Sugar Beet Top Food Value Saved by Mechanical Methods[1]

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The sugar beet plant is one of the most efficient users of the sun's energy in combining elements of the air, soil and water into useful human and animal nutrients. The lush growth of rich green beet leaves provides a storehouse for great quantities of carotene and protein. Common methods of utilizing these tops for livestock feed are very wasteful.

An analysis of the beet top shows that 45 percent of the dry matter, 85 percent of the carotene and 61 percent of the protein is contained in the leaves. After ten days in field curing 50 percent of the dry matter, 60 percent of the carotene and 50 percent of the protein are lost through mechanical handling and destruction by microorganisms, leaching, etc. This loss increases until, at the end of 40 days, 54 percent of the dry matter, 96 percent of the carotene and 63 percent of the protein are gone.

These losses have led to the establishment of a sugar beet top utilization project at the Colorado A & M Agricultural Experiment Station in cooperation with the U. S. Department of Agriculture and the Beet Sugar Development Foundation. The 1950 experiments were made possible through the cooperation of the National Alfalfa Dehydrating and Milling Company, the Great Western Sugar Company and the farmers who supplied the beet tops, Mr. Huwa and Mr. Marty.

Commercial Dehydrating Possible

Laboratory and pilot plant scale experiments prior to 1950 indicated the possibility of commercial dehydration as a means of conserving the valuable carotene and protein in beet tops. The 1950 experiments were conducted on a scale large enough to obtain data on the physical and economic feasibility of commercial application. Two methods were used to harvest the green top material in the field. The entire top including leaves, stems and crowns, the part which is normally removed during the root harvest, was obtained with an experimental John Deere two-row topper. This machine topped and loaded the tops directly into a truck or trailer, thus keeping the tops free of dirt. Earlier work suggested the desirability of dehydrating the high quality leafy material of the top separately.

This led to the development of a new machine by the mechanical engineering section of the Colorado A & M Agricultural Experiment Station cooperating with the Bureau of Plant Industry, Soils and Agricultural Engineering, division of farm machinery, USDA.

The machine, a self propelled tricycle-type, has an operating width of four rows of sugar beets. It was developed following earlier experiments with a single row type of machine. After removal of leaves, stems remain and the field appears as if hit by a violent hail storm.

Dagger-like knives, spaced two inches apart on revolving drums 15 inches in diameter, comb through the beet tops and strip off the leaves. Knives are

[1] The work on dehydration of beet tops reported herein was done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act. The contract is being supervised by the Western Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry.

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one-half inch wide and two inches long. The drum turns in the opposite direction of the movement of the machine at about 300 revolutions per minute. The drums can be raised or lowered depending on the height of the beet tops. The machine operates best at about 2 1/2 miles per hour.

Revolving action of the drums throws stripped beet leaves on a horizontal portion of the elevator belt. The elevator lifts the leaves to a truck or trailer driven along side. Normal recovery is about 70 percent of the leafy material. The remainder of the top can be utilized as pasture or ensilage.

Particle Size Reduced

It was found necessary to reduce the particle size for proper dehydration by cutting the green material as fine as possible. The whole tops and the stripped leaves were chopped in a John Deere No. 110 forage mill which had the hammers replaced by thin sharp knives and the hammer mill screen removed entirely. The auger at the bottom and the blower-elevator were also removed to prevent the fan from pulping the chopped material.

Both chopped tops and chopped leaves were dehydrated successfully in a commercial Heil alfalfa dehydrator of the National Alfalfa Dehydrating and Milling Company at Johnstown, Colorado. This machine is a triple pass, gas fired, drum drier commonly used in this area for dehydration of field crops. The capacity of the Heil drier is rated at 6,000 pounds of water evaporated per hour which determines the output of dried beet tops or alfalfa. Since the moisture content of sugar beet tops is somewhat higher than alfalfa the output of dried tops is less than alfalfa.

