OVERHEAD POTATO STORAGE FILLING SYSTEM & LOW DAMAGE HARVESTER

by

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Ever since 1968 when I returned to Idaho to work on potato mechanization to reduce damage, I felt there should be a better way to haul potatoes than the hopper bottom trucks. I had suggested working on some other type of handling system to several growers, but most said they already had too much invested in present equipment to consider some other method.

In the fall of 1974, Leland Clinger, American Falls, mentioned to me he wanted to start growing potatoes the next year and sought my advice as to equipment. In following conversations, my desire to try a new type of handling system was discussed if a grower could be found to cooperate who did not have much invested in potato equipment. Mr. Clinger indicated his willingness to cooperate if I would design the equipment for him. When I was unable to secure the necessary industry support to design and evaluate the system as an integral part of my research work, I secured a leave-of-absence without pay from the University of Idaho. The development of this system was accomplished as a private effort between Mr. Leland Clinger and myself. An application for a patent on the system has been filed.

The following list of potential advantages and disadvantages were determined to be of importance when considering this system.

Advantages:

1. Less bruise damage. Estimated to be 3-5% less than present system.
2. Fast handling. Design capacity 6000#/min.
3. Relatively low cost. About 2/3 the cost of the super piler and ground level conveying system of the same capacity.
4. Better cleaning. Better environment for trash picking crew. Handling from unloading apron to pivot belt to be on chain with high frequency agitation. Anti-roll belt will be used on incline conveyor.
5. Tare to be kept outside and loaded into dump truck for disposal.
6. Storage closed during filling to facilitate and maintain proper environment.
7. Air distribution pipes can be placed in storage when convenient.
8. Storage filled to a uniform depth.
9. End dump truck beds could be used. This bed could then be used for all forms of jobs i.e. flat bed, beets, potatoes, grain, cattle. Beet type beds are about 3/4 the cost of the combination or swinging tailgate potato beds.
10. System would accept either dump or belt bottom trucks.
11. System would require 2 or 3 men to operate.
12. Dump bed trucks to be used would require no boards. This would decrease lost truck time in the field and prevent trouble from forgetting the boards.
13. Unloading speed could be varied to match conditions.
14. Little or no cleanup would be required. Unloading would never be held up for cleaning.
15. Loaded trucks would not enter storage. This would reduce possibility of damage to trucks or structure driving in and out.

Disadvantages:

1. One large high capacity system used. Everything stops if breakdown occurs.
2. Cannot be moved to fill another building. In most cases this would not be a disadvantage as the harvest is over when the storage is full.

3. A piler would be required to start the pile. This could be a small piler and a small amount of potatoes would be required.

A sketch of the system is shown in Figure 1. End dump beet trucks are used. Some simple modifications were made on the beet beds. A 15 inch high hinged door was built in the drivers side of the bed. A sloping chute was added to the rear of the truck to keep the potatoes from rolling back under the bed as they were dumped. Chains were added to keep the tailgate from swinging out too far as the potatoes were dumped. Belting was added inside the tailgate to keep the potatoes from hitting the grain chute and the edge of the tailgate.

The truck is backed up a ramp so the truck bed overhangs the unloading apron which is 8'6" wide to accommodate the full truck width. The apron is raised to the "up" position and with the chains in place restricting the tailgate opening to about 12 inches, the tailgate is released. The first few potatoes fall about 14 inches to the unloading apron chain. As the truck is raised to unload, the apron is lowered. Each apron is equipped with a safety relief valve enabling it to lower from truck pressure before damage to the apron occurs. The potatoes feed out onto the apron about 12 to 14 inches deep without any additional dropping. The apron speed can be regulated to feed the potatoes at any desired rate.

The potatoes fall from the apron to a 33 inch wide covered conveyor chain. Rollers that carry this chain impart a high frequency vibration to the chain sifting loose soil. The potatoes are carried on this chain passing by a picking station, then up an incline to the top of the storage facility. An anti-roll belt is used on the incline to eliminate the necessity of flights.

The incline conveyor chain delivers the potatoes to a short pivot belt that can deliver them to either of two belts that travel the length of the storage facility. The belts are on either side and supported by the center air plenum. A rotating brush shear sweeps the potatoes from the long belt onto the cross conveyor which is sloped in such a manner that potatoes roll to the edge and fall from it unless the potato pile is above the edge of the belt; then the potatoes stay on the belt until they can fall off. The pile is built the entire width of the storage facility so no potato ever falls further than 6-10 inches.

The excess soil is collected on tare belts beneath the unloading aprons and conveyor chain and delivered to the tare truck.

The handling system was highly successful. The entire crop of potatoes was harvested and placed into the storage facility using this system. Data were not taken to make a complete evaluation of the system. However, we were able to come to some conclusions with regards to the potential advantages and disadvantages.

