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POTATO HARVESTING METHODS IN OREGON\*

Production

Acres and production estimates of potatoes in Oregon for the years 1938 to 1943 inclusive as published by the Bureau of Agricultural Economics are as follows:

	<u>Acres harvested</u>	<u>Production</u> (Bushels)
1938 . . . . .	35,000	6,755,000
1939 . . . . .	33,000	6,171,000
1940 . . . . .	35,000	7,805,000
1941 . . . . .	35,000	7,175,000
1942 . . . . .	35,000	6,825,000
1943 (preliminary) . . . . .	53,000	10,335,000

There are three principal commercial potato-producing areas in Oregon. The most important area is in Klamath County where during the last five years approximately 30 percent of the total potato acreage in the State has been grown. The second most important area is in Malheur County in which approximately 15 percent of the total acreage has been grown. The third most important area is in Deschutes and Crook Counties where approximately 12 percent of the total potato acreage in Oregon is produced. The Willamette Valley also has a number of local specialized areas where potatoes are produced commercially. In the aggregate this area usually has over 25 percent of the total acreage in the state.

Harvesting

Time

The harvest period ranges from July to November, depending upon the area and the variety of potatoes grown. Early potatoes are grown to a limited extent in several areas in the State, with the majority being produced in Malheur County. Late potatoes for commercial distribution are grown principally in Klamath, Malheur, Deschutes, and Crook Counties.

Methods:

Harvesting methods may be classified as:

1. Digging, with one- or two-row diggers, and hand-picking.
2. Digging, and sacking with trailer-sacker.
3. Digging, and sacking with combined digger-sacker.
4. Digging, and elevating in bulk with combined digger-bulker.

\*This study was conducted under the Farm Work Simplification Project, in cooperation with the Purdue University Farm Work Simplification Fund granted by the General Education Board.

### Procedure Under Each Method

1. Digger, - hand pickers. Potatoes are dug with one- or two-row diggers, one-row machines being most common. The digger shakes the dirt from the potatoes and deposits them in a row on the ground behind the machine. The potatoes are then picked up by hand. Picking belts are used by a majority of the pickers. A potato picking belt consists of a web belt about 4 inches wide with 2 large steel hooks so spaced on the belt that they occupy positions approximately over the hip pockets of the picker (see Figure 1), while a board approximately  $3/4 \times 1/2 \times 18$  inches is attached with screw eyes to metal rings in the front of the belt. Two hooks are placed approximately 15 inches apart on this board, to which the picking sack is attached. The upper edge of the mouth of the sack is held taut by the hooks, the remainder hanging down and providing an opening into which the picker can toss the potatoes with a minimum of attention (see Figure 2). Extra sacks are carried on the hooks over the hips. Baskets are seldom used, as too much time is consumed in moving the basket forward and in carrying it to the sack when filled. When using a picking belt, a picker fills each sack slightly over half-full or until it contains about 60 pounds of potatoes, then unhooks it from the picker belt and sets it to one side of the row.

Pickers are usually paid on a piece-work basis. The rate of pay is based on a certain amount for each sack containing a certain weight of potatoes. This weight is usually 60 pounds, although an agreement may be made between the grower and the picker to pick 40-pound or 50-pound sacks instead, depending upon the physical ability of the picker. Women and children are seldom able to handle the 60-pound sacks with the picking belts as considerable strength is required to drag the sack along the ground between the picker's legs when the weight of potatoes in the sack approaches 60 pounds.

The fact that pickers have been paid on a piece-work basis has made speed in picking more the concern of the picker than the grower and has kept the grower from being particularly interested in training individual pickers to work efficiently. However, with the scarcity of labor prevailing under present conditions and the necessity of getting the crop harvested within a certain time, growers are beginning to realize that they have a definite interest in increasing the daily output of the pickers.

