

The Value of the Beet Top Crop

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The sugar beet crop has always been two crops in one: the beet root for sugar extraction, and the tops and crowns for stock feed. Changing farming methods and practices call for constant re-evaluations. Changes in harvesting methods: mechanical harvesters, beater toppers and laxity of hand labor in topping beets, have resulted in a tendency by the beet grower to deliver to the factory more and more crown with the beet root. Improperly topped beets have been accepted since there is an awareness of the harvesting problems.

The worth of the beet root and crown has not been clearly evaluated for present day factory and feeding operations. A. W. Skuderna, vice president and general agriculturist for the American Crystal Sugar Company, suggested that such study would be worthwhile and, accordingly, tests were conducted at several factories of the Company.

It is the purpose of this paper to present and evaluate data on roots and crowns for percent sucrose, juice purity and percent extraction sucrose, along with present monetary value. The data presented was obtained during the 1951 harvest season from six of the eleven growing areas of the American Crystal Sugar Company.

Methods

Freshly harvested beets were taken to the nearest factory laboratory and divided into samples of 10 or 15 beets. The petioles were cut from the crowns, and the crowns cut from the root at the lowest leaf scar as prescribed by standard tare instructions. The weight of the crown and root portion was then recorded. Pulp was obtained from the roots by rasp or Spreckles saw. The entire crown portion was reduced to a finely chopped mass using a Buffalo chopper. Sodium and potassium were measured using the flame spectrophotometer. Sugar was determined by the Sachs-Le Docte method and direct polarization. Purity determinations were made on a hot water digest of the pulps using a refractometer for Brix measurements. The other reported data were obtained by application of the 13 equations listed.

1. Weight of the part percent of the total weight of the plant = (b)

$$(b_r) = \frac{(a_r) \times 100}{(a_r) + (a_c)}$$

$$(b_c) = \frac{(a_c) \times 100}{(a_r) + (a_c)}$$

Subscripts r and c used in the equations denote the data refers to roots or crowns, respectively.

2. Extractable sugar percent on sugar present = (e)

$$(e) = (190. - \underline{9,000}) (S - .60)$$

P
S

Where P = purity of beet material

S = sugar content of beet material

assumes a standard factory condition of

1. Total sugar losses of 0.60 percent on beets
2. Beet end non sugar elimination 40 percent
3. Purity of final molasses 60.

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3. Extractable sugar in the part % of weight of part = (f)
(f) = (c) X (e)
4. Extractable sugar in the part % on weight of total plant = (g)
(g) = (b) X (f)
5. Extractable sugar in the part % on total extractable in the plant = (h)
(h_c) = (g_c) X 100/[(g_c) + (g_r)]
(h_r) = (g_r) X 100/ [(g_c) + (g_r)]
6. Total payment per ton basis sugar content, dollars = (k)
(k) was found by using a factory contract used recently.
7. Per ton extraction value of the crowns, based on extractable sugar in the crowns, dollars = (m)
(m_c) = $\frac{(e_c) \times (k_c)}{(e)}$
(m_r) = (k_r)
8. Difference between payment basis contract and the extractable sugar value per ton of crowns = (n)
(n_c) = (k_c) — (m_c)
9. Weight of the crowns % of the weight of the roots = (p)
(p) = $\frac{(a_c) \times 100}{(a_r)}$
10. Contract value of the crowns from one ton of roots based on extractable sugar in the roots and crowns, dollars = (r)
(r) = (m) X (p)
11. Yield of dry tops % on roots = (s)
(s) = 50% of weight of fresh crowns
12. Value of dry tops from one ton of roots = (t)
(t) = $\frac{(s) \times \$24.40}{100}$
13. Difference between the sugar value and the feed value of tops per ton of beets = (u)
(u) = (t) — (r)

Experimental Results

We wish to find the relative value of the tops and roots. This indicates to us the ultimate use to which the top portion of the crop should be put and should be based on three factors: 1. the extractable sugar in the parts, 2. the beet contract price value and 3. the stock feed value.

The data in Table 1 indicate that different varieties, locations, growing conditions and maturity of the crop affect the composition and weight of both crown and root. The many variations are apparent in the data; nevertheless, it will be seen that the relative composition of the roots and crowns is constant in one direction. By including several varieties from many areas, generalized conclusions can be reached.

