Fertilizer Use in the Future: A University Perspective

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Over the last few years, several agronomic, economic, political, environmental and sociological trends have begun to emerge which will significantly affect fertilizer use in the next decade and perhaps beyond. The wide-spread use of fertilizers is a relatively recent development. Over the past 40 years, farmers repeatedly saw the benefits of fertilizer applications and developed a faith in their need. However, the 1990's are not the 1950's. As pointed out by Dean L. M. Walsh in a recent paper in Dealer Progress (Walsh, 1989):

> "We can argue about the need for practical rules and fair standards, we can demand demonstration of effectiveness, we can fight for realistic implementation schedules, and we can blow a little smoke. But we can not hide from the fact that agriculture's impacts on the environment will be monitored and controlled as never before. Agriculture increasingly will be held accountable."

In actuality, the fertilizer industry has matured. The successful players in the industry must position themselves in recognition of this maturation. The fertilizer application needs of the future are not now, nor will they be in the future, the same as were the needs of the past.

Some Physical Evidence

Soil test summaries are an excellent means by which we can trace changes in the fertility status of a state or region. Table 1 shows the average soil test P and K values for Wisconsin over the past 20 years. It is apparent that values have increased substantially. As expected, the distribution of soil test values has also shifted toward many more in the high and very high ranges (Table 2).

Wisconsin is not unique in this accumulation of nutrients as several other states have published similar information (Thomas, 1989; Killorn, 1988). It is interesting to note that when the Wisconsin data for 1964-1967 were being summarized for the fertilizer industry, it was concluded that "very little additional phosphorus is needed." (Walsh, 1969). However, this has not been the trend for fertilizer use in the Midwest. Voss (1987) showed clearly for Iowa that P use continued to climb relative to crop removals from 1940 through the 1970's, and K use has continued to increase into the 1980's (Table 3).

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Table 1. Changes in average soil test values for Wisconsin 1968-1985.

Summary period	Avg Soil test P	Avg Soil test K
	lb/a	lb/a
1964-1967	59	173
1968-1973	66	179
1974-1977	73	196
1977-1981	80	212
1982-1985	88	248

Wisconsin soil test summaries 1969, 1973, 1977, 1982, 1986.

Table 2. Distribution of soil test P and K for Wisconsin 1968-1973 versus 1982-1985.

	Phosphorus			Potassium	
Test Range	1968-1973	1982-1985	Test Range	1968-1973	1982-1985
lb/a	----------%---------		lb/a	----------%---------	
≤20	13	11	≤80	8	6
21-30	13	11	81-120	21	14
31-40	13	11	121-160	23	18
41-50	11	11	161-200	18	18
51-60	8	9	201-240	12	13
61-80	13	14	241-280	7	10
81-100	8	10	281-320	4	7
101-150	10	12	321-400	4	7
151-200	4	5	>400	3	7
>200	5	6			

Table 3. Crop removal, fertilizer use and ratio of use to removal of P and K for selected years in Iowa.

	Crop Removal[1]		Fertilizer Use[1]		Use/Removal	
Year	P	K	P	K	P	K
1940	65,693	179,137	1,197	732	0.018	0.004
1945	64,571	177,784	10,226	6,239	0.158	0.035
1950	73,742	205,058	23,318	12,499	0.316	0.061
1955	78,903	223,406	44,001	41,325	0.558	0.185
1960	103,263	284,027	50,631	53,815	0.490	0.189
1965	112,845	308,422	99,207	115,700	0.879	0.375
1970	125,524	341,683	180,955	288,257	1.442	0.844
1975	153,009	397,154	186,785	367,546	1.221	0.925
1980	184,200	491,339	211,765	520,689	1.090	1.060
1984	179,816	444,455	174,516	502,984	0.971	1.132

[1]Removal and use are expressed in elemental P and K.
Data from Voss, R., 1987.

Most scientists agree that little response to fertilizer occurs after soil tests are in the high range or above (Kelling, 1988; Killorn, 1988; Peaslee, 1978) with perhaps the exception of some starter fertilizer on some soils. Therefore, if profitability and environmental concerns are real, it is unlikely that the current pattern of fertilizer use will continue. As asked by Grant Thomas, "Since soil bank accounts are higher than ever, and farmers' bank accounts are in bad shape, does it make sense to continue to push for higher soil fertility?"

Similar questions are also being raised with respect to nitrogen usage. The amount of nitrogen applied is usually the most important component affecting crop use efficiency and the potential for N loss to groundwater. In today's economic environment, farmers attempt to choose the N rate to maximize return. Society, however, in attempting to protect against possible environmental degradation tends to favor rates which favor higher N recovery. Table 4 shows an example of Wisconsin data which illustrate the dichotomy involved. Whereas 160 lb N/a is clearly the economically optimum rate of nitrogen, this resulted in a recovery of only 17% of the last 40 units of N applied. This means that the remaining 33 lbs of N are still in the environment (soil, residue, and soil water) to potentially be lost. At some point this may be environmentally unacceptable.

Table 4. Yield, economic return and recovery of applied N in corn grain, Janesville, WI, 1983-1985.

