

POTATO HARVESTING, HANDLING AND STORAGE

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This paper is not a research report. Its purpose is to acquaint those of you who are not intimately associated with this work with changes that have taken place in the handling of the potato crop and the many problems still to be solved.

As do other branches of agriculture, the potato industry faces special problems in the fields of cost of production, quality control and merchandising. It is believed that further mechanization of potato harvesting and handling if combined with the provision of properly designed storage can assist in solving many of the problems now faced by the industry.

It is a large field and it can not be expected that all details will be covered in the time that has been allotted.

Harvesting

In considering harvesting operations all related factors must be taken into consideration. In the past the potato harvesting operation has consisted of lifting with a potato digger, hand picking into baskets, emptying baskets into barrels or bags, loading barrels or bags onto trucks or wagons, transporting to storage and placing into storage by dumping the field containers.

In an operation designed to harvest 1000 barrels per day the following labor force would be required:

- 1 Tractor Driver—operating digger.
- 15-20 Pickers.
- 1 Truck Driver.
- 1 Loader for a total labor force of approximately 20 persons.

Such a sizable labor force presents special problems—not only in securing the necessary personnel but also in its supervision.

A machine that would reduce the harvesting crew from 15 or 20 persons to 4 or 5 would result not only in a saving in labor costs and at the same time reduce the human element that frequently causes so much injury.

Potato Harvester Development

Idaho potato growers pioneered in the field of harvester development and bulk handling and by 1951 approximately 70% of the potato crop was harvested mechanically.

At the same time farmers in the Red River Valley were carrying on a development program and it is significant that the development of the

potato harvester brought many new names into the farm machinery industry.

Basically all modern harvesters operate on the same principles. They consist of an elongated digger bed, a sorting area and a bulk loading elevator. Most of the machines new on the market depend almost entirely on hand removal of tops, clods and stones. The size of the crew necessary to carry out this operation is largely dependent upon soil conditions in the field where the machine is used but varies from 2 to 8 persons. Various vine separation devices have been used including chains with open mesh that allowed the tubers to fall through while the vines were carried over or counter rotating rollers that pulled the vines down through. Stone removal devices have consisted of inclined belts that allowed the round and lighter tubers to roll to one side while the heavier stones stayed where deposited. These have been only moderately successful and in stony land large crews were still necessary.

As late as 1954 farmers in the potato growing areas of Maine and New Brunswick were still saying that the harvester had not been built that could be used in their area. Forced by labor shortages they started to buy machines in 1955 and by the fall of 1956 over 50 machines were being used in Aroostook County in Maine. Practically all of the major manufactures were represented with Dalhman, Bean and Lockwood machines predominating.

In 1957 the number of machines in use declined slightly. Overenthusiased by the way potatoes came out of the ground, many users had operated their machines at too high a speed and their entire crop was suitable only for starch production.

One solution to the problem of stone removal is being tried by many Maine and New Brunswick farmers. It is a concentrated stone removal program using a mechanical stone picker. The machines most in favor are being manufactured in the area.

Progress to date clearly indicates that harvester development has reached a point where rapid progress is possible. The entrance of one or more of the full line machinery companies into this field is anticipated. A proto-

type of one machine was observed under test in 1958 and appeared to have a refinement of engineering design that was lacking in most other machines.

Potato Handling

With harvesters beginning to take over it is apparent that some form of bulk handling will follow rapidly with the gradual elimination of the bag and barrel as field containers. There are apparently two methods finding popular acceptance.

The first of these consists of loading the potatoes directly into large bulk handling trucks equipped with unloading conveyors. There are only slight differences between the different makes. All consist of a hopper shaped box with a drapper chain or belt conveyor running between the sills. The potatoes are supported above this conveyor by slats that telescope so that potatoes may be deposited on the conveyor at a uniform rate. The boxes work very well and the transfer from the harvester to the box to the bin loader can be achieved with a minimum of injury.

The second method consists of using pallet boxes which hold approximately 12 barrels. Three of these boxes are placed on a flat bed truck and taken to the field where they are filled by the harvester. At the storage they are stacked using a fork lift truck. This method has many advantages. Since they eliminate movement of the individual tubers at the storage it is possible to eliminate up to one-third of the chances for mechanical injury. In the storage they separate the potatoes into individual lots surrounded by air spaces and in most cases the provision of special air circulation fans and ducts can be eliminated. The separation also prevents heating and the spread of rot where potatoes are placed in storage in poor condition.

Cost appears to be the one deterrent to the wide acceptance of this type of handling. The boxes must be strong and a cost of \$1.00 per barrel of capacity appears to be a minimum. A good fork lift truck will cost \$3000-\$4000 and a storage using clear span trusses is necessary for maximum efficiency. It is extremely unlikely that the method will be adopted by the smaller growers of under 50 acres.

The continued use of the barrel as a field container is anticipated by authorities in Maine. Some changes in storage design have been recommended in order to facilitate handling. A storage incorporating these recommendations was constructed at Florenceville, N. B. two years ago and has been found to be most efficient.