In Table 2 is found the experimentally determined qualities of the samples and the calculated factor, the extractable sugar in the part, percent of total extractable in the plant. In all cases the amount of extractable sugar contained in the crown is a small percentage of the total extractable in the plant. It is general knowledge that, the higher the topping, the poorer is the quality of juice obtained from the crown.

Table 3 is presented to show the difference between the contract payment value and the extractable sugar value per ton of crowns. Even though

Table 1.

Average of Rocky Ford test, Variety 0-410, 60 Beets Tested					
Part	Weight	% Sugar	Purity	% Na	% K
Root	1.26	14.25	90.54	.082	.158
Crown	.33	4.53	79.16	.134	.153
Difference		9.72	11.38	-.052	.005
Average of Rocky Ford test, Variety 3N, 60 Beets Tested					
Part	Weight	% Sugar	Purity	% Na	% K
Root	1.31	13.65	88.59	.164	.153
Crown	.32	4.33	74.71	.193	.135
Difference		9.32	13.88	-.029	.018
Average of Texas test, Variety US 22, 60 Beets Tested					
Part	Weight	% Sugar	Purity	% Na	% K
Root	1.99	15.52	92.87	.016	.281
Crown	.45	5.08	85.74	.025	.221
Difference		10.44	7.13	-.009	.060

this particular contract may not be in use at present, the same relative values would hold and comparisons are valid. One can conclude that the contract price for crowns is not a fair basis of payment since the crowns contain a poorer quality of juice and hence there is an overpayment to the grower which ranges from \$.65 to \$2.27 per ton of crowns.

The fact that the crowns are not valuable for sugar making purposes might be unfortunate if it were not for the fact that the crowns have another value which is greater than their sugar-making value. When applied in feeding operations it is found that the value of the crowns is a very real one that will net the farmer a very good return. Table 4 shows the value obtainable by the feeding of tops. The replacement value of tops per ton of beets of \$24.40 was obtained by using Maynard's (1)² replacement values of 322 pounds of corn and 1,050 pounds of alfalfa hay. The market value

Table 3.

Test Area and Varieties		Parts of the Plant	Total Payment per ton Basis sugar content, dollars	Per ton Extraction value of part, basis extractable sugar in the part, dollars	Difference between payment and value of ton of crowns
			(k)	(m)	(n)
Clarksburg	US No. 33	Root	14.22	14.22	
Clarksburg	US No. 33	Crown	9.82	7.72	2.10
Rocky Ford	Am. 3 N	Root	11.72	11.72	
Rocky Ford	Am. 3 N	Crown	5.34	2.57	.97
Rocky Ford	Am. 1-0410	Root	12.24	12.24	
Rocky Ford	Am. 1-0410	Crown	5.53	2.69	.84
Texas	US No. 22	Root	13.59	13.59	
Texas	US No. 22	Crown	4.02	5.37	.65
Chaska	Am. 3LSR	Root	14.76	14.76	
Chaska	Am. 3LSR	Crown	11.46	9.95	1.51
E.G.F.	Am. 3N	Root	13.00	13.00	
E.G.F.	Am. 3N	Crown	11.04	8.77	2.27
Mason City	Am. 3LSR	Root	15.22	15.22	
Mason City	Am. 3LSR	Crown	12.64	11.42	1.22
Mason City	US 216-47501	Root	15.30	15.30	
Mason City	US 216-47501	Crown	13.10	11.88	1.22

² Numbers in parentheses refer to literature cited.

Table 2.