N rate	Yield	Value of Yield Inc.	Return	N Recovery
lb/a	bu/a	$/a	$/a	%
0	93	--	--	--
40	115	44	38	45
80	131	32	26	45
120	138	14	8	20
160	144	12	6	17
200	145	2	-4	0

Assumes $0.15/lb for N and $2.00/bu for corn.
Adapted after Bundy, 1987.

There is also evidence that the optimistic return of farmers may be partly responsible for higher than necessary fertilizer applications. A recent survey of Nebraska corn producers demonstrates this optimum. In the 4-year survey of 158 producers, only 10% consistently reached their yield goal, 50% attained 80% of their yield goal, and the remaining farmers fell more than 20% short of their estimated yield goal (Schepers et al., 1988).

Some Political Evidence

In 1984, Wisconsin passed a groundwater protection bill that will lead to strict enforcement standards for pesticides and nutrients. Different cropping regions will have best management practices prescribed to meet the established standards.

Iowa's Attorney General and Secretary of Agriculture both stated their belief that Iowa farmers were applying excessive rates of fertilizer, which were leading to reduced profitability and environmental pollution. They implied that soil testing laboratories were making unnecessarily high recommendations. This resulted in the creation of the Iowa Soil Testing Task Force with the charge of reviewing problems, and making recommendations to correct these problems and improve the credibility of soil testing. On a broader scale, I believe this and related activity has caused all states to reexamine their recommendation programs.

In a similar way, national politics have also moved to stem what lawmakers believe to be excessive applications. In each of the last two years, increased amounts of money have been allocated for LISA research. In 1988, Senator Wyche Fowler (D-Ga.) introduced legislation under Senate Bill S2898 which, if enacted, would have strongly encouraged the reduced use of commercial fertilizers and chemicals, regardless of their effect on farm profits.

This bill was superseded in 1989 by S970 which removed most of the monetary incentives to cut back fertilizer usage, but kept the goals of removing land from production, increasing research to support this reduced usage and creating labeling that would differentiate between crops grown with fertilizer from those that are not. This kind of differentiation in labeling implies that food produced with the help of commercial fertilizers must be different from food that is produced from manure or other natural fertilizers. The practicality of establishing this difference was not delineated. Just as environmental interests played a crucial role in shaping the 1985 farm bill, these factors will likely be a major force in the 1990 Act.

The Psychological Evidence

The attitudes of at least some farmers is changing. Dean Walsh stated in his recent paper that he believes some business and university leaders have resisted environmental considerations too vigorously in their belief that farmers themselves found such environmental demands unreasonable. He doubts this assumption was ever true and "knows it does not reflect reality today."

Some quotes from an article in Dealer Progress (Anonymous, 1989) on farmer reactions to BMP's, include:

> "If we as farmers and as an industry don't meet the safety issue head-on...the consumer is going to get right back to us."

"These practices are good management practices and they really haven't hurt any farmers, and they've helped a lot."

"It's much better for us make these adjustments on our own than to wait for the government to mandate them."

"What we are trying to avoid here is wasting material and if it goes into the environment it's wasted. I think from that standpoint, dealers can really place environmental stewardship hand-in-hand with better farmer profit."

In the spring of 1989, the University of Wisconsin College of Agricultural and Life Sciences held five "listening sessions" on sustainable agriculture to give those interested in this concept the chance to say what research and Extension programs are needed. Over 220 people attended, many of whom were very critical of the university, and totally distrustful of dealers. Important concepts and ideas related to crop fertilization that were repeatedly mentioned included: 1) evaluation of rotational systems for minimizing the need for purchased N; 2) consideration of soil balance and health in making fertility recommendations; 3) determination of the best system for using manure as fertilizer; 4) evaluation of crop and animal mix that maximizes profit and reduces chemical need; 5) shifting crop breeding programs to develop varieties that require lower inputs; and conducting research on societal cost associated with fertilizer and pesticide use.

The Future

With these forces in motion, it seems apparent that at best fertilizer use will stabilize if not decline. In many instances, the dealer is in the crucial position of both supplying the product and making the recommendation for which products and rate to use. Although farmer acceptance of the dealer's recommendation may be increased by aligning the dealer's suggestions with university philosophies or programs, there is little economic incentive on the part of the dealer to recommend a bare-bones, environmentally-oriented fertilizer or pesticide program when the dealer's sole source of income is based on product sales. However, there is an opportunity for both parties to benefit because a common question put to dealers is, "What does the university recommend?". If the dealer can show that his program is comparable to that recommended by the university by using techniques such as university soil test recommendation programs or following university pest management guidelines, then significant credibility is gained. In some states this elevation of dealer credibility is of major important to farmer clients.

If dealer sales are going to be adversely affected by more environmentally driven recommendation programs, we believe that the current trend of farmers paying for advising services of consultants (independent or dealer-affiliated) will have to continue, and that this source of income may partially offset the income lost from decreased product sales. A transition to such a system will not be easy since those who charge may initially be in competition with others "giving" away the service. The success of this transition to more paid dealer services will be dependent upon the dealer supplying credible and usable information that the grower can translate into improved profitability or acceptance of the environmental benefits.

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