Potato Storage Design

Future potato storage design will be influenced by the harvesting and handling method that is adopted. It is anticipated that the multiple floor track side storage will be replaced by single storey warehouse type building. It would appear that construction of new on the farm potato storages will decline. This trend will be accelerated by improved trucking facilities, the desire to make regular shipments throughout the winter months when below freezing weather makes transportation of potatoes in unheated trucks risky and more rigid requirements as to grading facilities.

Potato storage design becomes more complicated as the size increases. At the present time most trackside storages in New Brunswick and Maine are of multiple storey design with potatoes being stored in the basement and one or more above grade floors. This requires the use of hoists and the barrels frequently have to be rolled a considerable distance before dumping into bins. A similar time and labor consuming operation is necessary when potatoes are removed from storage. The newly designed Maine barrel storage provides for gravity movement with potatoes being moved only a short distance horizontally.

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board but the engineering drawing is the means of communication between the design engineers and the production department which must fabricate the desired item. The ability to create designs on the drafting board and to interpret drawings made by others is essential for the design engineer. I know of nothing more satisfying than to see a product develop before ones very eyes and the remuneration should, and I believe will, be as rewarding to the competent as any other field of engineering.

A general knowledge of agriculture and of farming operations is of great benefit to the designer of farm machinery. A graduate agricultural

We are presently promoting single storey above ground trackside storages with potatoes being placed in bins with a bin loader or piler. The first storage of this type was constructed in 1957 and two more will be constructed during the summer. They offer storage facilities at a cost of approximately \$1.00 per barrel of capacity and since potatoes are conveyed rather than dropped into storage, mechanical injury is greatly reduced.

Potato Storage Ventilation

There is a considerable lack of sound basic information on potato storage ventilation. It is true that authorities generally agree that temperatures of 38° F. and relative humidities of 85% are the most suitable for the storage of table potatoes. There is, however, considerable disagreement as to air movement within the storage and through the stacked potatoes. These recommendations vary all the way from shell circulation with no movement through the potatoes to movement of 1 c.f.m. per 50 lbs. of potatoes through the pile. There seems to be some evidence that under certain conditions it will be necessary to vary air flows. As far as I have been able to ascertain the only research work on this problem was instituted at the Aroostook Farm, of the Maine Experimental Station two years ago when a system was installed that provided a means of controlling air delivery to different bins within the storage. Definite results are not yet available but their first year's work showed that shrinkage was at a minimum at no air flow and at high air flows—3-4 c.f.m. per barrel with medium air flows of 1 to 2 c.f.m. resulting in the highest shrinkage.

engineer obtains a good grounding in the agricultural sciences in school and in many cases has been raised on a farm. A survey of the Product Engineering Departments in eight Deere & Company plants in 1955 showed that 62% of these engineers were either raised on farms or had farming experience before entering their present engineering activities.

There are, of course, other possibilities for agricultural engineers in the farm machinery industry. My remarks so far have chiefly covered the research and product engineer in our Industry, since most of our agricultural engineers are in that type of work, but there are other important and rewarding opportunities.

For those engineers who are interested in factory production ope-

This information is absolutely essential if we are to design potato storage ventilation systems.

We have had a modulating type recirculation system in use for the past three years. Air is discharged into underfloor ducts with slatted covers at the rate of 1/2 c.f.m. per barrel. This storage is used for storing seed and excellent results have been obtained. The controls are set to hold a temperature of 38° F. and it is able to do this so that over a six weeks period in the winter of 1956-57 when outside temperature varied from -15° to +50°, inside temperature varied less than the 2° calibrations on the recording thermometer. Relative humidities varied between 80 and 85 percent.

The development of new uses for potatoes particularly by the chip and quick frozen french fries industries have presented new storage problems. Ideal temperatures for the storage of potatoes for these purposes appear to be 50° or higher. Work done by the frozen food industries appear to indicate that at these high temperatures best results are obtained with humidities kept as low as possible preferably 50%-60%. With constant temperatures and low humidities dormancy has been maintained until April. The use of sprout inhibitors is becoming common for this type of storage.

The design of storage presents many problems for the Agricultural Engineer. Provided with the necessary basic information new designs will emerge that combine long life and efficiency.

rations, there are many opportunities where their training can be put to good use.

Another opportunity which is almost wide-open and for which agricultural engineering training is extremely valuable is that of sales work. As farming operations get larger, more competitive and more complex, the technical training of a salesman becomes of more value. The Company salesman, farm equipment dealer or retail salesman who has technical information on crops, soils, agricultural chemicals, crop drying, fertilizing and the many other farm practices of today has a great advantage over a less informed sales person.

In summary, I have attempted to indicate the type of work the Agricultural Engineer is doing in our own company. As I said at the beginning, I believe this is rather typical of the entire farm machinery industry. In pointing out the activities of the engineers, the qualifications for this

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