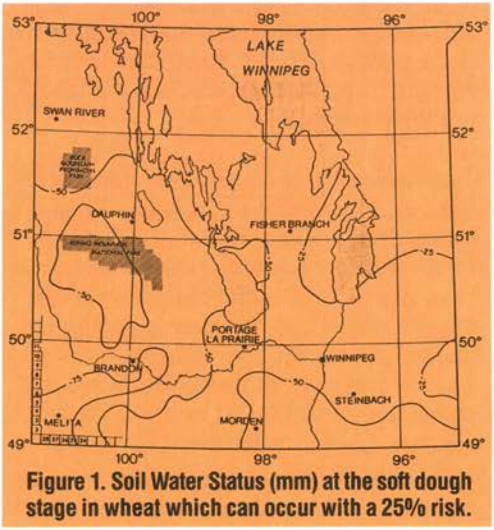


Figure 1. Soil Water Status (mm) at the soft dough stage in wheat which can occur with a 25% risk.

The authors are with the Department of Plant Science, University of Manitoba, Winnipeg.

Table 1. Effect of nitrogen x plant growth regulator on yield of Norstar winter wheat.

Plant Growth Regulator	Nitrogen Treatment (Kg/ha)				
	0	90	80/40	180	90/30/60
	Grain Yield (Kg/ha)*				
Cycocel	5,443	5,369	5,871	5,187	5,778
Check	4,743	4,755	4,477	4,505	4,871

*All treatments protected with fungicides.

the standing stubble of the previous crop to trap snow, have allowed the creation of a micro-environment in which winter wheat survival is virtually guaranteed.

Excellent winter survival combined with unique capability to minimize the limitations of our climate give winter wheat the potential to be the most highly productive crop in the Prairie Provinces.

Developing an Intensive Cereal Management Package

ICM winter wheat trials were initiated in 1981 by the University of Manitoba, Department of Plant Science at Minto and Portage la Prairie Field Stations. These trials have studied the effect of cultivars, nitrogen fertilizers, plant growth regulators (PGR), fungicides, seeding dates, seeding depth and their interaction on the yield of winter wheat. The key factors for maximum yields are:

1) **Cultivar choice.** Even using zero tillage techniques, the highest yields were obtained from the most cold hardy cultivars, such as Norstar. Less hardy cultivars often had poor yields under zero till and were completely winter-killed under severe micro-climate, conventional tillage. Winter hardy cultivars have the potential to produce yields up to 7.5 T/ha (112 bu/A) in Manitoba.

2) **Fertilizers & Plant Growth Regulator.** Using conventional management, high fertilizer rates often causes lodging resulting in poor yield response and difficult harvest conditions. Applications of plant growth regulators in an ICM program in Manitoba have allowed substantial yield enhancement, particularly when nitrogen applications are partitioned to fit the needs of the plant. **Table 1** illustrates the effect of nitrogen rate and timing in combination with plant growth regulator on the yield of Norstar winter wheat. The results of this trial show that without the Cycocel, there was no benefit from adding additional nitrogen. (Soil tests indicated high levels of nitrogen in the soil.) Nitrogen applications without Cycocel increased lodging and resulted in lower yield in many cases. However, split applications of nitrogen were found to give economic yield increases when applied in combinations with Cycocel. The 80/40 split, 80 kg/ha applied in early spring followed by 40 kg/ha applied at first node stage in conjunction with Cycocel resulted in the highest yields.

3) **Fungicides.** The advantages of using foliar fungicides to control diseases in winter wheat were demonstrated during 1983 **(Table 2)**. Tanspot and Septoria

Table 2. Effect of mancozeb on yield of Norstar winter wheat.

Location	Principle diseases	% Yield increase
McGregor 1983	Tanspot & Septoria	27%
Minto 1983	Stem rust	63%

(continued on next page)

glume blotch were the major diseases at McGregor. Yields were increased 27% when mancozeb was applied to Norstar as compared to the untreated plots. Stem rust was the major disease at Minto. Grain yield was 63% higher than the checks when mancozeb was applied to control stem rust.

4) **Application of post seeding treatments.** The use of ground application equipment employing tramlines was found to be a cost effective method to ensure treatments are applied at the optimum time and uniformly.