The relatively short season when fresh beet tops are available makes it desirable to have some means of stockpiling leaves and tops. Earlier work had indicated that this might be done by the use of silos which have the added advantage of removing some of the water without any appreciable loss of nutrients. In 1950 five temporary silos with various treatments were used as follows:

Silo No. 1, Stripped leaves
Not chopped
No acid treatment
Silo No. 2, Stripped leaves
Chopped
Two gallons of phosphoric acid per green ton of leaves
Silo No. 3, Entire tops with crowns
Chopped
Two gallons of phosphoric acid per green ton of tops
Silo No. 4, Stripped leaves
Not chopped
Two gallons of phosphoric acid and 7 1/2 pounds of sodium propionate per green ton
Silo No. 5, Stripped leaves
Chopped
Two gallons of phosphoric acid and 7 1/2 pounds of sodium propionate per green ton

Sodium propionate was added as a preservative and phosphoric acid was used to adjust the acidity for good silage quickly and to release water more rapidly. Stripped unchopped leaves were used with and without acid

treatments with the idea that the ensiling process might break down the cell structure and free the water so that chopping would not be necessary. **All** source materials in the chopped form dehydrated in a satisfactory manner whereas the same materials in unchopped form did not.

At Brighton, Colorado, stripped leaves were chopped and mixed with pressed beet pulp and dried in the pulp drier of the Great Western Sugar Company factory. The induced draft fan for the drier furnace produced air currents strong enough to effect a partial separation of leaves and pulp

Table 1.—Analysis of Carotene and Dry Matter in Sugar Beet Tops.

Eight treatments were dehydrated as follows: TREATMENT	Original Carotene before dehy. mg./lb. d. m. basis	Carotene after dehy. mg./lb. d. m. basis	Original dry matter % into dehydrator	Dry matter after dehy. %
1. Fresh tops and crown, chopped	38	22	17.8	91.7
2. Fresh stripped leaves, chopped	68	62	19.1	87.5
3. Fresh stripped leaves mixed with pressed beet pulp	41	9[1]	15.3	92.7
4. Silage, stripped whole leaves not chopped	71	89	15.8[2]	93.0
5. Silage, stripped leaves, chopped plus 2 gals. H_3PO_4 per green ton	68	69	20.1	94.5
6. Silage, whole tops, chopped plus 2 gals. H_3PO_4 per green ton	38	22	19.3	92.7
7. Silage, stripped leaves, not chopped, plus 2 gals. H_3PO_4 and 7½ lbs. sodium propionate per ton	82	93	17.7	91.9
8. Silage, stripped leaves, chopped plus 2 gals. H_3PO_4 and 7½ lbs. sodium propionate per green ton	82	82	18.9	93.1

[1] A rather large part of the finely chopped leaves in the mixture was dried and drawn out the top of the dehydrator by the induced draft fan rather than falling to the bottom of the drum where the rest of the leaves and pulp were taken out.

[2] Drainage was poor in this silo, making it very difficult to get an accurate sample.

Note: There is an apparent increase in carotene in some of the acid treated silages. This apparent increase also showed up in the 1949 tests.

Mowed leaves could not be obtained for inclusion in the experiment as was originally planned.

so that parts of the leaves were carried over to the cyclone separator and did not come out of the bottom of the drier where the mixture was supposed to be removed. The dried pulp and leaf mixture was a good product but not as rich in leaves as the mixture was when it entered the drier. This type of equipment could be redesigned to do a satisfactory job.

New Equipment Developed

The development of new beet harvesting equipment has opened the way to better utilization of tops. Fewer man-hours are now required to harvest an acre of beets, which allows more time for the processing of tops.

Table 1 shows the carotene and dry matter analysis of the tops both before and after dehydration. These experiments show that it is possible to retain the carotene and obtain a high quality feed by dehydration. Farmers, livestock men and feed processors are becoming increasingly aware of the potentialities of sugar beet tops for livestock feed. The economic phase of the experimental work includes data on physical inputs of labor, machinery, green tops, etc., per unit of output and dehydrated product. These inputs

