# Progress in Beet Harvester Development At The University of California, 1945

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Harvester studies at Davis during the past few years have centered about the development of a single-unit harvesler capable of topping the beets, windrowing the tops, lifting and cleaning the roots, and conveying them to a stationary vehicle at the edge of the field. Since the sugar companies are in an excellent position to observe the work of machines in commercial use, less emphasis has been placed on observation and testing of these machines by the University than was the case in the earlier stages of their development.

Certain objectives and standards of performance were agreed upon at the outset of the project which were thought to be representative of what the industry might accept as satisfactory performance in a beet harvester. Some were drawn from sugar company recommendations and others from then current field practices. In the light of present practices some of these objectives appear unreasonably high, but the unsettled state of the beet industry makes revision at this time purely guesswork.

The objectives toward which the Davis staff has been working are:

#### General

**1.** All apparatus to be mounted on a standard type wheel tractor for ready maneuverability.

2. Harvest crew to consist of one machine operator and not more than one scavenger.

3. No unusual skill to be required in operation of machinery.

4. All operations to be completed in one transit of machine through the field.

5. Operation to be possible in **all** ordinary soil types under any field moisture conditions which permit operation of wheel tractor.

6. Machine to be capable of opening its own lands.

### Topping

1. Topping to be satisfactory in beets ranging up to 9 inches in height, and in tops of any size.

2. Topping loss under ordinary conditions not to exceed 1.5 percent and top tare not to exceed 3.5 percent.

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3. Tops to be left clean and in acceptable condition for forage or harvesting.

#### **Digging and Lifting**

1. Losses after scavenging not to exceed 3 percent by weight.

2. Beets to be delivered free of serious bruising or other injury.

3. Dump screenings not to exceed 3 percent of beet weight except in muddy conditions.

No attempt, was made to establish fixed standards of field efficiency, harvesting capacity, or first cost since there were no precedents on which to base them. These three factors are interrelated in the operating cost and would probably vary widely among different systems of harvesting.

Because of the multiplicity of operations to be performed by a single unit, the machine is certain to be complex. Since the design is circumscribed by a large array of requirements, development is certain to be slow. Progress has been consistent but much slower than was thought probable at the outset.

A combination of machine elements has been devised which, with further development, shows promise of satisfying the foregoing requirements. The machine's ultimate cost and fieldworthiness are open questions. A pair of coulters and jointers are used to prepare the row for subsequent operations. A narrow, self-centering, power driven, track-equipped finder rides over the center of each beet and elevates a knife blade to the proper topping level. The severed crowns are grasped by spring-fingered drums which windrow them just inside the tractor wheel.

The roots are loosened by a pair of helical plow points which simultaneously fracture the lower 3 inches of disturbed soil. The remainder of the soil is fractured by a pair of driven coulters operated at such an angle and spacing as just to permit the largest beets to pass between them. The portion of the tap root projecting below the plow points is grasped by a pair of gathering chains, and the larger beets are similarly gripped by overhead chains which operate above the surface of the soil. The soil is thus permitted to fall free as the beets are elevated into a hopper.

The hopper is a long, inclined, conveyor-type bin of 1 ton capacity. It is mounted on the tractor and is equipped with a slow drive for use in filling and a fast drive to discharge the beets into a truck. It thus serves the dual purpose of hopper and elevator.

All working parts are held at a fixed level with respect to the

ground, in the beet row with conventional hydraulic lift equipment. Operation is thus independent of field roughness within ordinary limits.

#### Field Results-1945

Results obtained with the machine during the 1945 harvest season are summarized in table 1. The first four entries were in dry fields; the last two, in wet fields. The third entry shows a total failure in the Clarksburg region in a partial peat soil.

Table 1.—Results obtained with the U. C. Harvester in California fields during 1945. The first four (eats were in dry fields and the last two in wet fields.

