POTATO HARVEST EQUIPMENT OPERATION

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As a result of a cooperative project between the University of Idaho, Washington State University and Tiokol Chemical Corporation, two low-damage potato harvesters were designed and built at the University of Idaho Aberdeen Experiment Station. One machine was designed for testing in Idaho and the second machine was designed for testing in Washington. Washington growers generally plant 34-inch rows instead of 36-inch as in Idaho. Washington conditions generally do not require a roll table for cleaning. The Idaho machine included a short section of roll table at the transfer between the side elevator and the boom chain, whereas the Washington machine moved the tubers directly from the side elevator onto the boom chain.

The machine for testing in Washington was delivered to the Pasco area on September 10, 1974. Through the efforts of Mr. Ellis Charvet of Chef-Reddy, Mr. Jeff Vogt furnished an International Harvester Model 1056 tractor to power the harvester.

DESIGN CONCEPTS FOR BRUISE REDUCTION

Several concepts with a potential to reduce bruising were incorporated into the design of this harvester. The concepts to reduce damage and comments about some of these concepts follow.

1. Vibrating digger blade.

   A vibrating digger blade which oscillates about a center pivot was used on the low-damage harvester. Researchers from Idaho have reported that the vibrating blade reduces injury. However, research results in Washington have shown that injury at the digger blade has not been a problem. Vibrating soil tools generally have less draft requirements than non-vibrating tools, and this might be an advantage in soils where traction is a problem. However, because of the complexity of the vibrating blade and the power expended in powering the blade, it is believed that, in Washington, the vibrating digger blade cannot be justified for potato harvesters.

2. Infinitely variable speed control on chain drives.

   The machine was powered by a PTO shaft to a gear box which drives three hydraulic pumps. One pump supplied power to the vibrating blade, a second provided power for the digger chain and deviner chain and a third provided power for all other functions of the harvester. By utilizing hydrostatic drives for all chains, complete speed control was possible. However, loaded speed was often 30 percent less then no-load speed.

3. Tractor seat control for the primary chain and deviner chain speed.

   Because the speed of these two chains should be dependent on soil and field conditions, control from the tractor seat is essential for the operator to properly maintain the flow of material across these chains. Speed control provisions were provided by utilizing a variable delivery, manually controlled, hydraulic pump and a fixed displacement motor. Because of power deficiencies, the digger would not dig deep enough and often the operator would run the primary and deviner chains faster than optimum. This was somewhat overcome when a sprocket drive gear reduction was installed on the primary chain.

4. Extra long digger section.

   The moveable digger section of the harvester was lengthened 15" over that of the standard machine so that the lift angle at which tubers are elevated at normal digging depth was 20°. This smaller angle should result in reducing tuber rollback and tuber motion on the primary chain.

5. Return side drive on secondary chain.

One goal of the low-damage harvester was to limit drop heights to the minimum possible amount. Drop height from the secondary chain to the rear cross was reduced by providing a return side drive which keeps the chain in tension as it goes around the head shaft.

This allowed the rear cross to be moved within about 1-1/4 inches of the secondary chain without the problem of chain entanglement which can occur if the chain goes slack as it comes off a driven head shaft.

6. Auxiliary roller prior to head shafts of secondary and side elevator chains.

A shorter drop height and a lower impact velocity results by reducing the slopes of the secondary and side elevator chains. This was accomplished by passing the chains over idler rollers just prior to the headshafts. Thereby, the chains were angled slightly downward so that tubers were discharged toward the receiving chains rather than up and away from them.

7. Staggered loading of rear cross.

The full width of the rear cross conveyor was utilized by staggering the discharges of the secondary chain. The row furthest from the side elevator discharged onto the back half of the rear cross and the near row discharged onto the front half of the rear cross. Maximum utilization of the full width of the rear cross allows a lower chain speed and more uniform loading with a reduced rearward slope on the chain. Some problems were encountered with the belting used along the side of the rear cross, in that the belting would become pushed out of its retainers which would allow tubers to fall out of the rear of the machine.

8. Removal of flights from side elevator.

The drops from the rear cross to the side elevator and from the side elevator to the boom were minimized by removing the flights from the side elevator. To prevent the tubers from rolling down the flightless elevator, an anti-roll belt was installed between the uprights on the side elevator and was driven by a head shaft and two friction wheels. This anti-roll belt, which is an endless belt with no tail pulley, held the tubers against the chain and prevented them from rolling down the elevator. The anti-roll belt aided in breaking up clods and removing dirt; however, considerable abrasive action and skinning of tubers was observed.

9. Boom height monitoring control.

A controller using high frequency sound to sense the distance of the boom from the potatoes was installed on the harvesters; however, the unit on the Washington harvester was never operative. It appears that this controller may be too complex and costly for use on a potato harvester.

10. Vine handling.

Green, wet or tough vines can present a very difficult problem. They hang up on the sides of the opening in the front of the harvester and tend to wrap around shafts. To help allieviate this problem, coulters and discs have been added to harvesters, but the tough vines resist cutting. During the development of the vibrating blade, the problem of vines catching on the digger opening was very serious because the vibrating blade required arms between the rows. At the suggestion of a grower, double disc hillers were used to clear the vines and weeds between the rows. This device worked well and very few vine problems were encountered when preceeding the harvester with a set of these discs. A small tractor equipped with a set of discs can keep ahead of several harvesters. A few growers used similar arrangements this year and they estimated that by using these discs in bad vine conditions harvester output could be increased by approximately ten percent.

FIELD TRIALS

In 1974, the Idaho machine harvested about 100 acres and the Washington machine about 25 acres. Damage evaluation from the Idaho machine showed a consistent reduction in bruise damage, but reductions were not as much as anticipated. Washington field tests included point-to-point data, Table 1. No damage was indicated until the potatoes were on the cross conveyor. Damage then gradually increased until the tubers were through the machine. The reduced level of damage off the end of the boom was considered to be due to sampling error.

TABLE 1

RESULTS OF WASHINGTON STATE TESTS OF LOW-DAMAGE HARVESTER

LOCATION	AVERAGE PERCENT BRUISE FREE
From Field (Hand dug)	100
On Primary	100
On Secondary	100
On Cross Conveyor	98
On Lower End of Elevator	94
On Sorting Table	80
Off End of Boom	90

Average of six replications, ground speeds between 2 and 3 mph, 10 tuber samples, lye peeled, chain speeds near optimum and field conditions near optimum.

BOBBING SENSOR BOOM HEIGHT CONTROLLER

A boom controller utilizing a bobbing sensor has been designed and constructed. The head shaft of the boom continuously drives the sensor up and down. Micro-switches, operated by cams on the shaft driving the sensor indicate location of the sensor. If the sensor is at the down limit of its stroke, and it is not in contact with the pile of tubers, a signal is given to lower the boom. When the sensor is at the down limit of its stroke and is in contact with the pile of tubers, no signal is given. When the sensor is at the top of its stroke and is in contact with the pile of tubers a signal is given to raise the boom.

The simplicity and anticipated low cost of producing such a sensing mechanism warrants further development and testing of this mechanism.