

NITROGEN MANAGEMENT FOR PROFITABILITY AND GROUNDWATER PROTECTION

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ABSTRACT

Sugarbeet production practices have changed drastically in the last two decades in Minnesota and North Dakota. Changes in grower payment systems mandated change to production of high sugar content low impurity level beets. Development, refinement and extensive use of the soil nitrate-N test in concert with the sugar company quality payment program resulted in greatly reduced N fertilizer use while increasing crop yield and quality.

DISCUSSION

Sugarbeet production in the Red River Valley of Minnesota and North Dakota began in 1919 with 11 acres raised near Crookston, Minnesota. Interest in sugarbeet raising increased to the point where the American Beet Company (presently American Crystal Sugar Company) began operating a factory at East Grand Forks, Minnesota in 1926. More than 10,500 acres of sugarbeets were grown that year. Eventually American Crystal Sugar Company expanded to four factories with about 1,500 growers producing nearly 300,000 acres of sugarbeets. In 1972 Red River Valley sugarbeet growers organized a successful effort to buy the privately owned company. American Crystal Sugar Company became a cooperative when purchased by the growers for \$66,000,000 in 1973. Three additional grower owned cooperatives were established at Wahpeton and Hillsboro, North Dakota in 1974 and Renville, Minnesota in 1975 respectively. The Hillsboro cooperative merged with American Crystal Sugar Company in 1975. In 1989 2,300 grower-owners produced over 500,000 acres of sugarbeets for these seven factories. The sugarbeet industry of Minnesota and North Dakota represents nearly 40% of the United States sugarbeet acreage. Sugarbeets are big business in the Red River Valley providing 30,000 jobs and over one billion dollars in economic impact to the region.

Before 1973 the privately owned American Crystal Sugar Company mandated many production practices to its contracted growers. Sugarbeets were produced with crop rotations that included summerfallow and a legume green manure crop. Nitrogen fertilizer application was strongly discouraged. The company maintained strict control of acreage contracts with few incentives for growers to produce a high quality, yet high yielding

sugarbeet crop.

Numerous changes in Red River Valley sugarbeet production accompanied the purchase of the private sugar company by this group of progressive growers. Acreage allotments for sugarbeet contracts were now determined by the amount of stock the grower owned in the cooperative, one acre per one share of stock. The new grower-owners became concerned about profitability of the sugar company as well as their payment for sugarbeets delivered. Acreage allotments to growers expanded significantly in the 1970's. Major improvements were made in the processing factories along with sugarbeet piling and handling equipment. Farming practices began to rapidly change as well. Acreage of summerfallow declined sharply as federal government farm policies changed. By 1970 very few livestock enterprises were located in the Red River Valley and green manure crops essentially disappeared from crop rotations.

From 1970 to 1979 sugarbeet growers were paid on gross sugar delivered to the factory. Therefore it was to the growers advantage to raise the largest tonnage crop possible for maximum profit. Little regard was given to sugar content and crop quality. Nitrogen fertilizer application to all sugarbeet acreage greatly expanded in the early and mid 1970's. More nitrogen was routinely applied to beet fields than was required for maximum root yields. Even though the nitrate-nitrogen soil test was already available at North Dakota State University as early as 1968 less than two percent of the fields received fertilizer nitrogen recommendations based on the test. In the mid to late 1970's high yielding-low quality sugarbeet varieties became widely available to sugarbeet growers. In an attempt to produce even more tons per acre, over-fertilization with nitrogen became widespread. Extensive production of poor quality sugarbeets resulted in serious problems efficiently processing these beets. Cost of factory operations became much greater than necessary to produce a pound of sugar.

In response to these escalating factory operation costs, the growers adopted a new payment system in 1980 (Phase I), which paid a small premium for sugarbeets which had greater than average sugar concentration. This occurred because better quality sugarbeets allowed for more efficient sugar processing at the factory and more profit for the factory owners, the growers. Still under Phase I if a grower was located close to the factory it was to his benefit to raise a high tonnage crop. Phase I mandated a higher awareness of the value of high quality sugarbeets, thus more profit for all growers from more efficient factory operations.

