MINIMIZING TUBER BRUISING AFTER THE HARVESTER

by
Gary M. Hyde
Agricultural Engineering Department
Washington State University, Pullman, Wa.

ABSTRACT

This presentation discusses what you can do and what we are doing to minimize tuber damage from field through storage to processing or through the freshpack line. New technology is on hand to pinpoint hazards and to measure the effects of tuber loading and equipment speeds on tuber damage potential. We have begun work with an instrumented sphere that can go through the handling equipment with the tubers to measure impacts and predict tuber damage. It is being used together with high speed video to evaluate handling equipment and predict effects of design changes and cushioning materials.

The Problem

Field to Storage Damage

Let's look at the progression of tuber damage as the crop moves from the harvester to the storage pile. Data from 1986 (Fig. 1) show a total of about 25% damaged tubers by the time they reach the storage pile for 5 good harvesting operations. This is considerably better than occurred in the 1978 data, where the damage level was about 45% (Fig. 2). The 20% difference could be worth as much as $40 million annually if everyone were doing as well as the 1986 samples.

Freshpack Damage

Figure 3 shows freshpack damage averages for three packing sheds. Damage from harvesters was higher than necessary; but it increased further by almost 5% for each location from the first conveyor to the singulator. The tubers sampled here were 8-10 oz. as were those for the harvester data above. Seventy percent of the 90-count carton tubers in the bottom 1/3 of the box were bruised. That's a problem!

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Figure 1. Moderate and severe tuber bruise damage from harvester to storage pile, five operations, 1986.

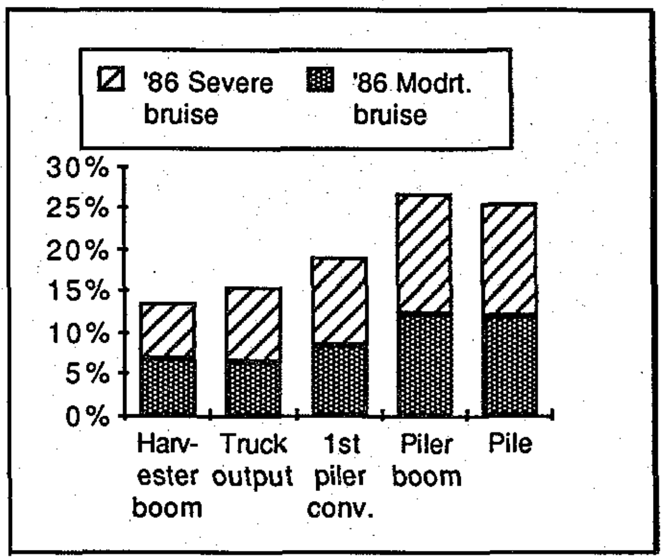


Figure 2. Comparison of 1978 and 1986 total bruise damage, field to storage.