The use of these key inputs as well as other good management practices has allowed record winter wheat yields in Manitoba this past year. On an 80 acre field at Minto, we were able to obtain 4.0 T/ha (60 bu/A) of Norstar winter wheat. This was an exceptionally good yield considering this field received only 93 mm of rainfall after the last snowfall and no rain during the last 4 weeks of development. Farmers at Portage la Prairie where rainfall totals and distribution were more favourable were able to produce up to 5.4 T/ha (80 bu/A). More intensive trials at Portage showed that yields up to 6.6 T/ha (98 bu/A) are possible.

Conclusion

ICM has the potential to increase the yields of winter wheat in Western Canada. The areas of the Prairies with soil water deficits at or near zero will have the greatest potential to profitably use ICM. In the future top winter wheat yields of 5 to 8 T/ha (75 to 120 bu/A) will not be uncommon in these areas.

However, Intensive Cereal Management will only be implemented and profitable if two criteria are met. Firstly, ICM on the Prairies will have to be a flexible system, a system where the level of inputs will be based on the cropping conditions within a single year. Benefits from ICM will not be achieved by controlling diseases which are not present or by adding nitrogen beyond the climatic limitations imposed on the variety. The second criteria is that localized research will be required to develop cultivars and specific recommendations to maximize the net returns under our environmental constraints.

While our research has allowed us to develop an ICM package for winter wheat, it has also shown that we are far from reaching the potential for ICM to maximize winter wheat yields on the Prairies. ■

Top Yields Also Most Profitable in Landmark Agro High Yield Wheat Club

THE 1984 results obtained by 13 growers in a Manitoba, Canada, high yield wheat club are summarized in the table below. The club is sponsored by Landmark Agro Ltd., of Landmark and Steinbach, Manitoba, with some assistance and financial support from suppliers.

Grower	Acres	Yield bu/A	Fertilizer Costs $/A	Total Costs $/A	Gross Profit $/A	Net Profit $/A	Unit Cost $/bu
Average (13 in club)	70	53.8	42.29	163.50	227.94	64.44	3.12
Top	52	75.5	48.24	167.28	313.33	146.05	2.22
Low	100	42.5	33.00	161.27	182.75	21.48	3.79

Note that the fertilizer cost for the top yield was only $5.95 more per acre than for the average yield. The cost to produce each bushel was only $2.22 at the top yield level, compared to $3.12 for the average and $3.79 for the low yield.

The member with the top yield in 1984 also achieved the highest net profit per acre. The 1982 winner also achieved the greatest net profit per acre. In the extremely dry year of 1983, the grower with the second best yield recorded the best net profit per acre. ■

Four Individuals Appointed To Institute Advisory Group

FOUR new members and a new chairman have been named to the Advisory Council of the Potash & Phosphate Institute (PPI), succeeding other agricultural leaders whose three-year terms were completed at the end of 1984.

The new members are: **Dr. Donald A. Holt, Dr. Thomas A. Kerby, Dr. John F. Marten**, and **Dr. Eugene C. Sample**. The new Chairman, **Mr. Marty Thornton**, is Vice President and Senior Farm Manager, Peoples Bank of Bloomington, Illinois. He succeeds Dr. W.J. Moline, Director of Arkansas Cooperative Extension.

"Since it was initiated in 1976, the PPI Advisory Council has served in a unique and productive function," said Dr. R.E. Wagner, President of PPI. "Our contact with the Advisory Council provides a two-way channel for these agricultural leaders and the Institute to communicate and interact. Just as interdisciplinary involvement is beneficial in research, it can stimulate greater results in other programs."

• **Dr. Donald A. Holt** is Director, Agricultural Experiment Station, and Associate Dean of Agriculture at the University of Illinois, Urbana-Champaign. Previously, Dr. Holt was Head of the University of Illinois Agronomy Department. He was a faculty member of the Purdue University Agronomy Department from 1967 to 1982. Dr. Holt's research interests include environmental physiology of crops, computer simulation of crop growth, and forage crop management.

• **Dr. Thomas A. Kerby**, Extension Cotton Specialist, University of California-Davis, is currently working at the USDA Cotton Research Station at Shafter, California. His responsibility is to provide leadership and coordination to the applied cotton research program in California as well as serve as liaison between the University, growers, chemical dealers, and allied industries. Dr. Kerby is a native of New Mexico and holds a B.S. degree from Brigham Young University, and M.S. and Ph.D. degrees from the University of Arizona.

