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SUGAR BEET CULTURE

Thesis

Submitted to Michigan Agricultural College for
the degree of Master of Agriculture

By

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1922

101165



The farmer upholds the sugar beet
because the sugar beet upholds the farmer

Except where otherwise noted, the material presented in this bulletin is the result of five years personal observation and work with the sugar beet industry,- first as County Agricultural Agent and later as Agriculturist for the Menominee River Sugar Company at Menominee, Michigan.

SUGAR BEET CULTURE

A New Industry

Sugar beet culture is a relatively new industry. The first sugar factory to be established in Michigan was built in Bay City in 1898, just twenty-four years ago. During the next seven years, twenty-three other factories were built in the state. Seven of these have been moved away, leaving Michigan with seventeen active sugar factories. It is a noticeable fact, however, that no new factories have been built in Michigan during the past seventeen years.



Fig. 1. A satisfied beet grower. The sugar beet is one of Michigan's most important cash crops.

The First Aid

Politics as well as scientific agriculture and chemistry have been a very important factor in the development of this industry. The Dingley Tariff Act of 1897, providing for a tariff of \$1.95 per hundred on refined sugar was the first important favorable legislation to benefit this phase of American agriculture. The financial provisions of this Act were reduced twenty-five per cent on March 1, 1914. The tariff which is being considered at the present session of Congress provides for a still greater protection for this great American industry.

An Important Cash Crop

Although the sugar beet is a relatively new crop in Michigan, it is already established as one of our stable industries. It returns to the growers, in actual cash returns from \$7,000,000 to \$11,000,000 per year. Table I, taken from the 1921 Annual Summary of the Crop Report for Michigan gives some valuable information relative to the extent of the sugar beet crop in this state for the past twelve years. It gives only the cash returns from this crop, however. With all farm crops there are certain other advantages as well as disadvantages which should be taken into consideration. The other benefits, which have long been recognized, derived from sugar beet culture are likewise very important, but will be discussed in other parts of this paper.

Table I. A twelve-year report on the acres harvested, yield and total value of Michigan's sugar beet crop.

YEAR.	Acreage harvested.	Average yield per acre.	Total production, (000 omitted.)	Average price December 1.	Total value, (000 omitted.)	Average value per acre.
	Acres.	Tons.	Tons.	Dollars.	Dollars.	Dollars.
1900.....	78,779	9 0	708	5.22	3,696	64.98
1910.....	117,500	10 3	1,208	6.00	7,248	61.80
1911.....	145,837	9.9	1,444	5.74	8,289	56.83
1912.....	124,241	6.8	839	5.69	4,774	38.69
1913.....	107,965	9.0	955	5.83	5,603	53.37
1914.....	101,263	8.5	857	5.23	4,482	44.45
1915.....	122,000	8.2	998	5.91	5,898	48.46
1916.....	99,619	5.5	544	6.14	3,337	33.77
1917.....	82,151	6.4	462	8.04	3,714	51.46
1918.....	114,976	7.9	890	10.08	8,971	79.63
*1919.....	123,000	9.8	1,205	12.52	15,087	122.70
*1920.....	150,000	8.8	1,320	10.08	13,306	88.70
*1921.....	125,000	8.3	1,038	6.00	6,228	49.80
Average.....	114,795	8.3	959	7.12	6,976	61.13

*Final revisions not completed.

A further important factor to be presented in the preliminary economic discussion of this crop is its relation in acreage and value to certain other stable cash crops of this state. A presentation of this table (Table II) is necessary to fully understand Michigan's need for this crop and its importance to the agriculture of the state as a whole. In other words, how much richer financially is the agriculture of Michigan on account of the beet crop than is the agriculture of Iowa, Illinois or some similar state without it?

From Table III it is found that the potato is the only farm crop that has a larger ratio of total acres to total value than has the sugar beet. The ratio of the potato crop is 1 to 4.39, while that of the sugar beet is 1 to 3.07, followed by beans with 1 to 1.69, corn with 1 to 1.16, wheat with 1 to 1.00 and by rye with 1 to 0.56.

Table II. A summary of the acreage, yield and valuation of the farm crops of Michigan for the year 1921.

CROP.	Acrea. (000 omitted.)	Yield per acre.	Production, (000 omitted.)	Price Dec. 1.	Total value (000 omitted.)	Value per acre.
Winter wheat.....	857	16.0 bus.	13,712	\$1.04	\$14,260	\$16.64
Spring wheat.....	40	9.0 bus.	360	1.04	374	9.36
Corn.....	1,703	39.0 bus.	66,417	0.48	31,880	18.72
Oats.....	1,544	18.2 bus.	28,101	0.36	10,116	6.55
Barley.....	235	17.5 bus.	4,112	0.57	2,344	9.98
Beans.....	263	11.3 bus.	2,972	2.40	7,133	27.12
Rye.....	642	13.8 bus.	8,846	0.70	5,842	9.10
Buckwheat.....	39	16.0 bus.	624	0.78	487	12.48
Potatoes.....	240	80.0 bus.	27,200	0.95	25,840	76.00
Tame hay.....	2,928	1.0 tons	2,928	13.00	38,064	12.00
Wild hay.....	60	1.1 tons	66	9.20	607	10.12
Sugar beets.....	125	8.3 tons	1,038	6.00	6,228	49.80
Clover seed.....	111	1.5 bus.	166	19.75	1,618	14.62
Apples (agricultural).....		bus.	6,317	1.95	12,318	
Apples (commercial).....		bbles.	1,208			
Peaches.....		bus.	358	2.90	1,038	
Pears.....		bus.	532	11.75	931	
Total.....	8,887				\$159,080	

Table III. Relation of the acreage and value of various farm crops to the total acreage and total value of all crops given in Table II.

	Per cent of total crop acreage	Per cent of total crop value	Ratio, acreage to value
Corn	19.1	32.0	1 to 1.16
Wheat	10.1	10.1	1 to 1.00
Rye	7.8	4.4	1 to .56
Potatoes	3.8	17.8	1 to 4.39
Beans	2.9	4.9	1 to 1.69
Sugar Beets	1.4	4.3	1 to 3.07

Promotes Diversified Farming

Thus Michigan is indeed favored by having soil and climatic conditions which are ideal to the production of another crop. In other words it offers a still greater opportunity for diversified farming. It adds from \$7,000,000 to \$11,000,000 to the farmers' pocketbook and at the same time 125,000 acres of land produce a crop which is not in direct competition with our other cash crops.

One of our greatest agricultural problems is not necessarily reduced acreage and production, but a readjusting and redistributing of our farming enterprises. We find, therefore, that as a general rule the states with a highly developed type of diversified farming, or in other words, a better distribution of farm enterprises, have not so keenly suffered from the present serious agricultural depression as have the one crop states.

The sugar beet industry, a highly specialized form of agriculture, has helped Michigan in this proper distribution of farm crop enterprises. It is "just a real good cash crop" which, when properly handled, can always be depended upon to return a cash balance at harvest time.

It is one of the few crops handled on a contract basis. When he plants his crop in the spring, the farmer knows the minimum price per ton he will receive in the fall. Present contracts also contain a provision which enables the grower to receive a higher return for his crop should the price of sugar be higher than the minimum stated in the contract.

Professor J. F. Cox, head of the Farm Crops Department of the Michigan Agricultural College, stated recently: "There is a special need for a few 'contract crops' to help lend stability to our farming enterprises." The sugar beet crop helps to fill that need.



Fig. 3. The sugar beet is "Just a Real Good Cash Crop."

Although, as stated in the beginning, politics played a very important part in establishing the sugar beet industry, the fact remains that scientific agriculture has also performed an important service for this crop. There is, however, much more that scientific agriculture can do for the sugar beet industry along the lines of improved breeding, improved cultural methods and disease and insect control.

Extent and Location of Michigan's Beet Areas

All but one of Michigan's seventeen factories are located

in the lower peninsula. The upper peninsula has one 1200 ton plant at Menominee. These factories are located in the best farming areas of the state, in fact sugar beet culture and fertile, well kept farms seem to go hand in hand. Michigan now ranks third in the United States in importance as a sugar beet producing state. It is the leading state in beet sugar production east of the Rocky Mountains.



■ SUGAR FACTORY
- 1000 ACRES SUGAR BEETS.

Map showing location of Michigan beet sugar factories and leading production areas.

The accompanying map, from Michigan's Special Bulletin No. 106, shows the location of Michigan beet sugar factories and the leading production areas.

This map shows that the "thumb area" in eastern Michigan produces the bulk of the crop. Other areas are distributed over the southern portion of the lower peninsula and in Menominee County of the upper peninsula.

The following list gives the names of the various sugar factories now in operation in the state:

Columbia Sugar Company,

Bay City, Michigan
Mt. Pleasant, Michigan

Continental Sugar Company,

Blissfield, Michigan

Holland-St. Louis Sugar Company,

Holland, Michigan
St. Louis, Michigan

Independent Sugar Company,

Marine City, Michigan

Menominee River Sugar Company,

Menominee, Michigan

Michigan Sugar Company,

Bay City, Michigan
Alma, Michigan
Caro, Michigan
Carrolton, Michigan
Croswell, Michigan
Sebewaing, Michigan

Mt. Clemens Sugar Company,

Mt. Clemens, Michigan

Owosso Sugar Company,

Lansing, Michigan
Owosso, Michigan

West Bay City Sugar Company,

West Bay City, Michigan

CULTURAL METHODS

Soil Selection

The types of soil best adapted to grow good crops of beets are the loams, silt loams, clay loams and fertile sandy loams. The fact is though, any fertile, well drained soil that will grow a good crop of grain, corn, potatoes or clover will, when handled properly, produce a good crop of sugar beets; however, the crop seems to grow best on the heavier types of soil. On these soils we secure a combination of a good tonnage and sugar yield. The lighter types of soil will usually produce beets of fairly high sugar content, but unless this land is very fertile and well supplied with organic matter the yield is not sufficient to make the crop a success.

