RAPPORT DE VISITE

Michigan Sugar Company, Michigan
American Crystal Sugar Company, Minnesota

Juillet 1983

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Michigan Sugar Company, Saginaw, Michigan 25/26 juillet 1983
American Crystal Sugar Company, Minnesota 27/28/29 juillet 1983

La mission était constituée des personnes suivantes:
Dr. M. Tabi, MAPAQ, M. Germain Moreau, Station de recherche,
Dr. Ghislain Gendron, Université laval,
Dr. Edward McKyes, Collège Macdonald, M. Raymond Deguoy, MAPAQ,
M. Lionel Michon, MAPAQ, M. Jean-Louis Dagenais, MAPAQ,
Mme Danielle Bourgeault, MAPAQ et M. Germain Lefebvre, R.S.Q.

Cette mission consistait à étudier comment ces entreprises d'expérience opéraient dans le secteur agricole.

Chez ces deux entreprises, il faut noter que les vice-présidents à l'agriculture M. Dave Sunderland de Michigan Sugar Company et M. Stewart Bass d'American Crystal Sugar Company nous ont accordé tout le temps nécessaire et leur personnel a été disponible pour toute la durée du séjour.

Les éléments de la visite sont rapportés ci-dessous par sujets plutôt que chronologiquement.

LA RECHERCHE

Michigan Sugar Company possède une ferme d'environ 100 ha avec la Saginaw Valley Beet & Bean Farmers Association (50-50). Tout le budget d'opération provient de l'université d'état alors que toutes les immobilisations sont faites par la ferme. Deux techniciens de l'université y sont affectés à temps plein.

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Les essais de variétés sont effectués dans 6 à 7 sites bien répartis dans les régions de production. Ils sont faits à 6 répétitions pour MIchigan Sugar et à 8 répétitions pour American Crystal. Une variété doit être testée pendant trois ans avant d'être commercialisée. Les essais de variétés sont réalisés par le personnel de la compagnie sous la responsabilité du secteur de l'agriculture. American Crystal dispose d'un centre de recherche très moderne où l'essentiel de l'activité est centré sur l'usinage, le développement et l'amélioration des procédés. American Crystal a un programme de recherche bien structuré et commence à produire de très bonnes variétés. Des différences significatives ont été observées entre les variétés sur leur aptitude à la conservation. L'amélioration génétique est la seule activité de recherche agricole de la compagnie. American Crystal et Michigan Sugar sont intéressés à vendre des semences à la R.S.Q.

L'Université du North Dakota, l'Université du Minnesota, les services de l'extension des deux états et le U.S.D.A. consacrent aussi beaucoup d'efforts à la recherche sur la betterave. On y effectue aussi de la recheche sur la fertilisation et des essais d'herbicides. Le U.S.D.A. travaille sur la génétique, la phathologie et la physiologie. Le producteur participe au fonds de recherche en contribuant 2 à 3¢ par tonne récoltée. Cette activité de recherche a débuté en 1964. En 1966, l'injection de 1 500 000$ par l'Université du North Dakota permet la mise sur pied définitive de Red River Valley Sugar Beet Growers Association. Le comité est formé de 7 cultivateurs, 2 membres de l'Université du Minnesota, 1 membre du U.S.D.A., 2 membres de l'Université du North Dakota et 3 membres des coopératives.

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Tout l'aspect de la recherche agronomique est effectué dans le cadre de cette structure et est la responsabilité d'institutions publiques telles le U.S.D.A. et l'Université. Cette recherche comprend, par exemple, les effets de l'engrais, des pesticides, de la préparation du sol, etc...

L'EXTENSION

Le service de l'extension qui se compare au bureau local du MAPAQ, fait un travail de recommandations générales sur l'exploitation agricole des producteurs et des recommandations d'ordre technique. Il ne s'implique pas dans les différentes interventions relatives au respect du contrat qui lie le producteur et la compagnie.

LA PRODUCTION - LE RÔLE DU REPRÉSENTANT

Au Michigan, la betterave est semée en rang de 28 et 30 pouces en utilisant souvent les mêmes équipements que pour le maïs. On emploie un engrais riche en phosphore au semis et il est appliqué avec le semoir. L'azote est appliqué à la volée. Fertilisation environ 90-150-150. Au North Dakota, la betterave est cultivée en rang de 22 pouces. La moyenne de superficie au Michigan est de 60 acres et près de 200 acres au North Dakota. La plupart des producteurs possèdent leur propre équipement. Les rotations au Michigan sont: maïs, céréales et fèves, au North Dakota: pommes de terre, céréales et fèves. Le semis de précision est effectué presqu'à 100% au Michigan. Au North Dakota, 50% des producteurs éclaircissent les betteraves.

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L'opération semis est très importante et on accorde beaucoup de soin à fournir de la semence de bonne qualité.
Ces deux compagnies donnent un service d'ajustement de semoir grâce à un banc d'essai pour unité de semoir.
Ce service est utilisé à environ 70% par les producteurs.

Au michigan, chaque fieldman s'occupe de 7,000 à 10,000 acres de production regroupant 100 à 150 producteurs. Il fait signer les contrats et s'assure du respect des exigences de la compagnie. Les interventions sont notées dans un livre de champs pour chaque producteur. Le suivi des producteurs a permis d'améliorer très sensiblement la qualité et les rendements. Chez American Crystal, chaque représentant s'occupe de 80 à 90 producteurs et suit "chaque champ". Chaque champ représente un contrat où les interventions sont suivies et les résultats analysés par ordinateur. Cette méthode a d'ailleurs fait l'objet d'une présentation lors du congrès d'ASSBT de février 1983. Elle est d'une grande utilité pour maîtriser la production, améliorer la qualité, le rendement et la rentabilité de la culture.

Michigan Sugar publie un guide à l'intention des producteurs et au North Dakota c'est le service de l'extension qui le publie. Ce guide est très utilisé et apprécié par les producteurs.

LA RÉCOLTE ET LA RÉCEPTION

Recevoir des betteraves de qualité et les conserver parfaitement sont parmi les tâches les plus importantes de ces sucreries; et c'est le service agricole qui en a la responsabilité qu'il garde jusqu'à ce que les betteraves soient livrées au point fixe. Des betteraves propres et très peu décolletées sont exigées. La fertilisation azotée fait l'object de beaucoup d'attention. Un bon contrôle permet de diminuer le décolletage. Pureté: non décolletées 93%, décolletées 95%. On se soucie de la compaction et on utilise beaucoup de "minimum tillage".

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On exige des betteraves exemptes de pétioles. Pour American Crystal, la récolte débute le 7 septembre. Chaque producteur peut récolter 15% de ses betteraves jusqu'au 5 octobre. Elles sont usinées au fur et à mesure qu'elles sont récoltées. Une prime est payée aux producteurs pour ces betteraves. Le reste de la récolte s'effectue en 10 jours sous la responsabilité et la supervision des représentants. La campagne dure 185 jours et on congèle 10% des betteraves. Au Michigan, la campagne commence un peu plus tard et dure 130 à 140 jours et on fera une expérience de ventilation des betteraves pour la première fois cette année. Chez les deux compagnies, on commencera à empiler de la betterave seulement lorsque la température des betteraves aura baissée à 55°F. Lors de la récolte, si la température de la betterave dépasse ces maximums, la réception est arrêtée jusqu'à ce qu'elle baisse à nouveau. Si des betteraves sont gelées -26°F (non effeuillées), elles seront laissées au champ pour quelques jours pour que les tissus gelés soient cicatrisés. Si la betterave est déjà décolletée, elle devra être livrée directement à l'usine. Il ne faut jamais l'empiler. Il est préférable de ne pas empiler de la betterave plus de 20 pieds d'épais. Une forte capacité de réception est nécessaire pour rencontrer ces contraintes: environ 8% à 10% de la production par jour. Michigan Sugar opère 16 h par jour, 7 jours par semaine, pas de cédule de camions. American Crystal opère 24 h par jour, 7 jours par semaine, avec cédule de camions. L'empilage est fait à l'aide d'empileuses doubles surtout "Silver". Quatre hommes opèrent ces empileuses et chacune permet d'empiler environ 80,000 tonnes de betteraves. Les cours sont sur le sol avec une allée en ciment. Le coût est de 20$/vg² pour les allées. La reprise des betteraves est faite méthodiquement en éliminant les points chauds et en les ventilant. L'entreposage des betteraves propres dans des tas bien confectionnés est de très grande importance. On respecte scrupuleusement les normes de conservation.

RENDEMENT MOYEN

Michigan Sugar	19,35 tonnes/ha	18.2% sucre
American Crystal	17 tonnes/ha	16% sucre

ANALYSE (American Crystal Sugar)

40% des voyages sont échantillonnés. Les échantillons sont traités en 20 secondes et des analyses complètes sont effectuées. Les résultats sont remis aux producteurs dès le lendemain.

Chez Michigan Sugar et American Crystal, l'approvisionnement est assuré grâce à une valeur de la récolte très avantageuse par rapport aux autres cultures. Payée 35$/ST (US), c'est la culture qui est de loin la plus rentable. Ces entreprises travaillent à améliorer la qualité de leur matière première en suivant de très près les pratiques culturales, la récolte et l'entreposage des betteraves.

ASSOCIATIONS

Toutes les raffineries nord-américaines sont membres de "Sugar Beet Foundation". Une documentation pertinente nous sera envoyée sous peu par M. Fisher, secrétaire de l'association. Il serait très opportun que nous en soyons membre et que nous participions à leurs activités. Un rapport sera soumis lorsque nous aurons reçu la documentation.

L'établissement de liens et de connaissances dans l'industrie nord-américaine de la betterave sucrière est de grande importance et la participation à cette association en est le meilleur moyen.

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RECOMMANDATIONS

1) La recherche relative au domaine de la production agricole devrait être confiée exclusivement à un comité de coordination. Ce comité devrait être composé d'un représentant de la Raffinerie, de deux membres de l'Université Laval et du Collège Macdonald, de deux membres de la direction de la recherche et deux membres de la vulgarisation du MAPAQ et aussi d'un producteur. Le budget d'opération accordé aux institutions de recherche devrait venir des fonds de recherche conventionnels. Une participation des producteurs et de la R.S.Q. pourrait être envisagée dans le futur. Cette orientation est déjà amorcée et une continuité devra en être assurée. Étant donné l'importance de la recherche agronomique et la rapidité avec laquelle certaines mises au point technique peuvent être nécessaires, la R.S.Q. pourra s'impliquer directement dans certains projets de recherche ou certains projets de mise au point technique en collaboration soit avec des membres du CPVQ ou des producteurs et ce, de son propre chef.

2) La R.S.Q. devrait, via son service de recherche et de développement, travailler exclusivement à l'amélioration des procédés d'usinage et au développement de nouveaux produits.

3) Le rôle des vulgarisateurs du MAPAQ devrait se limiter à celui de conseiller en gestion agricole. Ils dirigeraient le producteur sur le choix de ses cultures et sur les moyens pour obtenir les meilleurs résultats.

4) Les représentants devront de plus en plus jouer un rôle de relationniste entre la R.S.Q. et le producteur par un suivi de l'application des normes de production. Ces normes seront établies par le secteur de l'agriculture de la R.S.Q. et assureront la production et la livraison de betteraves de qualité.

TOUR FOR GUESTS FROM QUEBEC

Monday - July 25, 1983

11:45 a.m. - Lunch, Sheraton Fashion Square Hotel, Tittabawassee Road.

1:00 p.m. - Depart for Saginaw Valley Beet & Bean Research Farm. Meet two professors from Michigan State University; Dr. Don Christenson and Dr. Earl Erickson. Dr. Christenson, Professor, Crops & Soils, will explain crop rotation with sugarbeets and answer any questions. Dr. Earl Erickson, Professor, Crops & Soils, will explain soil tillage systems. Dr. Richard Zielke, Director of Research, Michigan Sugar Company, will explain the variety plots if time permits.

3:15 p.m. - Depart Beet & Bean Farm for Ralph Fogg Enterprises. Mr. Fogg is a row crop specialist and outstanding sugarbeet farmer.

5:00 p.m. - Depart Ralph Fogg farm for dinner at 6:00 p.m. at the Old Town Warehouse Restaurant, 500 S. Hamilton.

Tuesday - July 26, 1983

8:00 a.m. - Depart Sheraton Fashion Square Hotel. Journey to Lloyd Hecht farm to observe variety tests under the direction of Dr. Richard Zielke, Director of Research, Michigan Sugar Company.

9:00 a.m. - Depart ~~Hecnt~~ farm for ~~Wallace Bierlein~~ Mike Zwerk farm. The Bierlein farm is a father and son cash crop operation. Mr. Bierlein is an outstanding beet grower and a Director of the Caro Beet Growers Association. Will discuss general farm practices.

10:00 a.m. - Depart Wallace Bierlein farm for Donald Keinath farm. Mr. Keinath is a cash crop farmer and seed producer. Also, a Director of the Caro Beet Growers Association.

11:30 a.m. - Depart Keinath farm for Lunch at the Capri Restaurant in Caro at 12:00.

After lunch meet at the Caro Agricultural Offices for a tour of the piling grounds and observe the beet pilers. Meet in the conference room at the Caro office for the remainder of the afternoon to discuss various topics such as:

1. Beet receiving - Mr. Sunderland and Phil Brimhall.
2. Herbicides and Fertilizer usage and recommendations - Phil Brimhall
3. Seed production, varieties and processing - Dr. Richard Zielke
4. Production Costs

1983 ESTIMATED CROP PRODUCTION COSTS

W.L.B. - 12/1/82

	Corn	Sugar Beets	Wheat	Dry Beans	Soybeans	Barley-Oats
Seed	$20.00	$ 9.00	$17.50	$12.00	$14.00	$10.50
Fertilizer	58.30	67.10	41.25	32.00	28.25	37.50
Herbicide	19.00	40.00	6.00	17.00	19.00	6.00
Insecticide	8.50	-	-	-	-	-
Soil Test & Pest Scouting	2.75	2.75	2.75	2.75	2.75	2.75
Hoeing	-	10.00	-	4.00	-	-
Interest	7.75	9.50	4.75	5.00	4.75	4.00
Plowing	14.00	14.00	-	14.00	14.00	-
Fitting	6.00	6.00	6.00	15.00	6.00	12.00
Planting	8.00	10.00	7.00	8.00	8.00	7.00
Cultivation	5.00	15.00	-	10.00	10.00	-
Spraying	3.50	3.50	3.50	3.50	3.50	3.50
Windrowing & Pulling	-	-	-	10.00	-	-
Harvesting	22.00	50.00	14.00	18.00	18.00	14.00
Trucking	11.25	63.65	7.00	3.00	3.50	7.00
Drying	30.00	-	-	-	-	-
Land Rent	105.00	105.00	105.00	105.00	105.00	105.00
TOTAL	321.05	405.50	214.75	259.25	236.75	209.25

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	Corn	Sugar Beets	Wheat	Dry Beans	Soybeans	Barley-Oats
Yield Index	125 Bu.	19 Ton	70 Bu.	15.0 Cwt.	35 Bu.	Barley - 70 Bu. Oats - 100 Bu.