• **Dr. John F. Marten** is Staff Economist of *Farm Journal* magazine and devotes substantial time keeping abreast of current agribusiness and farming practices and serving as a consultant. Major activities include outlook analysis and evaluation of current agricultural trends. Dr. Marten, who lives near West Lafayette, Indiana, holds a B.S. degree from Iowa State University and M.S. and Ph.D. degrees from Purdue University. He was a charter member of the PPI Advisory Council and is the first three-term member. Dr. Marten has co-authored PPI publications.

• **Dr. Eugene C. Sample** is Chief, Ag Research Branch, National Fertilizer Development Center (NFDC-TVA), Muscle Shoals, Alabama. He was employed by the Tennessee Valley Authority (TVA) in 1956 as a chemical analyst in the Soils and Fertilizer Research Branch. The research group he worked in made significant contributions to understanding the reactions of phosphate fertilizers in soils and their effects on plant nutrition. Dr. Sample received the M.S. and Ph.D. degrees in Soil Science at North Carolina State University. ■

Breeding and Management Improve Quality of Switchgrass Pasture

By Bruce Anderson, Ken Vogel, and John Ward

LIVESTOCK PRODUCERS north and east of the central Great Plains rely on cool-season grasses like smooth brome, orchardgrass, tall fescue, and timothy for pasture. Cool-season grasses can be highly productive and nutritious during spring and fall, but during summer they are less productive and low in quality.

Switchgrass is an erect, warm-season perennial grass native to this area. When switchgrass pastures are grazed during summer and cool-season grass pastures are grazed during spring and fall, livestock gains are higher than when cool-season grasses are grazed during the entire grazing season (**Table 1**).

Table 1. Daily gain of heifers during summer following spring grazing of tall fescue at Mt. Vernon, MO.

Grass	ADG
Tall fescue	0.92
Switchgrass	1.21

Matches et al. 1975-78. SWC Res. Rep. UMC

Historically, switchgrass has been difficult to establish because of slow seedling growth and weed competition. Today, switchgrass can be established in one growing season when atrazine herbicide is used to control weed growth (**Table 2**).

Although using switchgrass for midsummer grazing will improve cattle gains, the digestibility of switchgrass is lower than that of cool-season grasses harvested at similar stages of maturity. Digestibility measures the energy value of a grass, and the more digestible grasses usually produce faster rates of gain.

In 1973, a study was initiated in eastern Nebraska to improve switchgrass digestibility by plant breeding. Over 2,000 switchgrass plants that were similar in maturity and origin to 'Pathfinder' switchgrass were established in a selection nursery. Each of these plants had digestibility measured using a test-tube technique called *in vitro* dry matter disappearance (IVDMD). This technique uses rumen fluid collected from cattle to digest a sample of forage. Twenty-five healthy, vigorous plants were identified that had high digestibility. Another 25 vigorous plants with low IVDMD also were identified to help grass breeders estimate the genetic variability of digestibility in switchgrass. After the high and low IVDMD plants were identified, both

Table 2. Stands and forage yields of switchgrass seeded in 1978 at Mead, NE.

Atrazine	1978 Forage Yield	1979 Forage Yield	1979 Stand
---------lb/A---------	----------tons/A----------		%
0	0	4.0	65
0 + handweeded	3.9	5.2	90
1	2.7	6.0	97
2	2.4	5.0	94

Martin et al. 1982. Agronomy Journal 74:916-920

Dr. Anderson is Extension Forage Specialist and Dr. Vogel is Research Geneticist, USDA/ARS, in the Department of Agronomy, and Dr. Ward is Professor in the Department of Animal Science at the University of Nebraska-Lincoln.

Table 3. Forage yields and digestibility of three switchgrass hays seeded at Mead, NE in 1978.