Certain types of muck soils will, when properly fertilized and cared for, produce a good yield of beets of acceptable quality. Other types of muck will, however, give a good yield of beets but they are of a comparatively low sugar content. Further investigations regarding this type of soil is necessary before it can be classed as a sugar beet soil.

Hilly land that washes badly or very stoney land is not well adapted to the production of this crop.

Drainage

The sugar beet is a deep rooted plant and it is quite evident that any soil that is to be used for this crop should be well drained. Poor drainage is sometimes indicated by a very spotted field, because standing water drowns out the young plants. Sugar beets will stand as much, if not more flooding than any other farm crop, but long standing water will, in time, smother the young plants (Figs. 3 and 4, from Michigan Special Bulletin No. 106). In many cases the field, by observation at least, is apparently well drained, but at times the water table rises to within from five to ten inches of the surface. This causes a very short rooted, prongy beet of a low tonnage and sugar content (Fig. 5 from Michigan Special Bulletin No. 106).

In either of the foregoing cases the yield of the crop and thus the resultant profit is greatly reduced.

The field should also be drained well enough to enable the grower to properly prepare the seed bed in the spring, to plant on time and to cultivate, hoe and harvest without any serious handicap. There are now thousands of acres of land of a texture suitable to sugar beet production in the state, but which cannot be so used on account of poor drainage.

EXAMPLES OF ABNORMAL ROOT
DEVELOPMENT OF BEETS UNDER
POOR DRAINAGE CONDITIONS,
SHOWING HOW ROOTS ARE
MISSHAPEN AND THEIR GROWTH
STUNTED BY IMPROPER
REGULATION OF SOIL MOISTURE

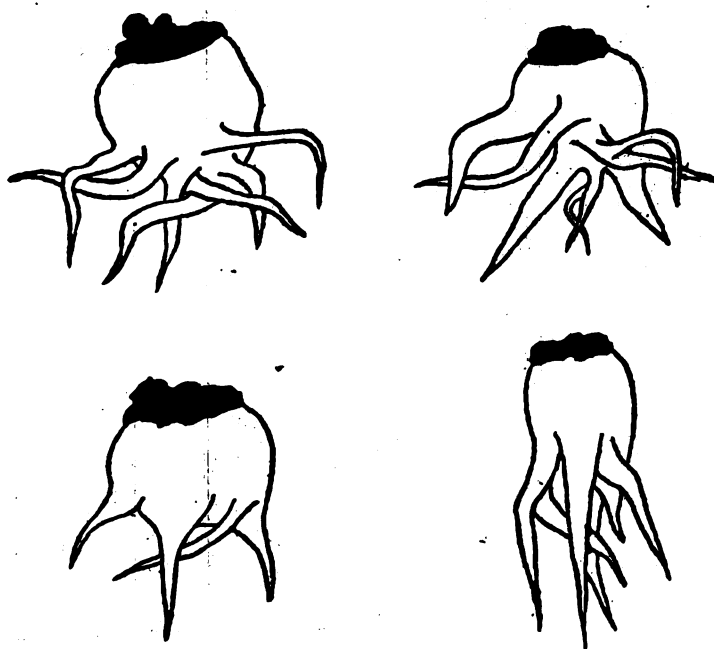


Fig. 5. Poor shaped beets are also caused by plowing under a tough sod or large amounts of barn yard manure, the spring of planting. They may also be formed by improper fitting of seed bed or by a hardpan at the bottom of furrow slice.

Soil Preparation

The proper preparation of the soil is one of the important phases of sugar beet culture. The choicest field, well fertilized but poorly prepared, will give poor results. A large amount of hand labor is connected with the production of this crop and the time spent in thorough soil preparation is highly profitable.

Fall plowing is usually recommended for most Michigan soils. Many farmers follow the practice of plowing twice for beets. The first plowing, about four inches deep, is made early in the fall. The land is then worked with a disc and drag. Later in the fall a second deeper plowing is made; the deeper plowing going about three-quarters to one inch deeper than the field had been plowed in former years. Seven to ten inches is usually sufficient on most soils. At no time should the land be plowed more than three-quarters to one inch deeper than the former plowings. To plow deeper than this would turn up too large a quantity of rather inert, unfertile sub-soil, which would be very unfavorable to the young beet seedlings. Increase the depth of plowing gradually, not all in the same year. No more work should be done to the field after plowing in the fall. The ground should be worked, however, the next spring, as soon as it is in proper condition.

The fall plowing provides for a thorough settling of the soil and makes it easier to secure the compact seed bed which is necessary with this crop. Although a compact seed bed is desirable, there should be no hardpan or hard furrow bottom

to prevent the tap root of the beet from following its natural course. In some soils, sub-soiling has given good results.

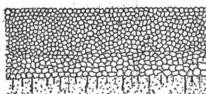
A Deep Firm Seed Bed Required

The sugar beet needs a deep seed bed so as to give the root a chance to grow longer and to secure the moisture stored at that depth (Fig. 6). The larger beets grown on soil prepared as described in the foregoing paragraphs will yield a larger tonnage per acre.

The writer observed an eight acre field of beets at Anston, Wisconsin, on a clay loam soil, following corn. This field had been plowed about six inches deep with a two-bottom plow pulled by a "reconstructed Ford roadster." The field was well fertilized and apparently well worked except for the plowing. From all appearances of the leaf growth an excellent tonnage was to be secured. At harvest time it was discovered that about seventy-five per cent of the roots were crooked, with a right angle bend about four to five inches below the crown. In fact it was found upon further investigation that a large number of the beets could be kicked out of the ground with the foot. The resulting yield was, of course, low and was no doubt due to the hard furrow bottom encountered by the tap root at five to six inches from the surface.

When the field is to be spring plowed, it should be

SUGAR BEETS REQUIRE A DEEP SEED-BED



PROPER SOIL+PROPER FITTING = PERFECT BEETS



COMPACT SUBSOIL+SHALLOW PLOWING = DISTORTED BEETS



IMPERVIOUS LAYER

= DISTORTED BEETS

Fig. 6. Land for sugar beets should be plowed deeper than for most crops, - from seven to ten inches is considered sufficient. It is not best to plow more than three-quarters of an inch to one inch deeper than the usual depth, at one plowing. This deeper plowing should be done in the fall. Spring plowing should be done at the usual depth.



done so as early as possible. Some soils give surprisingly better results when plowed in the spring. This is especially true on some types of clay soil that would be apt to puddle and become too compact over winter. The ground should be disced before plowing in the spring. Then when the ground is plowed, the loose disced soil on the surface helps to fill up the furrow bottom with fine material and thus immediately establishes direct contact between the furrow slice and furrow bottom.

Spring plowing should never be deeper than the deepest former plowing as it is not advisable to mix the sub-soil with the furrow slice in the spring.

Surface Preparation

With both the spring and fall plowing it is necessary to give the soil good surface preparation with the drag, disc and roller or culti-packer. Sugar beets require a deep, firm seed bed, one that is readily penetrated and yet not in a loose condition. The surface must be worked down in good shape, smooth and reasonably free from lumps.

Spring plowed land should be gone over with a roller or culti-packer and a harrow immediately after plowing. The rolling, harrowing and dragging should be continued at intervals until planting time. Fall plowed land should be gone over with the disc, harrow and drag at intervals until conditions are ready for seeding. Thorough work in preparing the seed bed properly will be repaid by a better stand of

beets and by lessening the work of weed control after the crop is planted.

Beet planters do not work successfully unless the land is well prepared. Thus a good stand and a resulting good yield depend quite largely upon thorough preparation of the soil.

In all cases the ground should be gone over with a light drag or weeder immediately preceding the drill. This kills any weeds that may have started and gives the beets an even chance with the weeds which may come later on. If this dragging is not performed, we find that the weeds will have a great initial advantage over the young beet seedlings.

Fertilizers

Although additional fertilizer is not always necessary, it does, however, when properly used, increase the profits secured from the sugar beet crop in the majority of cases. The two forms of fertilizers which are most often used with this crop are barnyard manure and the commercial preparations. There is quite an overhead labor charge for beets, regardless of the yield per acre, thus any practice which materially increases the resulting tonnage would lower the cost of production and increase the total profit. On account of this high labor overhead, a proper application of fertilizer for the beet crop will in most cases pay as well, if not better, than for many other crops.

Barnyard Manure

Barnyard manure is the most common fertilizer used on the farm today. It fills a need which practically no other single form of fertilizer can replace. It is very valuable in the production of a good crop. Not only are the fertilizing elements furnished by this material, but also the humus and innumerable very valuable bacteria. It also furnishes a large amount of food for the bacteria with the result that the plant food is made available for the beets.

The best kind to use depends largely upon the time of application. Well rotted manure may be safely and profitably applied in the spring of planting. Fresh manure should be applied in the spring or fall previous to planting beets to give the best results. Spring application of fresh manure the year the beets are to be planted is not to be recommended for several reasons: (1) The beet plant is not able to make the best use of this manure as all its fertilizing elements are not immediately available. (2) Heavy applications of fresh manure may cause short, prongy, low yielding beets. (3) The spring top-dressing of fresh manure, in many cases, is also a top-dressing of weed seeds. This greatly increases the amount of labor necessary to care for the crop and in some cases makes such a discouraging proposition out of it that the whole crop is plowed under.

