MICHIGAN STATE COLLEGE SUGAR BEET HARVESTER STUDIES

By: C. M. Hansen[1] and G. W. French[2]

Sugar beet growers in the Eastern Area experienced an unusually dry September-October harvest period with rainfall being the lowest for the past 60 years. Precipitation throughout the beet growing areas for the months of July, August and September was the lowest recorded by the Weather Bureau. This, nevertheless, made conditions very nearly ideal for the lifter-topper type harvester, while the ground-toppers had to contend with a clod problem which in some instances was solved by the use of a picking table.

An appreciable amount of rain began falling throughout the area in the last week of October and fell intermittently during the remainder of the harvest season. During this period harvesters were operated under soil and weather conditions which more nearly approached those of the 1945 season. However, only those harvesters which were operated on heavy clay soils were kept from the field and then, only for a short period of time.

Beets grown in 1946 on mineral soils for the most part developed long tap roots. This made it necessary to readjust harvester lifter points to greater depths, which in turn increased the draw bar requirements. Dry soil conditions caused a greater than normal amount of machine wear, particularly the lifter parts which had to be replaced at relatively short intervals.

HARVESTER STUDIES

Since 1943, Michigan State College and the U. S. Department of Agriculture have cooperated on sugar-beet harvester studies. The results from 1943 through 1945 have been recorded in the Michigan Agricultural Experiment Station Quarterly Bulletins of August, 1945, and May, 1946. The object of the 1946 mechanical harvester study was two-fold: (1) That of conducting performance checks on a number of harvesters, farmer-owned and otherwise, chosen at random; and (2) developing a principle by means of which dirt can be removed from the beet roots prior to their being loaded into an accompanying vehicle, and which might be applicable to any type sugar-beet combine.

- - - - - - - - - -

1. Assistant Professor, Department of Agricultural Engineering, Michigan State College.
2. Assistant Agricultural Engineer, U. S. Department of Agriculture.

Acknowledgment is made of the substantial help given by Herbert Hentschel and the Farmers and Manufacturers Beet Sugar Association, and the various sugar companies of Michigan and Ohio.

PERFORMANCE CHECKS

A total of 21 field tests were run on three different type harvesters. The first type is one which first loosens the beets in the soil by means of a single point lifter blade, after which the beets are carried by means of the leaves to a set of topping discs. In this paper this machine will be referred to as a lifter-topper type. The second type is a tractor-mounted, ground-topper which elevates the beets into an attached trailer. The trailer has an endless belt sorting table, which may or may not be used. This is the only type of ground-topper machine tested. The third type tested is commonly known as the spiked-wheel harvester. Untopped beets are carried by means of spikes located on the periphery of a large wheel to topping chisels.

Method Used To Check Harvesting:

The technique employed in making performance checks was as follows: A 100-foot section of row was marked out in what appeared to be a typical portion of the field and the number of beets in the section was recorded. Several soil moisture samples were taken at a depth of from six to eight inches in the marked section of the row. After the harvester had passed over the 100-foot section of row, the "tops" were gathered, and marketable tissue below the lowest leaf scar was cut from them and weighed. The beets which the machine failed to harvest were also counted and weighed. The tare and screening figures were obtained from the tare men at the factory weighing station. Results shown on Table I.

An attempt was made to obtain similar data on hand harvested beets. The time which often elapsed between lifting, topping and hauling made almost impossible the securing of data which would be comparable to that of mechanical harvesting. It was also impossible to ascertain the number of beets left in the ground or otherwise overlooked by the laborers. These findings are recorded in Table II.

Hand Harvesting Versus Mechanical Harvesting:

As was stated previously in this paper, the data in Table II does not represent in all respects the true picture of hand harvesting. It does, however, present an interesting comparison between the two methods. The average percentage tare figures for mechanical harvesting is 2.28 percent greater than for hand harvesting and there is only 48 pounds of dirt per ton of clean beets difference in favor of the hand methods. These are the only figures which can be used in making a true comparison. Further comparison would necessitate a more reliable method of determining the marketable tissue left in the field when hand methods are employed. In addition you cannot overlook the savings in labor and in beet shrinkage when beets are mechanically harvested. Mechanical harvesting does compare very favorably with hand harvesting if all these factors are considered.