Strains	Means 1978 Yield		1979 Yield		1980 Yield	
	Yield	IVDMD	Yield	IVDMD	Yield	IVDMD
	tons/A	%	tons/A	%	tons/A	%
High IVDMD	3.3	47.2	4.1	55.8	5.6	48.9
Pathfinder	3.2	45.6	4.0	54.0	5.2	43.6
Low IVDMD	3.3	43.3	4.1	52.8	5.6	44.1

Vogel et al. 1984. Crop Science 24:977-980

groups were moved to separate, isolated fields where seed was produced.

In 1978, seed produced from these isolated switchgrass fields and from Pathfinder were seeded in small plots (**Figure 1**). From 1978 through 1980, the IVDMD of the high IVDMD, Pathfinder, and low IVDMD strains averaged 50.6, 47.7, and 46.7%, respectively. The strains did not differ appreciably in forage yield (**Table 3**). Switchgrass responds well to nitrogen fertilizer (**Table 4**) so these high yields were obtained by applying 100 lb of N/A. Soil tests showed no P was needed in that particular study. However, switchgrass does respond to P applied on low P soils (**Table 4**).

On low P soils, switchgrass uses N fertilizer more efficiently when P requirements are met.

Table 4. Annual yield of switchgrass fertilized with N and/or P in Dixon County, NE.

P Applied	N Applied (lb/A) 0	40	80	120
lb/A	tons/A			
0	1.58	1.60	1.93	1.90
20	1.33	2.17	3.12	3.46
40	1.35	2.18	2.98	3.63

Rehm, 1981. Soil Sci. Res. Rep. UNL

Figure 1. Switchgrass plots.

(continued on next page)

Replicated one-acre pastures were seeded to these three strains in 1981. To speed establishment, 2 lb active ingredient of atrazine/acre was applied preemerge. In 1982 and 1983, pastures were burned in early spring and 2 lb of atrazine were applied to reduce weed invasion. Each year 100 lb of N as ammonium nitrate/acre was applied in May. Pastures were grazed by three beef yearlings/pasture for 69 and 62 days, respectively, in 1982 and 1983 (**Figure 2**). Heifers were used in 1982 and steers in 1983.

Yearlings grazing the high IVDMD strain gained 0.4 lb/day more than yearlings grazing Pathfinder and produced nearly 80 lb more beef per acre each year (**Table 5**). At 60 cents/lb, this would mean an additional $48 annual profit per acre. Gains during 1983 were much higher than in 1982. In 1982, yearling heifers began grazing when switchgrass was 32 inches tall and were unable to consume it as rapidly as new growth occurred, allowing many seedheads to develop. In 1983, yearling steers began grazing when switchgrass was 12 inches tall and consumed it at nearly the same rate as growth occurred. No seedheads developed during grazing. This illustrates the importance of grazing management practices that provide livestock with less mature, more digestible forage.

Conclusion

These results demonstrate that switchgrass is a highly productive warm-season grass for hay production or summer grazing. A small improvement in IVDMD produced a large increase in livestock gains. The high IVDMD strain has been released as the new cultivar 'Trailblazer', and switchgrass quality might be improved even more with additional breeding and improved forage management. Certified seed should be available for planting in the spring of 1986.

Breeding for improved forage quality in other grasses may also improve gains of livestock grazing these grasses. ■

Table 5. Average forage digestibility and performance of beef yearlings grazing switchgrass strains at Mead, NE.

	1982			1983			1982-83 Avg.	
Strain	IVDMD	ADG	Gain/A	IVDMD	ADG	Gain/A	ADG	Gain/A
	%	lb	lb	%	lb	lb	lb	lb
High IVDMD	49.4	1.0	210	63.7	2.2	402	1.6	306
Pathfinder	47.2	0.6	128	62.0	1.8	327	1.2	227
Low IVDMD	48.0	0.9	186	61.3	1.7	311	1.3	255

Ward et al. 1984. Journal of Animal Science 59 (Supplement 1):303 (abstract 385).

Figure 2. Beef yearlings grazing.

U.S. Farmer Produces for 78 Other Consumers

By Bill Humphries

SOMEWHERE out there, you have a farmer producing your food and fiber. But he isn't working exclusively for you. You have to share him with 78 other consumers. That means "your" farmer has a big job to do, week after week, year after year.

His job gets bigger all the time, because of expanding population and increased world food needs. His capital investment and his yearly operating expenses continue to grow.

The fact that each U.S. farm worker, on average, now supplies the food and fiber needs of 79 persons is one of the most significant measures of American farm productivity.