MICHIGAN AGRICULTURAL RESEARCH LABORATORY — WEIGHTED BY TONS

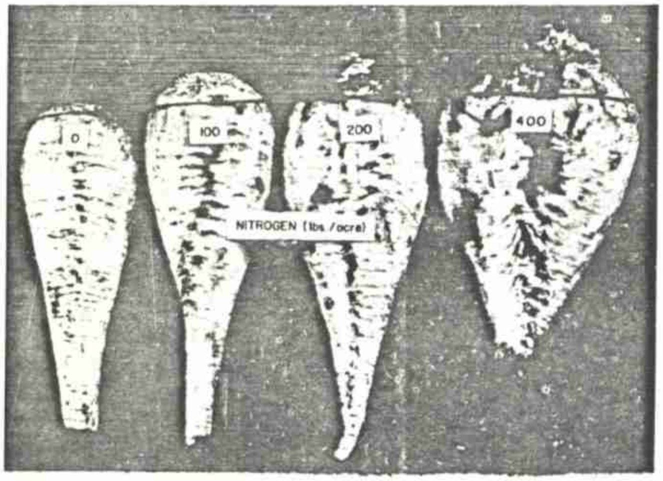
FINAL SUMMARY - ALL LOCATIONS

OCATION	TOTAL TONS	ACRES HARVESTED	TONS/ ACRE	% SUGAR	QUALITY FACTOR	PAYMENT PER TON	PURITY	NH2-N
RECKENRIDGE / SANFORD	132,525.88	7,513.40	17.64	18.18	0.99826	9.982	94.72	11.76
RECKENRIDGE	102,154.24	5,627.80	18.15	18.37	1.00853	10.085	94.76	11.99
ANFORD	30,371.64	1,885.60	16.11	17.55	0.96372	9.637	94.58	11.00
ARO	309,294.16	16,170.00	19.13	17.98	0.98685	9.868	95.15	9.70
ROSWELL	318,703.13	16,763.00	19.01	17.95	0.98571	9.857	95.19	8.50
ROSWELL FACTORY AREA	111,831.70	6,077.00	18.40	17.82	0.97811	9.781	95.10	8.51
UTH AREA	58,944.76	2,750.00	21.43	18.22	1.00013	10.001	95.22	8.49
ANDUSKY AREA	75,203.97	3,865.00	19.46	17.54	0.96285	9.628	95.11	8.97
ERONA	72,722.70	4,071.00	17.86	18.39	1.00935	10.093	95.38	7.98
ARROLLTON	170,529.79	8,440.60	20.20	17.55	0.96364	9.636	94.71	10.56
EBEWAING	406,163.43	20,221.00	20.09	18.89	1.03705	10.370	95.12	10.75
CHIGAN SUGAR COMPANY	1,337,216.39	69,108.00	19.35	18.22	1.00000	10.000	95.05	10.05

6% Shrink

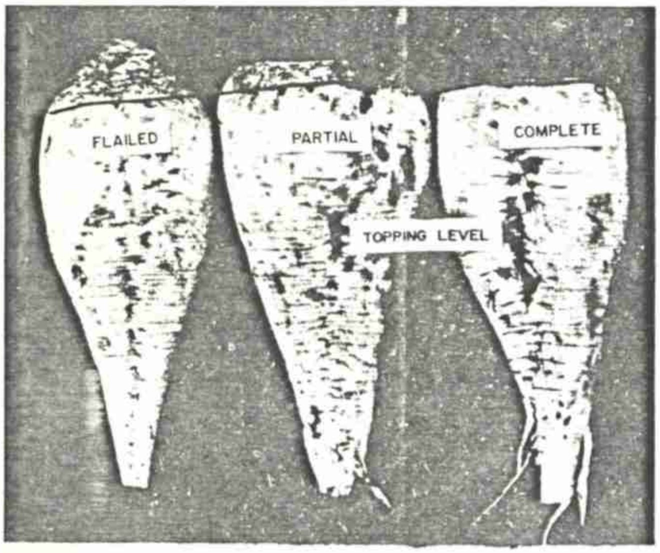
Watch harvesting, nitrogen for best sugarbeets

By A. D. Halvorson and G. P. Hartman



Increasing the amount of nitrogen in the soil (numbers on roots refer to pounds of nitrogen per acre) increases the size of sugarbeet roots and also the percentage of crown tissue (that above the black line in the photo).

Photo: S. A. Vicen



Flailing, left, retains the sugarbeet crown. That treatment and total removal of crown, right, results in the best storage characteristics. A majority of the roots presently delivered to processing plants are partially topped, center.

Sugarbeet growers and processors have some problems. They have seen a gradual increase in root yields since 1936, but a gradual decline in sucrose yield and quality during the same time. The basic reason for this is too much nitrogen fertilizer.

As more nitrogen fertilizer is applied to the crop, root yields increase while the sucrose content and purity of the roots decrease. Impurities in the sugarbeet increase as the nitrogen level increases. These impurities include sodium, potassium, amino nitrogen, invert sugars, and betaine, all of which lower the quality and quantity of the sugar yield and also make processing more difficult.

Crown vs. root

During the past 3 years, we have learned that the percentage of crown tissue (tissue above the lowest leaf scar) increases as the level of nitrogen fertilizer increases. In addition, nitrogen was causing the weight and size of the crown to increase faster than the higher quality root tissue (part of the beet below the lowest leaf scar).

Root tissue yields increased with increasing levels of soil nitrate nitrogen up to about 180 to 200 pounds per acre, then leveled off, while crown tissue yields continued to increase with larger amounts of nitrogen. Since the crown generally contains more impurities than the root, we found that, in effect, excess nitrogen fertilizer was increasing the impurities in the sugar produced by increasing the growth of the lower quality crown.

We found that maximum sugar production per acre occurs at that level of soil plus fertilizer nitrogen that results in maximum root tissue yield but not maximum crown yield. We found this level of nitrogen to be about 200 pounds per acre for our area. Although total root yield (root + crown) continued to increase at higher nitrogen levels, because of increasing crown weight, total sucrose yield declined as nitrogen levels increased further. So fertilizing becomes a matter of delicate balancing — enough but not too much.

When the sugarbeet was at maximum sugar production, about 20 percent of the total was contributed by the crown.

Most growers are paid for their crop on the basis of sucrose production per acre, not solely on root yield. The gross sugar production is determined by multiplying the sucrose content by root yield. The actual amount of sugar

a processor can recover, though, is not necessarily this great; it is lowered by the impurities in the beet. Higher levels of impurities result in more molasses and less white sugar extraction.

In addition to an increase in impurities, caused by excess nitrogen, we also found a decline in sucrose concentration, extractable sucrose per ton, and clear juice purity.

Crown removal?

Since there are more impurities and less sucrose in the crown than in the root, it might seem logical to remove the crowns before storing the roots. But things are not that simple because we have found that crowns contribute 15 to 28 percent of the total root yield.

Sugarbeets, bruised and scarred by crown removal and harvesting, are more susceptible to rot and other fungal damage before being processed into sugar — destroying even more of the potential sugar yield. With the greater yields of recent years, there is often need for long storage periods before the roots can be processed, allowing more time for the rot to cause problems.

If any crown tissue is to be removed, it should be the whole crown, otherwise there would be open surface wounds on the part of the sugarbeet most susceptible to rotting. But the crown contributes to sucrose yield.

A better solution would be to manipulate the amount of nitrogen to minimize crown growth and maximize root tissue growth in the first place. Then by removing only the leaves and petioles by flailing before harvest, the beets would have fewer open wounds resulting in less sugar loss due to respiration and spoilage.

Measuring nitrogen

Since the level of available nitrogen in the soil is so crucial to optimum sugarbeet yields, a soil test is essential. This test should measure both the available nitrate nitrogen (NO_3-N) to a depth of 4 feet and the soil organic matter (potential mineralizable nitrogen). Also, the quantity of residue from the previous crop incorporated into the soil and other organic sources, such as manure, needs to be considered before a person can decide how much additional fertilizer is needed.

The 200 pound per acre nitrogen level mentioned earlier is based on average yields. For specific fields, we have found that about 10 pounds of nitrogen is needed per ton of expected yield. In our particular area of the country, root yields generally are about 20 to 21 tons per acre, so for the example we are about to give, our recommendation will be for 210 pounds of total nitrate nitrogen per acre.

We measured the residual nitrate nitrogen in the soil to a depth of 4 feet and found it was 14 pounds per acre. The organic matter of the soil is 3.33 percent. Since each percent of organic matter will produce about 30 pounds of nitrogen, we expected about 100 pounds of nitrogen from this source. This 100, plus the 14 measured, subtracted from 210 would leave 96 pounds of nitrogen to be added. If there were wheat straw on the field, additional nitrogen would be needed to decompose it, but we removed the straw from this particular field, so our fertilzer recommendation for this field is 96 pounds per acre.

The formula we have just given is used in Montana and a few other states. Some other states use a nitrogen-mineralization factor instead of organic matter to estimate the amount of nitrogen the soil can produce during the growing season.

To sum up, then, unlike many other crops, sugarbeets will produce a better quality crop if they are slightly deficient in nitrogen than if they have too much. Crown tissue production can be minimized and sugarbeet quality can be improved by a good soil testing program and moderate use of nitrogen fertilizer.

The benefits of conservative use of nitrogen include:

- Improved extractability of sucrose, due to higher concentrations of sucrose and lower concentrations of sodium, potassium, amino nitrogen, invert sugars, and less crown tissue.
- Less tonnage processed to recover the same amount of sucrose.
- Lower transportation costs because less tonnage needs to be hauled to the processor.
- Maximum sucrose production and profits for both grower and processor.
- More efficient use of nitrogen fertilizer. □

A. D. Halvorson *is a USDA-SEA soil scientist and* G. P. Hartman *is an associate professor of soils at the Montana Agricultural Experiment Station, Sidney.*

A time to harvest

by Dave Hilde
Special Agriculturist
Extension Services

"*. . . a time to plant and a time to harvest . . .*" Ecclesiastes 3:2.

The sugarbeet in the Red River Valley is a long season crop grown in a short season climate. Because of its biennial nature, there are no visual ripening characteristics that can guide us in determining the proper time to harvest the root for sucrose, the product of its first season's growth. The sugarbeet will keep on growing until the first killing frost in the fall. The Bible does not mention any specifics on the sugarbeet harvest, so it becomes the responsibility of Crystal's Agriculture Department to determine an optimum harvest period that will result in maximum root yield and sugar accumulation, and, yet, complete the harvest before freezing weather sets in. Several factors that determine when the optimum harvest period will occur are: Weather conditions, rate of sucrose accumulation in the root, the tonnage expected to harvest, beet receiving capacity, and factory slice capacity.

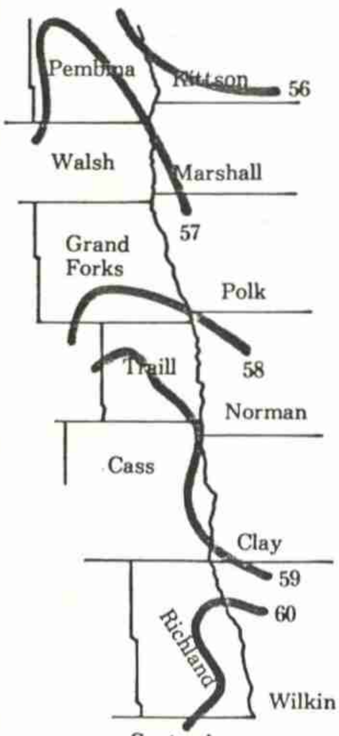
Weather

Weather is the all important factor in planning the sugarbeet harvest, one over which we have no control. We have to work with the weather. A study of long-term weather records tells us how and when we can use seasonal weather patterns to our advantage in harvesting and storing sugarbeets.

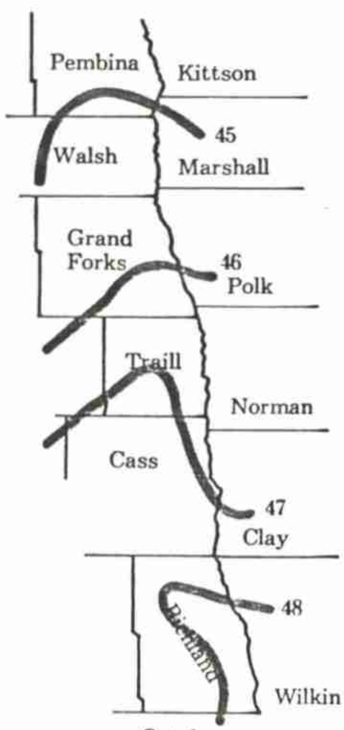
Temperatures at the beginning of harvest are critical factors in determining the piling date for long-term storage. Sugar lost in storage, due to respiration, must be kept at a minimum, so, harvesting beets for storage is done when the average air temperature is 50° F or lower. This usually occurs between October 5 and October 8. Cooling the beet pile down to 40° F as rapidly as possible is ideal. This is usually accomplished by the end of October, through natural ventilation, and, in some factory piles, through forced ventilation. Beet harvest in the warmer September temperatures is limited to the daily factory slice capacity with no more than a three-day reserve. Beets deteriorate rapidly when stored at high temperatures.

The following chart shows the average temperature for the months of September, October and November.

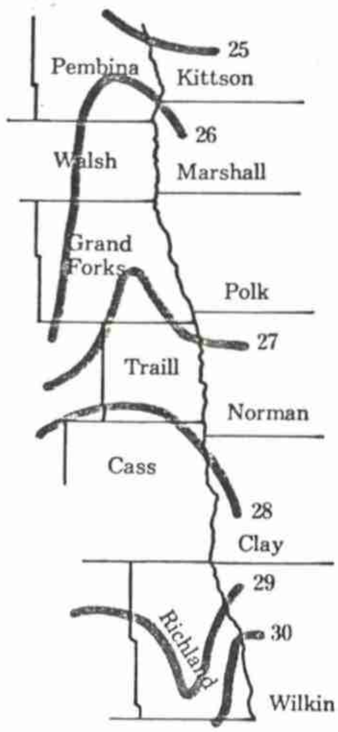
Average Air Temperatures Red River Valley*
(Degrees Fahrenheit)



September
Too warm to harvest beets for storage.



October
Ideal time to harvest beets for storage.



November
Too late for harvest. Ground beginning to freeze.

*Climate of North Dakota, Ray Jensen, Climatologist for North Dakota National Weather Service, North Dakota State University, Fargo

Another weather factor that determines the length of the optimum harvest period is the date when extended freezing temperatures begin. Long-term weather records at North Dakota State University show that by October 25 there is a 50 percent probability that minimum temperatures in the Red River Valley will be 32° F or lower for five days in a row. Beet harvest is on borrowed time after October 25. This fact is important in determining the starting date of harvest and the amount of beet receiving equipment needed to adequately handle the crop in a short time period.