The writer has observed many fields where the owner has made a spring or late winter application of fresh manure for

beets and has been very much discouraged with the results. The failure to get beneficial results was largely due to the foregoing three reasons. In many cases twenty to twenty-five loads were applied per acre, and the grower cursed the sugar beet crop because it took all his manure and did not yield a very high tonnage. In this case one of the causes for a low yield was the heavy application of manure lying between the furrow slice and the furrow bottom. In most instances the manure was not properly mixed with the soil and it inhibited the flow of capillary moisture to the furrow slice. When the beet tap root came in contact with large lumps of this material it went no further and instead of developing into a good shapely beet it grew into a prongy, rooty affair of light weight.

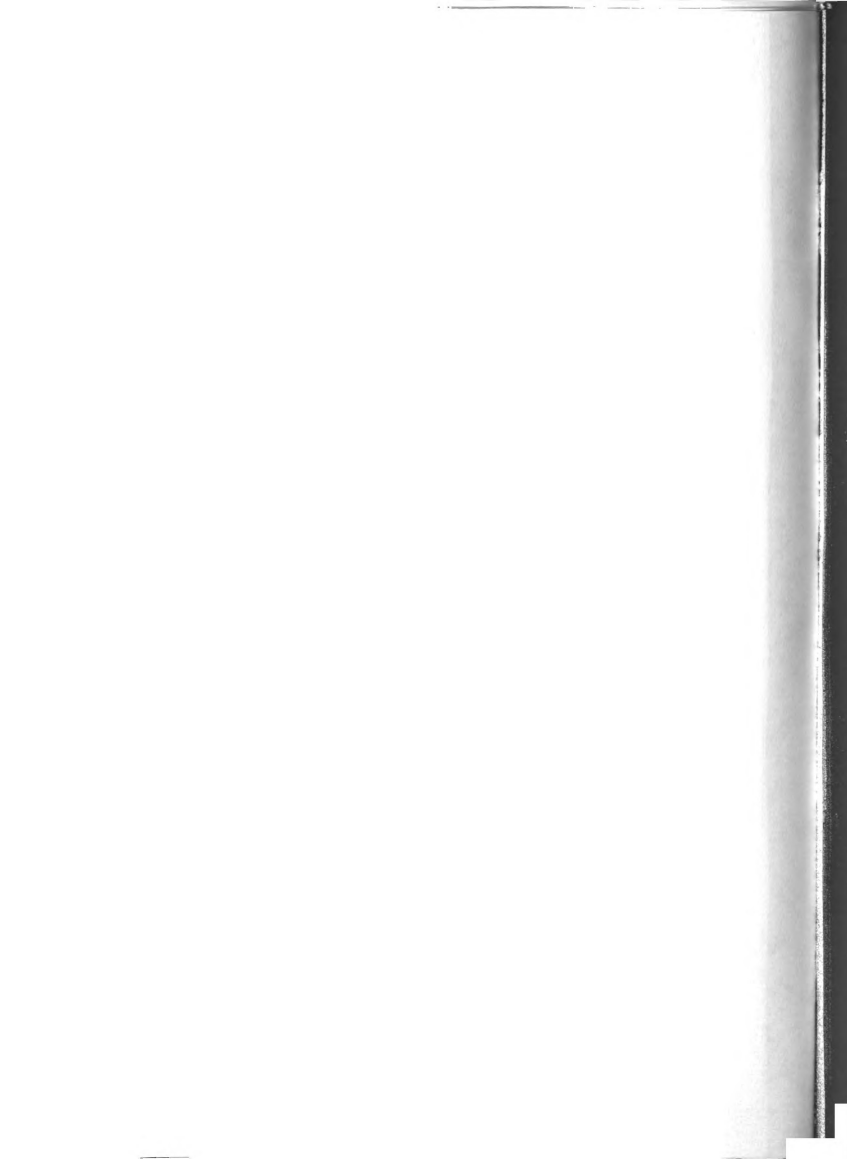
The crop following the beets receiving this heavy application of fertilizer, was really the one to receive the most benefit of the manure. Thus in many cases the spring application of fresh manure is of little value to the beet crop, but in many instances is the direct cause of a poor crop.

The manure is best applied by means of a spreader at the rate of eight to twelve loads per acre. If it is applied in the spring it should be applied before plowing and disced in the ground thoroughly. Light top dressings of weed-seed-free manure may be applied after plowing and worked in thoroughly.

Commercial Fertilizers

In many beet growing areas farmers would not plant sugar





beets unless they were able to procure commercial fertilizer to use with the crop. The reverse, however, is also true in some areas where the soil is of the fertile, heavy type and where large numbers of stock are kept. In no case should it be understood that commercial fertilizers take the place of barnyard manure, but that it reinforces it. A combination of the two usually gives the best results.

The best analysis of fertilizer to use depends quite largely upon (1) the kind of soil, (2) the crop rotation followed and (3) the amount and quality of barnyard manure used.

The area covered by the writer while in the employ of the Menominee River Sugar Company comprised Menominee and portions of Delta and Dickinson Counties of the Upper Peninsula of Michigan, and Marinette, Oconto, Brown, Kewaunee, Ontagamie, Calumet, Winnebago and Manitowoc Counties of Wisconsin. For the purpose of discussion in this article, the three main groups of soils in this area were the sand loams, loams and clay loams.

The Michigan counties and Marinette, Oconto and parts of Brown, Ontagamie, Winnebago counties of Wisconsin contained the sand loam soils. Brown, Ontagamie and Winnebago, Kewaunee and Fon Du Lac counties contained the loams. Calumet, Fon Du Lac, Manitowoc, Winnebago and Ontagamie counties contained the clay loams and clays.

In the year 1930 the writer put on about fifty fertilizer demonstrations distributed over the entire area. In a general



way it was a noticeable fact, as observed from one year's results, that the sand loam areas responded best, the loam areas were next and the clay loams and clays, in the majority of cases, responded very little.

Fertilizers on Sand Loams

In the sand loam area, Arthur DeCamp, of Stephenson, Menominee County, secured an increased yield of five tons 211 pounds per acre through the use of 300 pounds of 2-12-3 fertilizer applied in the rows. The effects of the fertilizer on the beets is clearly shown in Figure 7. The residuary effect of this fertilizer the year following on barley is well shown in Figure 8. On the same farm in 1921 one-half the field was given an application of 250 pounds of 2-12-3 and the other half was dressed with fresh barnyard manure. The result is shown in Figure 9. The commercial fertilizer, being quickly available, gave the beet plant a quicker start in the spring and this advantage was maintained throughout the season.

George Bell, Oconto, Oconto County, Wisconsin, on the sand loam type of soil, applied broadcast a 2-12-3 fertilizer at the rate of 400 pounds per acre and increased the resulting yield four tons per acre. Twelve tons per acre were secured on the fertilized and about eight tons on the unfertilized land (Figs. 10 and 11.).

Chas. Knutson, Underhill, Oconto County, Wisconsin, applied a 2-12-3 fertilizer broadcast at the rate of 400





Fig. 7. A fertilizer test on sandy loam soil. No fertilizer was applied on the right, while on the left 200 pounds of 3-12-2 fertilizer was applied per acre. Figure 8 shows the same field one year later, in barley. Farm of Arthur DeCamp, Stephenson, Menominee County, Michigan. Picture taken July 28, 1919.

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Fig. 8. This picture shows the residuary effect of a 3-12-3 fertilizer applied the year previous on beets. No fertilizer was applied on the right, while on the left 200 pounds of 3-12-3 per acre were applied. This is a picture of the same field shown in Figure 7. Picture taken July 9, 1920.



Fig. 9. Fertilizer demonstration on sandy loam soil. Fresh barnyard manure applied in the spring on the immediate foreground, 250 pounds of 2-12-2 fertilizer applied on the background. Farm of Arthur DeCamp, Menominee County. Picture taken July 9, 1930.



Fig. 10. Fertilizer demonstration on a sandy loam soil. No fertilizer on the left, while on the right 400 pounds of 3-12-3 fertilizer was broadcasted before seeding. Farm of Geo. Bell, Oconto, Wisconsin. Picture taken July 11, 1919. Note the quicker start made by the fertilized beets.

