A Survey of Sugar Beet Mechanization

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Historical—1900-1940

Most of the history of the sugar beet crop in this country dates back the last sixty years although there were factories in operation for several decades previously. A great deal has transpired since 1900 in methods of production of sugar beets. In the early years of the century the cost of thinning was only $3.00 per acre, and naturally there wasn't much incentive for mechanized thinning, although we find in the records that many machines had been patented prior to that time for sugar beet harvesting. Commonly beet growers planted 20 to 25 pounds of whole seed per acre in drills which were not too satisfactory except to distribute the seed in the row. The early cultivating equipment, even that used 25 years ago, was mostly cast iron and horse drawn. The tools were not accurate and were generally made by local blacksmiths—in fact, we did not have tractors in beet fields much before 1930 and at that time they were used principally for plowing.

The first field loaders were used about 1939 and beet harvesters on a successful basis came along about the time the war started. Processed beet seed started at about the same time. Researchers experimented considerably with fungicidal treatment of seed before the war but it was not commonly used to protect the young seedling against seedling diseases. We did very little about weed control except to leave it to hand labor. Mechanical thinning was done as early as 1919 by Hans Mendolsohn and others by using th common harrow, but it was not successfully applied commercially. The first mechanically thinned beets which were carried through to harvest were, to my knowledge, in an experiment about 15 years ago in Colorado, where the Uddenborg blocker was used quite successfully on whole seed planting, with a reduction in yield of only about one ton even though no hand thinning was done in the experiment. The difficulty at this time was in getting hand labor to top multiple beets. All of these things lead up to our present state of development which we might consider as the period just following the start of World War **II.**

Rapid Mechanical Development—1941 to 1950

It is interesting to make a comparison on the man hours of labor required to produce an acre of beets. Fortunately we have some very good figures on surveys which have been conducted:

Table 1.—Reduction in Labor in Beet Production.

	1924	1949	1955?
Man hours required per acre to produce sugar beets	115	68	40
Average beet yield (Tons)	9.2	14.0	15.0
Man hours required per ton	12.5	4.8	2.7

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You will note that, probably to the surprise of many people in the agricultural departments of beet sugar companies, we have made a very material reduction in the man hours required per acre. If this did **not** include considerable hand labor, the figure for 1949 would be lower. Most of the gains between 1924 and 1949 have been occasioned by the use of tractor methods. The beet yield average for the United States 25 years ago was 9.2 tons on 925,000 acres. There has been a gain in 25 years, through the use of better adapted seed and more timely methods, of nearly five tons to the acre. When this production is translated into man hours per ton of beets you will note that the figures today show that we use only about 40% as much labor in beet fields as we did in 1924. We still are going to make more rapid progress and 1 have compiled some tentative figures for five years hence as a goal, which may prove to be too conservative.

Only in the last five years have we made rapid machine development in the harvest. In 1945 we harvested about 7% of the acreage of the United Stats mechanically. In 1949 this reached almost 52% which is very well explained in the listing of the United States beet growing areas in Table 2, divided according to areas in which production methods are similar:

Table 2.—Proportion of Sugar Beet Production by Machine Methods

Area	States Included	Harvest		Spring	
		1946	1949	1946	1949
1	California	58.8	72.6	2.57	1.33
2	Washington Oregon Idaho Utah Arizona Nevada Western Montana Western Colorado	4.19	63.1	2.78	19.78
3	Montana Wyoming Nebraska Colorado New Mexico Western North Dakota Western South Dakota Kansas Texas	10.14	48.69	2.07	32.03
4	Eastern North Dakota Minnesota Iowa	.97	38.9	61.74	58.3
5	Wisconsin Illinois Indiana Michigan Ohio	4.42	35.58	....	.....
	U. S. Machine Methods: Harvest Spring[1]		1946 16.85% 7.71%		1949 51.89% 29.81%

[1] Area 5 not included.

It must be understood that we are now employing almost entirely processed seed, that is, decorticated, segmented or otherwise processed to break down the whole seed, and also are employing mechanical and chemical weedings and other methods to assist in reduction of labor, so you can see readily the progress which has been made in a very short period. More than 100,000 acres in the western part of the United States in 1949 had some form of spring mechanization. This is reaching important proportions in some areas and we can understand readily the reduction in labor caused by these practices.