Rate Of Sucrose Accumulation

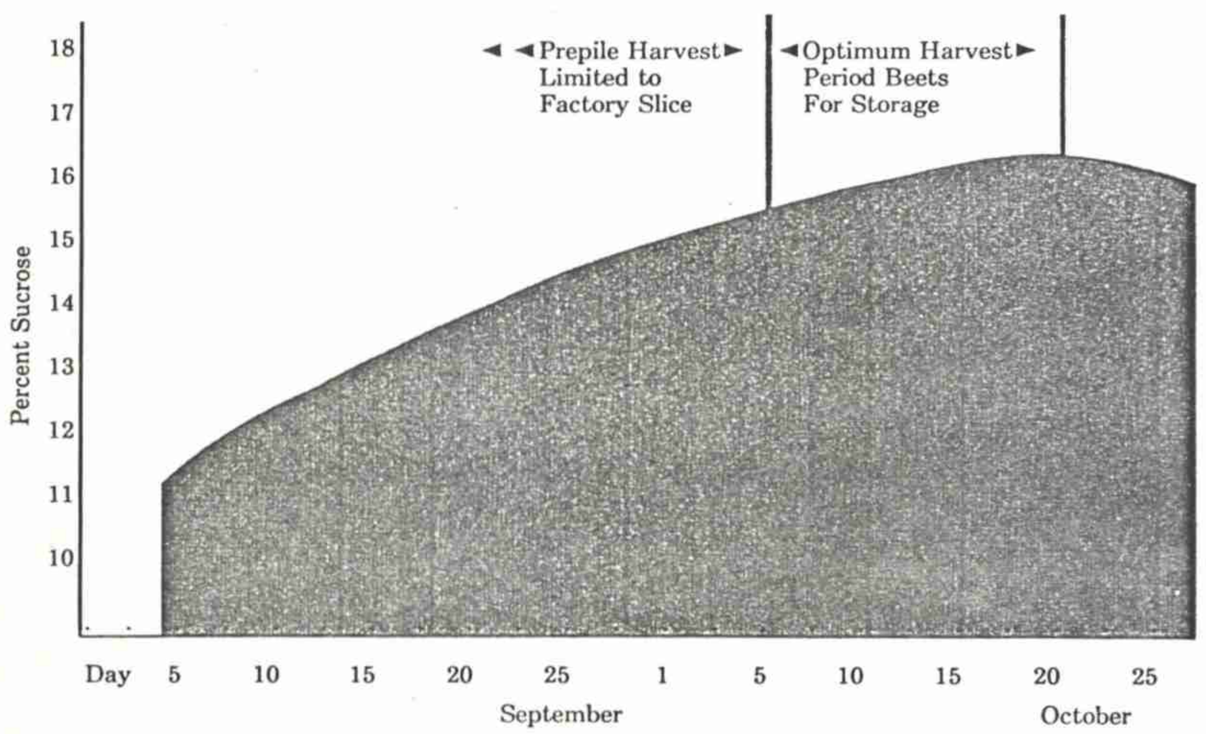
Harvesting sugarbeet roots with the maximum accumulated sucrose is one of the major emphases in Crystal's harvest plan. Sugarbeets are considered mature when the sugar content has reached a maximum for the conditions under which they are grown. This date will vary with each crop season and is a function of weather conditions. Factors that can influence and accelerate sucrose accumulation in the root are: A nitrogen deficiency, dry weather, sunny, warm days and cool nights. On the other hand, adverse weather, such as excessive rainfall or an early killing frost, can be detrimental to sugar content. A comparison of past crop records and weather probabilities act as a guide in determining the optimum harvest period for maximum sucrose accumulation for each crop year. Sugar accumulation in the root begins to increase in September, accelerates in early October and finally reaches a peak in mid October. Figure 1 illustrates the sugar accumulation pattern in the Red River Valley. This data is an average of seven years from the five factory districts.

Sugar content increases rapidly in September and reaches a peak in mid October. The time span for capitalizing on maximum sugar production per acre is short — approximately 15 days on the average. Harvest dates for storage and capacity of beet receiving equipment to handle 90 percent to 95 percent of the Valley crop is focused on the period from October 5 to October 20. The amount harvested prior to piling will vary from 5 percent to 10 percent of the total, depending on the size of the crop. The date that sugar content reaches the peak varies from year to year, depending on the date of the first killing frost in the fall. Figure 2 shows the sugar content pattern in a long growing season (1978) and Figure 3 shows the pattern in a short growing season (1976). In the seven-year period from 1973 to 1979, four years had early killing frost dates similar to that shown in Figure 3, and three years had the same general pattern shown in Figure 2. Thus, the final harvest results becomes a compromise of the weather.

Size Of Crop

Estimating the size of the crop is an important function of Crystal's

Figure 1. Relations Of Harvest Dates To Sugar Content Red River Valley Seven Year Average (1973-1979)



Agriculture Department. Agriculturists monitor the crop closely from planting to harvest and make yield estimates for the five factory districts as early as July 1. Estimates are updated periodically to reflect changes in soil moisture and other growing conditions. A review of yield estimates for the last five years reveals that Crystal Agriculturists are predicting final crop yield with a remarkable degree of accuracy — 98.48 percent to be exact!

The tonnage expected to harvest definitely affects the starting date of harvest. If a large crop is expected, the prepile harvest is moved to early September. If the crop is small, the number of prepile harvest days can be cut down and the schedule can be delayed until late September. The main adjustment in harvest schedules due to crop size is made at the "front" end.

Beet Receiving Capacity And Factory Slice Capacity

The Agriculture Department's harvest plans are coordinated with Crystal's Operations Department. A close teamwork exists between the departments from the beginning of harvest until the end of the processing campaign. The beet receiving capacity and the factory slice capacity definitely determine the starting date of harvest. Crystal's current beet receiving equipment has the capacity to receive approximately 8.5 percent of the total crop daily, or about 416,000 tons per day. This is based on a 17.5 ton crop on 280,000 stock acres. The optimum harvest period for beets going into storage, (See Figure 1), is about 15 days — from October 5 to October 20, so there is some time leeway for interruptions due to weather and for handling a larger than 17.5 ton per acre crop.

The average daily slicing capacity of the five Valley factories is 25,500 tons. So based on the estimated tons to harvest and the daily beet receiving capacity, final plans can be made for the start of harvest and the length of the processing campaign.

As an example, let's assume that the Valley sugarbeet crop will yield 17.5 tons per acre on the present 280,000 stock acres allowable to plant. A total of 4,900,000 tons would be harvested. Chances of high beet storage loss after March 10 increases rapidly, based on weather "means" established over many years. Therefore, March 10 will be used as the finish of the slicing campaign. Based on normal beet shrink, this 4,900,000 example crop would take 177 days to slice using the average slice rate of 25,500 tons daily. Prepile harvest would start on September 14 with slicing commencing September 15. Prepile harvest would continue until the start of full piling on October 5. Prepile harvest tons would total the 20 slice days (510,000 tons) plus 76,500 tons safety supply, for a total prepile of 586,500 tons. The remaining 4,314,000 tons would be harvested over 10⅓ days, leaving five days leeway before the scheduled finish date of October 20. If the crop is estimated to be a higher tonnage, then the starting date of prepile harvest would be set earlier. The date for piling could be earlier, if necessary, in order to finish the majority of harvest by October 20.

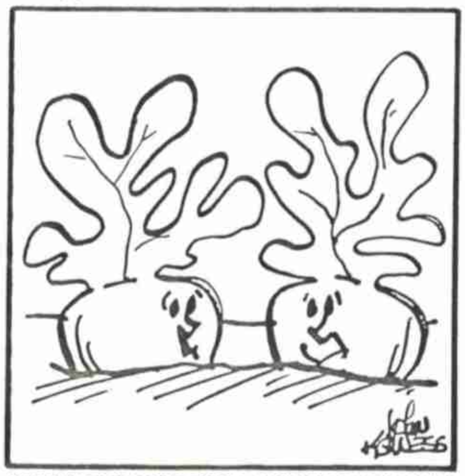
While the figures look good on paper, things don't always work according to plan. But, in general, these are the guidelines that the Crystal Agriculture Department uses in planning the annual sugarbeet harvest. The starting date for harvest is not just a figure picked out of the air. It is the result of a careful study of weather probabilities and the optimum period for sucrose accumulation in the root coordinated with the size of the crop and the capacity to receive and to process the total crop.

While the text in Ecclesiastes 3:2 was a bit sketchy, there certainly is "*. . .a time to plant and a time to harvest. . .*"

Sugar cubes

YA...I GUESS YOU COULD SAY I HAD A PRETTY FAIR YIELD ON SUGARBEETS THIS YEAR!

Sugar cubes



FREE WATER, FREE FOOD, PLENTY OF SUNSHINE AND A GREAT PLACE TO LIVE...I CAN'T FIGURE IT OUT, THERE'S GOT TO BE A CATCH SOMEWHERE!

Figure 2. Relations Of Harvest Dates To Sugar Content Red River Valley 1978 Crop (Long Growing Season)

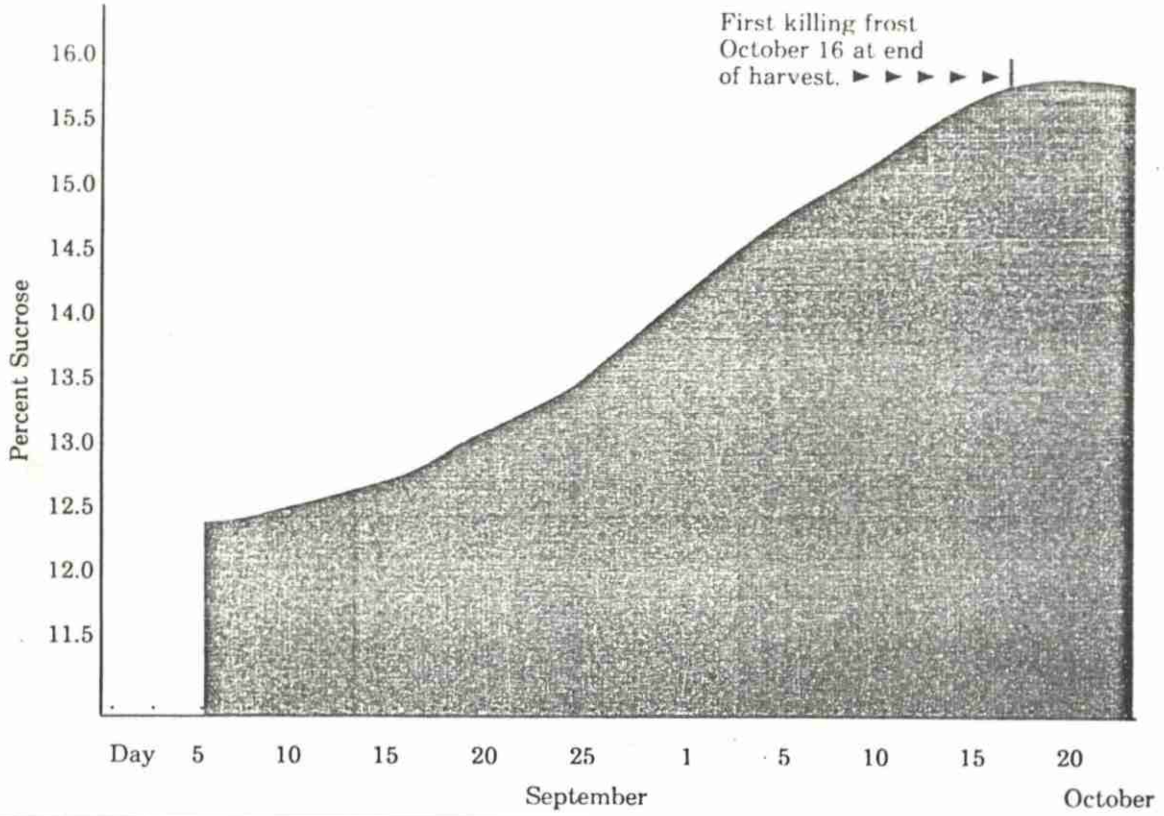
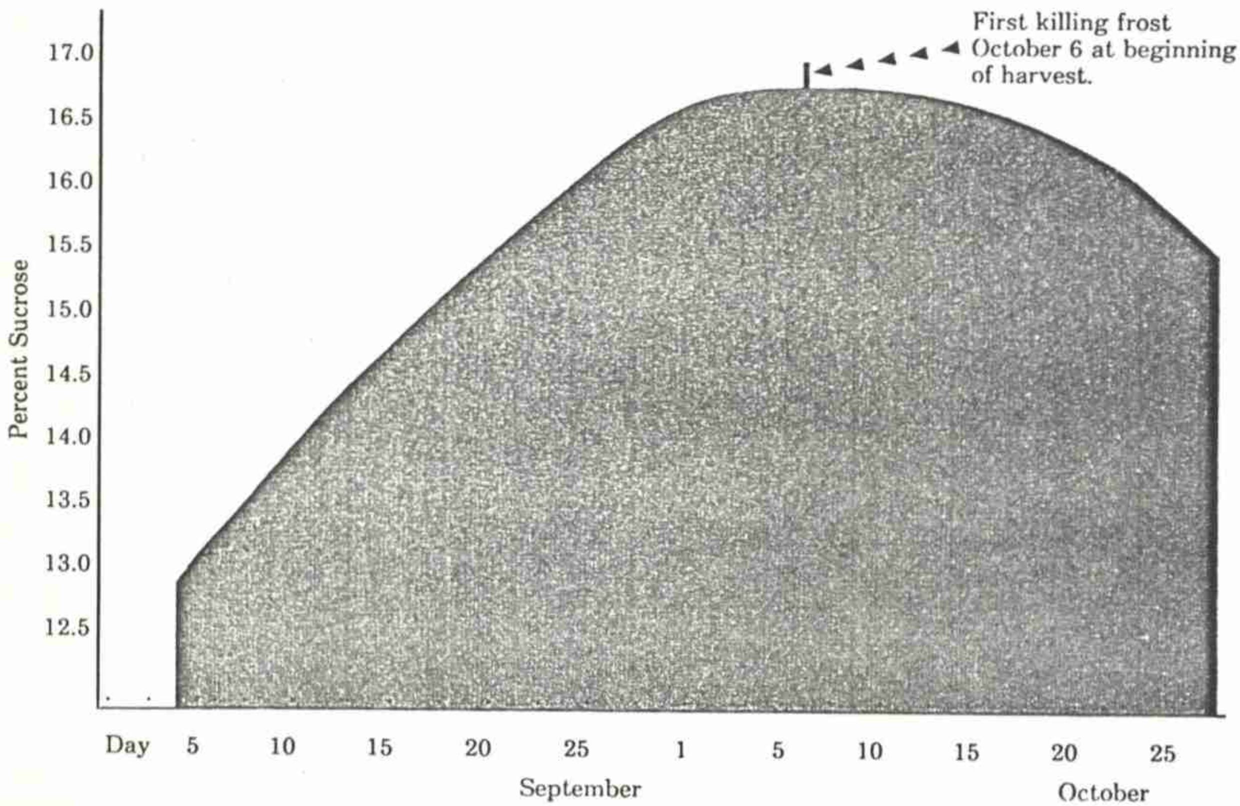


Figure 3. Relations Of Harvest Dates To Sugar Content Red River Valley 1976 Crop (Short Growing Season)



Agriculture is where it all begins

"To process and market for the shareholders their agricultural production from a minimum of the acreage represented by the outstanding shares, to maximize the return on their investment."