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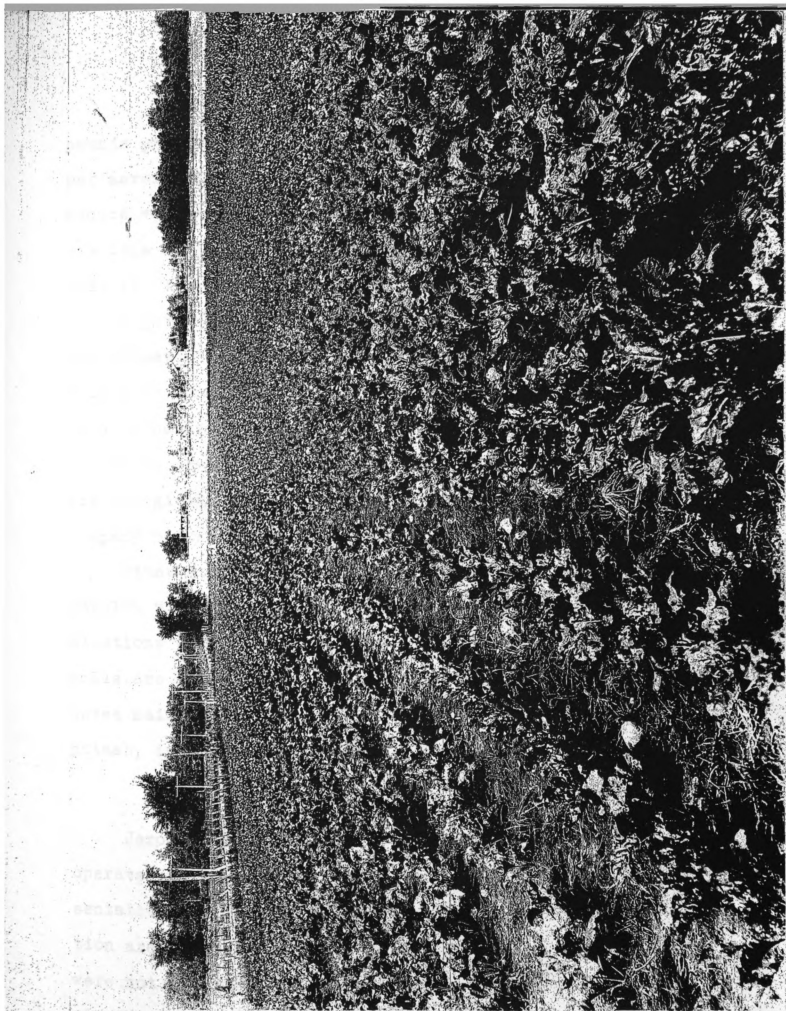


Fig. 11. Same field shown in Figure 10. Picture, taken 17 days later, shows the leaves on the unfertilized beets starting to catch up to the leaf growth on the fertilized beets.

pounds per acre and secured a yield of 11 tons 752 pounds per acre. On the other half of the field fresh barnyard manure was the only fertilizer used, the resulting yield was six tons 24 pounds per acre. A picture of this field taken July 11, is shown as Figure 12.

Figure 13 shows another illustration of the effect of fertilizer on this same area. The soil in this case was in a very poor, run-down condition before the treatment was made. This accounts to some extent for the very small, stunted growth on the unfertilized area. Yield figures on this field are not given, as the writer left the employ of the Sugar Company before the harvest was complete.

Other similar demonstrations on this type of soil gave results very comparable with the foregoing figures. The indications resulting from these tests are that the sandy loam soils are benefited by a complete fertilizer containing all three main fertilizing elements: nitrogen, phosphorus and potash, in the ratio of 2-12-2 or 3-10-4.

Fertilizers on the Heavy Loams

Jerome Briesse, Greenleaf, Brown County, Wisconsin, co-operated with a very complete demonstration on a soil representative of the loam area. The results of this demonstration are given in table 4. The results on some of the plots were not very consistent, the checks, however, ran rather close. It will be noticed that there is an increase factor entering in from the first check on one side to the 0-16-0

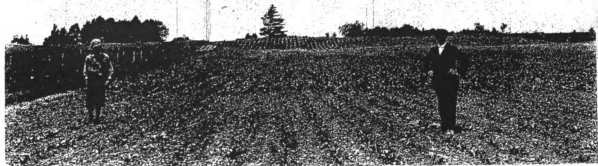


Fig. 12. The foreground received an application of fresh barnyard manure, while the beets on the back-ground received an application of 400 pounds of 2-12-2 fertilizer per acre. Farm of Chas. Knutson, Underhill, Wisconsin. Picture taken July 11, 1919.



Fig. 13. Picture taken August 10, 1920. No fertilizer on lower left hand corner, 400 pounds of 3-10-4 fertilizer on the right, 400 pounds of 3-10-4 fertilizer and barnyard manure on the upper left side of the picture. Farm of William Hayes, Oconto, Wisconsin.

on the other side. The conclusion one would draw from this demonstration is that phosphorus was the most essential fertilizer ingredient concerned in increased production. The average yield per acre on this ten acre field was 16 tons 1740 pounds per acre. The price per ton for beets that year, 1920, was \$12.50, the average return per acre was \$210.88. Figures 14 and 15 show views of this field. The following table, No.4, gives in detail the result of the demonstration.

Table 4. A graphic illustration of the fertilizer demonstration on the farm of Jerome Briesse, Greenleaf, Brown County, Wisconsin, in 1920:

Check	13 tons	1480 pounds	per acre			
3-8-7	16 "	460	"	"	"	"
2-8-0	16 "	568	"	"	"	"
1-8-3	16 "	1742	"	"	"	"
Check	15 "	848	"	"	"	"
2-10-4	18 "	524	"	"	"	"
3-10-0	18 "	508	"	"	"	"
0-10-4	19 "	1800	"	"	"	"
Check	15 "	306	"	"	"	"
0-16-0	18 "	362	"	"	"	"

One acre plots, average yield 13 tons 1740 pounds.

History:

1915 Oats, seeded down, seeding top-dressed, 6 to 8 loads per acre.

1916-17 Hay.

1918 Spring plowed 6 inches for corn.

1919 Fall plowed 8 inches for beets.

Silt loam soil.



Fig. 14. Fertilizer demonstration on a loam soil.
Check plot on the right, 400 pounds of 2-8-7 fertilizer
on left. Farm of Jerome Briese, Greenleaf, Wisconsin.
Picture taken August 6, 1919.



Fig. 1A. Fertilizer demonstration on a farm soil.
 Check plot on the right, 400 pounds of S-B-V fertilizer
 on left. Farm of Jerome Hirsch, Greenleaf, Wisconsin.
 Picture taken August 8, 1919.



Fig. 15. Check plot on right, 400 pounds of 3-10-4 fertilizer on the left. Farm of Jerome Briesse. Picture taken August 6, 1919.

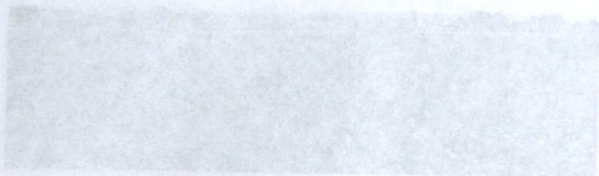


Fig. 18. Check plot on right, 400 pounds of 2-10-4
fertilizer on the left. Form of leaves grass. Photo
taken August 6, 1918.

Another demonstration on the farm of Jule Van Colster, Green Bay, Brown County, Wisconsin, on the same type of soil as in the foregoing discussion gave very comparable results, as indicated by the following table, No.5.

Table 5. Fertilizer demonstration on the farm of Jule Van Colster, R.F.D. No.9, Green Bay, Wisconsin.

Check	9 tons	328 pounds per acre			
0-16-0	10 "	1200	"	"	"
2-13-2	10 "	1860	"	"	"
Check	6 "	570	"	"	"
2-8-7	11 "	172	"	"	"
3-10-4	11 "	254	"	"	"

One-half acre plots.

The one distinguishing feature of this demonstration was the perfect stand secured on adjoining rows both sides of the middle check plot, while on the check plot the rows contained a rather poor stand. In this case, therefore, the fertilizer not only furnished more plant food but furnished it at the proper time to insure a better stand of beets. This is a very important consideration in sugar beet growing.

Other demonstrations on this same type of soil gave very similar results and showed that phosphorus was the element most needed. If a complete fertilizer was to be used, a 2-13-2 or 3-10-4 would be preferred to a higher potash fertilizer, in so far as the yield was concerned. Sugar tests of the beets from these plots were not made and so all ob-

Another demonstration on the farm of John Van Colster, Green Bay, Brown County, Wisconsin, on the same type of soil as in the foregoing discussion gave very comparable results, as indicated by the following table, No. 2.

Table 2. Fertilizer demonstration on the farm of John Van Colster, R. F. D. No. 2, Green Bay, Wisconsin.

Check	2 tons	2 tons	2 tons	2 tons
0-12-0	10 "	1800 "	" "	" "
2-12-2	10 "	1850 "	" "	" "
Check	8 "	870 "	" "	" "
2-8-7	11 "	175 "	" "	" "
2-10-4	11 "	224 "	" "	" "

One-half acre plots.

The one distinguishing feature of this demonstration was the perfect stand secured on adjoining four acre plots of the middle check plot, while on the check plot the rows contained a rather poor stand. In this case, therefore, the fertilizer not only furnished more plants per acre but furnished it at the proper time to insure a better stand of crops. This is a

very important consideration in sugar beet growing. Other demonstrations on this same type of soil have very similar results and showed that phosphorus was the element most needed. If a complete fertilizer was to be used, a 2-12-2 or 2-10-4 would be preferred to a higher potash fertilizer, in as far as the yield was concerned. Sugar beets of the best from these plots were not made and on all the



Fig. 16. Demonstration on the farm of Gregory East, Appleton, Wisconsin. No fertilizer on the right, 400 pounds of 3-12-3 fertilizer per acre on the left. Picture taken August 3, 1920.

servations and conclusions were drawn from the farmer's viewpoint or the tonnage yield per acre.

Fertilizers on the Clay Loams and Silt Loams

These soils found in the most fertile and richest farming sections of Wisconsin are farmed by the best farmers in the state. Livestock farming predominates as the principal farm enterprise.

As a general rule the soils in this area responded less to commercial fertilizer applications than did the soils of

the other areas. In many of the demonstrations no increase in yield was secured, regardless of rate and method of application and analysis. Acid phosphate seemed to be most in favor. Results secured in other years may, however, show up differently than they did in 1930.

The recommendations to be made on these soils is an application of about 150 pounds to the acre in the row at the time of planting. The analysis of fertilizer to use would, of course, vary under different conditions, but would be either 0-16-0, 2-12-3 or 3-10-4.

Fertilizers on Muck Soils.