Test Area and Varieties		Part of the Plant	Avg. Wt. of Part	Wt. of part % of Total	% Sugar of Part	Purity of part (Refractometer)	Extractable sugar in part % on sugar present	Extractable sugar in part % on weight of part	Extractable sugar in part % on weight of total plant	Extractable in part % of total extractable in the plant
			(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Clksburg	US No. 33	Roots	2.91	92.7	16.51	87.85	84.37	13.93	12.91	95.84
Clksburg	US No. 33	Crowns	.23	7.3	11.54	75.00	66.36	7.66	.56	4.16
R. Ford	Am. No. 3 N	Roots	1.31	80.4	13.65	88.59	84.52	11.54	9.28	94.79
R. Ford	Am. No. 3 N	Crowns	.32	19.6	4.33	74.71	59.90	2.59	.51	5.21
R. Ford	Am. No. 1—0410	Roots	1.26	79.2	14.25	90.54	86.78	12.37	9.80	94.05
R. Ford	Am. No. 1—0410	Crowns	.33	20.8	4.53	79.16	66.20	3.00	.62	5.95
Texas	US No. 22	Roots	1.99	81.6	15.52	92.87	89.49	13.89	11.33	94.18
Texas	US No. 22	Crowns	.45	18.4	5.08	85.74	74.99	3.81	.70	5.82
Chaska	Am. No. 3 LSR	Roots	1.58	84.0	17.03	89.10	85.95	14.62	12.28	89.54
Chaska	Am. No. 3 LSR	Crowns	.30	16.0	13.36	80.40	74.55	9.95	1.59	11.46
E.G.F.	Am. No. 3 N	Roots	.99	72.3	15.09	87.15	83.28	12.57	9.09	79.32
E.G.F.	Am. No. 3 N	Crowns	.38	27.7	12.94	74.60	66.14	8.56	2.37	20.68
M. City	Am. No. 3 LSR	Roots		Est. 80.0	17.50	91.50	88.50	15.49	12.99	84.06
M. City	Am. No. 3 LSR	Crowns		Est. 20.0	14.70	84.40	79.95	11.75	2.35	15.94
M. City	US No. 216—47501	Roots		Est. 80.0	17.60	91.40	88.41	15.56	12.45	83.61
M. City	US No. 216—47501	Crowns		Est. 20.0	15.20	84.50	80.19	12.19	2.44	16.39

Table 4.

Test Area and Varieties			Part of the Plant	Wt. of fresh crowns % of the wt. of roots	Value of parts from 1 T. roots, basis extractable sugar	Yield of tops % on roots, (50% fresh crowns)	Value of tops from 1 T. roots \$21.40 per ton	Difference between sugar value and feed value of tops from 1 T. of beets
			(p)	(r)	(s)	(t)	(u)	
Clarksburg	US No. 33	Root		14.22				
Clarksburg	US No. 33	Crown	7.90	.61	3.95	.96	.35	
Rocky Ford	Am. 3 N	Root		11.72				
Rocky Ford	Am. 3 N	Crown	24.43	.58	12.22	2.98	2.40	
Rocky Ford	Am. 1—0410	Root		12.24				
Rocky Ford	Am. 1—0410	Crown	26.15	.70	13.10	3.20	2.50	
Texas	US No. 22	Root		13.39				
Texas	US No. 22	Crown	22.61	.76	11.51	2.75	2.00	
Chaska	Am. 3LSR	Root		14.76				
Chaska	Am. 3LSR	Crown	18.99	1.89	9.50	2.32	.43	
E.C.F.	Am. 3N	Root		13.00				
E.C.F.	Am. 3N	Crown	33.38	3.37	19.19	4.68	1.31	
Mason City	Am. 3LSR	Root		15.22				
Mason City	Am. 3LSR	Crown	25.00	2.86	12.50	3.05	.19	
Mason City	US 216—47501	Root		15.30				
Mason City	US 216—47501	Crown	25.00	2.97	12.50	3.05	.08	

of corn was taken to be \$3.50 per cwt. and the alfalfa hay \$25.00 per ton. As the table shows, the feeder will obtain an additional revenue per ton of beets, ranging from \$4.68 to \$.96 without including any manure value. Moreover, the feed value is \$.08 to \$2.50 more than the sugar making value. Feed prices will fluctuate with areas and times. In the few instances where we worked through the data using corn and hay prices for other specific areas, it was found there were even greater differences in favor of feeding the tops.

This study was made because it is important that the farmer be provided with information which will make his operations as economically sound and profitable as possible.

Conclusions

The data presented here were drawn from across a wide area and thus the general situation for the entire western United States can be summarized in the following conclusions:

1. There are only relatively small quantities of extractable sugar in the crown.

2. The contract price basis is not a fair means for determining the value of the crowns.

3. Even though no manure values are credited to a feeding operation, the feed value of the tops is a significant portion of the total value of the beet crop and the tops should be thus used for the greatest advantage to the beet grower.

Literature Cited

- (1) MAYNARD, E. J.
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