Advantages:

1. Less bruise damage.
   a) No data was taken to determine bruising.

2. Fast handling.
   a) Unloading rate for one load was observed to be 4000#/min. Average unloading rate for an hour 3000#/min. Maximum average rate for all day 2100#/min. The design rate of 6000#/min could be reached with clean potatoes with a very minor modification.

3. Relatively low cost.
   a) Very little difference in cost from other systems of the same capacity.

4. Better cleaning.
   a) Potatoes were placed into the storage facility very clean despite the excessive tare brought in the loads. The travel on the chains removed all the loose soil.

5. Tare was kept outside.
   a) Only about 1000# of tare dirt was removed from the storage facility during filling with the system. Tare from chain conveyors and picking station was loaded automatically into dump truck.

6. Storage was closed during filling.
   a) The humidifiers and fans were run whenever the outside air temperature was favorable for cooling. Building was kept closed at all times.

7. Air distribution pipes were placed in storage when convenient.
   a) The air pipes were installed by the crew whenever time was available without stopping the filling system. The pipes were staked in place with digger links and the links removed as the potatoes covered the pipes.

8. Storage filled to a uniform depth.
   a) It was possible to get a uniform depth and an even pile top without moving any by hand.

9. End dump truck beds were used.
   a) The beet type beds worked very well. No difficulty was experienced in getting the potatoes out of the bed. The cost of modification of the beds was about $200/truck. Trucks can still be used for all usual jobs without further modifications.

10. System will accept either dump or belt bottom trucks.
    a) No belt bottom trucks were used but no difficulty using them would be experienced.

11. System did require 3 men to operate.
    a) Three men were required to operate the system plus the trash picking crew. Minor modifications could reduce the required number to two.

12. Dump bed trucks used required no boards.
    a) Turn around time in the field was reduced as no boards were required.

13. Unloading speed could be varied to match conditions.
    a) Flow of potatoes past the trash picking crew was varied to match their capability to remove the trash.

14. Little or no cleanup would be required.
    a) All the required cleanup was done by the unloading crew when they waited for trucks. Some work is still necessary on the system to further reduce cleanup time.

15. Loaded trucks did not enter storage.
    a) No collision damage occurred at the storage.

Disadvantages:

1. One large high capacity system used.
   a) Down time was less than anticipated.

2. Cannot be moved to fill another building.
   a) System should be matched to the size of storage facility and digging rate so the need to move would not be necessary.

3. A piler was required to start the pile.
   a) A method to start the pile with the system has been devised.

Because of the reduced turn around time at the storage facility and in the field and because only one truck unloaded at a time, two less trucks were required than anticipated. One truck could deliver more potatoes than the trash picking crews could handle. Trash picking crew is the limiting factor on the capacity of the system. The field digging units consisted of two windrowers and two harvesters.

Beet harvesting commenced at the same time potatoes were to be harvested; and using only the trucks not necessary for potato harvest, 450 acres of beets were dug. Extra trucks were available for beets when the vines were tough, a potato harvester broke down, or when digging conditions were not suitable for potatoes. On more than one occasion, alternate loads were beets, then potatoes.

Low Damage Potato Harvester

An additional years testing has been completed on the low damage potato harvester. The harvester was compared to four different standard harvesters. Samples taken show the harvester can reduce potato damage (Table 1). Samples taken to determine the extent each innovation was responsible for the reduction in damage (Table 2) were inconclusive even though there were a large number of samples. Data reveals more potatoes were bruised on the vibrating blade to the primary head shaft than was bruised on the standard machine to the same point. This difference appears to be significant. The vibrating blade design was changed before the 1974 harvest to a full width blade. Since 1974, the reduction in damage by the vibrating blade equipped harvester compared to a standard harvester has been less than found previously. The change in the blade design and the harvester set up during the test could account for the lower bruise reduction the past two years. The full width blade is pivoted in the center. The stroke length was set to give the blade the same stroke at the center of each row as previously designed. The stroke length at the outside of the blade is 50% longer than the previous design. The longer movement could afford a better opportunity for the potatoes to be injured by the blade at the transfer to the primary chain. Three cornered shakers were installed in the primary in the 1974 design as difficulty was experienced on one growers field removing the soil. The shakers were left in the remainder of the harvest and all of the 1975 tests even though much of the time they were not necessary because the vibrating blade removed most of the soil.

Two harvesters and two windrowers with vibrating blades were built to dig Clinger's potatoes. The design was essentially a copy of the low damage harvester built at the Research Center. No comparative bruise data was taken so their effect on bruising cannot be made. The machines did dig 585 acres with no more than the normal down time after the initial start up. One eccentric bearing and one main bushing was replaced on one vibrating blade other than the usual expected replacements due to wear.

CONCLUSIONS

The overhead handling system worked extremely well in handling potatoes. The system met or exceeded most of our expectations. Some of the more significant advantages are: (1) Large capacity, (2) Tare outside, (3) Air pipes installed any time, (4) End dump trucks are used, (5) Unloading rate can be varied to match conditions. This system makes it more economical for a grower to raise both beets and potatoes.