Mr. J. I. Ethridge of the Oconto Lumber Company, Oconto, Oconto County, Wisconsin, cooperated in putting on the only fertilizer demonstration on muck that was put on by the Sugar Company that year. Due to weather and labor conditions this field was planted late and thus blocked and thinned late, especially was this noticeable on the end of the field containing the 0-16-0 plot. So the decrease in yield factor must be taken into consideration in connection with this demonstration.

The detailed results are given in Table No.6. The effect of the potash is readily observed from this table. In fact, potash seemed to be the controlling element on this type of soil, in so far as tonnage was concerned. The fertilizer giving the most economical results was the 0-8-7.



the other areas. In many of the demonstrations no increase in yield was secured, regardless of rate and method of application and analysis. Acid phosphate seemed to be most in favor. Results secured in other years may, however, show up differently than they did in 1930.

The recommendations to the rate of these soils is an application of about 150 pounds to the acre in the case of the time of planting. The analysis of fertilizer to be used, of course, very under different conditions, but would be rather 0-15-0, 3-15-3 or 5-10-4.

Fertilizers on Poor Soils

Mr. J. I. Etridge of the Goetz Lumber Company, Goetz, Goetz County, Wisconsin, cooperated in putting on the only fertilizer demonstration on such land was put on by the Goetz Company that year. Due to weather and labor conditions this field was planted late and thus plowed and chisled late, especially was this noticeable on the end of the field containing the 0-15-0 plot. So the decrease in yield factor must be taken into consideration in connection with this demonstration.

The detailed results are given in Table No. 5. The effect of the potash is readily observed from this table. In fact, potash seemed to be the controlling element on this type of soil, in so far as tonnage was concerned. The fertilizer giving the most economical results was the 0-8-7.

Table 6. The fertilizer demonstration put on by J. I. Etheridge, Oconto Lumber Company, Oconto, Wisconsin.

Check	9 tons	96 pounds per acre			
2-8-7	9 "	1382	"	"	"
2-8-0	6 "	1362	"	"	"
0-8-7	8 "	546	"	"	"
Check	6 "	632	"	"	"
3-10-4	6 "	866	"	"	"
3-10-0	5 "	1420	"	"	"
0-10-4	4 "	740	"	"	"
Check	4 "	344	"	"	"
0-16-0	2 "	164	"	"	"

One-half acre plots. Muck Soil .

Method of Application

In all of the foregoing demonstrations, except where otherwise stated, the commercial fertilizer was applied broadcast at the rate of 400 pounds per acre and well worked into the soil a few days previous to seeding. It was originally planned to do some follow-up work on residuary effects of beets and fertilizers, but for various reasons this phase of the work was not carried through to completion.

It was thought, in planning these demonstrations, that under average conditions better results would be secured from the broadcast applications, both from the standpoint of the best crop and the following crops; and I believe that this assumption was correct on all the soils but the heavy clay

Table 5. The fertilizer demonstration plot on 1.1.

Eberhard, Ontario Waterbury Company, Ontario, Wisconsin.

Check	5 tons	10 tons	15 tons	20 tons	25 tons
3-8-7	5 "	10 "	15 "	20 "	25 "
3-8-9	5 "	10 "	15 "	20 "	25 "
3-8-7	5 "	10 "	15 "	20 "	25 "
Check	5 "	10 "	15 "	20 "	25 "
3-10-4	5 "	10 "	15 "	20 "	25 "
3-10-9	5 "	10 "	15 "	20 "	25 "
3-10-4	5 "	10 "	15 "	20 "	25 "
Check	5 "	10 "	15 "	20 "	25 "
3-10-9	5 "	10 "	15 "	20 "	25 "

One-half acre plot. Waterbury.

Method of Application

In all of the foregoing demonstrations, except where otherwise stated, the commercial fertilizer was applied broadcast at the rate of 400 pounds per acre and well worked into the soil a few days previous to seeding. It was originally planned to do some follow-up work on residual effects of bone and fertilizer, but for various reasons this phase of the work was not carried through to completion.

It was thought, in planning these demonstrations, that under average conditions better results would be secured from the broadcast applications, both from the standpoint of the best crop and the following spring, and I believe that this assumption was correct on all the soils but the heavy clay

and silt loams, where the row application seemed best.

Broadcast vs Row Applications

With the broadcast applications the main advantages are: (1) Gives better residuary results; (2) mixes the fertilizer with the soil, thus avoiding danger of burning the root; and (3) it tends toward a better, more normal root development. In many dry years, where the fertilizer is applied in the row, it does not fully go into solution and thus be in a form to be used by the roots. Many times I have noticed farmers, when plowing out their beets in the fall, plow out the fertilizer in about the same condition it was in when applied. The broadcast application tends to help the beet develop a normal extensive root system (Fig. 33) which is invaluable, especially in dry weather. The roots keep on developing in search of food, while in the row application the food is right next to the root and it does not have to develop as large a root system as in the former case.

The main point in favor of the row method is that quicker and better results may be gained with proportionally smaller quantities of fertilizer. A relatively light application, 100 to 150 pounds per acre, depending upon the analysis, may be applied at planting time, to aid in germination and to give the young plant a quick start. Many soils that are apt to be cold and slow in the spring, i.e. the clay and silt loams, require only enough fertilizer to aid in starting the plant, supplying such other plant food as the crop may need from its own reserve.



and side loams, where the row application seemed best.

Broadsheet or Row Application

With the broadcast application the main advantages are:

- (1) Gives better immediate results; (2) allows the fertilizer with the soil, thus avoiding danger of burning the roots; and (3) it tends toward a better, more normal root development.

In many dry years, where the fertilizer is applied to the soil, it does not fall so into solution and runs off in a loss to be used by the roots. Many times I have noticed farmers when plowing out their beans in the fall, follow out the fertilizer in about the same condition it was in when applied. The broadcast application tends to help the best developed normal expansive root system (Fig. 33) which is invaluable, especially in dry weather. The roots keep on developing in search of food, while in the row application the food is right next to the root and it does not have to develop so large a root system as in the broadcast.

The main point in favor of the row method is that delay-er and better results may be gained with proportionally smaller quantities of fertilizer. A relatively light application, 100 to 150 pounds per acre, depending upon the analysis, may be applied at planting time, to aid in germination and to give the young plants a quick start. Many soils that are apt to be cold and slow in the spring, i.e. the clay and silt loams, require only enough fertilizer to aid in starting the plants, supplying such other plant food as the crop may need from its own reserves.

The residual effects of the fertilizer application is clearly shown in Figure 8.

Liming

Soils that are acid should be given an application of sugar beet refuse lime at the rate of one to three tons per acre or one to two tons of finely ground limestone per acre. This will not only increase the yield of sugar beets but will also increase the yield of following crops of clover and alfalfa, thus providing a greater residue of organic matter and nitrogen, improving both the fertility and structure of the soil.

Refuse lime may be secured from the various sugar companies in most cases free of cost. The cost of loading is usually the only charge made for car-load lots of 40 to 50 tons. This lime is as good as can be secured for use in correcting soil acidity. On account of its physical condition, being somewhat moist and occasionally lumpy, it will not work through a lime distributor. Distribution is usually made from the wagon or piles by means of a fork or shovel, or with a manure spreader. The best time to make the application is in the fall, or winter when the snow is not too deep.

Many inquiries are often made relative to the analysis of sugar beet factory refuse lime, and the following table, No. 7, is a report by Professor A. J. Patten of the Michigan Agricultural Experiment Station.

The residual effects of the fertilizer application is clearly shown in Figure 3.

Liming

Soils that are acid should be given an application of sugar beet refuse lime at the rate of one to three tons per acre or one to two tons of finely ground limestone per acre. This will not only increase the yield of sugar beets but will also increase the yield of following crops of clover and alfalfa, thus providing a greater measure of organic matter and nitrogen, improving both the fertility and texture of the soil.

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Many inquiries are often made relative to the analysis of sugar beet factory refuse lime, and the following table, No. 1, is a report by Professor A. L. Patton of the Michigan Agricultural Experiment Station.

Table 7. Analysis of Sugar Beet Factory Refuse Lime.

Contents.	Sample No. 1.	Sample No. 2.
Moisture.....	37.40 per cent	79.84 per cent
Calcium and Magnesium Carbonate.....	49.96 per cent	.29 per cent
Nitrogen.....	.18 per cent	.65 per cent
Phosphoric Acid (P ₂ O ₅).....	.39 per cent	.09 per cent
Potash (K ₂ O).....	.07 per cent	

The wide variance in analysis is due mainly to the difference in moisture content. Sample No.1 contained over 37 per cent water, while Sample No.2 contained practically no moisture.

After the lime has served its purpose in the beet factory, in purifying the beet juices, it is washed out of the filter presses with large quantities of water. This thin mixture of lime and water is then run into a settling pond. Refuse lime taken directly from the settling pond is in rather poor physical condition with a great deal of moisture. A few factories have used their power shovel and transferred large amounts of this lime from the settling basin to piles on high ground. After remaining in these piles for two to five years, the lime has changed from a pasty condition to a drier mealy state, which is then in good shape for distribution on the soil with a manure spreader, fork or shovel.

In Europe, where the sugar beet industry has thrived for about 115 years, the sugar beet growers are allotted refuse lime in proportion to the tons of beets delivered. There is a clause in their beet contract providing for their allowance

of lime. All this refuse lime, at the European factory, is usually cleaned up by three weeks after harvest.