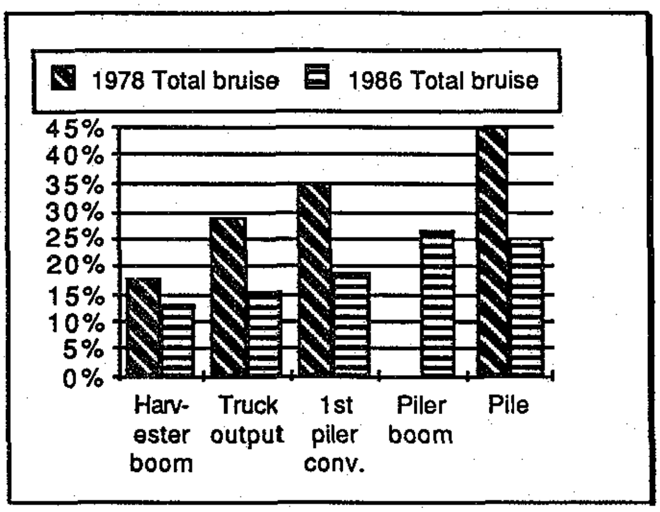
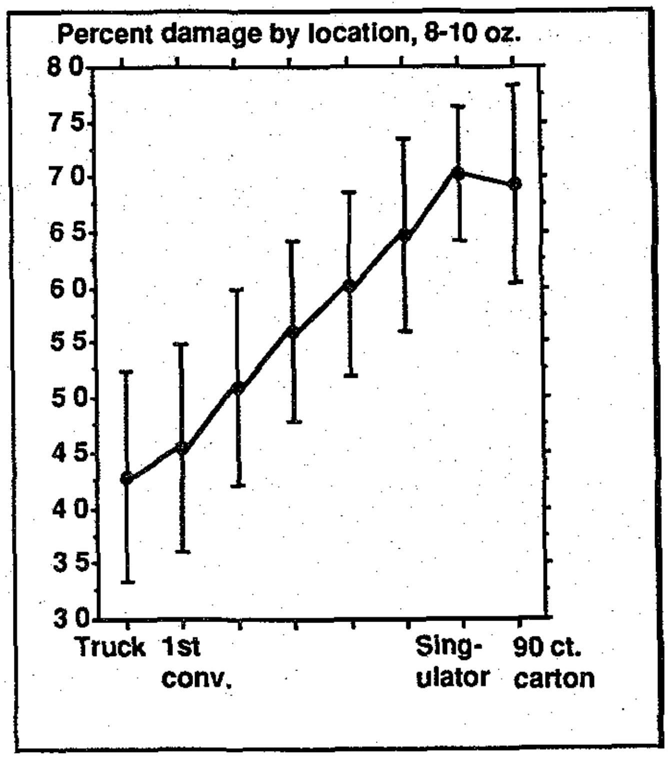


Figure 3. Tuber damage through three freshpack operations in 1986.



What's the solution?

What We Know Now

Harvester Operation

Minimizing tuber damage after the harvester depends in part on doing a good job during harvesting. Eliminating as much soil as possible early in the harvester and keeping the rear-cross, elevator and boom conveyors as full of tubers as possible without rollback or backfeeding will result in less bruise and less soil in the truck. Then the subsequent handling operations can proceed with less need for soil elimination and thus with more gentle treatment of the tubers.

Reducing harvester bruise by carrying tubers rather than soil is more than just a theory. Figures 4 and 5 show, respectively the results of experiments in sandy and in silt-loam soils where tuber bruise damage was measured for three levels each of soil loading and tuber loading on the same potato harvester. In both soils, keeping conveyors full of tubers reduced tuber damage more than did carrying extra soil.

Figure 4. Harvester bruise damage vs. soil & tuber loading in sandy soil.

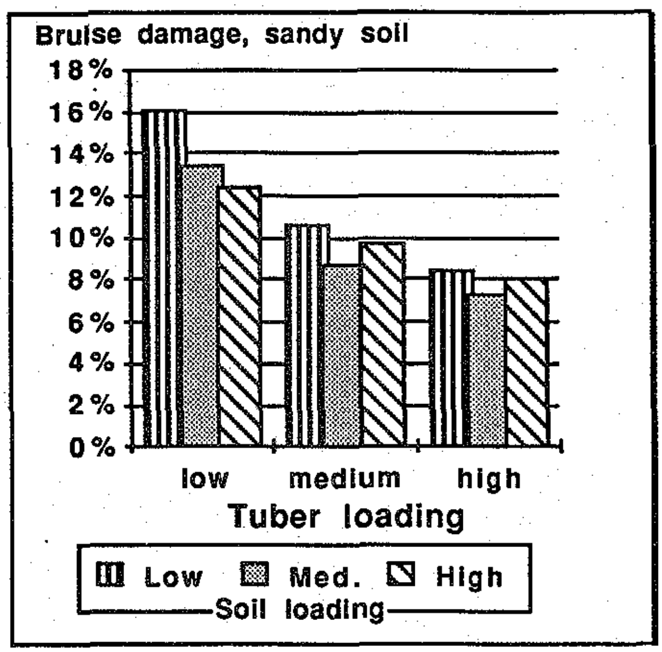
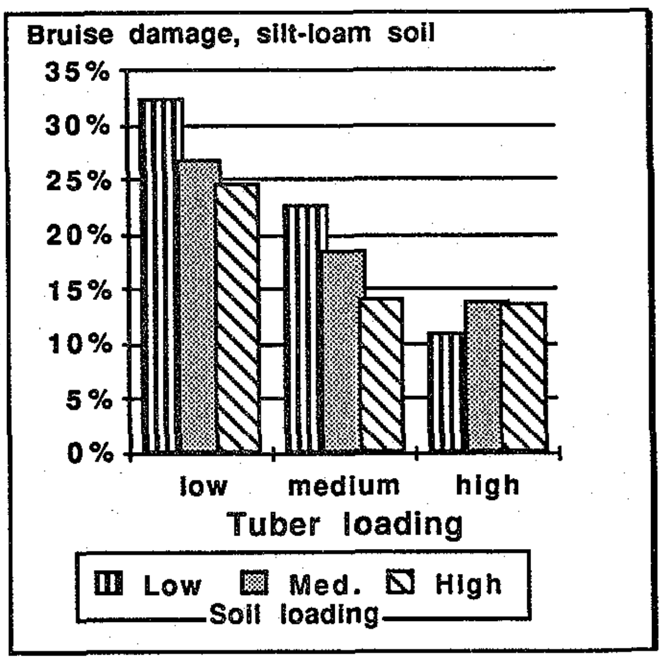