This is the overall mission of American Crystal, or its "reason for being," and **agriculture is where it all begins!** The first link in Crystal's sugar chain is the production of the raw product—sugarbeets. The Company's Agriculture Department is involved in every step, from the production of sugarbeet seed in Arizona and Oregon, to the growing and harvesting of the sugar-laden beet root in the Red River Valley.

Agriculture's major responsibilities are to: contract with the grower to produce the raw product (sugarbeets) under the guidelines of the Company Bylaws; assist the grower to raise a high quality crop with the most efficient methods; receive the crop at harvest in a timely and efficient manner; store the crop for processing with the least possible loss of recoverable sugar; and supply the factories with the requested quantity of good quality beets for processing.

Increase grower profit

A major goal of Crystal's Agriculture Department is to improve sugarbeet quality in the Red River Valley, thereby increasing the profit to the member through the production of more recoverable sugar per acre. The quality payment system, initiated in 1980, provides the incentive for the individual grower to adopt production practices that will result in more sugar and less impurities in the beet root. This is commonly referred to as improving sugarbeet "quality" and is, perhaps, the largest **untapped** dollar resource potentially available to the progressive sugarbeet grower in the 1980s.

The Agriculture Department also serves as a consultant to growers and provides technical assistance in improving recoverable sugar production per acre. Communication with growers is an important function of Crystal's Agricultural staff, and technical advice is on a one-to-one basis through the agricultural managers and agriculturists. Grower meetings, *Crystal Ag Notes,* and *Crystal-ized Facts* provide timely and up-to-date information on sugarbeet production practices.

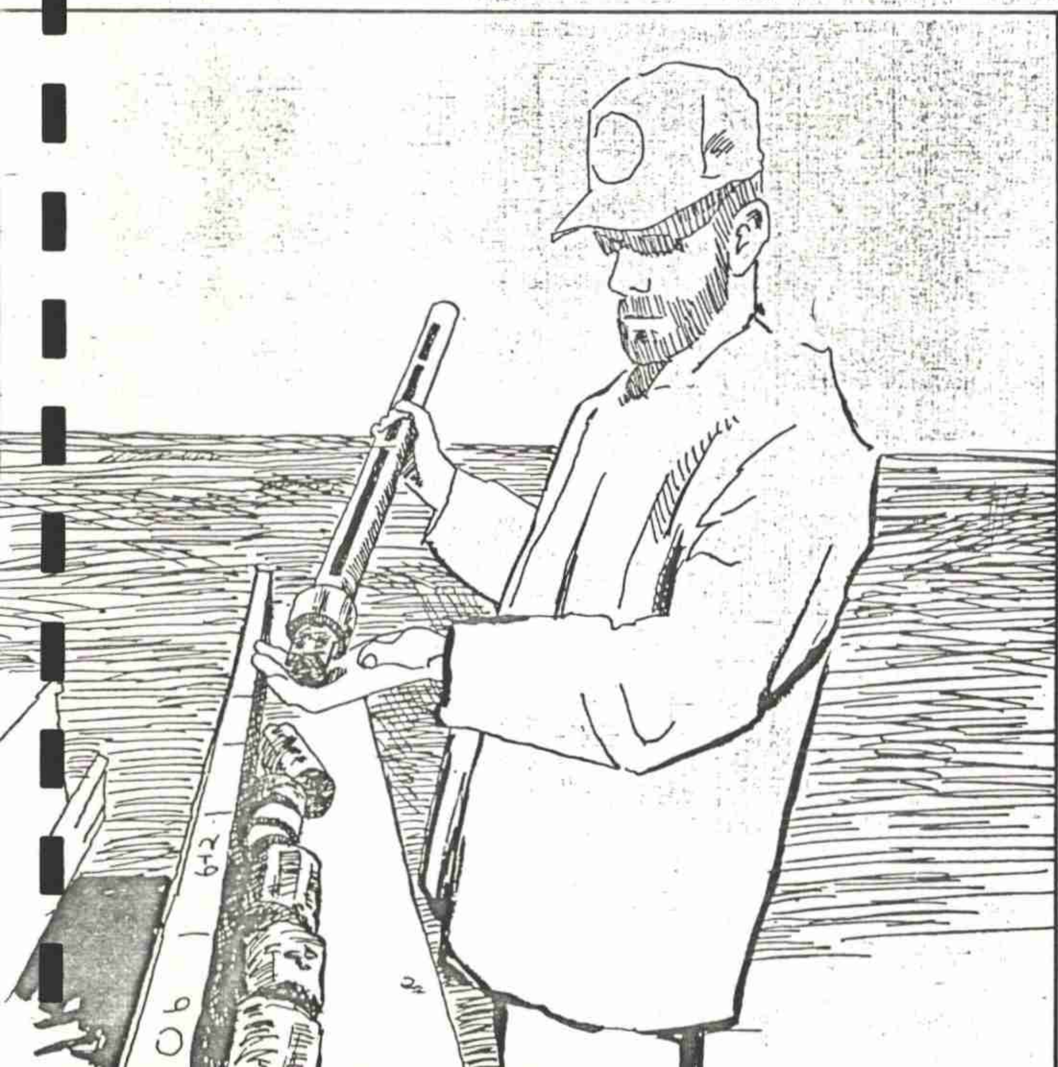
Another useful method of analyzing sugarbeet production practices is the Grower Practices System. This is a computer analyzed field record that compares agronomic practices to the actual lab quality results (sugar content and impurities) for each grower contract. This record analysis will become more valuable as historical data is gradually accumulating from the new quality payment system.

How we produce a quality raw product

Grower production practices can influence sugarbeet quality to a large extent and can be directed towards producing more recoverable sugar per acre.

Crystal agriculturists are specialists in sugarbeet agronomy. They work with the grower in crop planning and in solving production problems during the growing season. Advanced planning is a must because many production practices for the sugarbeet crop are carried out in the preceding summer and fall.

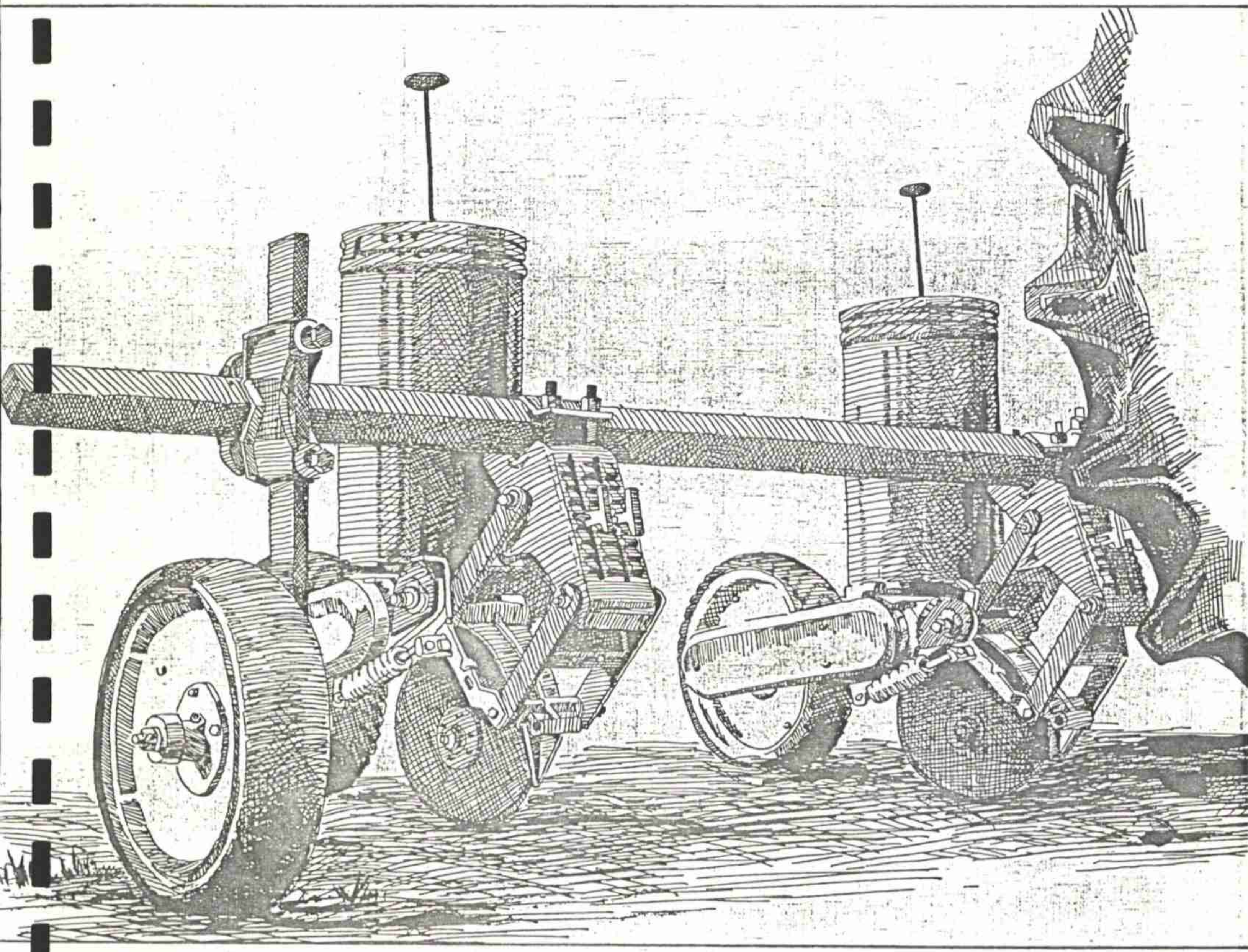
Soil testing is done in late fall and is one of the most important quality control procedures. Nitrogen is the single most important controllable factor influencing sugarbeet quality. A measure of the nitrate content in the soil is essential in planning a balanced fertility program for growing high quality sugarbeets.

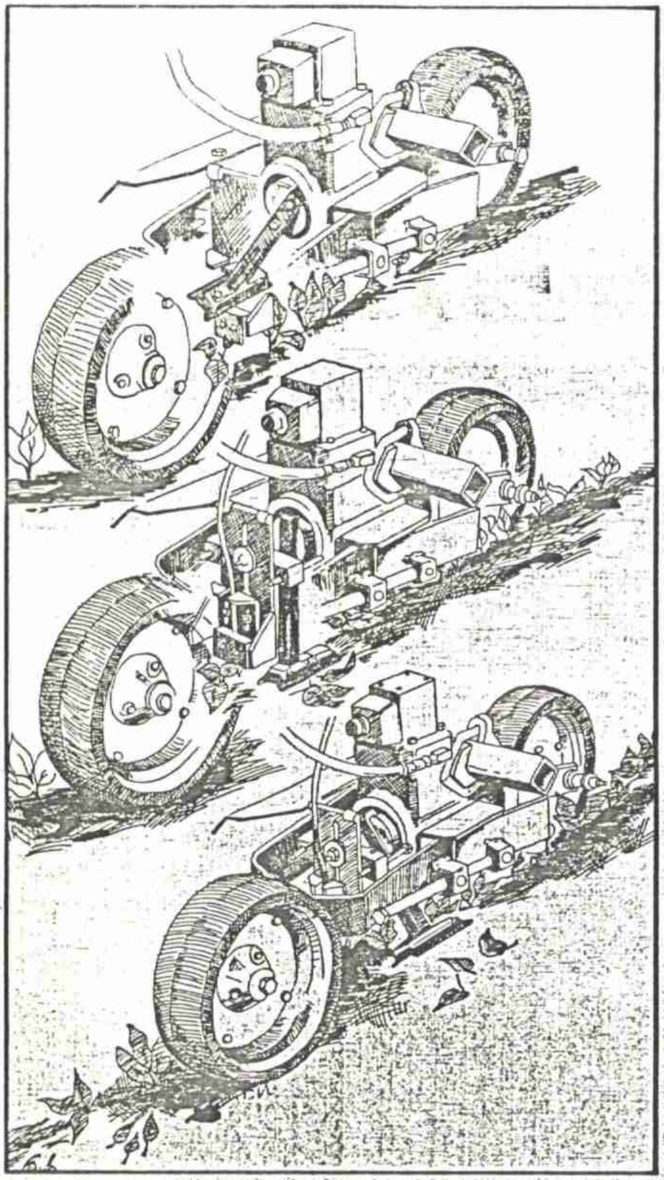


Fall seedbed preparation is done as soon as the preceding crop has been harvested. Fields are plowed, disced, or chisel plowed with subsequent harrowings and sometimes a land leveling. Fertilizer and herbicides are also incorporated in the fall. The last operation in the fall is ridging the field to protect the soil against wind erosion and also to aid in holding snow on the fields.

Spring seedbed preparation is done as early in the spring as field conditions permit. This is a minimum tillage operation designed to conserve soil moisture and provide a firm seedbed for the small sugarbeet seed. A favorable environment for the seed is an important initial step in the production of a quality sugarbeet crop.

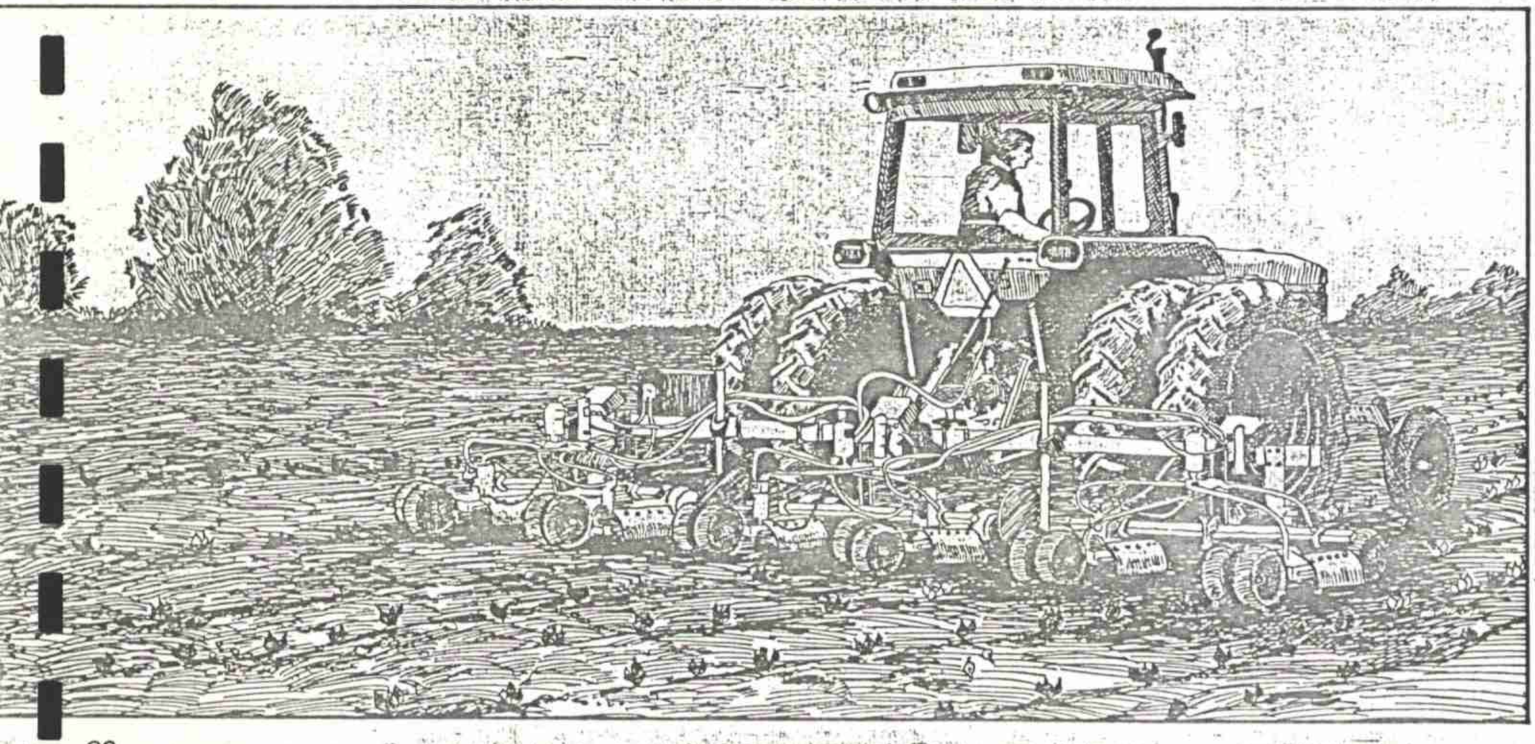
Planting seed varieties that have a high sugar content, low impurities, high recoverable sugar per ton and per acre and resistance to disease is essential in producing a quality raw product. Seed varieties are thoroughly tested under Red River Valley growing conditions and the best selections are made available to growers for planting. Planting is done as early in the season as is practical to provide a maximum growing season and a complete utilization of the available soil nitrogen which is necessary for maximum growth of high quality sugarbeets.