Sugar beet refuse lime is a practical and cheap source of agricultural lime. Most sugar companies in Michigan make no charge for this lime in carload lots. The only cost to the beet grower is the actual loading charge at the factory and the freight to his station. The lime capacity of cars varies from 30 to 45 tons. Farmers may group together in the purchase of carloads.

There are great piles of this material, valuable for the correction of our sour soils, that are standing, unused, at the various sugar factories in the state. This waste material if properly used would add greatly to our agricultural prosperity.

Sugar companies also have each year a few carloads of fine dry air-slaked lime, which was not used in the purifying process. This lime accumulates from the lime burners. It is usually in excellent physical condition. Its analysis would be about the same as the hydrated lime purchased from commercial lime concerns.

In ordering carloads, it is first best to send for a sample, and thus avoid any misunderstanding.

Planting

The seeding of sugar beets needs to be carefully done by one who thoroughly understands all the requirements of the beet seed and the planter. Proper seeding is the first step

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In ordering carloads, it is first best to seek for a sample, and thus avoid any misunderstanding.

Planting

The seeding of sugar beets needs to be carefully done by one who thoroughly understands all the requirements of the best seed and the planter. Proper seeding is the first step

toward securing a good stand, without which a profitable tonnage cannot be grown. A comparatively level, well prepared soil is, of course, the first requisite to proper planting.

There are three machines which may be used in this work: the 4-row, the 3-row, and the 1-row seeder. The particular one to use depends upon the condition of the seed bed and the acreage to be planted. Many farmers use the ordinary grain drill, equipped with packer wheels, to plant the beets. Enough of the cups are plugged to give the proper spacing of rows and the packer wheels pack the soil next to the seed and insures its being planted at the proper depth. The machines may be purchased, either with or without the fertilizer attachment. The width of rows recommended are from 23 to 24 inches.

The quantity of seed planted should never be less than 15 pounds per acre. It cannot be too strongly emphasized that plenty of seed should be used to insure a good even stand of beets and to reduce the cost of thinning. Great care should be taken to plant at the proper uniform depth, which is not deeper than one-half to three-quarters inches. The depth depends somewhat upon the character of the soil, the deeper plantings are made on the lighter types. Deeper planting than is recommended above is apt to smother the young beet plants.

Planting should begin as early in May as the seed bed can be brought into condition and is warm enough to cause germination. The usual planting period ranges from May 5 to May 30,

toward securing a good stand, without which a profitable tonnage cannot be grown. A comparatively level, well prepared soil is, of course, the first requisite to proper planting. There are three machines which may be used in this work, the 4-row, the 3-row, and the 1-row machine. The particular one to use depends upon the condition of the seed bed and the nature of the soil. Many farmers use the ordinary grain drill, equipped with pocket wheels, to plant the beets. One of the cups are rigged to give the proper spacing of rows and the pocket wheels pack the soil next to the seed and insure its being planted at the proper depth. The machines may be purchased, either with or without the fertilizer attachment. The width of rows recommended is from 24 to 36 inches.

The quantity of seed planted should never be less than 15 pounds per acre. It cannot be too strongly emphasized that plenty of seed should be used to insure a good even stand of beets and to reduce the cost of thinning. Great care should be taken to plant at the proper uniform depth, which is not deeper than one-half to three-quarters inches. The depth depends somewhat upon the character of the soil, the deeper plantings are made on the lighter types. Deeper planting than is recommended above is apt to smother the young beet plants.

Planting should begin as early in May as the seed bed can be brought into condition and is well enough to cause germination. The usual planting period ranges from May 5 to May 20.

but plantings may be made as late as early June where the early plantings were impossible or failed.

On soil which has a tendency to bake or crust over, the use of a culti-packer after planting and before the beets are up is recommended. In some cases this is the only means of saving the crop. When the soil crust becomes too hard, it is practically impossible for the beet seedlings to break through and as a result are smothered out or come up later after a warm rain. In either instance, if an uneven stand results, the culti-packer helps to remedy the situation.

The sugar beet seed is supplied to the contracting grower at cost, by the sugar company. Special effort is made by these companies to secure seed of high germination from high yielding strains which will produce beets of high sugar content.

Transplanting

One somewhat objectionable feature of sugar beet culture, to some growers, is the extra amount of hand labor necessary to properly care for the crop. Several means of avoiding this difficulty have been suggested. One method was to plant the seed in a bed and then transplant the young plants at about the four to six leaf stage. The young plants would, of course, be spaced at the proper interval and thus do away with blocking and thinning.

Figure 17 is a picture of a field of beets grown in this manner. The beets were planted by means of a cabbage planter, but no water was used. The young beet plants stood the transplanting as well, if not better than did the cabbage trans-

but plantings may be made as late as early June where the early plantings were impossible or failed.

On soil which has a tendency to bake or other over, the use of a split-packer after planting and before the first rain is recommended. In some cases this is the only means of saving the crop. "Then the soil must become too hard, it is practically impossible for the best seedlings to break through and as a result are smothered out or come up later after a rain rain. In either instance, if an uneven stand results, the split-packer helps to remedy the situation.

The sugar beet seed is applied to the contrasting ground at cost, by the sugar company. Special effort is made by these companies to secure seed of high germination (less than 10%) and strains which will produce beets of high sugar content.

Transplanting

One somewhat objectionable feature of sugar beet culture to some growers, is the extra amount of land labor necessary to properly care for the crop. Several means of avoiding this difficulty have been suggested. One method was to plant the seed in a bed and then transplant the young plants at about the four to six leaf stage. The young plants would, of course, be spaced at the proper interval and then be weeded with hoeing and thinning.

Figure 17 is a picture of a field of beets grown in this manner. The beets were planted by means of a cabbage planter, but no water was used. The young beet plants stood the transplanting as well, it not better than did the cabbage trans-

planted on an adjoining area. A very good stand was secured and the crop looked fine throughout the entire growing season.



Fig. 17. A five acre field of transplanted beets on the farm of Wm. Lauer, Shiocton, Wisconsin. These beets were transplanted on June 25 with a cabbage planter. A very good stand was secured.

It was in the fall when the harvest commenced, that the real test began. At that time the disappointment of having a poor crop was evident. A very heavy percentage (about 75 per cent) of the beet roots were very short and prongy and the resulting yield was low. The first four or five inches of the beet root was of the normal size, but below this was nothing more than a mass of small, sprangling roots. This was caused, no doubt, by breaking the tap root of the young

planted on an adjoining area. A very good stand was secured and the crop looked fine throughout the entire growing season.



Fig. 17. A five acre field of experimental plants on the farm of Mr. Baker, Chicago, Wisconsin. These plants were transplanted on June 25 with a 2000 lb. fertilizer. A very good stand was secured.

It was in the fall when the harvest commenced that the real test began. At that time the development of having a poor crop was evident. A very heavy frost (about 25 per cent) of the best roots were very short and gnarled and the resulting yield was low. The first four or five inches of the best root was of the normal size, but below this was nothing more than a mass of small, sprawling roots. This was caused, no doubt, by breaking the tap root of the young

seedling at the time of transplanting. Where the entire root was taken, the chances were fairly good for a more normal root development. Three different fields of transplanted beets were studied by the writer, and each gave very similar results.

Cultivation

Careful work with the cultivator will save an enormous amount of hand labor later on. A great deal of trouble with the beet labor is caused by poor cultivation by the grower. The cultivation is best accomplished by use of the regular two or four row beet cultivator. Discs or knife weeders and deer tongues should be used for the first two cultivations. After that remove the disc weeders and use knife weeders and deer tongues, or deer tongues alone. Duck feet should be used with care, as they are apt to cover up the beets and weeds in the beet row, thus making it very difficult to do the hand work.

The first cultivation should come immediately before blocking and thinning, which should be done when the seedling has developed four leaves. At this time the cultivator should be run as close to the row as is possible without cutting out the beets. Rollers or culti-packers are often used with good results after blocking and thinning to smooth over and level off the dirt hoed into the middle of the row in blocking. In many cases it would be nearly impossible to cultivate immediately after blocking and thinning, if the roller or culti-packer were not used.

The beets should be cultivated at least five or six times

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Cultivation

Careful work with the cultivator will save an enormous
amount of hand labor later on. A great deal of trouble with
the best labor is caused by poor cultivation of the ground.
The cultivation is best accomplished by use of the roller
or four row post cultivator. Discs or knife weeder are best
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after blocking and thinning. If the roller or knife weeder
were not used.
The plants should be cultivated at least five or six times

for the best results. These cultivations not only aid in clean culture but help to retain the soil moisture. Growers should not be afraid of cultivating too many times. In fact many farmers owe their good beet yields and thus good profits to liberal and careful cultivation. The first and second hoeings should be close to the rows and may be fairly deep, but later cultivations should be shallow, not more than two or three inches deep. If deep cultivations are made at these later dates, many feeding roots of the beet root will be cut off. These roots interlace near the surface between the rows after about a month's growth.



Fig.18. A four-row beet cultivator on the farm of Henry Bergman, Van Dyne, Wisconsin. This picture also shows the proper time for second hoeing.

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 to liberal and careful cultivation. The first and second
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 but later cultivations should be shallow, not more than two or
 three inches deep. If deep cultivations are made at these
 later times, many leading roots of the beet root will be cut
 off. These roots interfere with the upward growth of the row
 after about a month's growth.



Fig. 18. A four-row beet cultivation on the farm of Harry
 Bergman, Van Buren, Wisconsin. This picture also shows the
 proper time for second hoeing.