In 1983, the most recent year for which figures are available, total farm employment—including farm operators, unpaid family workers and hired workers—was 3.5 million.

The total U.S. population July 1 that year was estimated at 234.5 million. Thus, farm workers accounted for only 1.5% of the entire population.

For every worker on the farm, of course, 5 or 6 nonfarm workers produce resources and provide services used in producing, processing, transporting, wholesaling and retailing farm products.

"Your" typical farm worker in 1983 supplied food and fiber for 57.6 persons in this country and 21.5 persons abroad.

These figures represent a new high in productivity for the farmers of the United States or any other nation.

Americans today virtually take their food supply for granted. They never worry about overall shortages.

Most people in the world today, in fact, are fairly well fed, although hunger and starvation continue in Ethiopia and elsewhere.

How did the United States become the first major nation in history to have to deal with food surpluses as a chronic "problem"?

(Excessive supplies of various farm commodities in this country date back more than half a century. Surpluses are a problem in that they depress prices received by farmers.)

High farm productivity in the United States came about partly, of course, because of the nation's abundant and varied natural resources, and partly because the American economic system is based on the profit incentive.

Under this system, only those who plan well, work hard and manage efficiently can expect profits consistently from their farming or other business enterprises.

A third factor is that U.S. farmers have an expanding domestic market for their output because population continues to grow. Export markets also are of major significance and offer opportunities for expansion once this country's currency achieves a more realistic alignment in value relative to other currencies.

One of the most important reasons for the high level of productivity of U.S. farmers is "science power."

Agricultural research has resulted in a steady stream of discoveries that have enabled farmers to produce more bushels and bales and pounds per acre, more peaches and apples per tree, more pigs per litter, more beef and poultry per pound of feed and more milk per cow. ■

Mr. Humphries is with North Carolina State University Agricultural Communications.

Support Continues to Increase for Foundation for Agronomic Research

THE GROWING number of supporters in the Foundation for Agronomic Research (FAR) now includes BCM, Inc., Poole Chemical Co., Inc., and Union Carbide Agricultural Products Company, Inc.

BCM,Inc.

BCM,Inc., is a supplier of basic materials and chemicals for agriculture and industry. Mr. Robert B. Johnson, President of BCM,Inc., said the firm has pledged a total of $30,000 to be paid in three annual installments to FAR.

BCM was originally formed in 1974 as Basic Chemicals & Materials,Inc., a sales and consulting firm serving the fertilizer industry. Since then, BCM has expanded its scope of activities to include industrial chemicals, trading, warehousing, and shipping. Corporate headquarters are in Memphis, Tennessee, with other regional offices located in the U.S. and an international sales office in Lakeland, Florida.

Poole Chemical Co., Inc.

Poole Chemical Co., Inc., with headquarters in Texline, Texas, will support FAR with a three-year contribution totaling $24,000. Poole Chemical offers a broad line of fertilizers and other crop chemicals, marketing wholesale in Colorado, Kansas, New Mexico, Oklahoma, and Texas. The company operates a retail plant at Texline. Poole Chemical provides regular agronomic and other training to its dealer customers.

Mr. Jim Poole, President of Poole Chemical said the contribution came in recognition of the importance of new information from research and education.

Union Carbide Agricultural Products Company, Inc.

Union Carbide Agricultural Products Company, Inc. has added its support to FAR with a grant of $10,000 for 1985 and pledged continued support to total $30,000 over three years. The announcement came from Mr. Donald L. Page, Marketing Manager, Plant Growth Regulators.

Union Carbide Agricultural Products Company has its technical and business center in Research Triangle Park, North Carolina. The company markets several agricultural products, including plant growth regulators, herbicides and insecticides.

"Union Carbide has a growing interest in the crop management approach to maximum economic yields, particularly in corn, small grains, and cotton. It is the result of this interest, plus our awareness of the excellent research being sponsored in this area by FAR and PPI, that has prompted us to support further research efforts through our grant," said Mr. Page of Union Carbide.

FAR is a tax exempt organization which encourages maximum yield research and crop production management systems for maximum economic yields. The Foundation is affiliated with the Potash & Phosphate Institute (PPI), with headquarters in Atlanta, Georgia.