2. Digger, and Trailer-sacker. Recently the use of sackers that trail behind the digger has become quite popular as one means of saving labor. In many cases the sackers are rebuilt from old diggers. The modification consists essentially of removing the blade, and raising the front end so that the elevator chain travels more nearly horizontally for most of its length, with a sacking attachment placed at the rear end. The trailer-sacker is carried on two wheels, and is attached behind the digger in such a position that the potatoes drop from the digger to the conveyor chain on the sacker. As they pass along on the conveyor chain an opportunity is given for laborers on either side to remove vines, stones, sticks, rocks, or other foreign material, leaving only sound potatoes to pass over the end of the conveyor into the sack. One or two men standing on a platform at the rear of the machine fill the sacks to about 60 pounds, remove them from the sack holder and set them on the ground without stepping off the platform.

As a general rule the extra draft of the trailer-sacker is not sufficient to require a larger tractor than would ordinarily be used to operate a digger alone.



Fig. 1. Hand-picking behind 2-row potato digger.



Fig. 2. Hand-picking potatoes.

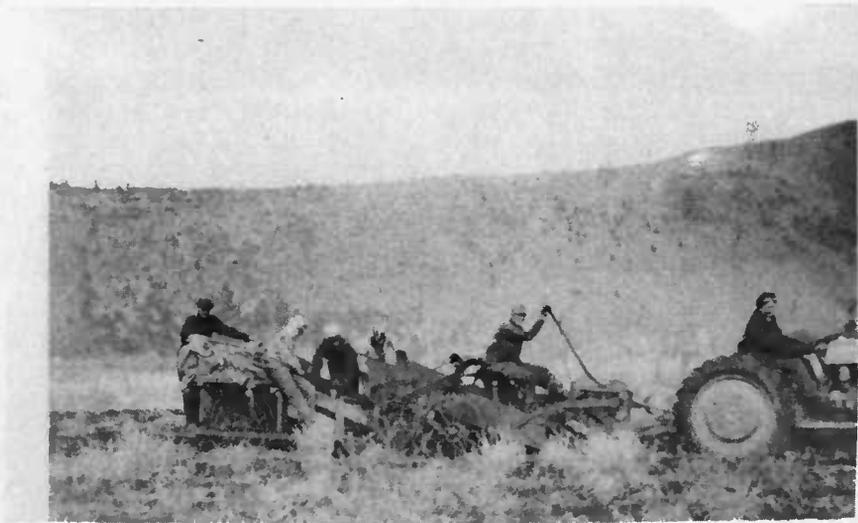


Fig. 3. Homemade trailer-sacker operating behind 1-row digger.



Fig. 4. Combined digger-sacker in operation.

3. Combined Digger-Sacker. On the combined digger and sacker, usually called a "potato combine", the digger and sorting conveyor chain are combined in a single machine, mounted on a single axle supported by two wheels. To avoid an excessively long machine, the sorting conveyor is placed at right angles to the digger elevator, making the machine of greater width than a regular digger but one that is practically as easy to maneuver, since the actual length of the machine is but little more than that of the conventional digger. Potatoes are sorted on the potato combine and sacked from the end of the conveyor much as they are on the trailer-sacker.

The combined digger-sacker has an auxiliary engine to operate the digging mechanism. For this reason the machine can be pulled by a tractor of the same size ordinarily used for a regular one-row digger with a power take-off operation of the digging mechanism.

4. Combined Digger-Bulker. The most recent development in potato harvesting machinery is handling potatoes from a combine in bulk. This method was used last season in the Klamath County Area by one grower. A combined digger-bulker is essentially the same as a combined digger-sacker except that the sacking attachment is replaced by an elevator. See Figures 6 and 7. The elevator receives the potatoes from the end of the conveyor on the potato combine and lifts them into trailers pulled beside the machine. In this way the use of sacks and lifting and loading the potatoes by hand is entirely eliminated.