TABLE I. -- RESULTS OF SUGAR BEET HARVESTER PERFORMANCE CHECKS ON FARMER OWNED MACHINES

Fields	Soil Type	Soil moisture content percent	Percentage tare			Total dirt per ton of clean beets (Pounds)	Marketable tissue unharvested per acre				Number of beets per 100 feet of row
			Crown	Dirt	Total		On unharvested beets		On "Tops" Tons	Total Tons	
							Number	Tons			
48	Carlisle Muck	97	4	2	6	256	373	.466	.488	.954	57
50	Miami-Conover	9	1	2	3	191	0	.000	.238	.238	85
42	Miami-Conover	15	3	2	5	154	186	.065	.218	.283	83
43	Brady Loam	13	4	3	7	270	560	.642	.242	.884	54
44	Brady Loam	13	3	3	6	191	62	.062	.704	.766	94
47	Brady Loam	19	3	3	6	239	560	.466	.074	.540	90
35	Conover-Brady	14	5	3	8	157	46	.023	.256	.279	56
38	Conover Loam	7	3	1	4	85	560	.280	.456	.736	76
39	Conover Loam	10	1.5	0.5	2	110	186	.093	.418	.511	87
45	Conover Loam	14	5	2	7	173	560	.280	.725	1.005	91
49	Conover Loam	16	5	1	6	213	186	.149	.261	.410	95
41	Conover Loam	17	2.5	0.5	3	166	373	.186	.101	.287	68

(Continued on next page.)

TABLE I. -- RESULTS OF SUGAR BEET HARVESTER PERFORMANCE CHECKS ON FARMER OWNED MACHINES

Fields	Soil Type	Soil moisture content percent	Percentage tare			Total dirt per ton of clean beets (Pounds)	Marketable tissue unharvested per acre				Number of beets per 100 feet of row
			Crown	Dirt	Total		On unharvested beets		On "Tops" Tons	Total Tons	
							Number	Tons			
32	Selkirk Loam	9	9	2	11	337	186	.096	.336	.432	94
37	Brookston Loam	6	9	3	12	160	745	.372	.056	.428	83
40	*Brookston Loam	9	6	1	7	84	1116	.558	.139	.697	81
46	Brookston Loam	14	3	3	6	276	93	.093	.018	.111	93
33	Brookston Loam	18	6	2	8	207	186	.093	.680	.773	60
36	Brookston Loam	16	2	1	3	155	360	.280	.158	.438	86
34	Brookston Loam	21	5	1	6	253	373	.587	.233	.820	66
53	**Brookston Clay	7	2	1	3	56	186	.102	.018	.120	78
51	**Brookston Clay	26	2	26	28	1605	373	.130	.224	.354	72
52	**Brookston Clay	26	2	16	18	1169	746	.261	.242	.503	68
	Average		3.8	3.5	7.3	296	364	.240	.286	.526	78

*Spiked-wheel harvester.
**Ground topper (disc) harvester.
Remainder of field tests were on lifter-topper type harvester.
Sorting table used in field tests 53 while it was not used in tests 51 and 52.
Field tests 33, 41, 45 and 47 beets were not loaded directly from harvester to vehicle that conveyed them to weighing station.

TABLE II. -- RESULTS OF CHECKS OF HAND-HARVESTED SUGAR BEETS

Fields	Soil Type	Soil moisture content percent	Percentage tare			Total dirt per ton of clean beets (Pounds)	Marketable tissue unharvested per acre				Number of beets per 100 feet of row
			Crown	Dirt	Total		On unharvested beets		On "Tops" Tons	Total Tons	
							Number	Tons			
12	Miami Loam	19	1.0	1.0	2.0	104	0	0.0	.185	.185	82
13	Miami Brady	15	3.0	1.0	4.0	170	0	0.0	.102	.102	85
16	Brady	10	6.0	1.0	7.0	188	0	0.0	.047	.047	107
11	*Conover-Brady	12	1.0	2.0	3.0	193	0	0.0	.0	.0	82
17	Conover-Brady	17	5.5	2.5	8.0	381	745	.745	.018	.763	69
14	Conover-Brady	20	3.0	0.0	3.0	173	0	0.0	.000	.000	89
15	Brookston Loam	20	4.5	2.5	7.0	435	0	0.0	.515	.515	90
18	Brookston Loam	24	3.0	4.0	7.0	432	0	0.0	.047	.047	102
	Average		3.37	1.75	5.12	260	93	.113	.115	.228	89

*Pick-up loader used
Remainder loaded by hand

MICHIGAN STATE COLLEGE HARVESTER BEET CLEANING DEVICE

Wet soil conditions prevalent during the 1945 sugar beet season prompted the Agricultural Engineering Department and the U. S. Department of Agriculture to develop a method of removing more of the dirt from beets before they are loaded onto vehicles which convey them to the weighing station.