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; Cansulex Ltd.; Chemical Enterprises, Inc.; Chevron Chemical Company; C-I-L Inc.; Cominco American Incorporated; Dow Chemical U.S.A.; Duval Corporation;

Estech, Inc.; Far West Fertilizer Association; 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; Texasgulf Inc.; Terra Chemicals International; and The Sulphur Institute. ■

Chevron Chemical Company and Conserv, Inc. Join Institute

TWO COMPANIES have recently become members of the Potash & Phosphate Institute (PPI).

Chevron Chemical Company

Chevron Chemical Company is the largest non-petroleum subsidiary of Standard Oil Company of California. Its Ortho Fertilizer Division produces various plant nutrient products, sold primarily to domestic independent dealers.

Chevron Chemical Company will have two members serving on the PPI Board of Directors. They are: Mr. David C. Smith, Vice President and General Manager; and Mr. Peter McCrea, Marketing Manager, Ortho Fertilizer Division.

Mr. Smith recently announced that the Ortho Fertilizer Division is proceeding with development of a major phosphate fertilizer project in Rock Springs, Wyoming.

"Chevron is most supportive of PPI's programs and looks forward to a long and fruitful relationship," noted Mr. McCrea.

Conserv, Inc.

Conserv, Inc., an important producer of phosphate and other fertilizer products, has headquarters at Nichols, Florida. Conserv is a subsidiary of Intercontinental Development Corporation.

Conserv will have two members serving on the PPI Board of Directors. They are: Mr. John J. Lee, President and Chief Executive Officer (CEO) of Intercontinental Development Corporation; and Mr. J.W. Hall, Jr., Chairman of Interdec (U.S.A.), Inc.

"We are pleased to welcome these companies and we are confident that our research and education programs will be strengthened even more by this support," said Dr. R.E. Wagner, President of PPI and FAR. ■

Higher Yields Help Protect Against Soil Erosion

CONSERVATION TILLAGE slows erosion by leaving more residue on the surface. Higher yields help by leaving more residue. A rule of thumb is that for each additional bushel of corn produced there is 55 lb more residue; for each bushel of soybeans, 80 lb; and for each bushel of wheat, 100 lb. USDA information shows that with 2000-3000 lb of surface residues after planting corn, soil losses with no-till were reduced 52% compared with moldboard plowing. However, with over 6000 lb of surface residues, no-till reduced soil losses 92%.

In a 10-year study in Iowa, added N increased corn yield 34 bu/A and reduced soil and water loss. In Oklahoma, N fertilization alone on wheat decreased runoff and erosion more than cropping systems and residue management.

Crop residues were applied annually for 8 years in a fallow-wheat rotation in Montana at rates of 0, 750, 1500 and 3000 lb/A. The erodible fraction after 8 years (surface soil passing 0.84 mm sieve) was 50, 46, 38 and 28%, respectively. This shows the importance of crop residue for potential reduction of wind erosion.

Quotes from some authorities

"We have to manage for higher yields to reduce erosion. High crop yields improve C factors in the universal soil loss equation." G. W. Langdale, Southern Piedmont Conservation Research Center.

"High crop yields, providing maximum cover to the soil during both the cropping period and during the non-crop period, are one of the most cost effective methods of preventing soil erosion." J. W. Bauder, Montana State University.

"Any system that promotes high yields and high residue accumulation should reduce soil erosion." Ardell Halvorson, USDA-ARS.

"To effectively reduce both wind and water erosion the benefits from high crop yields cannot be overstated. For example, to effectively control erosion on a coarse-textured soil in southwest Saskatchewan, a crop of 30 bu/A is required to produce sufficient residue to prevent soil erosion." W. Nicholaichuk, National Hydrology Research Institute, Saskatchewan.

"Although grain yield is not always directly related to vegetative cover, it is generally true that maximizing yields usually results in reduced soil erosion because of high levels of vegetative cover and residue." Robert E. McDole, University of Idaho.

"While we like to see crop residue left on the soil surface (30% surface residue reduces erosion by water 60%), plowing under stover from a high yielding corn crop also reduces erosion (12% reduction for each ton turned under)." W. C. Moldenhauer, Research Leader, National Erosion Laboratory.