#### Hauling to the Storage Cellar

When handling the potatoes in sacks a truck is driven through the field as soon as a number of rows of potatoes have been picked, the sacks are loaded on the truck and hauled to the storage cellar. Loading may be from one or both sides of the truck, depending upon the distance between rows of sacks and upon the number of men available. In loading, the truck is driven slowly along a row of sacks while one man walks alongside and lifts the sacks of potatoes to the truck bed where another man picks them up and places them on the load. Two men are required for each row of sacks being loaded although in some cases, as shown in Figure 8, three men work on a single row. When loading two rows of sacks simultaneously a typical hauling crew will consist of five men: the driver, two men to lift and two men to load. These men usually change positions after each load.

If two trucks are used for hauling, the field crew loads one while the other is unloading. Unless the length of haul from field to cellar is extremely great, two trucks will keep a loading crew busy in the field most of the time.

At the cellar the sacks are emptied into a hopper on an elevator that lifts the potatoes and transports them to a storage bin. The unloading is done by the truck driver and a man who ordinarily remains at the cellar to supervise placing the potatoes in storage.

When handling potatoes in bulk, the operation of loading the sacks in the field is eliminated. The trailer-load of bulk potatoes is unloaded at the cellar by a detachable electric motor power unit operating a conveyor in the bottom of the trailer, and requires the attention of only one man while operating.



Fig. 5. Removing vines and clods from cross-conveyor.



Fig. 6. Combined digger-bulker.



Fig. 7. Elevator adjusted to deliver potatoes to bottom of trailer.



Fig. 8. Loading sacked potatoes.

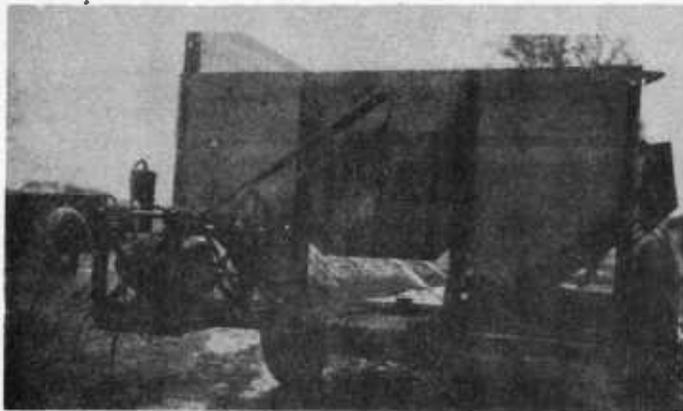


Fig. 9. Potatoes are unloaded by conveyor belt driven by removable power unit.

## Labor Requirements

While the exact number of hand pickers, truck drivers, etc., will vary with the yield of potatoes, length of haul and other conditions, the following figures are approximately correct for yields of not over 250-300 one-hundred pound sacks per acre and hauls up to  $3/4$  miles.

Table 1. Crews required for harvesting potatoes by four different methods, assuming one-row equipment harvesting approximately 4 acres per day in each case.

Member of crew	Method			
	Digger, hand pickers	Digger, and trailer-sacker	Combined digger-sacker	Combined digger-bulker
Tractor driver . . . . .	1	1	1	1
Digger operator . . . . .	1	1	1	1
Pickers . . . . .	12	-	-	-
Vine remover . . . . .	-	1	1	1
Clod sorters . . . . .	-	2	2	2
Sackers . . . . .	-	2	2	-
Elevator operator . . . . .	-	-	-	1
Truck drivers . . . . .	2	2	2	3*
Sack loaders . . . . .	4	4	4	-
Cellar man . . . . .	1	1	1	1
<b>Total crew . . . . .</b>	<b>21</b>	<b>14</b>	<b>14</b>	<b>10</b>

\* An extra truck or tractor-trailer unit is added to avoid delaying the digger due to lack of a vehicle to receive the bulk potatoes.

The above table indicates a saving of one-third in the number of men required when using a digger-sacker instead of hand picking, and a saving of over 50 percent when handling in bulk compared with hand picking.