Place	Acres burrested	Net tons hurvested	Av, serrenings per 5 tous (Pounds)	Ar. factory tare (Porcent)	Topping Joss (Perceut)	Toji Iare (Percent)	Кревчегу птетде (Гетевс)
U. C. over- wintered beets	2,0	50.0					88.0
Diener Bros. Harnish Bros., Heim	8.74	43.3	324		2.2	2.75	82.8
Mson & Slater Clerksburg	0.74	12.0					60 (est.)
Jas. Mar- shall, Clarksburg	5.19	100.4	348	3.4			86.5
17. C. 1945 beets	2.4	86.8	830	4.4			84.8
J. Simmons, Davis	5.3	129.5	870	6.9		··· ···	
Total	19.37	871.5					

## Observations on Field Trials

Topping.—Topping probably fulfills our original objectives in clean, well-thinned fields, dry or wet. It is appreciably but not seriously affected by a poor thinning job or by weeds under dry field conditions. A combination of wet soil and tough-stalk weeds, however, causes the quality of the work to depreciate to a barely acceptable level.

The tops are left in satisfactory windrows and are not run over

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by the machine or any other vehicle. It would be desirable to include apparatus for placing more than one row of tops in a windrow.

Lifting.—The beets are loosened satisfactorily by the plow under all conditions. The recovery of roots by the grasping chains is about 85 percent by weight under most dry ground conditions, and grades to a maximum of 95 percent under optimum wet field conditions. The missed beets are left in plain view on the ground surface, but there are many obstacles in the way of their recovery by hand methods. One man is unable to follow the harvester and load the missed beets directly into the machine. Two men cannot work effectively behind the machine and can keep up to it only when its speed is far below optimum.

When two men are used to windrow the beets, it is necessary that each work a single row since earth is crowded into the harvested rows by subsequent passages of the machine. This, combined with the necessity of handling the beets twice, makes the operation too expensive to be practical.

The cleaning of the beets probably satisfies our original requirements. Dump screenings varied from 3 percent under favorable conditions to 12 percent under muddy conditions. Whereas it would be desirable to lower the latter figure, it is already well below that for beets harvested under similar conditions by hand methods.

**Hopper.**—The hopper-elevator system of storage of the harvested roots has proved successful. It permits operation in fields far too muddy for successful truck operation, and it has proved a great boon in opening lands. Its greater maneuverability as compared with a trailed hopper permits operation in small fields with narrow headlands. It does, however, impose a severe static load on the tractor. No difficulty was experienced from this source during the year's work, but it may reasonably be expected to shorten tire life considerably. Whether or not its advantages are sufficient to offset this disadvantage can be determined only by further field experience.

General.—The maneuverability of the machine in turning or backing is good. In this respect it is limited only by the characteristics of the tractor to which it is attached. Control of the machine in the row is less satisfactory. The coulters and jointers which prepare the row for the topping operation interfere with steering. The rough condition in which the ground is left by the plow combined with the tendency of a wheel tractor to follow deep furrows makes control difficult under some conditions. The relatively heavy draft imposed by the plow and its standards tends to produce wheel slip and its accompanying side draft. Fortunately the plow is relatively insensitive to off-row operation, so these factors do not prevent successful operation. Improvement in these respects is, however, imperative if the machine is to operate at maximum efficiency.

The complexity of the mechanism is one of the major defects in this system of harvesting. Whether or not the machine can be built with the required degree of fieldworthiness at a figure which would justify its use is a problem, for commercial interests.

In general the present machine is functionally satisfactory in all operations excepting root recovery and will be worthy of consideration as a practical machine only if it can be greatly improved in this respect. The possibilities have not been exhausted, and a new model is now under construction.

#### Objectives for 1946

- 1. Increase average recovery to 92-95 percent.
- 2. Improve topper performance in wet, weedy fields.
- 3. Improve control of machine in the row.
- 4. Simplify digging and elevating units.

5. Harvest 40 to 50 acres of beets under a wide range of conditions.