Thinning sugarbeets to a desirable plant population is another important step in producing a quality raw product. A high plant population in the range of 24,000 to 30,000 plants per acre fully utilizes the available soil moisture and nutrients for maximum yield and sugar content. Thinning sugarbeet fields is accomplished by electronic thinners and/or by planting to a final stand with hand labor assistance used where needed for added stand reduction and weed elimination.

Pest control protects the growing sugarbeet from the detrimental effects of weeds, insects, and diseases, and thus contributes to the production of a quality raw product. Yields can be increased with early season weed control because competition with the beets for moisture and nutrients is reduced. Spraying with pre and post emergence herbicides and the use of mechanical methods, such as cultivators, rotary hoes, and weeders, are effective weed control measures. Insecticides applied at planting for the sugarbeet root maggot and post emergence insecticides applied for cutworms are used to control these stand reducing insects. Cercospora leafspot, a

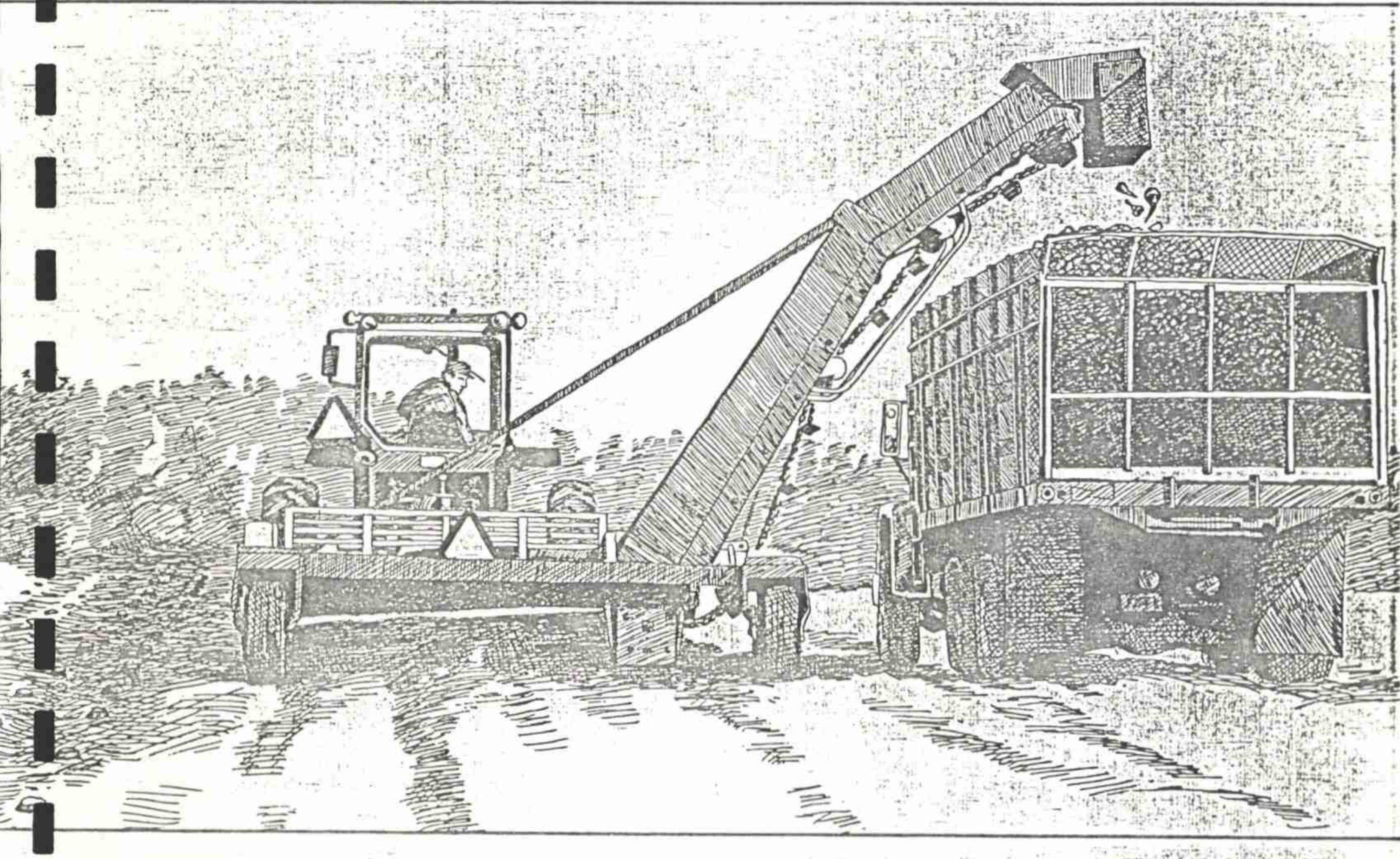


disease that can reduce both yield and sugar content, is effectively controlled by planting resistant varieties and by timely spraying with fungicides.

Harvesting is the final phase of the growers' production practices, and good harvest techniques contribute to a quality raw product. Fields are generally harvested in relation to planting dates to maximize sugar production per acre. Earlier planted fields normally have higher yields and sugar content and are harvested first. Later planted fields are given a chance to "mature" and are harvested last.

The field harvest is a two-step procedure. First, a rotobeater equipped with scalper knives completely removes the foilage and excess crown material from the beet. Leaves, petioles and crown tissue are high in impurities, and, if left on the beet, can cause a lower recovery of sugar in the factory process. Rotobeating is done just a few hours in advance of the harvester to prevent a reduction in sugar content caused by regrowth of new leaves. The second step of the harvest procedure is lifting and loading the well-topped beets and delivery of the raw product to a receiving station. Four and six row harvesters loading sugarbeets into large tandem and semi trucks is a common sight in the Red River Valley in October.

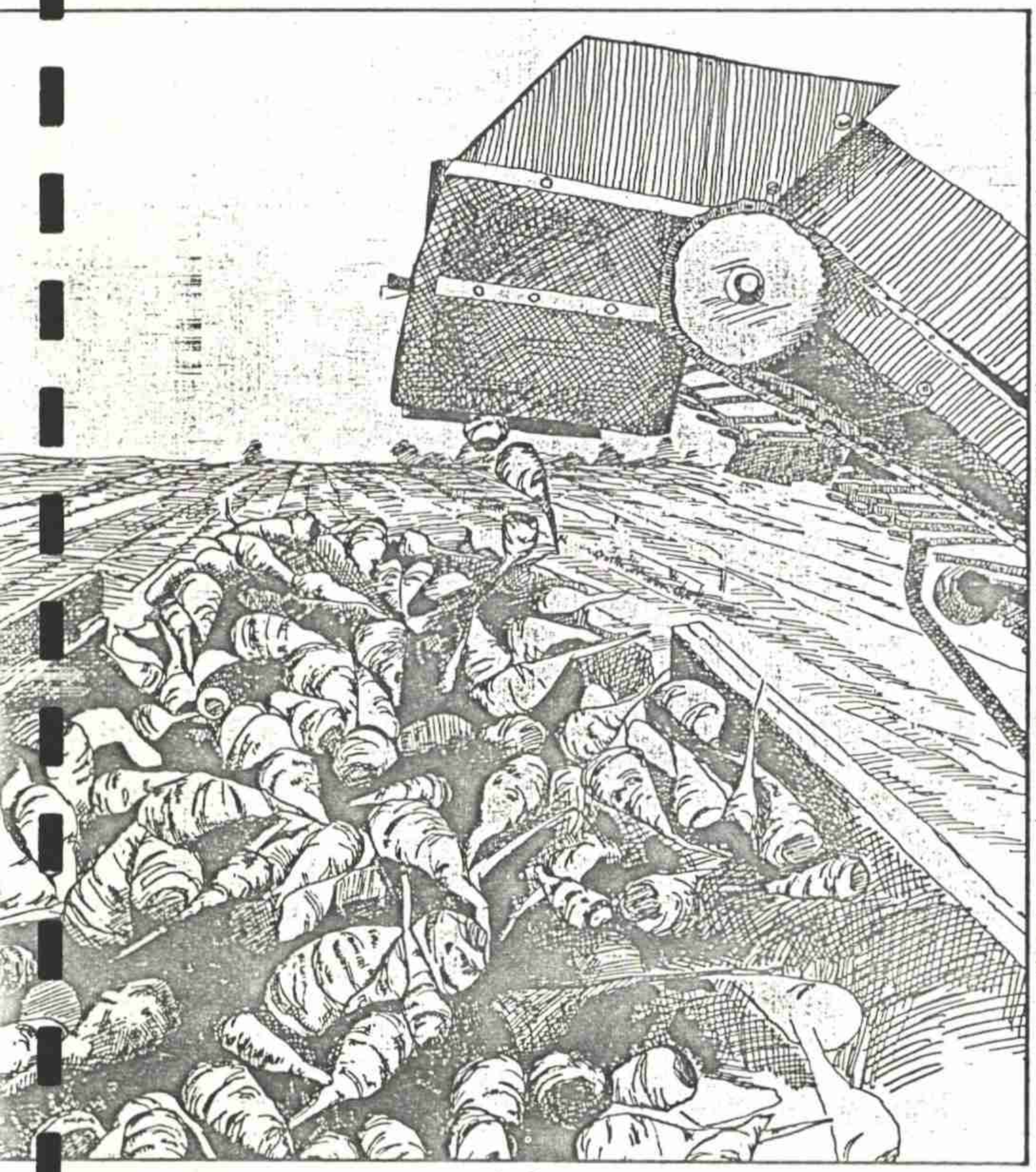
From seedbed preparation to the harvest of the sugarbeet crop, the final production decisions are the growers' responsibility. Agriculture's role, up to harvest, has been in administration and technical advice. For both the grower and the agricultural staff, the harvest is the culmination of the steps required to produce a quality raw product.



How we handle the crop at harvest

American Crystal's harvest plans are focused on the time span from October 5 to October 20, when sugar accumulation in the beet root is at the maximum. This requires sufficient receiving equipment to handle a large volume of beets (over 5.1 million tons this year) in a very short harvest period. During the piling period, harvest and receiving are conducted 24 hours a day. In ten to eleven working days 85 to 95 percent of the total crop is received. It takes over 350,000 grower truck loads to transport the 5.1 million ton crop to the receiving stations. If the truckloads were lined up, they would extend over 3,000 miles—more than the distance from New York to Los Angeles.

The "title" to the harvested beets transfers from the individual grower to the American Crystal at the receiving station. The full responsibility for the Valley beet crop now shifts to American Crystal's Agriculture Department and remains there until the last beet enters the factory wet hopper.



Modern receiving stations are maintained at the five factory sites and at twenty-two "country" sites strategically located throughout the Valley. The growers' beet loads are first weighed, then unloaded over pilers, screened and conveyed into huge storage piles. Approximately 90 to 95 percent of the total Valley crop is stored for future processing. About 35 percent of the individual grower's loads are sampled after cleaning over a grab roll screen on the piler.

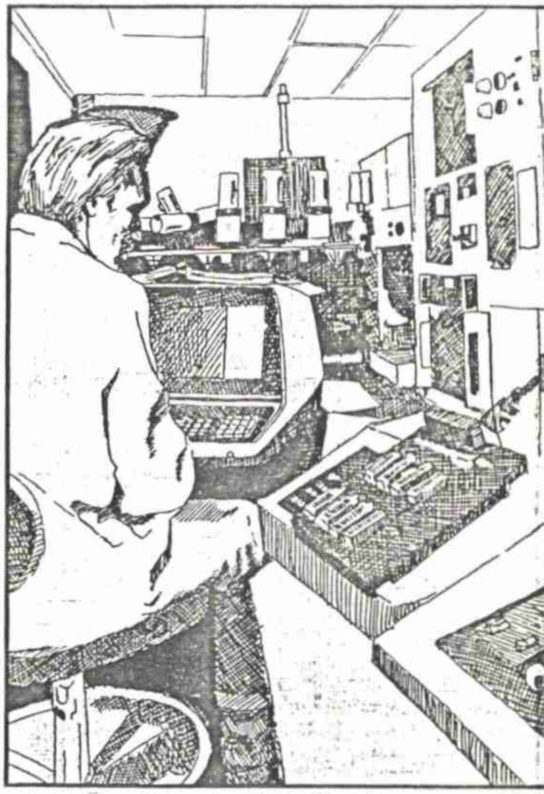
Samples are bagged, identified by the grower's ticket, and delivered to the **Beet Quality Lab** located at East Grand Forks for analysis of dirt tare, sugar content and impurities. These intricate analyses measure the amount of recoverable sugar (fresh beet basis) that is potentially available for processing from the grower's crop. Recoverable sugar per ton of beets is the unit measurement that forms the basis for the quality payment system and is the final result of the grower's production effort.