Figure 5. Harvester bruise damage vs. soil & tuber loading in silt-loam soil.



The general trend is shown in Figure 6. Carrying more soil reduces bruise some, but keeping everything full of tubers and eliminating soil early in the harvester reduces tuber damage much more.

Figure 6. Potato harvester tuber damage vs. soil and tuber loading in general.

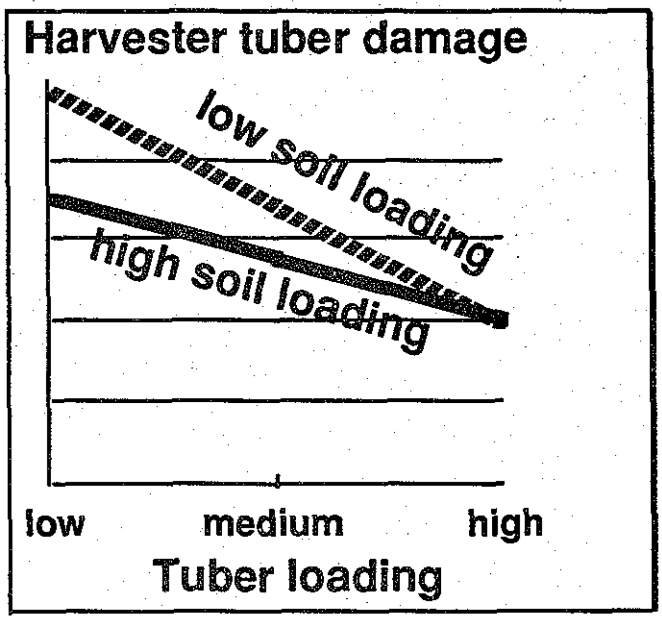
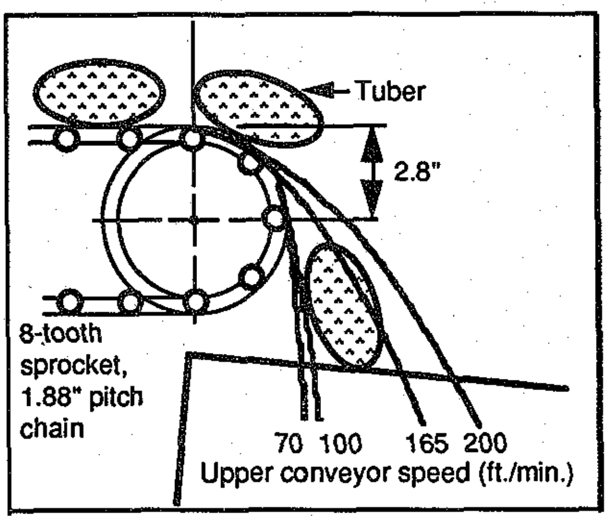


Figure 7. Trajectories of potato tubers at transfers to a subsequent conveyor running at 90°, such as secondary to rear cross.