A study made in 1949 shows a saving of 42.72% in the hours of labor in those beets mechanically harvested. It shows a saving of 35% in man hours of labor for mechanical thinning tools used which represents, in our opinion, a very excellent progress to date, even though we must recognize that mechanical harvesting is still not too efficiently done, the by-products are not too well conserved and the beets are not of as high a quality as we would like to have for processing due to trash and improper topping. However, we now put beets into the storage pile with mechanical harvesters which are much lower in temperature than the hand-harvested beets and hence they keep much better in storage.

The mechanical thinning practice on 1949's 100,000 acres is far from perfect, but the development of machines and techniques required is coming along very nicely even though it is in the "Model T" stage. Spring mechanization naturally will reach greater perfection as soon as farmers have had opportunity to experiment and gain confidence. This has proven true with mechanical harvesters and already in the four or five years of our mechanical harvesting experience we have gained considerably in the modification and improvement on harvester machines. You might be interested in some comparisons compiled from many experiments and studies on the subject of time studies in spring mechanization. This is shown in Table 3 in which hand blocking and thinning whole seed is used as a check or standard.

Table 3.—Labor Requirements for Different Spring Procedures.

Hand blocking and thinning whole seed (timely)	100.00%
Hand blocking and thinning processed seed	80.00%
Long Handle hoe thinning	70.00%
Thinning after mechanical blocking	60.00%
Weeding after mechanical thinning	50.00%

You will note what processed seed has given us in the way of saving and, in many cases, this has been greater than that shown in these "rounded figures." With improvements in general farming methods the mechanical blocking and hand work can be entirely eliminated, in our opinion, in a few years time if strict attention is paid to a program for complete mechanization.

I remember a test conducted in 1949 at Colorado A & M College comparing a number of mechanically handled plots with whole seed. The whole seed was planted at the rate of 24 pounds per acre and the processed seed at 10 seeds per foot. It is interesting to compare the saving in time between

the best mechanically handled plots and the whole seed when thinned at a timely size. In fact, only 18% of the labor was required on the best mechanically handled plots as compared with the check. The yield was practically identical although there was a reduction of more than six tons per acre when the thinning time of the whole seed plots was delayed 10 days. This is a point which many of us overlook—even the last five years has made a difference in our memories in this respect. Processed seed has a much better possibility for good tonnage even though it might be thinned slightly on the large size. We have made large acreage gains in the use of processed seed commercially to eliminate this decrease in tonnage. With the use of mechanical methods a further competition is reduced to a minimum and when the work is done at the proper time it would appear reasonable that increases in yields will result.

A Program for Mechanization—1950-1955

Any survey of mechanization in the United States would not be complete without setting down a definite program for development of improved machine use in the next few years. I have chosen to list in some 11 or 12 different items, for the sake of brevity, some of the important features of such a Program:

1. Rotation. Rotation, or crop sequence, is very important to fulfillment of our aims in complete mechanization. This comes about through weed control in the preceding crop, not the crop of beets.

2. Weed Control Chemicals in Grain, Corn and Other Crops Ahead of Beets. The use of 2,4-D and Dinitros and other forms of weed chemicals to kill weeds in growing crops has become quite a popular practice and should be taken advantage of in our cropping system. Strict attention should also be given to fence rows, ditches and waste areas which might mature seeds and infest cultivated fields. We have all seen evidences of such good farming practices and how well they reflect in better yields and lower cost of producing the crop. Prepare seed beds early in areas where weeds germinate before normal beet planting. Use pre-emergence sprays at planting time in these locations.

3. **Weed Control Districts. In** a great many states laws provide for the setting up of weed control areas by townships or counties, where the county and state set about to take care of not only obnoxious weeds but also weeds along highways, drainage ditches and other public properties which might infest farmers' fields. These can also be extended in some states to weed removal on privately owned farms where the farmer has not handled his farm cleanly.

4. **Fall Plowing and Fallowing.** We all know the advantages of fall plowing in improving soil structure, water holding capacity and improvement, of course, in germination of seed as well as weed control. The practice of summer fallowing after spring plowing of such crops as sweet clover or alfalfa is a growing one because it not only improves the tilth but controls the weeds very effectively. These methods, of course, cannot be followed on light or blowy soils.

5. Seed Bed Preparation. We should not omit in our mechanical suggestions the proper preparation of seed beds. A light harrowing just ahead

of planting might well eliminate a weed problem. More thorough packing of the soil might improve the chances of getting a good stand in some soils. The use of ridge cover planting might be called an item under seed bed preparation in that we are preparing the soil for the seed in order to raise the moisture and hold it around the seed and, when the ridge is removed, weeds are eliminated. This has been practiced very successfully on thousands of acres.