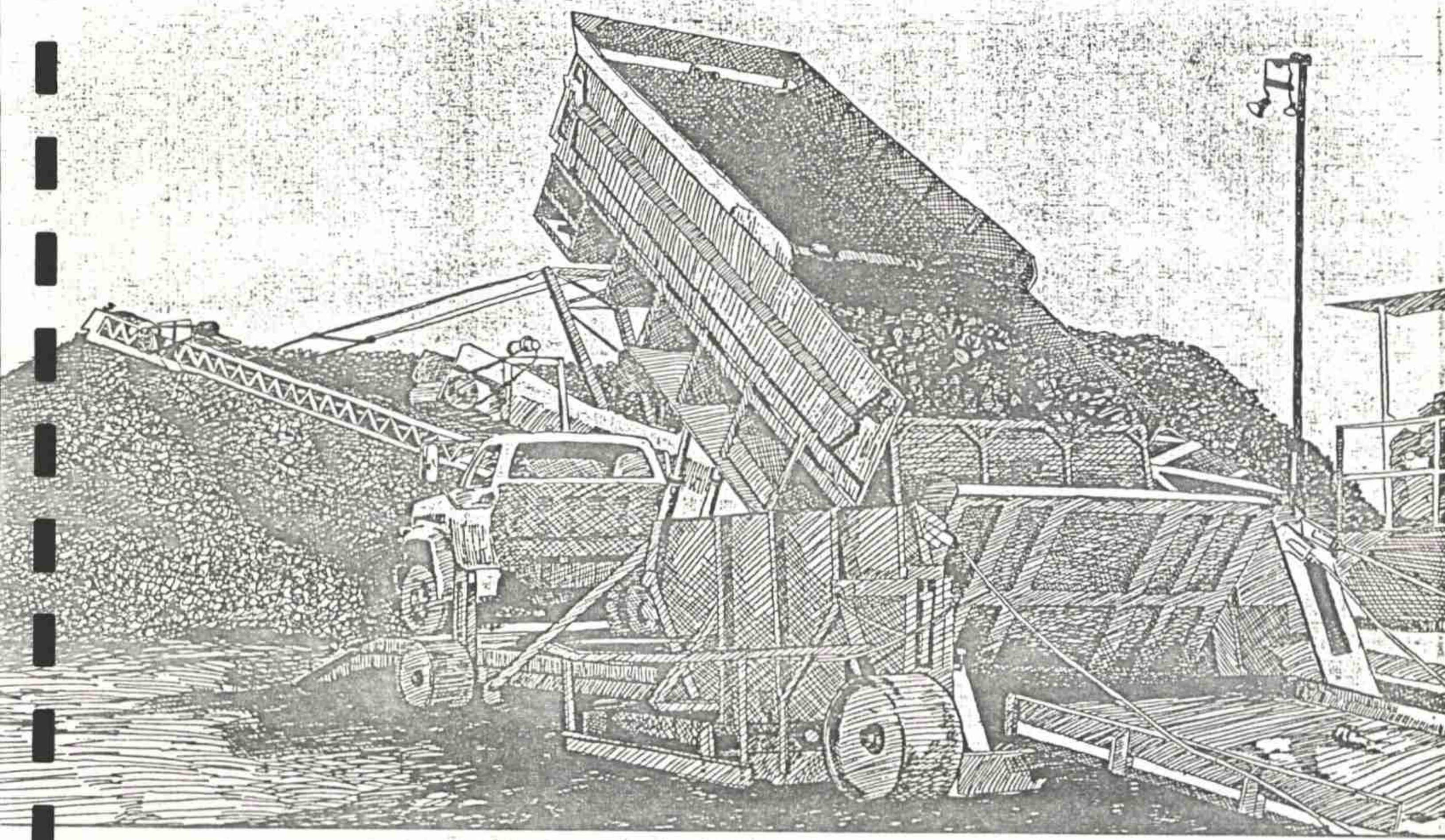
Protecting beet quality is a big job

A major responsibility of Agriculture is to store the crop for processing with the least possible loss of recoverable sugar. Some sugar loss is normal because the harvested beet is a living organism and it respires, or "burns", sugar in order to maintain life. Lower air temperatures will reduce sugar loss in beet storage piles due to respiration, so American Crystal's harvest and crop storage is planned to take advantage of seasonal weather patterns. Harvesting beets for storage is done when the average air temperature is 50°F or lower. This usually occurs during the first week of October. Colder temperatures in late fall and winter will retard respiration and further reduce sugar losses in storage.

Since beets generate heat from respiration, ventilation is essential to cool beet piles to 40°F or lower as rapidly as possible. **Pile structure** becomes very important in providing natural ventilation throughout the pile. Pile heights are kept at 20 to 22 feet. Every precaution is taken to prevent dirt and trash entering with the beets to be piled, so free air spaces are not blocked. Beets that are frosted in the field are not placed in long-term storage piles because they deteriorate rapidly and require special handling. A pile of **clean** beets, to some extent, ventilates itself, because warm air in the center rises and colder air is drawn in from the surrounding atmosphere.

Long-term storage piles can be cooled faster by removing and processing the warmer center section first. This technique is called **pile splitting** and was pioneered by American Crystal's Agriculture Department. Another technique developed by American Crystal to reduce sugar losses in storage is **deep freezing.** Ventilating fans force air through ducts under the beet pile and cool air is circulated throughout the pile. In late fall, fans are run periodically to cool the beets. When air temperatures reach below zero and long-range predictions are for continuing cold, ventilating fans are operated continuously until the entire beet pile is frozen solid. The deep freeze method is used on about 100,000 tons respectively at Hillsboro, Moorhead, and East Grand Forks. It is designed to provide these factories with better quality beets up to the last day of campaign.





How we supply the factory with quality beets

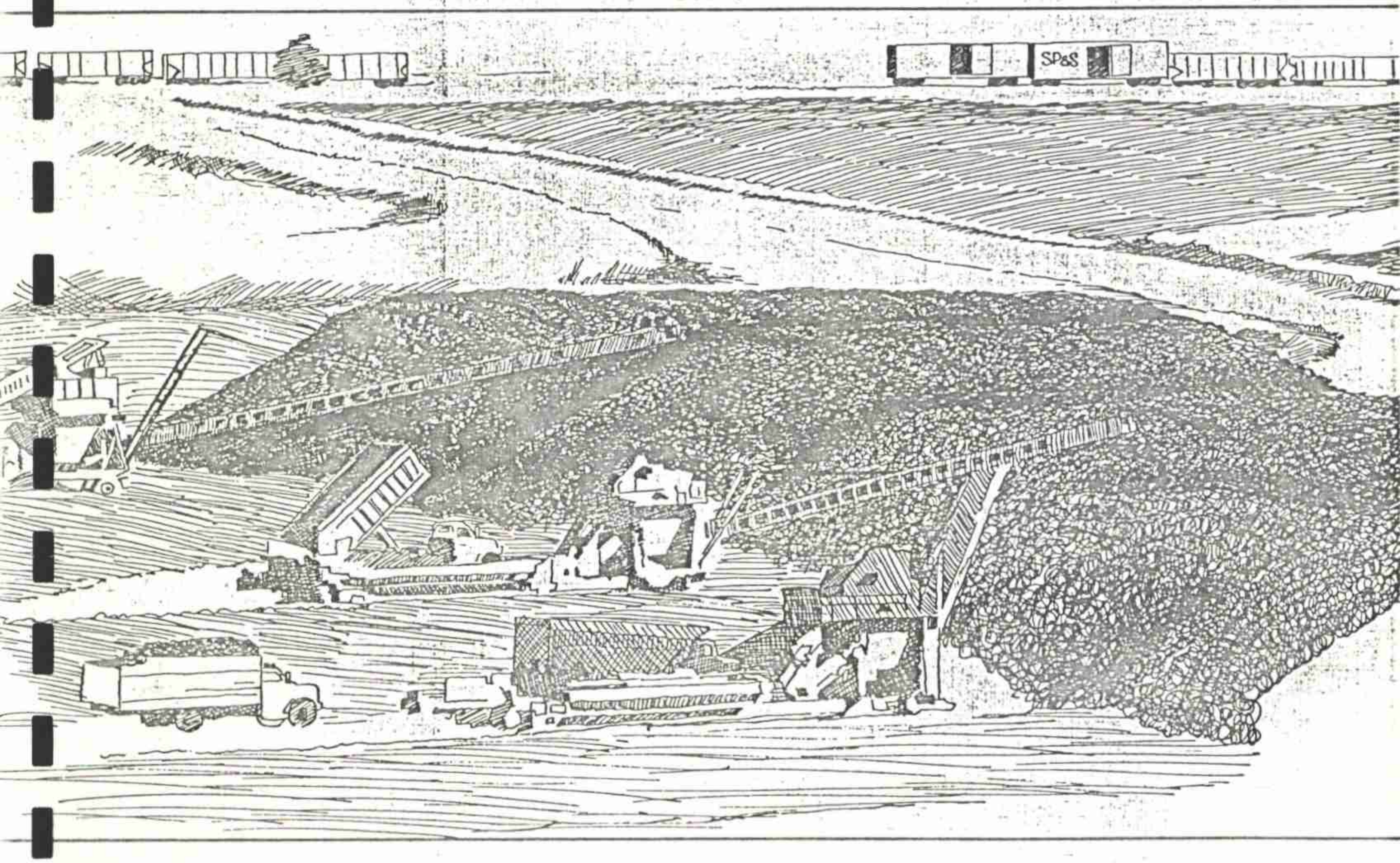
The final phase of Agriculture's role in Company operations is to supply factories with the requested quantity of good quality beets for processing.

Reloading out of storage piles and **transporting** to the factories is coordinated with American Crystal's Operations Department. A constant beet delivery system to the wet hopper must be maintained in order for factories to achieve their maximum slice capacity. Fleets of semi trucks and front end loaders are under the direct supervision of the Agriculture Department. Distribution of beets from outlying receiving stations is made on the basis of factory capacity and freight costs. Supplying good quality beets for processing out of long-term storage piles is a real challenge for Agriculture. Generally, beets that are harvested first are processed first, but, when "hot spots" develop that could lead to spoilage problems, it becomes necessary to "bend the rules." Relying on daily pile monitoring, past experience, and good judgment by the agriculture managers and agriculturists is the key to protecting and saving the potential recoverable sugar in long-term storage piles.

Another method of quality control is using the pile report generated from the East Grand Forks Beet Quality Lab. This shows lab information (dirt tare, nitrate, conductivity, sugar content, and the impurities sodium, potassium and amino nitrogen) in each one of our storage piles by harvest day. This gives the agriculture manager and factory manager another tool to use in processing stored beets for the most recovered sugar possible.

Beet quality is the watchword in American Crystal's Agriculture Department. **Increasing** the recoverable sugar in the raw product (sugarbeets) through improved grower production practices; **protecting** the recoverable sugar in the raw product through good harvest, beet receiving and pile storage techniques; and **saving** the recoverable sugar in the raw product from the ravages of long-term storage through good beet delivery management, means a maximum return to members on their investment.

Agriculture is where it all begins!



GROWER PRACTICES SYSTEM PROMOTES BEET QUALITY IMPROVEMENT IN THE RED RIVER VALLEY

D. J. Hilde, Special Agriculturist

AMERICAN CRYSTAL SUGAR COMPANY
AGRICULTURE DEPARTMENT
CORPORATE OFFICE
MOORHEAD, MINNESOTA

Presented at
ASSBT General Meeting
February 20-24, 1983
Phoenix, Arizona

A14

Grower Practices System Promotes Beet Quality Improvement In The Red River Valley

D. J. Hilde, S. Bass, R. W. Levos, R. L. Ellingson*

The Agriculture Department of American Crystal maintains crop production records on each grower field contract in order to monitor agronomic practices that affect the yield and quality of sugarbeets. A study of crop records, to determine what happened and why it happened, helps us to make sound recommendations to our growers for improving beet quality thus increasing the amount of sugar that can be recovered and sold.

With the advent of the quality payment system in 1980, which bases the individual grower beet payment on recoverable sugar per ton, it became apparent that we needed a record system that could handle a vast amount of data fast and accurately. The Company's main frame computer, Burroughs Model 2930 and the Honeywell Level 6, Models 43 and 47 at the five factory locations, provided this capability. Data from the grower production practices on individual field contracts could now be matched to other information that included the quality lab data and scale weight data used to calculate the beet payment for those contracts. The amalgamation of various data for crop analysis is called the Grower Practices System.

The grower and the agriculturist are the key people in making the Grower Practices System a useful and successful program. The grower provides the field information and the agriculturist records and prepares the information for encoding into the computer. Special provisions are taken to insure that the information used in the program is accurate.

*The authors are Special Agriculturist, Vice President Agriculture, General Agriculturist, and Agriculture Information Coordinator, respectively, American Crystal Sugar Company, 101 North Third Street, Moorhead, Minnesota 56560.

1. Each field must be written as a separate contract.
2. All fields must be accurately measured.
3. All beet deliveries must be credited to the correct contract.
4. Information on agronomic practices must be correct.

For the purpose of this paper, a brief summary of crop records includes: 1. Grower Practices Reporting Form; 2. Grower Field Report; 3. Grower Five-Year History Report; 4. Yield and Quality Results By Nitrate Grade, and 5. Beet Quality Analyses In Relation To Plant Nutrition Research.

Grower Practices Form - Grower Field Report - Five Year History.

The grower practices information sheet and codes are attached to the annual contract. Some information is collected at contracting and other crop information is collected during the growing season. Attached is a completed sample form for an individual field contract and the final grower field report and a five-year history report.

The grower field report shows the yield and quality results for the individual field contract and can be compared with the results of the grower's total fields, delivery station, factory district, and the Red River Valley. This report is given to the grower by the agriculturist and is discussed when contracting for the next year's crop.

A crop history report for each grower is maintained beginning with the 1980 crop, the first year of the quality payment system. Eventually a five-year crop history will be maintained for each Crystal grower. This report can be useful in determining fertilizer rates based on realistic yield goals. It also shows what progress, if any, has been made in improving beet quality.

ANNUAL 1982 CONTRACT between AMERICAN CRYSTAL SUGAR COMPANY and

1. GROWER: J. R. Grobeetski

Address Route 1, Forest River, ND 58233 Home Station Ardoch 8|0|2|0

Contract Number 8|0|0|3|2|2|0|1 Ag Rep. I. M. Fieldmann

a. S|E Quarter, Sec. 2|4, Twp. 1|5|5, Rng. 5|3, Acres 90 Haul Miles 23.5

b. ______ Quarter, Sec. ______, Twp. ______, Rng. ______, Acres ______, Haul Miles ______

c. ______ Quarter, Sec. ______, Twp. ______, Rng. ______, Acres ______, Haul Miles ______

County Walsh 5|0 State N.D. ASC County Walsh 5|0 ASC State N.D.