The ground around the beets should not be hilled up; throw up just enough soil at the last cultivation to keep the top of the beet from being greened by the sun. A last cultivation should be made when the tops practically cover the row. Do not cultivate too deep or too close to the row at this time. A few leaves may be broken off, but this slight damage will be more than offset by the increased yield due to the tillage operation. The careful grower cultivates close to the rows early in the season and gets all the weeds possible by means of machinery. Weeds should be thoroughly cleaned out.

Blocking and Thinning

Beets should be blocked and thinned at about the four leaf stage. Block out the rows with a six or seven inch hoe, leaving bunches of about an inch, every eight to ten inches, and then thin out to one plant in a place, leaving the healthiest plant. The best yields of both beet roots and sugar are secured when the plants are spaced about ten to twelve inches in the row. Sixteen beets to the rod make a good stand.

It is especially important that the blocking and thinning be started and completed as soon as possible after the beet plants are large enough to work. Yields are greatly reduced when this work is delayed. A bonus is oftentimes paid the laborer by the grower for an increase in yield over a certain tonnage per acre. This is often an incentive to the laborer to do better work and to do it at the right time.

Usually a second and third hoeing are all that are necessary to keep the beet rows free from weeds for the rest of

The ground around the roots should not be killed up
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the row. The soil should be kept for two days for the row
at this time. A few leaves may be broken off, but this slight
damage will be more than offset by the increased yield due to
the tillage operation. The careful grower will also give
to the roots early in the season and give all the water possible
by means of machinery. Water should be thoroughly drained out.

Pricking and Thinning

Seeds should be pricked and thinned at about the four leaf
stage. Prick out the roots with a six or seven inch tool, leaving
punches of about an inch, every eight to ten inches, and then
thin out to one plant in a place, leaving the smallest plants.
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to do better work and to do it at the right time.
Usually a second and third hoeing are all that are neces-
sary to keep the best roots free from weeds for the rest of

the season. The second hoeing should be made about ten to fourteen days after thinning.



Fig. 19. Most of the hand labor on sugar beets is done on a contract by regular beet workers. This picture shows a group of such workers on a ten acre beet field at Carney, Michigan.

Harvesting

The maturity of beets is indicated by a browning of the lower leaves. The date of harvesting is set by the factory as a result of a series of sugar tests on the beets taken at intervals in the fall. The process of sugar manufacture is closely associated with the ripening of the beet. A difference of a week or ten days in harvesting may mean a very great difference in the sugar content. Harvesting usually

the season. The second harvest would be made about ten to
fourteen days after the first.



Fig. 18. View of the field from the sugar cane is done
on a contract by regular pest workers. This is the same
a group of such workers on a sugarcane field in Hawaii,
Michigan.

Harvesting

The maturity of sugar is indicated by a change in the
lower leaves. The date of harvesting is set by the maturity
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intervals in the fall. The process of sugar maturity is
closely associated with the ripening of the cane. A harvest
made of a cane or ten days in harvesting may mean a very
great difference in the sugar content. Harvesting usually



Fig. 20. Boys are sometimes employed to do the hand labor on beets. This shows a bunch of boys on the farm of John O'Brien, Eden, Wisconsin.

begins in late September and continues through the month of October.

A special machine, called the "beet-lifter" is used in harvesting to loosen the beets in the row. The beets are then pulled by hand, knocked together to remove the dirt and thrown into convenient piles for topping. Beets from sixteen to eighteen rows are thrown into one row of piles. A regular beet topping knife is used for removing the leaves and crowns. The crowns are cut off at the base of the lowest leaf. The topped beets are then thrown in piles and covered with the tops to prevent excessive losses of moisture.



Fig. 30. Boys are sometimes employed to do the hand labor on beets. This shows a bunch of boys on the farm of John O'Brien, Eden, Wisconsin.

begins in late September and continues through the month of October.

A special machine, called the "beet-tiller" is used in harvesting to loosen the beets in the row. The beets are then pulled by hand, knocked together to remove the dirt and thrown into convenient piles for topping. Beets from sixteen to eighteen rows are thrown into one row of piles. A regular beet topping knife is used for removing the leaves and crowns. The crowns are cut off at the base of the lowest leaf. The topped beets are then thrown in piles and covered with the tops to prevent excessive losses of moisture.



Fig. 21. A characteristic group in the beet field. The company field man, the farmer and the beet laborers. A man and wife can care for twelve to sixteen acres of beets during the season.

The following paragraph, taken from Michigan Special Bulletin No. 106, explains the reasons for careful topping:

"It is important both to the grower and manufacturer that beets be carefully topped. The crown and leaves of the sugar beet are relatively high in potash and phosphoric acid, and by retaining them on the land or feeding them on the farm, much of the mineral fertility contained in the beet crop is returned. The salts contained in the crown prevent the proper crystalization in the process of sugar manufacture. Consider-



Fig. 31. A characteristic group in the best field. The company field man, the farmer, and the best laborer. A man and wife can care for twelve to sixteen acres of beets during the season.

The following paragraph, taken from Michigan Special Bulletin No. 208, explains the reasons for certain results. "It is important both to the grower and manufacturer that beets be carefully topped. The crown and leaves of the sugar beet are relatively high in potash and phosphoric acid, and by retaining them on the land or feeding them to the farm, much of the mineral fertility contained in the best crop is returned. The salts contained in the crown prevent the proper crystallization in the process of sugar manufacture. Transfer-

ing this, and the fact that the sugar content of that portion of the beet above ground is low, it is apparent that careful topping must be insisted upon by the manufacturer, and he is fully justified in deducting the amount of tare due to poor topping.

Average yields per acre range from eight to ten tons, but good growers frequently secure twelve to fourteen tons and exceptional fields yield from sixteen to eighteen tons per acre."



Fig. 22. A fairly typical sugar beet worker's house. Many of the workers move to the large cities in the winter for employment. Others remain in the community, purchase land and become settled inhabitants.

ing this, and the fact that the sugar content of that portion of the best above ground is low, it is apparent that considerable topping must be insisted upon by the manufacturer, and he is fully justified in deducting the amount of cane due to poor topping.

Average yields per acre range from eight to ten tons, but good growers frequently secure yields of twelve to fifteen and exceptional fields yield from sixteen to eighteen tons per acre."



Fig. 28. A fairly typical sugar cane grower's house. Many of the workers move to the large cities in the winter for employment. Others remain in the community, purchase land and become settled inhabitants.

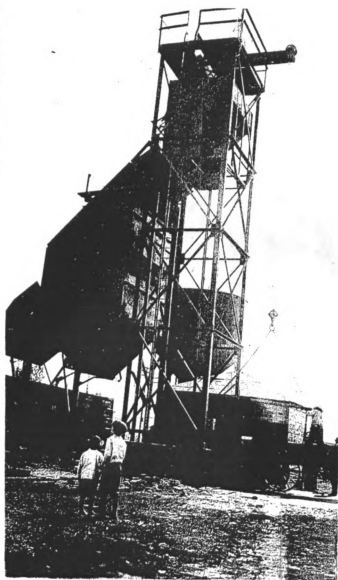


Fig. 23.

Figures 23 and 24: Hauling sugar beets to the station has been made easier by installation of unloading devices. These views show two stages in the operation of the Waverly Beet Hoist at Stephenson, Michigan. A two to five ton load of beets is handled in from three to five minutes.



Fig. 23.

Figures 23 and 24: Handling sugar cane to the station
has been made easier by installation of unloading devices.
These views show two stages in the operation of the newly
Boat Hoist at Stephenson, Michigan. A two to five ton load
of cane is handled in from three to five minutes.

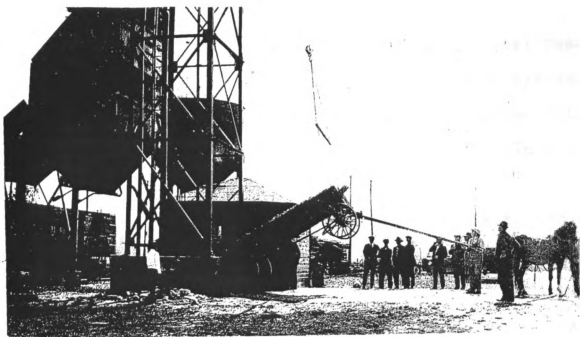


Fig. 34.



Fig. 25. The conveyor type of beet unloader works successfully in the smaller stations.



Fig. 87



Fig. 88. The conveyor type of coal unloader works successfully in the smaller stations.

Crop Rotation

Sugar beets, as do other crops, give the best results when they become part of a proper crop rotation system. It is a very valuable crop in the rotation on adapted soils. It has taught many farmers the value and habit of clean culture. It is a real good dependable cash crop.

Proper crop rotation aids in (1) maintaining the soil fertility, (2) eliminating weeds and insects, and (3) controlling plant diseases. Figure 26 shows diseased areas in a beet field caused by Phoma Root Rot. This field was in beets the preceding year and the diseased areas the following year corresponded closely to the piles of tops from the beets of the previous year. Thus it is observed that beets planted two years in succession on this field are sometimes badly infected with disease.



Fig. 26. Crop rotation aids in controlling fungous diseases. The spots showing Phoma Root Rot were the spots where the beet leaves and crowns were left the fall before, after the crop was harvested.

Crop Rotation

Good results, as in other crops, have been obtained when the potato crop is a part of a proper crop rotation system. It is a very valuable crop in the rotation on steep slopes. It has brought many farmers the value and benefit of clean potatoes. It is a real food staple crop.

Proper crop rotation also is (1) maintaining the soil fertility, (2) eliminating weeds and insects, and (3) controlling plant diseases. Figure 32 shows disease spots in a potato field caused by Brown Spot rot. The disease in potato the preceding year and the disease in the following year corresponded closely to the place of the potato crop in the rotation. Thus it is observed that spots appeared the previous year. Thus it is observed that spots appeared two years in succession on this field and sometimes only in spots with disease.