Conveyor Speeds

Figure 7 shows the approximate trajectories of tubers as they fall from a conveyor running at speeds of 70, 100, 165 and 200 feet per minute. If the second conveyor is running at 90° to the first one, then the first must run at least 100 ft./min. to get the tubers clear so that they won't backfeed under it. The first conveyor can run at up to 200 ft./min. before the tuber velocity caused by the conveyor equals half that caused by an 8-inch drop. (A half-inch drop results in an impact velocity of 98 ft./min.)

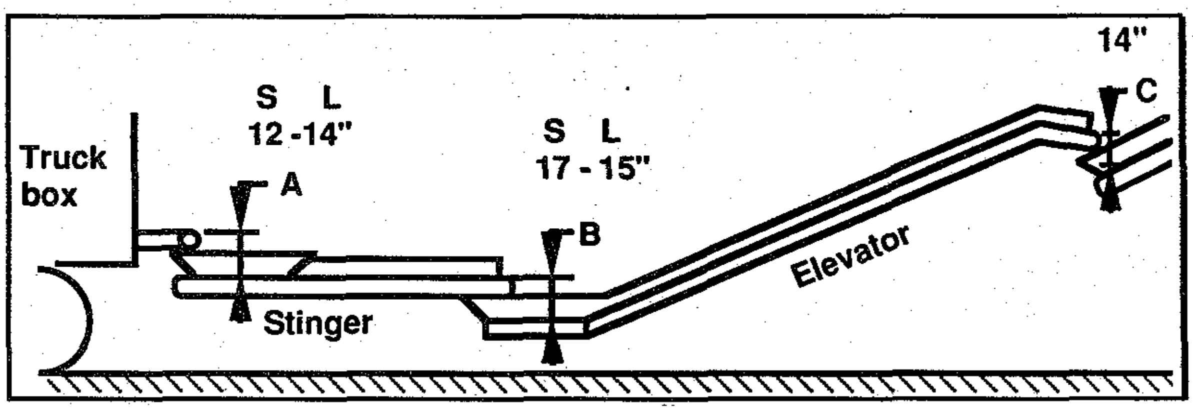
Piler Operations and Drops

Reduction of tuber damage in piling equipment follows the same principles as with harvesting equipment namely:

1. Reduce number of drops.
2. Reduce heights of drops.
3. Keep conveyors full to reduce affect of drop heights and to minimize jiggle of tubers on the conveyors.
4. Keep flow out of truck uniform.

Figure 8 shows a typical configuration for two similar pilers, S being a small, narrower machine and L being a wider machine. In both cases, the total drop height from truck to piler boom was about 43 inches. The larger piler produced more tuber damage, even though the smaller one had the 17-inch drop from stinger to elevator. The probable reason was that the larger machine was not kept as full of tubers as was the small one.

Figure 8. Typical truck-piler configuration. S = small piler; L = larger (wider) piler. Total drop about 43 inches with 5.5 inch diameter truck roller.



Damage levels in either machine could be reduced by eliminating the stinger and its drop all together (Fig. 9). If space is needed for hand picking of vines and rocks, then the stinger can be made part of the elevator (Fig. 10) and the drop is still eliminated.

If neither of the above solutions is feasible, then the drop from stinger to elevator can be reduced by dropping the stinger down into the elevator bowl (Fig. 11). Note that the three solutions eliminate the ability of the stinger to swing sideways to align with the truck.

A solution to that problem is to tie a rope to the middle of the piler that can extend out sideways half the width of the truck. Put a white stick at the outer end of the rope and use it as a sight for the truck driver so that he can align his truck accurately with the piler.

Figure 9. Elimination of stinger. Total drop 26 to 28 inches.

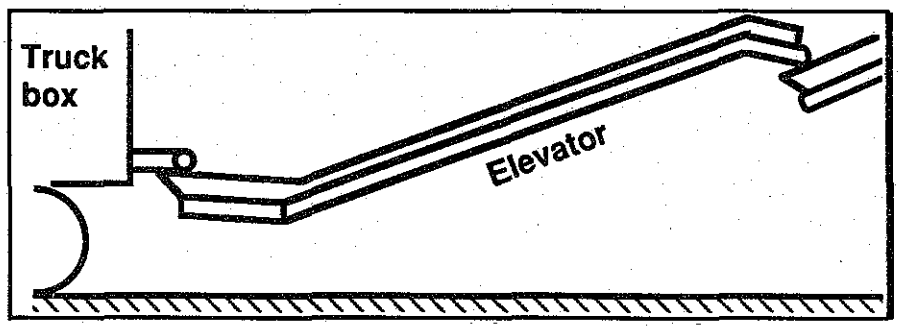


Figure 10. Incorporation of stinger into piler. Total drop 26 to 28 inches.

