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

A. A, MAST, R. C. WOOD AND I. M. MCDONALD[1]

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.

The Wells Brothers of Logandale, Nevada, were apparently the first to prove the practicability of beet-seed harvesting and threshing equipment. In 1934 they built the first beet-seed harvester, which was used for several seasons prior to the development in the Salt River Valley. They also were the first to use a thresher which picked up the windrow left by the harvester, hereafter referred to as a travelling thresher.

In the spring of 1937, under the direction of H. A. Eleock, at that time in charge of the operations of the Western Seed Production Corporation, several beet-seed harvesters were built in the Salt River Valley. As was to be expected many defects were found, but the basic ideas proved to be sound, and improvements since that time have made them quite indispensable to growers with over 100 acres of seed. During the past season 13 machines were in operation, cutting over 80 percent of the entire crop, a total of 3,112 acres.

Development of the Harvester

The beet-seed harvester follows the general design of a grain header with respect to the arrangement of flat platform, reel, horizontal sickle, and stub conveyor, which, in this case, deposits the beet seedstalks in a continuous windrow. Tn addition, the beet-seed harvester is equipped with a vertical, sickle, which cuts free the overlapping branches, and a conveyor for collecting shattered seed. The harvester platform is approximately 84 inches long by 54 inches wide and cuts 4 rows and deposits these in 1 swath.

In the case of the Wells Brothers' machine, an offset hitch was used. Because of the extremely heavy foliage common in the Salt River Valley, it has proved more satisfactory to push the machines from the rear. With this arrangement the machine is mounted on and entirely supported by a crawler-type tractor. The 40-horsepower size has been found to be quite suitable.

Several basic improvements have been made over the past 4 years with respect to type of reel used, method of collecting shattered seed, distribution of weight, and replacement of platform canvas with a slotted wooden draper.

In the survey previously mentioned, it was suggested that a reel working on the principle of the side-delivery rake would better serve the purpose than the rigid paddle-type reel with which the original machines were equipped. A universal reel was first tried out in 1938. It not only reduces the amount of shattered seed and loss in advance of the sickle bar. but does a far more efficient job of pulling the seedstalks onto the platform draper.

Formerly the shattered seed collected from the platform was conveyed by a scroll, which in turn delivered the seed to a paddle-type elevator equipped with a bagging spout. The use of an open-drag elevator, having an overhead return, has eliminated clogging and reduced the clearance required under the machine.

Much has been done in reducing and redistributing the weight of these harvesters, resulting in less breakage and greater maneuverability in the field. Refinements, such as provision for raising and lowering the machine, and, also, the reel by adjustable levers, have permitted much better work.

A slotted wooden platform draper in preference to the canvas draper was recommended in the report previously mentioned. Several machines have been so equipped. This type draper allows a greater distance in which to separate the shattered seed from the foliage and gives longer performance. Being chain and sprocket driven, there is no chance for slippage as with a canvas draper.

The practice of using the crawler-type tractor for propelling the beet-seed harvesters has several distinct disadvantages. Designed for a particular model tractor, changing tractors usually necessitates redesigning of the harvester with respect to mounting and bracing. The type tractor generally used is quite expensive to operate and is much larger than is necessary from the standpoint of power required. Two, harvesters were built this past season, using, in one case, a 4-wheel tractor and, in the other, a truck. For the 4-wheel tractor, the harvester was mounted on the rear and the tractor driven backwards. Tried out this past season in the Mesilla Valley of New Mexico, this model gave excellent performance. In the case of the truck, the cutter was suspended from the back end, the front wheels moved back under the motor to give a shorter turning radius and the truck driven to the rear. While this machine had many shortcomings, it demonstrated beyond question that this arrangement was entirely practical.

As the mechanical harvester cuts and lays the seedstalks in a continuous windrow it is highly desirable to thresh from the windrow, if labor costs and shatter are to be held to a minimum.

Development of the Thresher

Consequently the development of the travelling thresher has gone hand in hand with that of the harvester. The Wells Brothers of Logandale, Nevada, used a No. 36 Caterpillar Combine with a pick-up attachment. In the Salt River Valley, no combines have been found with sufficient capacity to thresh the crop properly.