The grower-owners took the quality concept another step forward in 1982. They then adopted a new beet payment system (Phase II) which put a much greater value on quality sugarbeets. A part of this payment system was a processing charge on a per ton basis against each individual field of beets raised by coop grower-owners. Grower return per ton declined sharply if they produced high tonnage beets with mediocre sugar content and low purity. This payment system put total emphasis on growers producing the highest possible levels of recoverable sugar per ton and per acre. Table 1 illustrates the effect of beet payment scale on return per acre from the 1980 versus the 1989 American Crystal Sugar Company crop.

Table 1. Effect of the American Crystal Sugar Company beet quality improvement program on the value¹ of a ton of sugarbeets

Payment Parameters	1980	1989
Recoverable sugar/ton (lbs)	268.0	298.0
Other sugar losses/ton (lbs)*	<u>-48.9</u>	<u>-48.9</u>
Recovered sugar/ton (lbs)	219.1	249.1
Value of sugar per ton (.24723/lb)**	\$54.16	\$61.68
Value of by-products (\$/ton)**	\$ 6.21	\$ 6.21
Value of sugar and by-product/ton	\$60.37	\$67.79
Cost Of processing sugarbeets (\$/ton)***	<u>\$27.33</u>	<u>\$27.33</u>
Net value of sugarbeets (\$/ton)	\$33.04	\$40.56
Increased value of one ton of sugarbeets in 1980 versus 1989 = \$7.52/ton		

¹Based on American Crystal Sugar Company Grower Practices Record System Data (D. Hilde)

*Storage losses from beet piles, etc.

**Assumed mean realistic value of sugar and by-products for the 1980's.

***Assumed mean realistic cost of sugar factory operations

Assuming a total average production of 6,000,000 ton of sugarbeets per year, grower-owners of American Crystal Sugar Company would receive \$45,000,000 dollars more for the high quality 1989 crop than the low quality 1980 crop.

What effect did this evolution of payment system have on crop characteristics and production practices? Table 2 lists root yield, sugar concentration, recoverable sugar per acre, and recoverable sugar per ton over the ten year period as payment systems changed. Yield and quality of beets produced increased steadily during this time.

The growers benefited in both productivity and profitability because of increased sugar yields, more efficient use of crop production inputs, especially nitrogen, and increased processing efficiency at the sugar factory. Another positive aspect from the increased factory efficiency is that the sugarbeet acreage available to growers could be increased without increasing factory size or capital expenditures.

Table 2. American Crystal Sugar Company root yield, sugar concentration, recoverable sugar per acre, and recoverable sugar per ton, 1980-1989

Year	<u>Yield</u>	<u>Sucrose</u> Content	<u>Recoverable Sucrose</u>	
	Ton/A	%	Lb/Ton	Lb/A
1980*	14.3	15.63	268	3832
1981	18.7	14.97	255	4769
1982	17.3	16.04	283	4896
1983	17.4	15.09	262	4559
1984	16.2	17.23	311	5038
1985	16.7	16.71	307	5046
1986	17.6	17.08	312	5491
1987	19.3	18.08	329	6350
1988*	13.4	18.25	330	4422
1989*	14.5	16.72	298	4321

*Much below average rainfall. (D. Hilde)

What management practices did Red River Valley sugarbeet producers adopt to meet the challenges of the 1970's and 1980's to increase crop quality?

1. Crop rotation: Crop rotation changed from those with sweet clover and summerfallow to rotations with grain crops, mainly spring wheat and barley. This reduced the amount of mineralized N from the rotation available to the sugarbeet crop. This change also caused an increase in use of inorganic N fertilizer which has made management of N inputs easier.
2. Soil Nitrate Test: The use of the soil nitrate test to depths of two or four foot each year sugarbeets are grown in the rotation and to a two foot depth during the other years of the rotation has become an invaluable N management tool. With semipermeable soils and annual rainfall of 22 inches or less in the Red River Valley where sugarbeets are grown, this soil test is very accurate in predicting N needs of each crop in the rotation. The adoption of the Phase I quality payment program in 1980 increased the use of soil nitrate testing particularly to a two foot depth.