"A surface mulch of 1,000 lb of straw per acre will reduce erosion by rainfall and runoff to less than one-third that from a field with a surface mulch of only 200 lb/acre.

Higher rates of surface residues can be achieved by either reduced tillage or increased crop yield. High crop yields result in greater residue production and hence, better erosion control." D. K. McCool, Washington State University.

Indirect effects

The above comments relate primarily to direct effects of the increased amounts of top and root residues in mechanically reducing soil erosion. Indirect effects of the increased amounts of dry matter on the soil properties are also important. Soil organic matter, soil tilth and soil aggregates are increased. This leads to more water infiltration and increased resistance of soil particles to detachment.

Increased rate of N on corn in Iowa increased soil organic matter. In the long term Morrow plots at the University of Illinois, soil organic matter has been increased markedly by rotation and improved fertilization. Yields of corn have reached 200 bu/A. In Arkansas increasing rate of N from 0 to 125 lb/A increased yield of lint cotton from 944 to 1398 lb/A over an 11 year period. Percent of soil organic matter increased from 0.69% to 1.02%.

In Peru, continuous cultivation with proper fertilization and other agronomic practices improved chemical soil properties and maintained other agronomic properties. Without complete fertilization absence of a vigorous crop canopy resulted in surface soil compaction and exposure to erosion.

J. V. Mannering, Purdue University, says it well, "High crop yields that result from good management are very important as part of the overall solution to excessive soil erosion." ■

"Soil Fertility and Fertilizers" Text Fourth Edition Now Available

MACMILLAN Publishing Company recently announced that the Fourth Edition of *Soil Fertility and Fertilizers* is now available. The text is recognized as one of the most authoritative and useful for courses in fundamentals of plant nutrition and fertilizer use.

The authors are Samuel L. Tisdale, Werner L. Nelson, and James D. Beaton. Dr. Tisdale was formerly Professor of Soils at North Carolina State University, and President of The Sulphur Institute. Dr. Nelson was formerly Professor of Agronomy at North Carolina State University, and is currently Senior Vice President of the Potash & Phosphate Institute (PPI). Dr. Beaton was formerly Instructor, Soils, at the University of British Columbia, and is currently Western Canada and Northwestern U.S. Director of PPI.

In its fourth edition, the text continues to provide in-depth coverage of soil fertility practices with the latest information and applications to farming. The material has been extensively updated and new chapters added. First covering the history and development of soil fertility and fertilizers, the text moves on to plant growth and nutrition, fertilizer manufacture and crop management, and includes the latest information on maximum yield research, maximum economic yields, moisture use efficiency, conservation tillage and interactions.

The authors emphasize the description of each nutrient with respect to its occurrence, forms, behavior in soil, and the major factors influencing availability and uptake. Material is included relating soil fertility practices to such topics as reduced tillage, a new and important farm practice. Plant factors affecting nutrient needs and responses receive considerable attention.

The text is abundantly illustrated with photographs, figures and tables.

For more information about the textbook, contact: Macmillan Publishing Co., College Marketing, 866 Third Ave., New York, New York 10022. Phone 1-800-223-3215. ■

Federal Farm Policy

SIXTEEN TIMES A MINUTE we do something that is vital for life. We breathe. We take it for granted and don't even notice it.

Though some have respiratory problems, most of us just keep on breathing, though we do sympathize with those who have trouble.

So it is with farming. We take for granted the farmers (4%) who feed the rest of us (96%), though we do sympathize with those farmers who have problems.

And problems there are on the farm front, especially in the area of federal farm policy. This stems from inconsistent programs of the 1970's—two embargoes—plant more, - plant less, - invest more, - disinvest. No one knew what would be next.

Many believe our farm policy tools - of support prices and loan rates—are obsolete—"tools of a Stone Age called on to function in an era of Star Wars."

There is general agreement that the new Farm Bill must be market-oriented and must be consistent. But we must go further. National farm policy is in bad need of new concepts. We need something to offer to farmers with first-class farming skills who are searching for ways to do a better job.

That's just what PPI hopes will evolve from its MEY program—something out of the ordinary for the farmer who realizes he can't afford to be ordinary.

Let's work for a dynamic, imaginative, effective farm policy that looks to a sound future.

—J. Fielding Reed

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