In an effort to got a thresher with enough capacity to handle the windrow, W. O. Meier, a Salt River Valley grower, in the spring of 1937 converted a 36-inch Case thresher into a traveller. This was done by putting on rubber tires, redesigning the feeder for use with a rotary pick-up and pulling through the field from an offset hitch. The machine is powered by a motor mounted on top. Except for the rotary pick-up, which was very wasteful and inefficient, soon replaced by an Allis-Chalmers' type draper pick-up, this machine is still being used with only minor changes. This past season 17 travelling threshers and 6 combines threshed over 80 percent of the entire acreage harvested in the Salt River Valley, a total of 3,132 acres.

Travelling threshers built since that time are fundamentally the same. In two cases these were built to be self-propelled, one driven from the rear wheels and the other from the front wheels by using the front-end assembly of an old FWD truck. The rear-wheel drive gave considerable axle trouble and was not satisfactory, but the front-wheel drive, driven by an auxiliary motor, worked very well. Two machines are pushed from the rear, but are difficult to manipulate because of the inability of the operator to see the pick-up.

The most common difficulty encountered with the travelling threshers has been the building of a pick-up which will pick up the windrow with a minimum of shatter and feed it into the cylinder properly, without allowing the shattered seed to be lost. To accommodate a heavy windrow, the pick-up should be 5 feet wide. The cylinder widths vary from 32 inches to 40 inches, depending upon the size of the machine used. This means reducing the width of the feeder 20 inches to 28 inches, which is the source of the trouble.

To overcome this difficulty, one grower built the cylinder out to the same width as the pick-up. This not only entails considerable expense but has the disadvantage of having a cylinder too wide to permit satisfactory removal of seedballs from stems, because material going into it is insufficient to permit a good job of removing seed.

The best method has been to use a horizontal wooden slat draper on wdiich the inclined draper dumps the stalks and seed for feeding the material into the cylinder. This permits feeding straight into the cylinder rather than on an angle.

The types of screens and straw racks used vary considerably. Two types of straw racks are used. One is a metal rack made from corrugated iron, with the corrugations transverse to direction of seed travel and $^{1}/_{2}$-inch holes in the valleys to permit the seed to fall through. In this case, grates are used, introducing the maximum amount of seed directly onto the grain pan. The other type straw rack is built of wood, with V2-inch square strips running lengthwise and $^1/_2$-inch quarter round running crosswise. Both are spaced 1 inch between centers, giving openings $^1/_2$-inch square. Grates are blanked off when this rack is used to force all the material onto the straw rack, thus relieving the load on the grain pan. This type of rack is more extensively used.

Screens vary from flat screen with round or oval hole to the Closz adjustable screen, with the Closz adjustable screen predominating.

All machines are equipped with a section of 7/64-inch screen as the bottom of the shoe and a portion of the grain pan. These serve to remove a great amount of leafy material and small seed.

With the idea in mind of increasing the capacity of available threshing equipment and at the same time reducing the quantity of material sacked as field-run seed, it has been proposed that a rough job of threshing be done and the seed recleaned or scalped by a cleaning mill set up in the field. With this arrangement seed would be collected in a suitable hopper installed on the thresher, from which it would be dumped into trailers and hauled to a central cleaning station. Recleaners installed directly on threshers, under our conditions, tend to limit thresher capacity. A separate field station recleaner could have capacity sufficient to handle material from several threshers. It could be operated over a longer period of time a day than the threshers. It is quite possible that the tare of seed as delivered to main cleaning plants would be reduced by from 50 percent, or more, which would result in the following advantages:

1. Reduction in storage space required for thresher-run seed.
2. Reduction in costs of delivery of thresher-run seed to cleaning plant.
3. Reduction in cleaning costs.
4. Reduction in number of field bags required.
5. Earlier completion of threshing.
6. Eliminate sacker and jigger on each thresher served.

A cleaning mill that would handle around 100,000 pounds field-rim seed per 24-hour day can be purchased for $1,000.00. This would give a capacity sufficient to handle the output from 4 or 5 machines under our conditions.

The development of mechanical[1] methods of harvesting and threshing has played an important part in sugar-beet seed production in the Salt River Valley. From 1938 up to the present time some 7,344 acres, producing around 12 million pounds clean seed, have been cut with mechanical windrow machines and all but a small part of this acreage threshed with travelling threshers. At this time this development is of increasing importance in Arizona, and in the other beet-seed producing areas as well.