### Advantages and Disadvantages of Each Method

#### Digging with Mechanical Digger, Hand Picking

##### 1. Advantages

a. The tractor and digger, pickers, and haulers, comprise three working units, each of which can be operated independently of the others.

(1) This makes possible a close adjustment of the number of workers to the yield of the crop.

(2) When the surface soil is frosty and clods are numerous, the digger can start early in the morning before clods are thawed out. With combines such conditions would mean the presence of too many clods to be sorted out.

- b. Hand picking requires the minimum investment in mechanical equipment.
- c. Hand picking is especially adapted to small-scale operations and irregular-shaped fields where the use of the "combines" would result in more time lost in turning and in the loss of potatoes either injured or not dug at the ends of the rows.
- d. The potatoes have an opportunity to lie on top of the ground for a time, which allows the skin to cure or dry out a little and to become firm, thus improving their appearance.

## 2. Disadvantages

- a. Requires a much larger labor force than other methods.
- b. Picking potatoes by hand is hard, back-breaking labor that is not especially attractive to laborers, especially when other jobs are available.
- c. In order to secure labor for hand picking it is necessary to pay wages high enough to compete with more attractive jobs. This greatly increases the cash cost of harvesting the potatoes.

## Digging and Sacking with a Trailer-Sacker

### 1. Advantages

- a. Using a trailer-sacker behind a regular digger eliminates the need for hand picking.
- b. Less robust labor can be used to remove the vines, clods and other foreign material from the potatoes as they pass along the conveyor chain on the sacker, since no lifting is necessary and the workers ride while at work.
- c. When compared with the combined digger-sacker, the trailer-sacker has the advantage that under unfavorable conditions for the use of the sacker it may be disconnected and the digger used alone in the conventional way.

### 2. Disadvantages

- a. The sacker coupled to the digger makes a rather long outfit, one that requires considerable room to turn at the end of the row and one that cannot be backed readily.
- b. When a large number of clods, stones, or other foreign material is present it may be difficult for the workers to remove the foreign material from the conveyor chain as rapidly as necessary. However, this disadvantage can be met by lengthening the conveyor chain and by increasing the number of sorters.

## Combined Digger-Sacker

### 1. Advantages

- a. The combined digger-sacker has the same advantages as the trailer-sacker when compared with hand picking.
- b. When compared with the trailer-sacker, the combined digger-sacker is more compact and requires less turning space at the end of the row. The entire machine is mounted on two wheels, which makes it easier to back and to maneuver into position.

### 2. Disadvantages

- a. The digger cannot be separated from the sorting conveyor and operated as a digger only.

## Combined Digger-Bulker

### 1. Advantages

- a. The combined digger-bulker has all the advantages of the trailer-sacker or combined digger-sacker when compared with hand picking.
- b. Compared with the trailer-sacker and combined digger-sacker, the combined digger-bulker has the advantage that the potatoes are loaded directly into the transporting vehicle without the need for filling and setting off sacks, or for picking up and loading the sacks later on. As shown in the table in Section "Labor Requirements," this not only eliminates four men from the crew, but eliminates the only remaining lifting of potatoes involved in the harvesting operation. This is important when we remember that setting each sack off the combine, lifting it to the truck bed, placing it on the load, and lifting, carrying, and dumping it into the elevator at the cellar, requires picking up each sack at least four times. If the potatoes are yielding 250 one-hundred pound sacks per acre, then 4 x 25,000 pounds or 100,000 pounds of potatoes are probably lifted an average vertical distance of 5 feet and carried horizontally an average distance of 10 feet for each acre of potatoes harvested. In other words, handling the potatoes from the digger in bulk completes the mechanization of the harvesting operation from the field to the storage cellar, with the exception of removing vines, clods, etc., from the potatoes as they pass over the sorting conveyor on the combine. The significant fact is that not only has the number of men in the crew been reduced, but also that all heavy lifting and all stoop labor has been eliminated.