The low damage harvester with the vibrating blade can do the job in an actual harvest.

Table 1. Results of 1975 total bruise comparison of the low damage harvester. Average Percent Bruised

Grower	A	B	C	D
Low Damage Harvester	16.6	10.1	20.5	37.4
Conventional Harvester	24.7	17.1	19.5	47.4
Percent Low Damage is of Conventional Harvester	67	59	105	79

Grower A, B & C were russets direct harvest.
Grower D was Kennebec using a windrower

Table 2. Effect of innovations on damage. Average percent change of bruised potatoes from point to point.

	Low Damage Harvester	Conventional Harvester	Difference
Ground to primary	22.13	18.30	- 3.83
Primary to top secondary	2.15	2.77	+ .62
Secondary to rear cross	2.94	3.90	+ .96
Rear cross to side bottom	4.83	1.98	- 2.85
Side bottom to clod rolls	- .73	.71	+ 1.44
Clod rolls to boom chain	2.98	7.31	+ 4.33

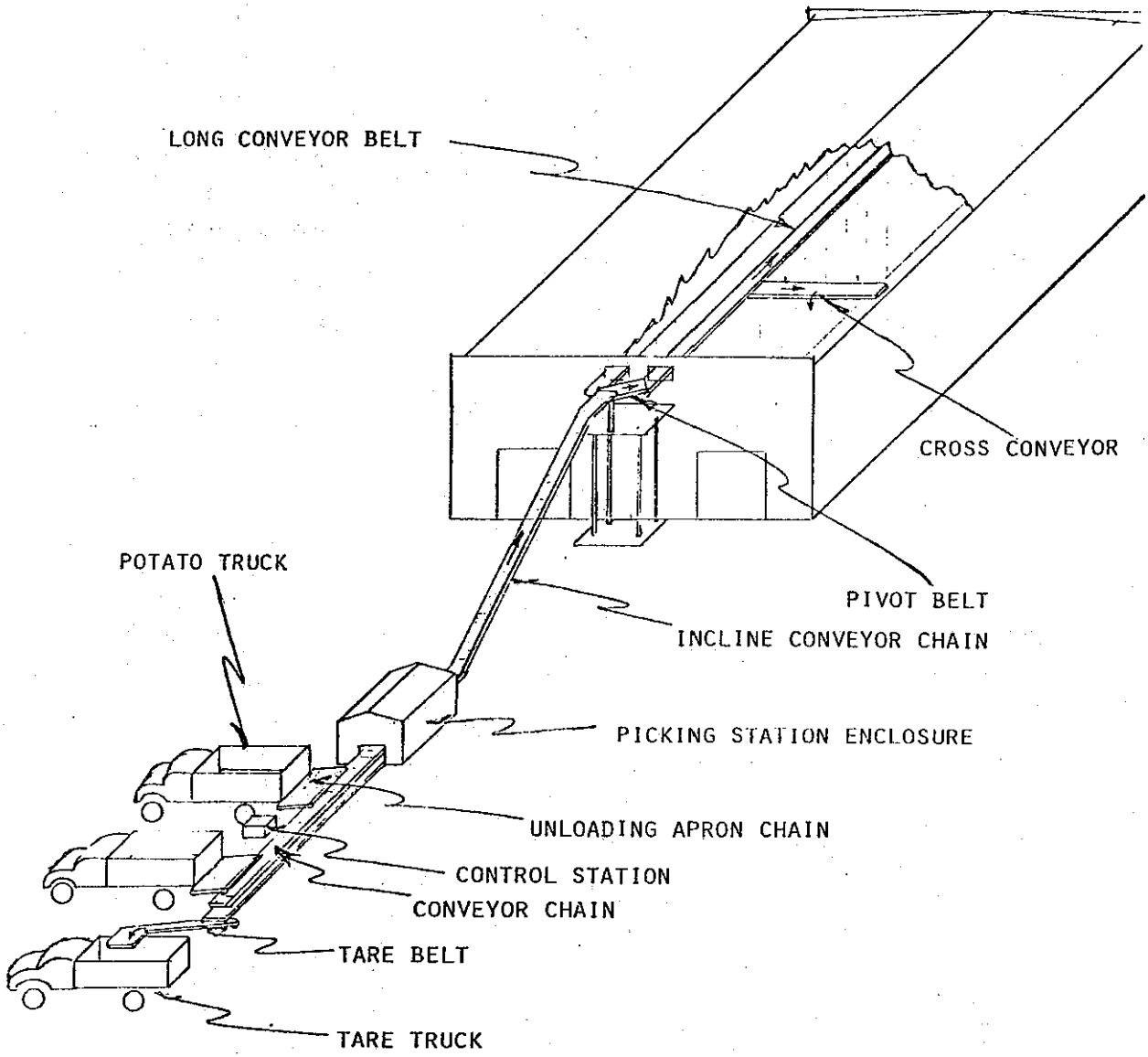

FIGURE 1. OVERHEAD POTATO STORAGE FILLING SYSTEM