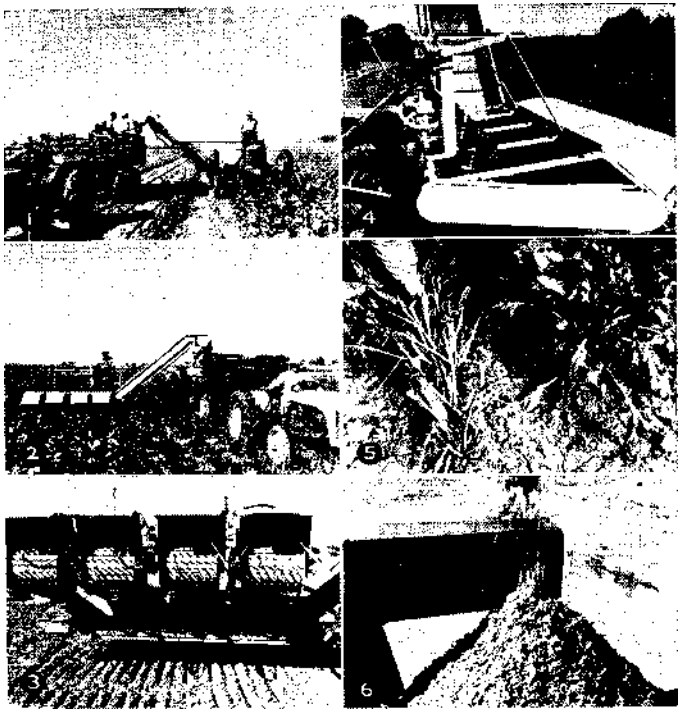

Figure 1. Harvesting the entire top with a John Deere experimental two row topper.

Figure 2. Harvesting the highly nutritive leaves with the Beet Leaf Stripper.

Figure 3. Close-up showing spiked drums which comb through beet tops stripping the leaves. The drums are adjustable for height.

Figure 4. Horizontal elevator belt which catches leaves thrown back by drums.

Figure 5. Stripped and unstripped rows.

Figure 6. Chopped leaves are more easily dehydrated, and retain a high nutritive value.

Figure 7. The type of dehydrator in which the chopped leaves and tops have been successfully dried.

Figure 8. Dehydrated sugar beet leaves.

Figure 9. Ensiling leaves may aid in removing moisture. By stock piling leaves, the normal dehydrating season could be prolonged.

Table 2.—Cost of Dehydrating Stripped Sugar Beet Leaves.

Cost of green leaves per dry ton of dehydrated material (7% moisture) calculated on the basis of $0.375 per root ton, 20 tons yield and exceptionally good tops producing .28 lbs. of leaves per foot of row			$11.00
Cost of stripping and hauling per dry ton			12.53
5 men at $1.00 per hr.	$ 5.00		
Gas and oil $0.35 per hr.	.35	1.075 tons	
Machine cost per hr.	2.66	dry material	
3 trucks at $1.75 per hr.	5.25	per hr. capacity	
	$13.26		
Cost of chopping per dry ton			2.79
2 men at $1.00 per hr.	$ 2.00		
Gas and oil $0.45 per hr.	.45	1.254 tons	
Machine per hr.	1.00	dry material	
		per hr. capacity	
	$ 3.45		
Milling cost—calculated by comparing with alfalfa on a moisture content basis			21.08
Cost of sacks			3.50
Total cost per dry ton (7% moisture)			$50.70

were converted into cost figures on the basis of the present price level. The tops harvested and processed by the different methods were sufficient in quantity to be representative of commercial operations.

Tables 2 and 3 show the cost of harvesting and dehydrating stripped leaves and entire tops, respectively. At the present time costs of dehydrating beet tops are high but as more tops and leaves are processed and a market for the feed is developed these production costs will be reduced.

Table 3.—Cost of Dehydrating Entire Sugar Beet Tops.

Cost of raw material on a dry ton basis (7% moisture) calculated at $1.00 per root ton and one ton of tops per ton of roots			$ 5.21
Cost of harvesting and hauling whole tops (Ave. field) per dry ton			7.73
5 men at $1.00 per hr.	$ 5.00		
3 trucks at $1.75 per hr.	5.25		
Topper cost $2.00 per hr.	2.00	1.822 tons	
Gas and oil $0.63 per hr.	.63	dry material	
Tractor cost $1.20 per hr.	1.20	per hr. capacity	
	$14.08		
Cost of Chopping			3.88
3 men at $1.00 per hr.	$ 3.00		
Gas and oil $0.45 per hr.	.45	1.148 tons	
Machine cost $1.00 per hr.	1.00	dry materials	
		per hour capacity	
	$ 4.45		
Milling cost—Calculated by comparing with alfalfa on a moisture content basis			23.02
Cost of sacks			3.00
Total cost per dry ton (7% moisture)			$42.84