6. Seed. Processed seed, we feel, should be used solely and that is more or less what has happened in the last few years. Ten to twelve seeds per foot, and not less, should be planted, except on very good soil conditions where chances of getting weeds are small. The relation of the size of the seed to cell size of the plate is very important in order to get an improvement in drill efficiency and distribution of seed. The seed should be treated with fungicide and also with other chemicals where certain types of insect damage can be prevented.

7. Use Precision Drills. There are several drills which we would class as precision even though they might yet have some weaknesses which will be overcome in future development. Flute feed, internal feed drills and others of this type should not be used as their bunchy characteristic does not lead to a seed pattern which gives us a minimum of multiple plant hills. Speed of drills is important and we have found that it has a relation to the depth of the seed as well as to the distribution of the seed. Planting too rapidly makes for an erratic seed pattern and also some of the seed bouncing in the furrow to the extent that it is not covered as deeply. Use new, unworn seed plates in order to get maximum cell fill and good seed pattern. Use plates which are fitted to the size of seed to avoid erratic results. The new type drilling devices which compact the soil under the seed and leave a mulch of soil over the seed have shown a great improvement in emergence and lessening of crust danger. We feel that this type of planting is going to grow in favor because of its generally great improvement in emergence over the old type shoe runner disc opener with concave press wheel type of drill. Experiments are going on further on a larger basis to prove the adaptation of the furrow former wheel to be used in place of present furrow openers.

8. Mechanical Blocking and Mechanical Thinning. This at the present stage of development is advisable inasmuch as our agronomic practices are not yet at the point where we can safely plant the seed where we want the plants to remain, and for that reason we recommend either mechanical blocking or mechanical thinning. This may be done down-the-row or across-the-row, as the farmer chooses. There is an advantage in the small rotary knives now developed as a modification of some of the down-the-row equipment in that it is possible to leave, say, three small blocks an inch in size instead of one block three inches in size. This permits more rapid long handled hoe trimming by beet labor and if a machine is used two or three times in stands which are sufficient, the hand labor might be completely elirainated because of the increased number of singles following such a

procedure. There is very good evidence that this system will grow in popularity. It is well to note that it was tried 15 or 20 years ago with very good success as a down-the-row blocker but not, of course, adapted to across-the-row blocking on all soils inasmuch as it is not possible to make the narrow blocks which you get with the rotating knives. There are some new tools which have been developed for down-the-row blocking that are simple and give very good chances for commercial success.

There are probably three things which have caused a failure on mechanical blocking and thinning—these must be avoided if successful spring mechanization is going to take place: (1) Farmers waiting to block beets as a last resort. I have been called out a number of times by farmers who expressed a desire for mechanizing the spring work to look over their fields and, to my surprise and disgust, find beets a foot in height with weeds even taller. Too often farmers have little conception as to the proper time to employ machines. In spite of this, we have word from many individual growers who used machine blocking in 1949 to save their crops. They were satisfied with the result apparently, but how much better it would have been if they had planned their spring mechanization in advance. (2) Using machine blocking when stands are insufficient. We have had a rather embarrassing start in some places by attempting to use mechanical blocking when we had only 10 or 15 plants per 100 inches of row. In order to achieve equal tonnages with hand blocking and thinning it is necessary to have at least 25 plants per 100 inches, and we should think in terms of possibly 40 plants per 100 inches in order to achieve equal success with the yields from hand blocking. This goes back to a repetition on the recommendation of heavier seeding rates. (3) Letting weeds get ahead of beets. This quite often happens through no neglect of the farmer but through rainy weather or extremely dry conditions when the beets have not come up and weeds have gotten ahead. In some of these cases, we would advise, if not too late, the reworking of the ground and replanting of the beets. This should not be allowed to happen and will not take place if good weed control, crop sequence, fall plowing and fall irrigation are possible. Weeds, in the small stage of growth, can then be eliminated by using spring-tined weeders.

9. Mechanical and Chemical Weed Control. At the present time we do not have any selective weed chemical control which we could advise farmers to use generally. Some farmers could quite successfully use salt sprays employing saturated solutions (say 200 pounds per acre) , but in many other soil areas this cannot be recommended. The experimental use of 160 pounds of polybor looked optimistic in the University of Manitoba weed experiment last year and may have some promise for commercial adaptation as a selective weed killer.