Contracted 0|9|0.0 Planted 0|9|0.0 Replanted 0|0|0.0 Thinned 0|8|9.2 Harvested 0|8|9.2

Contracted Miles 2|3.5 Number Plates 3 Common Field Description Old Johnson Farm

CULTURAL PRACTICES - 04

Data Classification: (If non-rep, enter 02) Represent. 0|1

Preceding Crop: Barley 0|4

Variety: ACH 30 ___ , ___ , ___ , 2|3

Planting Date: 0|5/0|2/8|3

SOIL ANALYSIS - 05

Soil Tested: Yes 0|1

Texture: Fine 0|1

PH: 7.5 O.M: 4.5 NO_3(0-2'): 0|3|5 P: 0|1|7

K: 4|6|0 NO_3(2-4'): 0|2|5

FERTILIZER - 05

N Applied (Lbs / A.) 0|6|5

P_2O_5 Applied (Lbs. / A.) 0|2|0

K_2O Applied (Lbs / A.) 0|0|0

HERBICIDE - 07

1. Brand Ava. + Ept. ___ , ___ , 0|1 , 0|7
   Application Method Fall Broadcast 0|2
   Acres Treated .... 0|9|0.0
2. Brand Dowpon ___ , ___ , ___ , 2|0
   Application Method Spring Band 0|3
   Acres Treated .... 0|9|0.0
3. Brand Treflan ___ , ___ , ___ , 1|9
   Application Method Spring Broadcast 0|4
   Acres Treated .... ___ . ___
4. Brand ______
   Application Method ______
   Acres Treated .... ___ . ___
5. Brand ______
   Application Method ______
   Acres Treated .... ___ . ___

INSECTICIDES - 08

1. Brand Counter 15G 1|6
   Application Method Band 0|1
   Acres Treated .... 0|9|0.0
   Insect Sugarbeet Root Maggot 0|3
2. Brand Sevin Bait 0|9
   Application Method Broadcast 0|2
   Acres Treated .... 0|9|0.0
   Insect Cutworm 0|6
3. Brand ______
   Application Method ______
   Acres Treated .... ___ . ___
   Insect ______

FUNGICIDE - 08

1. Brand Mertect 0|3
   Application Method Aerial 0|1
   Acres Treated .... 0|8|9.2
   Disease Cercospora Leafspot 0|1
2. Brand Topsin M 1|9
   Application Method Aerial 0|1
   Acres Treated .... 0|8|9.2
   Disease Cercospora Leafspot 0|1
3. Brand ______
   Application Method ______
   Acres Treated .... ___ . ___
   Disease ______

STAND REDUCTION - 09

Planted To Stand: 0|0|0.0 Acres Seed Spacing: (Inches) 3.0

Electronically: 0|8|9.2 Acres

Mechanical: 0|0|0.0 Acres

Labor: 0|0|0.0 Acres

WEED REDUCTION - 10

1. Mechanical: 0|8|9.2 Acres Type: 0|1
2. Mechanical: 0|8|9.2 Acres Type: 0|2

Labor: 0|5|0.0 Acres

GROWER PRACTICES CODE CARD

CULTURAL PRACTICES - 04

Preceding Crop:
01 Alfalfa
02 Beans Pinto
03 Beans Soy
04 Barley
05 Corn
10 Potatoes
11 Summer Fallow - Black
12 Summer Fallow - Green Manure
13 Sunflowers
15 Wheat
18 Peas
19 Beans Navy
20 Oats
21 Sugarbeets
22 Flax
99 Other

Varieties:
21 ACH 14
01 ACH 17
23 ACH 30
38 ACH 153
39 Beta 1230
25 Beta 1237
08 Beta 1443
29 Beta 1839
19 Bush Monofort
32 Bush Johnson 19
31 Bush Johnson 27
24 GW R-1
27 GW R-2
33 GW R-105
40 GW R-107
14 Hilleshog Monika
13 Hilleshog Monoricca
28 Hilleshog 309
30 Hilleshog 833
41 HH-30
34 Maribo Monova
35 Maribo Ultramono
36 Maribo Unica
42 Maribo Magnamono
43 Van der Have H6608
44 Van der Have Puressa
16 Mixed
99 Other

SOIL ANALYSIS - 05

Soil Tested:
01 Yes
02 No

Soil Texture:
01 Fine
02 Medium
03 Coarse

HERBICIDES - 07

Herbicide Brands:
01 Avadex
02 Betanal
03 Betanex
04 Carbyne
05 Dowpon
07 Eptam
09 Herbicide 273
10 Paraquat
11 Pyramin
15 Ro-Neet
16 TCA
17 Nortron
19 Treflan
20 Betanix
21 Antor
99 Other

Herbicide Application Method:
01 Fall Band
02 Fall Broadcast
03 Spring Band
04 Spring Broadcast

INSECTICIDES - 08

Insecticide Brands:
02 Diazinon
03 Dyfonate
04 Dylox
05 Malathion
06 Parathion
07 Sevinmol
08 Sevin 80
09 Sevin Bait
10 Temik 10 and 15G
11 Thimet 10G
12 Thiodan 50
15 Thimet Liquid
16 Counter 15G
17 Furadan 10G
18 Lannate
19 Lorsban 15G
21 Lorsban 4E
99 Other

Insecticide Application Method:
01 Band
02 Broadcast

Insect Species:
01 Sugarbeet Nematode
03 Sugarbeet Root Maggot
04 Webworm
05 Wireworm
06 Cutworm
07 Armyworm
09 Grasshopper
12 Flea Beetle
13 White Grub
14 Leaf Miner
99 Other

FUNGICIDES - 08

Fungicide Brands:
01 Dithane M-45 & Manzate 200
02 Du-Ter
03 Mertect
04 Benlate
05 Sulfur
12 Polyram (Maneb & Zineb Comp.)
15 Copper (Various Copper Comp.)
16 Topsin M
17 Super Tin
99 Other

Fungicide Application Method:
01 Aerial
02 Ground

Root and Leaf Disease:
01 Cercospora Leafspot
02 Ramularia Leafspot
03 Phoma Leafspot
04 Alternaria Leafspot
05 Powdery Mildew
08 Bacterial Leaf Blight
13 Damping Off
14 Rhizoctonia Root Rot
99 Other

WEED REDUCTION - 10

Weed Reduction Mechanical Type:
01 Harrow
02 Rotary Hoe
03 Weeder
04 Electronic Zapper
99 Other

HOME STATION AND COUNTY CODES

Moorhead Factory:
6010 Moorhead Minnesota
6011 Moorhead North Dakota
6020 C-W Minnesota
6021 C-W North Dakota
6030 Dalrymple North Dakota
6040 Kindred North Dakota
6041 Kindred Minnesota
6050 Amenia North Dakota
6060 Perley Minnesota
6061 Perley North Dakota
6070 Felton Minnesota
6071 Felton North Dakota
6080 Sabin Minnesota
6081 Sabin North Dakota

Hillsboro Factory:
6510 Hillsboro Minnesota
6511 Hillsboro North Dakota
6530 Ada West Minnesota
6570 Midway Minnesota
6571 Midway North Dakota

Crookston Factory:
7010 Crookston Minnesota
7011 Crookston North Dakota
7020 Nielsville Minnesota
7021 Nielsville North Dakota
7030 Eldred Minnesota
7031 Eldred North Dakota
7050 Ada North Minnesota

East Grand Forks Factory:
8010 East Grand Forks Minnesota
8011 East Grand Forks North Dakota
8020 Ardoch North Dakota
8040 Oslo Minnesota
8041 Oslo North Dakota
8050 Warren Minnesota
8060 Argyle Minnesota

Drayton Factory:
9010 Drayton Minnesota
9011 Drayton North Dakota
9020 Bathgate North Dakota
9030 Hamilton North Dakota
9040 Nash North Dakota
9050 Grafton North Dakota
9060 Humboldt Minnesota
9061 Humboldt North Dakota
9070 Stephen Minnesota

Counties:

09	Cass	14	Clay
18	Grand Forks	35	Kittson
34	Pembina	45	Marshall
39	Richland	54	Norman
46	Steele	60	Polk
49	Traill	63	Red Lake
50	Walsh	84	Wilkin

AMERICAN CRYSTAL SUGAR COMPANY
1982 GROWER FIELD REPORT

Grower: J. R. Grobeetski — Ag Rep: I. M. Fieldmann
Contract Nbr: 80-0322-01
Land Desc: SE Qtr, Sec. 24, Twp. 155, Range 53

AVERAGE

Contracted	Planted	Replanted	Thinned	Harvested
90.0	90.0	.0	89.2	89.2

YIELD AND QUALITY DATA

Descr.	Field	Grower Total	Station Ardoch	Factory E. Grand Forks-A	Valley
Net Tons	1,599.19	1,599.19			
Beet Ton/Acres	17.9	17.9	18.7	16.5	17.3
Sugar Content	17.211	17.211	15.857	15.768	16,042
Sodium	325	325	676	613	557
Potassium	2501	2501	2542	2400	2367
Amino N	315	315	571	594	628
Sugar Loss Mol.	1.416	1.416	1.929	1.880	1.886
Recoverable Sugar					
Per Ton	316	316	279	278	283
Per Acre	5656	5656	5217	4587	4896
Est Thin Juice Pur	94.80	94.90	92.50	92.64	92.73
Dirt Tare	7.173	7.173	5.789	6.119	5.359
Nitrate Grade	3.2	3.2	4.5	4.3	4.0

Cultural Practices — Soil Analysis — Applied Fertilizer

Data Class: Representative
Preceding Crop: Barley
Planting Date: 05/02/82
Seed Variety: ACH 30

Soil Analysis		Applied Fertilizer	
Soil Texture:	Fine	N:	65
PH:	7.5	P205:	20
Organic Matter:	4.5	K20:	0
NO_3- 0-2 Feet:	35		
Phosphorus:	17	Available	
Potassium	460	Nitrogen	120
NO_3- 2-4 Feet:	25		

Recommendations:

AMERICAN CRYSTAL SUGAR COMPANY
1982 5 YEAR GROWER REPORT

Grower: J. R. Grobeetski
Contract Nbr: 80-0322

Ag Rep: I. M. Fieldmann

YIELD AND QUALITY DATA

Year:	1982	1981	1980		
Descr.					
Contracted Acres	90.0	90.0	90.0	0.0	0.0
Planted Acres	90.0	90.0	93.6	0.0	0.0
Replanted Acres	0.0	0.0	0.0	0.0	0.0
Thinned Acres	89.2	89.2	86.6	0.0	0.0
Harvested Acres	89.2	89.2	86.6	0.0	0.0
Total Net/Tons	1,599.2	2,374.2	979.7	.0	.0
Beet Ton/Acres	17.9	26.6	11.3	.0	.0
Sugar Content	17.211	15.088	14.806	.000	.000
Sodium	325	912	822	0	0
Potassium	2501	2433	3608	0	0
Amino N	315	703	704	0	0
Sugar Loss Mol	1.416	2.175	2.534	.000	.000
Recoverable Sugar					
Per Ton	316	258	245	0	0
Per Acre	5656	6863	2769	0	0
Est Thin Juice Pur	94.80	91.23	89.76	00	.00
Dirt Tare	7.173	5.006	5.074	.000	.000
Nitrate Grade	3.2	5.2	6.2	.0	.0

Average All Years

Beet Ton/Acre	18.7
Sugar Content	15.728
Sodium	702
Potassium	2686
Amino N	576
Sugar Loss Mol.	1.997
Recoverable Sugar	
Per Ton	275
Per Acre	5143
Est Thin Juice Pur	92.20
Dirt Tare	6.331
Nitrate Grade	4.1

Acreage Usage Reports

Usage reports of herbicides, insecticides, fungicides, and acres planted to stand, thinned by machine or hand labor, are compiled from individual field contracts. These reports show trends in chemical use and indicates what weed, insect, or disease problem is prevalent. Chemical suppliers frequently request this type of information. It enables them to predict what the problems are and what inventory of critical agricultural chemicals to have on hand. Similarly, the acres planted to stand, thinned by machine or labor, indicates future trends. With more acres planted to stand or machine thinned, there will be a continuing need for good preemergence and postemergence herbicides.

Grower Practice Reports

Correlation reports can be made from the combined statistics from the individual field contracts. Yield and quality comparisons are available for many grower practices, including the following:

1. Nitrate grade (brei nitrate)
2. Seed variety
3. Planting date
4. Preceding crop
5. Soil test nitrogen levels(0-2') by nitrate grade
6. Soil test nitrogen levels (2-4') by nitrate grade
7. Soil test potassium levels (low, medium, high, and very high)
8. Soil test phosphorus levels (low, medium, high and very high)

Only representative field contracts are used in these reports. Representative means that the fields were accurately measured, all loads were credited to the correct contract and agronomic information is correct. The three-year data (1980-1981-1982) represents 85% of the total fields analyzed for yield and quality. Data from nonrepresentative field contracts are <u>not</u> used in any yield or quality analysis.

Yield and quality results from the representative field contracts for various grower practices are available by Agriculturist's area, factory district, and the total Red River Valley. This information has been extremely valuable in formulating sound recommendations to our growers for improving overall beet quality.

Nitrate Grade - Useful In Determining Nitrogen Recommendations

In our crop analysis, fields are separated by nitrate grade (brei nitrate determined in the central beet quality lab). This is a good method of analyzing the nitrogen effects on yield and quality and, also, to determine what level of available nitrogen will produce the most recoverable sugar per ton and per acre. The nitrate content of the beet at harvest is a good indicator of beet quality and is directly related to the amount of residual nitrogen in the soil and the fertilizer nitrogen applied. The following table shows the number of fields, harvested acres, and net tons in each nitrate grade range.

Table 1. American Crystal Sugar Company
Red River Valley Three-Year Average
(1980, 1981, 1982)

Nitrate Grade	No. Of Fields	Harvested Acres	Net Tons Harvested	Average Nitrate Grade
2.0 - 2.9	247	15,977.7	282,805	2.6
3.0 - 3.9	1611	107,902.0	1,920,656	3.5
4.0 - 4.9	3655	232,410.6	4,136,909	4.5
5.0 - 5.9	4031	268,579.4	4,700,140	5.3
6.0 - 6.9	430	26,656.3	450,491	6.1
	9974	651,526.0	11,491,001	

Note: 338,346 beet samples were analyzed in the Central Beet Quality Lab during the three-year period.

The nitrate grade is based on a logrithmic scale. A small change in the grade number means a large change in the brei nitrate content. In the following table the approximate nitrate concentration is shown for the average nitrate grade of the five nitrate grade ranges. Note that a nitrate grade of 6.1 has a NO_3 concentration 10 times greater than a low reading of 2.6.

Table 2. Approximate NO_3 Concentration For Nitrate Grades

Nitrate Grade	PPM NO_3
2.6	116
3.5	209
4.5	404
5.3	684
6.1	1157

The nitrate concentration in the beet root as expressed by the nitrate grade directly relates to the available nitrogen in the soil at harvest. A low reading of 2.6 indicates that the available nitrogen has been nearly depleted, which is ideal. A high reading indicates that an excessive amount of nitrogen is still available to the beet. The data in table 3 shows the concentration of sodium, potassium, and amino nitrogen, in the beet root with increasing levels of nitrogen availability.

Table 3. Relation Of Nitrate Grade To Impurities In The Beet Root
Red River Valley Three-Year Average
(1980, 1981, 1982)

Nitrate Grade	PPM Na	K	am-N	Impurity Value
2.6	330	2209	530	11,724
3.5	441	2317	604	13,086
4.5	615	2522	677	14,892
5.3	809	2677	769	16,832
6.1	1010	2918	801	18,447

The impurities sodium, potassium, and amino nitrogen, are measured as individual elements in the Central Beet Quality Lab. They are associated with other salts and the total amount of impurities and the percent sugar loss to molasses can be calculated using the Carruthers formula. The standard formula developed by Dr. Carruthers, at the British Sugar Corporation, is slightly modified to reflect the measured sugar loss to molasses in Crystal factory operations on a fresh beet basis.