Table 3 lists the number of fields soil tested to two and four foot depths from 1979-1989. Rapid increases in soil testing to a four foot depth occurred after adoption of the Phase II payment system in 1983, because of the knowledge of detrimental effects of soil N below two feet on quality of sugarbeets. Today approximately 80% of the sugarbeet acreage is sampled to a two foot depth and 50% sampled to the four foot depth. In other words the sugarbeet producers in the Red River Valley know that soil testing pays.

Table 3. Percent of American Crystal Sugar Company sugarbeet fields tested for N fertilizer recommendations, 1979-1989. (D. Hilde)

Year	Percent of Fields Sampled	
	0-2 feet	2-4 feet
1979	28	1
1980	42	5
1981	59	5
1982	72	6
1983	73	13
1984	77	26
1985	76	38
1986	78	40
1987	82	39
1988	71	41
1989	71	45

3. Reduction of Fertilizer N use: From 1972 to 1979 the maximum recommended N level was 260 lb/A for a 26 ton yield goal. This was a combination of soil nitrate-N in the 0 to 4 foot depth plus applied fertilizer N. This recommendation was reduced to a maximum of 175 lb/A for the period 1979 to 1983. This reduction occurred because of the application of Phase 1 economics to N rate research findings. This recommendation would not always produce maximum root yield, but gave the maximum economic yield. In concert with emphasis on high quality sugarbeet production programs the type of sugarbeet variety available to growers changed drastically to high quality types. The current N recommendation for most profitable sugar production is 120 lb/A as soil nitrate-N in the 0 to 2 foot depth plus fertilizer N. Reducing N rate recommendations was not an easy practice to convince the growers to follow. Because of this reluctance a long term (9 years) N fertilizer experiment was established at the University of Minnesota's Northwest Experiment Station at Crookston, MN to demonstrate what N rate was needed to maximize economic returns. The results, Table 4, substantiate the current recommendation with maximum gross return to the grower occurring between 100 and 125 lb of available residual soil nitrate-N in the 0 to 2 foot depth plus applied fertilizer N.

Cooperative extension service educational programs throughout the 1980's emphasized production practice changes to produce high quality sugarbeets. The American Crystal Sugar Cooperative agricultural staff worked closely with growers, North Dakota State University and University of Minnesota extension specialists and a cooperative allied industry to assure proper nitrogen fertilizer use. The joint effort of all these groups resulted in the successful production of high quality beet crops by the mid 1980's.

Table 4. Effect of level of available soil plus fertilizer nitrogen on sugarbeet yield and quality, 1978-1986.

Nitrogen Soil + Added 0-24"	Yield	Sugar	Recoverable Sugar			Phase II*Return/ \$/T	Gross Return/ Acre(\$)
			lb/A	%	lb/T		
100	20.3	16.1	5639	87.5	281	26.07	529
125	20.6	16.0	5695	86.7	279	25.64	528
150	21.3	15.7	5740	86.4	272	24.11	514
175	21.2	15.2	5501	85.9	263	22.16	470
200	21.7	15.1	5489	84.5	255	20.42	443
Statistical Sig.	NS	**	**	**	**	—	—
B.L.S.D. (.05)	—	.2	246	.9	6.0	—	—

*Basis (Recoverable sugar/ton - 47.2 lb sugar lost to storage and processing x sugar price \$21.73/cwt + \$4.75 by-product revenue - membership cost) (L.J. Smith, Sugarbeet Agronomist, Northwest Experiment Station, University of Minnesota, Crookston, MN)

These production practice changes besides being economically attractive are also environmentally sound. Nitrogen fertilizer use is now about 65,000,000 lb less per year than it was in 1972 for sugarbeet production in Minnesota and North Dakota. The reduction in N fertilizer application has greatly reduced the amount of fall applied fertilizer N in the soil over winter and subject to movement before the year of sugarbeet production. The use of intensive soil testing has increased grower awareness of residual N levels in the soil, and provided for proper use of fertilizer N for high yield, high quality dryland sugarbeet production. At the same time an environmentally safe N use program minimizes the likelihood of surface or ground water contamination by improper N fertilizer use.

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