Spring-tined weeders are our best means, at the present time, of eliminating weeds. These can include both the rotary weeders which go down the row as well as the stationary tined weeders, such as the finger or pencil weeder, which can go at an angle to the row. There are many quite successfully used weeders of this type which are highly effective when the weeds are small. We find some danger of using them in dry weather con-

ditions and in conditions when the beets are too small, where the tines may cause a covering of the beets in the initial stage. We would suggest, for safety sake, that they not be used until the beets have at least two true leaves and better at the four leaf stage. A new adaptation of the spring-tined weeder on the rotary principle was used at Fort Collins last year which has a half inch knife on the tip end of the fingers. This worked out very satisfactorily for removing weeds and was quite useful even in beets of the cotyledonous stage.

10. Cultivation. More attention needs to be paid to proper cultivating. Farmers can no longer consider that they have fulfilled their job when they leave a 10-inch space, five inches on each side of the row, to be cleaned out by hand labor. They are going to have to think of a very narrow cut and also the use of knives placed in reverse from the present procedure which will tend to push some soil over against the plant. The use of knife-edged bull tongues in early cultivations as well as deer tongues and shovels for later cultivations where the soil is moved over slightly against the plant to cover the small weeds growing immediately in the row seems to give good control. The "Culti-Cover" tools act like a road grader, scrape away from the row with the first blade and push moist soil up against the beets with a second blade for covering weeds. There are also some rotary discs which are being tried for a similar type of work. These ideas can very successfully be used to eliminate hand weeding after thinning and cultivations should go along as long as possible during the season. For that reason we suggest that in many areas the row widths be widened to at least 22 inches, sacrificing perhaps some yield and sugar content for the benefit of lowering costs of production. These things will come in spite of us and we might just as well work to that end now, realizing the full benefit of mechanical practices in eliminating hand weedings.

11. Mechanical Harvesting. Mechanical harvesters are now being used on more than half of the beet acreage of the United States, and in many areas this approaches 85% and 90% of the acreage. We will continue to see improvement, particularly along the line of the development of harvesters, for four purposes: (1) To better handle the feed value of the tops and to deliver to the receiving station beets which are free from stringers and trash; (2) The development of a small harvester adapted for growers with less than 20 acres, which at little overhead expense can properly harvest small contracts; (3) The development of three- and four-row self-propelled harvesters which can handle large acreages daily, for use of large growers and custom type operators. This type of machine naturally has been very popular in grain harvests and we can look forward to development of this principle for sugar beets; (4) Improvement of present machines to eliminate totally need for hand sorting, and to enable reduction of power requirements.

Complete Independence o£ Field Labor

In the not too far distant future, we foresee, with the hundreds of research workers devoting time to the development of methods and machines and chemicals, that we will entirely eliminate hand beet labor from the production of sugar beets.

This will mean that we will have a beet drill which can plant in a precision-like way so that the seed, which may be 100% single, or possibly double germ in character, will produce a plant at the interval required under those conditions or giving the stand which normally can be developed. The chemical selective weeds sprays can then be applied after emergence of the plant and at successive intervals later in order to control weed growth before it develops. Spraying equipment which sprays directly on the soil underneath the foliage can well be developed for this use.

Beet harvesters which require no hand sorting of clods or handling of levers are in the offing with which hand labor will be a minimum. This will mean that contracts up to the size of 40 acres can be handled entirely by the farmer and his hired man.

We see evidences pointing to this ultimate production goal at the present time. In 1949, for example, in California a very good experiment was put on by a large grower comparing a precision planting with ordinary planting. The yield was in favor of the beet seed which had been precision-planted every three inches as against a rate of six pounds per acre for the non-precision planter. The yield was better than a ton per acre to the advantage of the beets which had received no thinning. Because of the weed control practice on this farm, the weed problem was not great and no extra charge was made by the labor for the weedings.

This type of thing can be looked forward to on a large scale in the future. We have developed methods in other areas, such as the Red River valley, where only one weeding has been necessary, even with our present knowledge and methods. The addition of chemical weed control to crops preceding beets, better rotation and selective weed killers, can readily give us the prediction that the beet crop of only a few years ahead will be raised entirely without the use of hand labor.

The future farm situation generally is one of ability on the part of farmers to oversupply the market. It is very important in sugar beet producing areas that farmers are acquainted with a half dozen things which they can do:

1. **Raise crops mechanically and** as **cheaply as possible.**
2. Increase acreage of crops **which are not in as great a prospective surplus.**
3. **Produce** as **high yields as possible on every acre.**
4. **Grow crops which fit into** a **livestock program.**
5. **Practice soil improvement through good rotations and use commercial fertilizers for maximum fertility.**
6. **Keep informed about general political and business conditions.**