Two factors were given consideration in the development of the device: (1) The principle to be employed should be applicable to any harvester; (2) The unit in its final design must be simple in order to keep weight and cost of manufacture at a minimum.

The principle which was finally developed embodied the use of rotating steel brushes and was mounted on a standard lifter-topper type harvester.

Description of Cleaning Device:

The brush set was constructed by mounting circular steel wire brushes 14 inches in diameter on two parallel shafts. The shafts were then mounted in a rigid frame. The lower beet conveyor of the harvester was lengthened and a potato chain was installed to serve as conveyor. This change made room for the brushes which were suspended over the conveyor by four springs so that the frame holding the brushes was free to move vertically within a range of ten inches. The brushes thus had sufficient flexibility to allow beets of all sizes to pass beneath them and yet in the passing removed some of the adhering dirt.

The brushes were operated at a speed of 250 rpm with the direction of rotation such that it accelerated the speed of the beets toward the rear of the harvester.

Method Used to Check Efficiency:

Performance checks were made to determine the amount of dirt delivered to the truck by beets which did not pass under the brushes and by those which were subjected to the unit treatment. Fifty-foot sections of row were marked out and the number of beets in each of the sections were recorded. Soil moisture samples were obtained in a manner similar to the technique used for tables I, II, and IV. All the beets harvested in the marked section of row were caught in a canvass. The dirt was then removed from the beets and weighed. These checks were made in three different fields with soils of the Conover loam series. All tests were made in pairs, one with the brushes in operation and one in which the brush unit was not in operation. (Table III).

Conclusion:

The soil moisture content during the performance checks ranged from 16 to 24 percent. In all the paired tests the difference in the dirt delivered to the truck was positive in favor of the use of the brush unit. A statistical analysis of the results indicate that the average reduction in dirt, 162 pounds per ton of clean beets, is highly significant.

However, with a soil moisture content of 16 percent, the reduction of dirt was only 42 pounds per ton of clean beets, whereas with a soil moisture content of 24 percent, the reduction of dirt was 227 pounds per ton of clean beets.

SOIL MOISTURE CONTENT AND DIRT TARE PLUS SCREENINGS

There is reason to expect that the soil moisture content at harvest time should influence the amount of dirt tare and screenings in any given field. The tabulated data (Table IV) is taken from the field tests on 18 farmer owned lifter-topper type harvesters where the beets were hauled directly to the weighing station. Similar data taken on eleven hand harvested fields.

The relationship between the soil moisture content and dirt in the load could not be shown graphically due to the variables which must be considered. The tests were made on a wide range of soil series and classes which can in themselves vary in this relationship. The field moisture content of soils within a series will fluctuate markedly with the amount of organic matter and the extent of tiling.

Another variable occurs with the wide range of beet sizes. The larger beets, pound for pound, do not carry as much dirt into the load as do the smaller ones.

Add to this the possible lack of uniform techniques in securing the soil moisture and it is not difficult to understand the reasons for the erratic variations which occur in the tables. However, the data does show a definite trend in that if the soil moisture content is increased, the dirt in the load will also be increased.

CONCLUSION

The following conclusion may be drawn from data which has been presented: (1) Mechanical harvesting compares favorably with hand harvesting methods with respect to factory tare figures, total dirt per ton of clean beets, and in recovery of marketable beet tissue. (2) Rotating brushes will reduce the amount of dirt in a load of beets by a significant amount. (3) The dirt per ton of clean beets is considerably increased as the soil moisture content is increased.

COMPARISON OF PERFORMANCE CHECKS
WITH AND WITHOUT REVOLVING STEEL BRUSHES
ON MICHIGAN STATE COLLEGE HARVESTER

Table III

Soil Series - Conover Loam

Moisture content of soil percent	lbs. Dirt per Ton of Clean Beets		Average Difference
	without Brushes	With Brushes	
16	186	144	42
17	104	66	38
18	519	270	249
18	425	183	242
19	494	243	251
22	433	349	84
24	419	192	227
Average	370	207	162

COMPARISON BETWEEN SOIL MOISTURE
CONTENT AND DIRT IN A LOAD OF BEETS

Table IV

Moisture %	Lbs. Dirt Per Ton of Clean Beets	
	Lifter-topper Type Harvester	Hand Harvested
7-8	122	
9-10	264	
11-12		193
13-14	213	
15-16	174	170
17-18	207	381
19-20	239	237
21-22	253	
23-24		432