

# Sugar Beet Harvester Studies at the University of California

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PROGRESS in the beet harvester development program at the University was discussed at a meeting of this Society at Denver, Colorado, in 1946. At that time the machine was reported to be functionally satisfactory under most conditions in the following operations: topping, top disposal, plowing, dirt separation, and root disposal. The root-pickup device was not considered satisfactory since the maximum recovery amounted to 85 percent, and this was deemed too low for successful field operation because of the expense of recovering the unharvested beets by hand methods. The complexity of the mechanism was admitted to be a formidable, though not necessarily an insurmountable barrier to operation by the average grower.

## Shop and Field Work—1946 and 1947

No changes were made in the fundamental operating principles of the machine during 1946 and 1947, and it now appears unlikely that such changes will be required in the development of a commercially acceptable machine. Mechanical improvement has now progressed to a point where most of the mechanism is field worthy in its present form, and beet loss has been reduced to a practical working level. Some of the mechanism is still susceptible to frequent failure; but changes made, especially during the past year, have opened new avenues for improvement.

Most of the 1946 harvest season was spent in the construction of a new digging and lifting unit and in the enlargement and remounting of the hopper. These changes required so much time that it was possible to spend only 12 days in actual field work; all in dry, sedimentary soil in the vicinity of Davis. Under these conditions, root recovery was approximately 90 percent as compared with 85 percent in 1945. However dump screenings of 10 percent nearly doubled the average of the preceding year.

Because of the limited field experience during 1946, it was deemed unwise to make major changes in the machine when work was resumed in 1947. Hence the spring of 1947 was spent in rebuilding only those parts of the mechanism which were obviously weak or faulty. Early field trials yielded no better results than those obtained in 1946. Faulty operation of a poorly designed hydraulic depth control system was finally isolated as one of the major sources of trouble. After rebuilding this, progress was rapid. Other faults which had been hidden by erratic performance then became apparent and most of them were corrected.

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On October 16, a test in dry, peat-loam soil at Clarksburg showed that root recovery had been raised to 93.7 percent and dirt pickup lowered to 6.8 percent. The fall rains began shortly thereafter and made further dry ground tests impossible. These results were definitely encouraging and if finally verified will indicate that recovery in such soil is on a practical working basis. However, further dry soil tests will be required before final judgment can be rendered.

During the remainder of the harvesting season, 294 tons of beets were harvested from three fields in the Clarksburg area under conditions ranging from moist to muddy. The results of these tests are summarized in table 1.

Table 1.  
Results of Field Trials—1947

Place	Acres harvested	Tons harvested	Factory screenings (percent)	Factory tare (percent)	Root recovery (percent)
Gus Olson, Clarksburg	6.4	220	11.9	3.4	95
Joe Holmes, Clarksburg	1.3	28	5.7	4.0	90
V. Hinsdale, Clarksburg	1.9	46	5.6	2.1	92

Peak performance was obtained in moderately wet soil where the harvesting rate was approximately 7.5 tons per hour; dump screenings, 7.3 percent; top and dirt tare, 2.4 percent; and topping losses, 1.5 percent. All losses, excepting those due to low topping, were recovered by one man following the machine.

As soil moisture increased above the optimum level, root recovery improved, but dump screenings increased because of adhesion of dirt to the beet roots. Reconstruction of the beet elevator to provide greater agitation of the roots lowered screenings from 18.8 percent to 5.7 percent under very muddy conditions, but appreciable tap root damage from the rough handling of the beets was evident.

### Attainment of Fundamental Objectives

The fundamental objectives of this project were reviewed at Denver in 1946. Since development work at the University has now been terminated, appraisal of its success or failure must be based on an examination of the performance of the harvester in the light of these objectives. It is the opinion of those on the Davis staff who have worked with the machine that the following objectives have been attained:

1. All apparatus to be mounted on a standard wheel tractor for ready maneuverability.
2. No unusual skill to be required in operation of the machine.
3. All operations to be completed in one transit of machine through the field.
4. Machine to be capable of opening its own lands.

5. Topping to be satisfactory in beets ranging up to 9 inches in height and in tops of any size.
6. Topping loss under ordinary conditions not to exceed 1.5 percent and top tare not to exceed 3.5 percent.
7. Tops to be left clean and in acceptable condition for forage or harvesting.
8. Root losses after scavenging not to exceed 3 percent by weight.

The following objectives have been only partially fulfilled, or have been satisfied only under certain field conditions:

1. Harvest crew to consist of one machine operator and not more than one scavenger. (In its present state of mechanical development, the machine requires an additional man to watch for mechanical failures and other field contingencies.)

2. Beets to be delivered free of serious bruising or other injury. (Under dry field conditions, damage to roots is no greater than in manual harvest; under muddy conditions, the vigorous agitation required to clean the roots results in appreciable tap root damage.)

Wider harvesting experience will be necessary as a basis for judgment regarding the following requirements:

1. Operation to be possible in all ordinary soil types and field moisture conditions which permit operation of a wheel tractor.

2. Dump screenings not to exceed 5 percent of beet weight except in muddy conditions.

### Favorable Features of the Harvester

The harvester delivers a high quality of product with a minimum of loss. Beets are cleanly topped and topping losses do not exceed those for hand-topped beets. The roots are delivered free of injury which might result in tonnage loss to the farmer or in storage loss to the processor. Dirt inclusion is not sufficient to interfere with milling operations. Tops are left in good condition for forage or harvesting. Unharvested roots are left on the surface of the ground where they may be readily recovered by a scavenger. The overall harvesting losses are thus kept at a level which compares favorably with those incurred in manual harvest. Since, at present price levels, each 1 percent of root loss is equivalent to an increase in harvesting cost of 15 cents per ton, this item plays a greater part in determining the cost of harvest with present machines than is generally recognized.

Operation is possible under a wide variety of field conditions. Hard ground, mud, high beets, heavy top growth, and light top growth interfere less with the operation of this machine than with other machines now in commercial use. A high degree of maneuverability and the ability to open its own lands adapt the harvester to work in small fields. The beet hopper permits operation in fields far too wet for successful truck operation.

### Unfavorable Features of the Harvester

The most unfavorable feature of the machine is its mechanical complexity. This is due in part to lack of experience on the part of its designers and to the fact that all mechanism is mounted on a single tractor. Some of its operating principles, however, appear to demand mechanism which is undesirable from a construction and maintenance point of view.

The performance of the harvester is adversely affected by beets in multiple combinations, by a preponderance of small beets, and by beets of odd shape. In these respects, the machine is less tolerant than most of those in commercial use. These faults appear to be inherent, and their correction must occur through cultural improvements rather than through improvement in implement design.

Root recovery is reduced in hard, dry ground; but to what extent this might limit the usefulness of the machine has not been determined. Experience with previous models, however, justifies the assumption that this factor would not reduce the recovery to an impractical operating level.

### Conclusion

The University has completed its phase of the harvester development program. A machine has been produced which is capable of high quality performance under the conditions in which it has been tested. Harvesting losses are low, and performance is relatively independent of many field variables which seriously affect the commercial harvesters now in use.

The harvester is not, however, capable of practical field operation in its present state of mechanical development. It will require redesign along practical lines by an agency experienced in this work and extensive field trials to establish its ultimate merit.