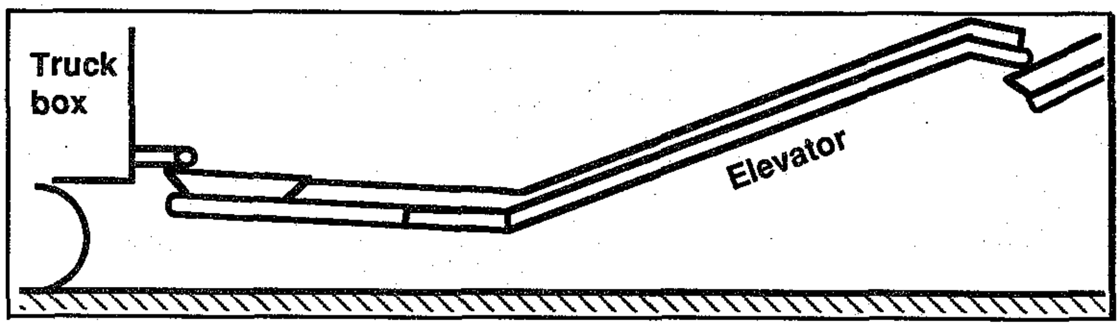
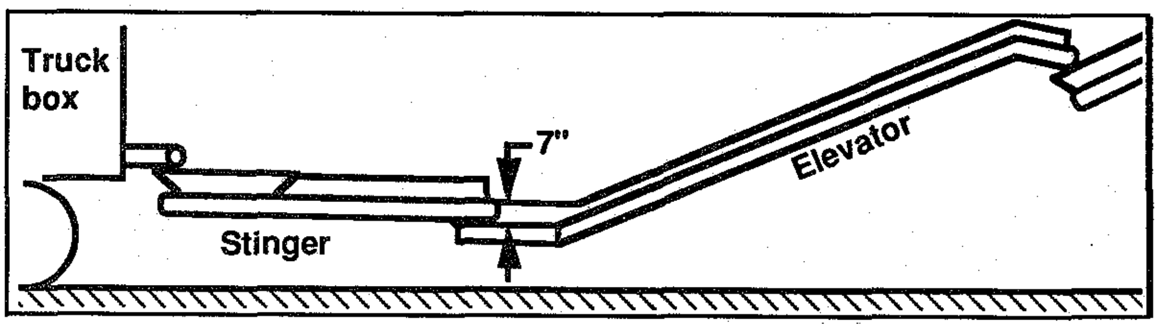


Figure 11. Lowering of stinger into piler bowl. Total drop 33 to 35 inches.



Where We Go From Here

Instrumented sphere + video

A new device called an instrumented sphere (I.S.) is on hand. The device is a $3\frac{1}{2}$ inch diameter ball that contains impact sensors, a rechargeable battery, a clock, a memory and some computer electronics. The I.S. is sealed and can go with the potatoes through handling equipment including washers. It records all of the impacts it experiences above a certain settable level, and so can for the first time give us an objective measure of the impact potential of a potato handling system.

We can run the I.S. through a particular drop, sizer, or other device and determine the magnitude of the impacts that occur. Coupled with a video camera with a stop-watch function and a high speed shutter, we can watch the kind of motion that caused the impact.

The I.S. can also be used to evaluate cushioning materials in handling systems, and even possibly to predict the value of adding cushioning and what type might work best. The overall objective of this research is, of course, to help produce bruise-free potatoes for the consumer and to do it efficiently. The instrumented sphere will help in improving current handling equipment, in the design of new equipment, and in telling how best to operate the equipment. It will give us actual numbers to tell the effect of tuber load level on reducing impacts on conveyors and at drops.