ANALYSIS OF MECHANICAL HARVESTER BRUISING

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Two years ago when I was first asked to speak to this group, I discussed the problem of bruising and presented ten suggestions for reducing bruise damage during the harvest operation. These were not original, but summarized recommendations currently being made. Since that time bruising has received considerable discussion; with much of the blame being directed toward the machine operator. This morning I would like to briefly review these suggestions, in light of how much control, at the time of harvest, the operator of the machine has of the factors affecting bruise damage. As we look at these you might also check the box score of how you are doing in your operation.

1. Use proper cultural practice from plowing to digging. Excess clods damage potatoes. Keep field travel before harvest to a minimum. Minimize cultivation wherever possible.
2. Apply a light irrigation to soften clods and to mellow the soil just before harvest.
3. Slow down your equipment. (We will say more about this recommendation later on in the paper.)
4. Make certain all chains are rubberized, i.e., digger chains, transfer and elevator chains on both combines and pilers.
5. Maintain a cushion of soil from digger point to transfer chain.
6. Do not use kickers or eccentrics on digger chains unless soil conditions require them.
7. Never allow potatoes to drop more than six inches.
8. Select a potato combine that has a minimum of direction changes and thus minimizes the number of times the potatoes must fall from one chain to another.
9. Use padding wherever damage might occur, whether it be on the combine, in the truck or at the piler. Particularly, the floor and sides of the truck where loading begins should be padded. First build the load to the full height in the padded area and then position the truck so that subsequent potatoes always fall on a previously built mound, thereby, reducing the distance they fall.
10. Handle, load, unload and distribute potatoes gently. Train all personnel that potatoes injure easily.

Now as you look over this list notice that the operator has control only of items 3, 5, and 6 and to a certain extent items 7 and 9, i.e., by proper control of the boom he can prevent some of the damage. Equally as important as the operator are the other decisions that have been made prior to the time when the operator takes the machine into the field.

This includes the selection of the machine, the condition of the crop, the type of chains, etc.

During the past harvest season I conducted a limited amount of research to find out what was happening inside the combine. However, most of this work was of a preliminary nature. It was intended to test procedures, to uncover some of the hidden problems, and in general to develop techniques more than to find answers to particular problems.

One of the initial problems was to find a suitable method for evaluating bruise damage. The method I finally used is a combination of the procedures advocated by several groups; but, is essentially the same as described by others on this program. A description of the procedure is included at the end of this paper.

Some data was obtained from several combines; however, only one study is worthy of note. This involved a Hallway Harvester operated by the American Potato Company on their farm near Moses Lake, Washington. In this study samples were taken and analyzed for bruise damage from the following locations: from the field, as the potato just started up the digger chain, just before potatoes dropped off the digger chain, just before and after the cross conveyor drop onto the elevator, and just before and after the drop into the truck. The cross conveyor chain and elevator chain speeds were held constant while the ground speed of the machine was varied from 0.75 to 1.6 miles per hour in four steps. The digger chain speed, likewise, was varied from 94 to 198 feet per minute in steps proportional to the ground speed.

It should be noted that the digger chain speed was approximately 20 percent greater than would be recommended if the chain speed was to be the same as the forward speed of the machine allowing for the incline of the digger bed.

Interestingly enough the overall damage was not greatly affected by the change in ground and digger chain speeds. It rose slightly between speed one and speed two and then dropped back down between speeds two and three and three and four. This could well be due to the increase in the number of potatoes on the cross conveyor and on the elevator at the higher speeds.

More significant was the difference between points within the harvester. In this test an average of 54 percent of the tubers taken from the truck bed were damaged seriously while less than 1 percent of the hand-dug potatoes receiving similar handling were damaged seriously. Thus approximately 53 percent of the tubers in the test were damaged seriously by the time they reached the truck bed. This increase in damage proceeded as follows. Five percent damage occurred as the potatoes just came onto the digger chain, an additional 16 percent damage at the first

drop and 21 percent at the second drop. Dropping the potatoes into the truck off the boom resulted in an average of 12 percent serious damage. Although this study was involved with only one harvester and certainly cannot be considered conclusive, two things are indicated: (1) damage to the tubers is caused more by what the operator doesn't have control of than by what he does have control of, assuming that the operator is reasonably competent; and (2) every time tubers are dropped from one chain to another you will get some damage. Thus, in my opinion, the most significant improvements in bruise damage at harvest time can be made through improvements in harvester design. Drops on some machines currently in use measure 20 inches or more; as a result either of ignoring current recommendations or of necessity to overcome design problems inherent in the machine. Also, I believe the manufacturers must assist in obtaining information on how to operate their own machines to reduce bruises.

Now that we have reviewed some of the operating procedures for the potato combine and have indicated some preliminary results showing how the damage increases as the potato travels through the potato harvester, I want to take you on a ride through the harvester itself. I suggest you fasten your seat belts for it is a bumpy one. I hope some of the manufacturers are present so they can feel some of the bumps. It may give them encouragement to hasten their design changes with respect to the harvester. As we travel keep in mind especially two of the recommendations we mentioned: (1) select a combine with a minimum of direction changes and (2) remember that the potato is a living organism that bruises easily and it has been shown that potatoes will bruise when dropped more than six inches.

The pictures were filmed by Bob Thornton, Washington State University Extension Horticulturist. In this film we will see three separate series of pictures: (1) the Hallway Harvester as previously discussed, (2) some scenes of a Sinner Harvester in very wet soil, (3) scenes showing harvesters at a demonstration held near Lethbridge, Ontario, Canada, September, 1968. These harvesters were set up and being harvested for minimum bruising under the direction of the manufacturers.

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(At this point an 8 1/2 minute color film was shown which consisted of scenes within the potato combine showing the dynamics of the potato tuber.)

In closing I think I talked more about problems than solutions. Some of the problems need design work and re-evaluation of our harves-

ting procedure. However, we should have illustrated the importance of (1) keeping drops to a minimum both in distance and number, (2) keeping proper control of the boom, (3) controlling chain speeds to keep the chains full but not overloaded, prevent roll back and keep potatoes from bouncing around due to high speed empty chains, and (4) getting the proper relationship of chain speeds within the machine to harvester ground speed.

BRUISE EVALUATION TECHNIQUE

Each sample consisted of ten potatoes selected from the location in question. These were washed and then dipped in the 2 percent catechol solution as recommended by Dr. Iritani. I then used a common household potato peeler to determine the depth of bruise and to score the potato as to slight, serious, or skinning.

The depth of bruise scale is measured as follows:

1. skinning--where one stroke of a peeler removes all the visible damage.
2. slight damage--where three strokes of a peeler remove all the damage.
3. seriously damaged--where more than three strokes of a peeler would be required to remove all the damage.

The potatoes were allowed to condition for three weeks at ordinary room temperature to allow the bruise to show up within the potato.

After scoring, the total bruise in a sample was weighted to obtain a total damage index as follows:

percent skinned x 1 + percent slight bruised x 3 + percent serious bruise x 7 = total damage index.

This bruise index rating was used as recommended by the Alberta Potato Commission at their potato harvester trial in September, 1968.