Costs on Harvesting Beets With a Manual Sorting Lifter Machine

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A review of attempts at complete mechanical harvest of sugar beets reveals that separation of beets from soil has been an ever present obstacle. This is particularly true in the case of the heavy California soils which fracture into large hard clods and resist separation by screening or agitation.

The principle of removing beets from surrounding masses of clods by hand is appealing, since the human mechanism possesses visual discrimination between beets and clods as well as the physical ability to make the separation. Thus a sugar-beet harvester utilizing these human abilities would give promise of being a stepping stone toward the ultimate purely mechanical device, and would be practical if the cost of the human element were not prohibitive.

A Fieldworthy Machine

Preliminary field tests were made in 1940 to indicate the cost of manual sorting of beets, and were sufficiently encouraging to warrant construction of a fieldworthy machine. The features of this machine are outlined herewith:

1. Two-row harvester.
2. Draft and power supplied by 30 hp. tracklayer tractor.
3. Ground-topping units with top windrowing conveyor.
4. Double-point plows to loosen beets.
5. Kicker rolls to provide initial elevation of beets and separation of fine soil.
6. Elevators to place beets and large clods on sorting conveyors.
7. Sorting conveyor belts positioned to accommodate 4 sorting operators.
8. Hopper to receive sorted beets.
9. Conveyor to elevate beets to truck.
10. Chute to return clods to harvested rows.
11. Bin to receive unaceeptably topped beets for hand trimming.

Field trials were made on the machine, both during and after construction, and numerous mechanical defects were revealed and remedied. The time lost in these preliminary tests, as well as that lost due to early rains, greatly shortened the period over which field studies could be made. Shortages of both labor and trucks still further reduced the time available for trials during the 1941 harvest season. Consequently, the data presented herewith are the result of

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harvesting only 3.05 acres of beets on the F. P. Wray field near Davis, California.

This field was fairly typical of California beet fields. Morning glory, pigweed, and watergrass were present in small quantities throughout the field, and conditions were aggravated by large numbers of volunteer tomato and grape vines. Fouling of these weeds in the beet-top conveyors was the greatest obstacle to continuous operation. Stops for clearing weeds from these conveyors, on the average, occurred once for each 1,100 feet of row harvested.

Forward speed was limited by draft and power requirements of the machine, rather than by the ability of the sorting operators to maintain their pace, despite unusually large values of yield and stand.

Two strips, 16 rows wide and 2,496 feet long, were harvested. This is an admittedly small sample of an 80-acre field, but is nevertheless fairly dependable, since this field was very uniform in yield and sugar content.

Performance of Machine.- -The recovery of beets from the field was reasonably good. Whereas careful counts of beets revealed that an average of 4.28 percent by weight were left in the field, the loss became less in proportion to the experience of the sorting crew. The field loss dropped from 6.2 percent to 2.4 percent after iy_2 hours of crew experience. Observations on the rejected clods showed that almost *no* beets were missed *hy* experienced operators, whereas about *2* percent by weight were lost at various points on the machine before reaching the sorting belts.

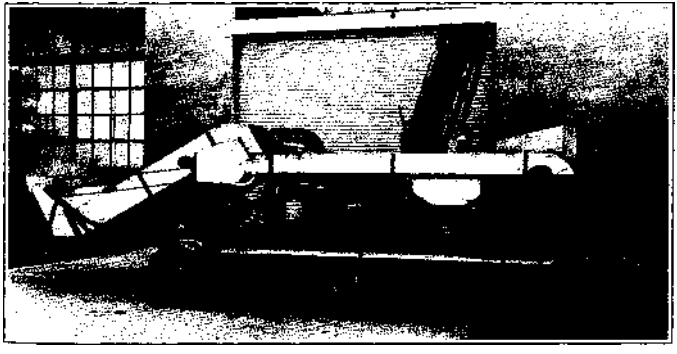

Figure 3.—Single unit, "J-row topping[1], lifting and hand "sorting beet harvester.

A more serious loss resulted from broken tap roots. Freshly dug beets are very brittle, and breakage of tap roots occurred on the kicker rolls, in the receiving hopper and in falling into the truck. Counts revealed that 75 percent of all beets had some tap-root breakage. The total loss by weight amounted to 5.6 percent.

Despite the large field loss, totalling 9.8 percent, the sugar per acre delivered by the machine was greater than that recovered by hand labor in the same field. This is attributed to the loss in beet weight and sugar content when beets are lifted several days prior to hand topping. This finding is in accordance with the data published by Charles Price, et al.[2]

Table 1.—The following tabulation summarizes the factory tare laboratory findings on the 3.05-acre test.

	Tare percentage	Sugar percentage	Average beet weight	Tons beets per acre	Tons sugar per acre
Machine harvesting; no scavenging				21.9	3.79
Machine harvesting 4.2 percent scavenging recovery	2.23	17.3	2.41	22.9	3.96
Hand harvesting	2.20	18.6	2.23	19.6	3.55

The saving in sugar resulting from machine harvesting appears to be of considerable consequence, and might well be considered as indicating the importance of minimizing delay between lifting and topping by hand methods.

Table 2.—Cost analysis of manual-sorting lifter machine. Following is a tabulation of the machine's performance in terms of labor requirements:

Yield of trial strips (tons per acre)	22.9
Stand (beets per 100 feet of row)	119
Output to truck (tons per hour of running time)	9.96
Man hours per ton of beets delivered to truck (4 sorters, 1 top trimmer, and tractor operator)	0.60

Field efficiency was not included in this tabulation, since only one truck was available for hauling. If an adequate supply of trucks had been available, the machine's field efficiency would have been close to 60 percent, allowances being made for turning time and stops for clearing weeds from the mechanism. On the basis of 60 percent field efficiency, a comparison of costs is in order and is given herewith, both in man hours of labor and dollars of machinery operation and amortization. Hand-labor figures are based on a **20-ton** yield.

[2] Journal of American Society of Agronomy, Vol. 33, No. 10, October 1941.

Table 3.—Comparison of costs.

	Manual-sorting- lifter machine	Present hand labor
Man hours per ton, topping- and loading	¥1.00	$1.42
Cost of lifting per ton		.125
Operating cost per ton*	.40	

•Based on $2,500 machine cost, $1.25 hourly tractor cost, 5-year depreciation, 5 percent interest, 10 percent annual repairs.

Summary

It is evident from these figures that the machine, as it performed on this test, had little to offer in over-all cost saving, but effected a 30 percent reduction in labor requirements at the expense of increased operating cost.

If this system of harvest is to be justified, the machine should embody the characteristics here summarized:

1. Reduced power requirements, to permit higher forward speed.
2. Development of a beet-top disposal system immune to fouling by weeds.
3. Development of a beet-conveying system less damaging to tap roots.

Recent Improvements in Sugar-Beet Seed Harvesting and Threshing Equipment

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Early in the development of the sugar-beet seed industry in the United States, the desirability of mechanizing the harvesting and threshing operations was recognized. At a meeting of the Associated Beet-Seed Producers in January 1937, a resolution was passed authorizing a survey of beet-seed harvesting and threshing equipment. In compliance with this resolution, a survey was made and a complete report prepared by the Engineering Department of the Amalgamated Sugar Company.

Work along this line was first started in Nevada in 1934 and in the Salt River Valley of Arizona in 1937. This paper deals with the work done in Arizona, but developments in other sections, which have been incorporated in ideas used in the Salt River Valley, are cited where known.

[1]Western Seed Production Corporation.