Impurity Value = (ppm Na x 3.5) + (ppm K x 2.5) + (ppm am-N x 9.5).

$$\text{Percent Sugar Loss To Molasses} = \frac{\text{Impurity Value}}{11{,}000} \times 1.5^{*}$$

*For each one pound of impurities, 1.5 pounds of sugar is lost to molasses.

As the impurities increase in the beet root, percent sugar decreases and the percent sugar loss to molasses increases. This relationship is shown by nitrate grade in table 4.

Table 4. Relation Of Nitrate Grade To Percent Sugar And Percent Sugar Loss To Molasses, Red River Valley Three-Year Average (1980, 1981, 1982)

Nitrate Grade	Percent Sugar	Percent Sugar Loss
2.6	17.0	1.60
3.5	16.5	1.78
4.5	15.8	2.03
5.3	14.9	2.30
6.1	14.1	2.52

Recoverable sugar per ton is calculated by subtracting the percent sugar loss to molasses from the percent sugar and multiplying by 20 hundredweight. Recoverable sugar per acre is calculated by multiplying the recoverable sugar per ton by the yield per acre. The data in table 5 are weighted averages of the fields in each nitrate range.

Table 5. Relation Of Nitrate Grade To Root Yield And Recoverable Sugar Red River Valley Three-Year Average (1980, 1981, 1982)

Nitrate Grade	Tons/ Acre	Net Sugar Content*	Pounds Recoverable Sugar Per Ton	Pounds Recoverable Sugar Per Acre
2.6	17.7	15.4	308	5479
3.5	17.8	14.7	295	5271
4.5	17.8	13.8	276	4945
5.3	17.5	12.6	253	4454
6.1	16.9	11.6	232	3919

*Percent sugar minus percent sugar loss to molasses (fresh beet basis.

Note that the yield per acre remains about the same with increasing nitrogen availability, while recoverable sugar per ton and per acre decreases. Yield per acre at the very high nitrate level of 6.1 is lower and this is probably due to a lower plant population in these fields.

American Crystal's Quality Payment System is based on recoverable sugar per ton on an individual grower contract basis. The sugar loss due to storage and process is subtracted and the payment is then calculated on the recovered sugar per ton. Recovered sugar per ton multiplied by the net selling price of sugar plus by-product revenue minus member business cost is calculated for each grower contract. The following table shows the beet payment for the field contracts in each nitrate grade.

Table 6. Relation Of Nitrate Grade To The Beet Payment
Red River Valley Three-Year Average
(1980, 1981, 1982)

Nitrate Grade	Beet Payment Per Ton	Beet Payment Per Acre
2.6	$ 38.63	$ 683.75
3.5	35.57	633.15
4.5	31.11	533.76
5.3	25.71	449.93
6.1	20.78	351.18

The nitrate grade becomes an important separation in determining nitrogen fertilizer practices that will produce the highest recoverable sugar per ton and per acre. The soil tested fields in each nitrate grade range shown in the following table provides some clues for refining nitrogen recommendations.

Table 7. Relation Of Nitrate Grade To Soil N, Fertilizer N, and Total N (0-2')
Red River Valley Three-Year Average
(1980, 1981, 1982)

No. Of Fields	Nitrate Grade	Lbs/Acre 2' Soil N*	Lbs/Acre Fert. N	Lbs/Acre 2' Total N
247	2.6	62	72	134
1611	3.5	79	66	145
3655	4.5	93	60	153
4031	5.3	109	56	165
430	6.1	111	60	171

*Soil test data represents 61% of the fields soil tested during the three-year period.

This data shows a trend towards increasing amounts of residual soil nitrogen in fields with the higher nitrate grades. Fertilizer applications tend to be on

the high side and this is reflected in the percent sugar, percent sugar loss to molasses and recoverable sugar shown in tables 4 and 5. The total available nitrogen in the 2.6 nitrate grade comes the closest to Crystal's 1983 nitrogen recommendation of 120 pounds of nitrogen per acre for top yielding high quality beets.

The increments of total nitrogen per acre are relatively small for each nitrate grade range and this does not adequately explain why the beet samples from fields in the 6.1 grade have a nitrate concentration 10 times greater than samples from the fields in the 2.6 grade.

Subsoil nitrogen is another important source of nitrate concentration in the beet root at harvest as expressed by the nitrate grade. A total of 625 fields representing 43,350 acres were tested during the three-year period from 1980 through 1982 for available nitrogen in the 2 to 4 foot soil depth. Although the data represents only 6.6% of the total fields, it does indicate that subsoil nitrogen is definitely an important source contributing to an increase in the nitrate grade.

Table 8. Relation Between Nitrate Grade, Total Nitrogen (4 Feet) And Yield And Quality
Red River Valley Three-Year Average
(1980, 1981, 1982)

		Lbs. Per Acre					
Number Fields	Nitrate Grade	Soil + Fert. N 0-2'	Soil N 2-4'*	Total N	Tons/ Acre	% Sugar	% Sugar Loss
247	2.6	134	47	181	17.7	17.0	1.60
1611	3.5	145	59	204	17.8	16.5	1.78
3655	4.5	153	69	222	17.8	15.8	2.03
4031	5.3	165	63	228	17.5	14.9	2.30
403	6.1	171	62	233	16.9	14.1	2.52
9974							

*Limited data - represents 6.6% of the total fields soil tested to 4' during the three-year period.

From the data in table 8, note that the total nitrogen per acre now has a greater spread between nitrate grades 2.6, 3.5, and 4.5, and this indicates that subsoil nitrogen is definitely contributing to an increase in the brei nitrate concentration. However, the differences in total nitrogen per acre level off with nitrate grades 4.5, 5.3, and 6.1. This indicates that there is an unaccountable source of nitrogen contributing to the brei nitrate concentration. The only other source left would be the nitrogen mineralized from the soil organic matter during the growing season. Red River Valley soils average approximately

5.0% organic matter and the amount mineralized during the growing season could be considerable and is not adequately accounted for in the North Dakota State University nitrogen recommendation for sugarbeets. Colorado research indicates that mineralization can be considerably higher in soils that test high in available nitrogen compared to low testing soils. This research also shows that on a pound for pound basis, the soil test nitrogen has a greater effect on sugarbeet yield and quality than the applied fertilizer nitrogen (1).

After a thorough study of our three-year yield and quality data and a thorough review of sugarbeet nitrogen research conducted over the past ten years by North Dakota State University and the University of Minnesota, American Crystal reduced the nitrogen recommendation for the 1983 sugarbeet crop by 30 pounds, from 150 to 120 pounds per acre. The 120 pounds per acre is the total of the soil test nitrogen in the 0-2' depth plus 80% of the soil test nitrogen in the 2-4' depth plus fertilizer nitrogen.

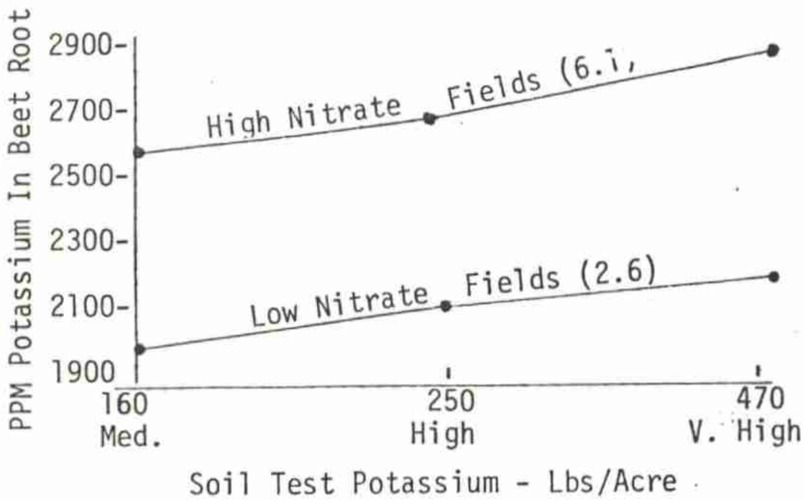
The fastest way to improve sugarbeet quality is to get nitrogen management practices under control. American Crystal will continue to refine the nitrogen recommendation for sugarbeets grown in the Red River Valley, as needed, to produce the highest recoverable sugar per ton and per acre to provide the maximum dollar return to our grower members.

Beet Quality Analyses In Relation To Plant Nutrition Research

It has been established by research studies that high nitrate uptake by the beet root results in an excessive uptake of positively charged ions such as sodium and potassium (2, 7, 8). This relationship is clearly demonstrated in the three-year crop analysis shown in table 3.

It is also generally recognized that potassium uptake will increase with higher soil potassium levels and that a reciprocal relationship exists between potassium and sodium uptake by the beet root. As potassium availability and uptake increase, sodium uptake decreases and vice versa(2, 3, 4, 5, 6, 9). The relationship between potassium uptake and soil potassium levels on high and low nitrogen fields are shown in figure 1.

Figure 1. Relationship Between K In Beet Root And Soil K On High And Low Nitrate Fields Red River Valley Three-Year Average (1980, 1981, 1982)

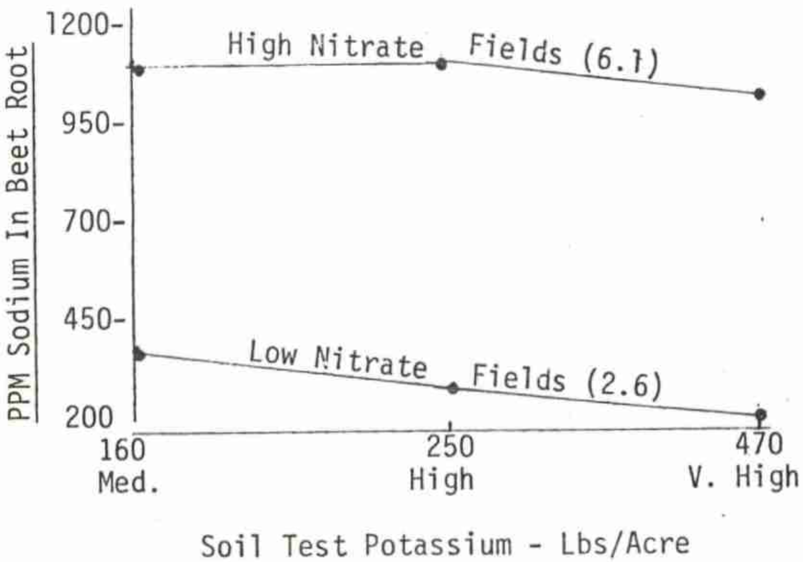


Potassium concentration in the beet root increases with increasing levels of soil potassium. The increase is accelerated on the high nitrogen fields. On the low nitrate fields, the potassium in the root was 2004, 2129, 2254 ppm at the medium, high, and very high soil K levels, respectively. On the high nitrate fields, the potassium in the root was 2595, 2665, 2913 ppm at the medium, high, and very high soil K levels respectively.

Figure 2 shows the relationship between the sodium concentration in the beet root with increasing levels of soil potassium.

Figure 2

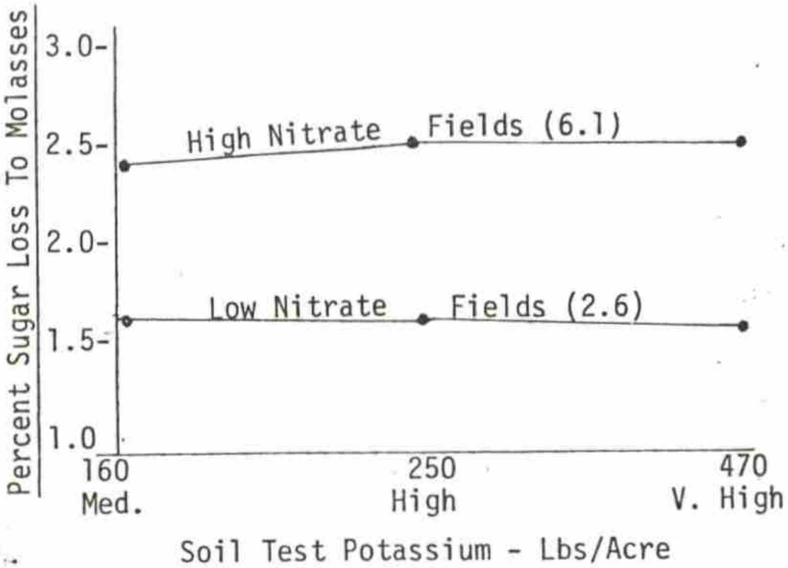
Relationship Between Na in Beet Root And Soil K On High And Low Nitrate Fields Red River Valley Three-Year Average (1980, 1981, 1982)



Sodium uptake decreases as soil potassium levels increase. Note that the high nitrate fields have a greater concentration of sodium in the beet root than the low nitrate fields and that the same relationship holds true -- sodium uptake decreases with increasing levels of soil potassium. On the low nitrate fields, sodium in the root was 386, 337, 320 ppm at the medium, high, and very high soil K levels, respectively. On the high nitrate fields, the sodium in the root was 1081, 1147, 1002 at the medium, high, and very high soil K levels, respectively.

Further proof that the relationship between nitrogen, sodium and potassium exist in the field and are measured in the Central Beet Quality Lab is shown in figure 3.

Figure 3 Relationship Between Percent Sugar Loss To Molasses And Soil K Level On High And Low Nitrate Fields Red River Valley Three-Year Average (1980, 1981, 1982)



The percent sugar loss to molasses remains constant with increasing soil potassium levels. Without research results establishing the reciprocal relationship between sodium and potassium, the reason for equal sugar loss to molasses at each soil K level would be very difficult to explain. On the low nitrate fields, the percent sugar loss to molasses was 1.6 at all soil K levels. On the high nitrate fields, the percent sugar loss to molasses was 2.4 at the medium soil K level and 2.5 at the high and very high soil K levels. The excellent correlation between American Crystal's beet quality analyses, soil fertility data and proven research results, narrows the cause of an increase in the measured impurities (Na, K and am-N) in the beet root to one source -- excessive amounts of available nitrogen.

Nitrogen management is the key to improving beet quality. In our Central Beet Quality Lab, we can now accurately measure the effect of nitrates on sugar content, the accumulation of the impurities (Na, K and am-N) in the root and the consequent sugar loss to molasses. The laboratory measurements are accurate and they do show ways to control and improve beet quality. What we need now in the Red River Valley is to more accurately measure the residual soil nitrogen to a depth of four feet, get a better accounting of mineralization from the soil organic matter during the growing season and begin petiole testing to determine the critical period of early season nitrogen requirements. With these measurements we can do a better job of matching the imput nitrogen to desired quality standards while still maintaining high root yield.

Summary

The quality analysis technology developed by American Crystal in the last few years and the implementation of the Grower Practices Reporting System, allows the opportunity for great progress in beet quality improvement to become a reality in the field. With the adoption of Phase II of Crystal's quality program (a higher payment for quality), new and long overdue economic rewards will accrue to Crystal's grower members.

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