### 2. Disadvantages

- a. Any delay of one piece of equipment will stop the whole operation. All machine units must operate simultaneously.

- b. The investment in and upkeep of mechanical equipment is greater than with other methods.
- c. If the equipment is improperly operated the potatoes may be subjected to considerable mechanical damage in handling.

#### Opportunities for Improving Working Conditions and Methods

1. Hand Picking, using a two- instead of a one-row digger. By depositing the potatoes from two rows in a single row, the two-row potato digger makes it possible for the picker to fill a sack of potatoes while traveling approximately half as far as when picking behind a one-row digger. On the other hand, the row of potatoes behind a two-row digger is wider and requires more movement of the picker's hands from side to side. It would be interesting to know the relative advantages and disadvantages of picking up behind two-row diggers as compared with one-row diggers. A two-row digger also effects a saving in the tractor operator's time and in the cost of tractor operation but requires a larger tractor to operate it.

2. Trailer-sacker. As previously stated, many of the trailer-sackers are rebuilt from old potato diggers, and even though the front end of the machine is raised somewhat the forward portion of the conveyor chain is still too low, requiring the worker to bend over in a rather uncomfortable position to remove vines, clods, etc., from the chain. Foot rests on which the worker stands also vary in material and width, and in many cases no hand rails or other supporting devices are available for the worker. An interesting study of trailer-sackers' design could be made with regard to the comfort and safety of the worker.

3. Combined Digger-sacker. At present, clods and other foreign materials are removed from the conveyor table by the worker grasping them and throwing them to the rear of the worker. It appears that the use of 1/8" by 2" band iron "dividers" on the conveyor table similar to those used on grading tables might greatly reduce the distance traveled by the hand of the worker when discarding a clod, increasing the number of movements and thus increasing the amount of material that could be handled in a given length of time.

4. Combined Digger-bulker. The same possibility exists for improvement on the conveyor table on the digger-bulker as on the digger-sacker.

5. Bruising. There is an opportunity for a study of the amount of damage done to the potatoes by bruising when harvested by each of the various methods, and means of preventing such damage.

#### Conclusions

Due to the prevalence of regular one- or two-row potato diggers in the potato areas and to certain advantages previously mentioned, it is likely that the conventional method of digging and picking up potatoes by hand will continue to be the most common method of harvesting potatoes for several years, particularly if an ample amount of seasonal labor becomes available after the war.

As a temporary expedient, and one that can be effected with the least additional investment in machinery, the building and use of trailer-sackers offers a possibility for a considerable saving in labor and eliminates the stoop labor involved in hand picking.

The combined digger-sacker is a refinement over the trailer-sacker and growers will undoubtedly use as many as can be manufactured within the next year or two.

The combined digger-bulker worked exceptionally well when it is considered that 1943 was its first season in the field. With a few refinements and modifications it should prove as dependable as the other machines now available. A combined digger-bulker with the necessary truck or trailer equipment represents a considerable investment but under many conditions the saving effected will soon offset the first cost of the equipment. Potato growers with a considerable acreage of potatoes, or growers with smaller acreages who can arrange to do custom work after their own crop is harvested, should investigate the possibility of using a combined digger-bulker.

It is realized that all of the machines which eliminate hand picking do not give the potatoes an opportunity to cure on the ground before being sacked. Under some conditions this may be a disadvantage in marketing and in such cases the continued use of the regular digger may be advisable. On the other hand the sacking and bulk handling machines offer such possibilities for saving labor that growers might well investigate whether or not their use will result in a less satisfactory product for the market. Even if a reduction in price results because of a less attractive product the saving in labor effected by the use of the trailer-sacker or the combined sacker or bulker may still more than offset the lower price.

Figures on the cost of harvesting potatoes by the various methods are greatly needed as a guide for growers to use in determining which method is most economical for them under their conditions.