Fig. 32. Crop rotation also in controlling potato diseases. The spots showing Brown Spot rot were the spots where the best leaves and crops were left the fall before, after the crop was harvested.

The clean culture given the beets is a great asset on every farm. The writer has observed many bad fields of quack grass that have been cleaned up by one crop of beets. It is very necessary in quack infested fields to give the field very careful and thorough preparation and frequent cultivations. Blocking and thinning, and hoeing must also be done well and at the right time.



Fig. 27. The potato is an excellent crop to precede sugar beets in the rotation. A seven acre field of potatoes on the farm of C. J. Salewsky, Menominee, Michigan.

The following rotations are especially well adapted to Michigan conditions:

- (1). First year - clover; 2nd year - corn, beans or potatoes; 3rd year - beets; 4th year - oats, barley or rye, seeded to clover.

The often culture given the state is a great asset on every farm. The river has covered many and fields of duck grass that have been cleaned up by the crop of water. It is very necessary in duck infested fields to give the field very careful and thorough preparation and frequent cultivation. Blooming and thinning, and hoeing also as down well and at the right time.



Fig. 37. The potato is an excellent crop to produce sugar beets in the rotation. A seven acre field of potatoes on the farm of O. J. Calaway, Monrovia, Michigan.

The following rotations are especially well adapted to Michigan conditions:

- (1) First year - clover; 2nd year - corn, beans or potatoes; 3rd year - beets; 4th year - oats, barley or rye, seeded to clover.

(2). First year - clover; 2nd year - corn, beans, potatoes, or beets; 3rd year - oats, barley, rye, or wheat, seeded to clover; 4th year - clover; 5th year - beets, corn, beans, or potatoes; 6th year - oats, barley, or rye, seeded to clover.

(3). First year - corn, beans, or potatoes; 2nd year - beets; 3rd year - oats or barley, seeded to alfalfa; 4th year - alfalfa; 5th year - alfalfa; 6th year - alfalfa.



Fig. 28. Clover is a valuable crop in the sugar beet rotation. A field of clover on the farm of the Menominee County Agricultural School, Menominee, Michigan.

Some apparent peculiarities were observed in connection with the crop rotations with beets. While corn is a very good crop to precede beets, still beets following potatoes usually gave a greater yield than when they followed the corn. This may be due in part to the deeper culture given the potato

- (3). First year - clover; 2nd year - corn, beans, potatoes;
or beets; 3rd year - oats, barley, rye, or wheat, seeded to
clover; 4th year - clover; 5th year - clover, corn, beans, or
potatoes; 6th year - oats, barley, or rye, seeded to clover.
(3). First year - corn, beans, or potatoes; 2nd year -
beets; 3rd year - oats or barley, seeded to alfalfa; 4th year -
alfalfa; 5th year - alfalfa; 6th year - alfalfa.



Fig. 36. Clover is a valuable crop in the sugar beet rotation. A field of clover on the farm of the Kalamazoo County Agricultural School, Kalamazoo, Michigan.

Some apparent peculiarities were observed in connection with the crop rotations with beets. While corn is a very good crop to precede beets, still beets following potatoes usually gave a greater yield than when they followed the corn. This may be due in part to the deeper culture given the potato

crop.

Grains are the ideal crop to follow beets. The clean, deep cultivation required in growing a crop of beets leaves the land in excellent condition for a following crop of small grain: oats, barley, wheat or rye. Lifting and pulling the beets in the fall makes plowing for the following crop unnecessary.



Fig. 29. Small grains: oats, barley, spring wheat and rye are ideal crops to follow the sugar beet in the rotation. A field of Worthy oats on the farm of Wm. Christiansen, Menominee, Michigan.

Beets do very well after clover sod, which has been fall plowed and well prepared. Spring plowed sod, unless especially well prepared is not as well adapted to beet culture.

crop.

Grains are the ideal crop to follow beans. The reason
deep cultivation required in growing a crop of beans leaves
the land in excellent condition for a following crop of small
grain: oats, barley, wheat or rye. Killing and pulling the
beans in the fall makes plowing for the following crop un-
necessarily.



Fig. 38. Small grain: oats, barley, spring wheat and
the are ideal crops to follow the sugar beet in the rotation.
A field of forty crops on the farm of W. J. Christensen, Mar-
quette, Michigan.

Beans are very well adapted to cold soil, which has been
fall plowed and well prepared. Spring plowed soil, unless
especially well prepared is not as well adapted to best cul-
ture.

Another very noticeable feature in connection with the rotation is that corn does very poorly when following beets. Neither the grain nor forage that could reasonably be expected are secured.

The part which the beet crop plays in maintaining soil fertility is discussed in the following paragraphs.

Advantages of Sugar Beet Culture

Not only does the beet crop rank high in acreage value, but there are also other valuable considerations connected with this industry.

The history of the sugar beet in Europe and in the beet growing sections of the United States, shows that the culture of this crop has been very closely associated with improved agriculture. Many good farmers have repeatedly stated: "that they have obtained larger yields of grains after beets than after other crops; that their soil is left in better physical condition; that the beet tops and leaves, when properly cared for and fed to the dairy cow are a wonderful milk producer."

Effects of Beets on the Productivity of Soils

The idea that the beet crop is a "soil robber" is sometimes held by farmers. If the tops and pulp or the resulting manure from feeding them is applied to the land which produced the beets, less fertility is removed by beets than by any other cash crop in Michigan. The following table taken from "The

"Sugar Beet in America" by F. S. Harris gives the amount of mineral plant food removed from the soil by beets and by other crops.

Table 8. Data showing the mineral elements removed from the soil by six of Michigan's important crops.

Crop.	Yield.	Nitrogen.	Potash.	Phosphoric Acid.
Sugar beets.....	10 T.	30.0 lbs.	70.0 lbs.	14.0 lbs.
Potatoes.....	6 T.	47.0 "	76.5 "	21.5 "
Wheat.....	30 bu.	48.0 "	28.8 "	21.1 "
Barley.....	40 bu.	48.0 "	35.7 "	20.7 "
Oats.....	45 bu.	55.0 "	46.1 "	19.4 "
Corn.....	40 bu.	56.0 "	23.0 "	21.0 "

As stated previously, the small grain crop does especially well after the beet crop. Increases in yield of grain following beets have long been recognized in Europe and is now being recognized in the beet growing areas of the United States. The following figures are of interest in this connection. The United States Department of Agriculture studied 115 farms and found that following sugar beets, the average yield of wheat was increased from 28.8 bushels per acre; oats were increased nearly 20 bushels and barley 20 bushels per acre.

The highest yield of rye ever obtained in Menominee County, Michigan, was a field of Rosen rye by Magnus Toberg of Daggett, which, following beets, yielded 42 bushels per acre. The highest yield of spring wheat recorded in the same county was produced by Nels Swanson, Menominee, with Marquis wheat, following beets, which yielded 43.2 bushels per acre. Increased yields of oats and barley, following beets, were also

Sugar Beet in America by F. E. Harris gives the amount of mineral plant food removed from the soil by beets and by other crops.

Table 2. Data showing the mineral elements removed from the soil by six of Michigan's important crops.

Crop	Weight of mineral elements removed per acre (lb.)	Weight of mineral elements removed per acre (kg.)	Weight of mineral elements removed per acre (tons)
Wheat	100	22.5	0.0225
Barley	100	22.5	0.0225
Oats	100	22.5	0.0225
Hay	100	22.5	0.0225
Alfalfa	100	22.5	0.0225
Clover	100	22.5	0.0225

As stated previously, the small grain crop does not yield as well after the first crop. Increase in yield of grain following beets have long been recognized in Europe and is now being recognized in the best growing areas of the United States. The following figures are of interest in this connection. The United States Department of Agriculture studied 115 farms and found that following sugar beets, the average yield of wheat was increased from 28.8 bushels per acre to 30 bushels per acre and barley 30 bushels per acre. The highest yield of the ever obtained in Minnesota County, Michigan, was a field of Reem's No. 12 wheat, which yielded 48 bushels per acre. The highest yield of spring wheat recorded in the same county was produced by Nels Swanson, Menominee, with Karplus wheat, which yielded 43.3 bushels per acre. Increased yields of oats and barley, following beets, were also

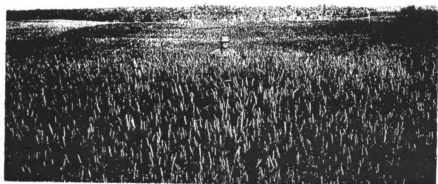


Fig. 30. Larger yields of grains are usually obtained when following a sugar beet crop. Spring wheat following beets on the farm of Chas. Salewsky, Menominee, Michigan.

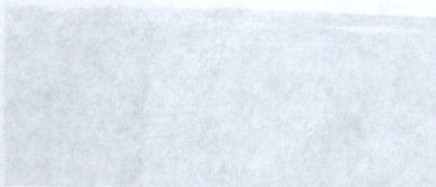


Fig. 30. Larger yields of grains are usually obtained when following a sugar beet crop. Spring wheat following beets on the farm of Chas. Salawsky, Mendota, Michigan.



Fig. 31.

Two pictures which tell the story of increased yield of grain following beets. These are views of two portions of the same field, one portion was in potatoes the year previous, the other (Fig. 33) was in beets. Note increased number of shocks of the grain on the portion following beets. Farm of Mrs. Lizzie Christensen, Taring, DeCoto County, Wis.

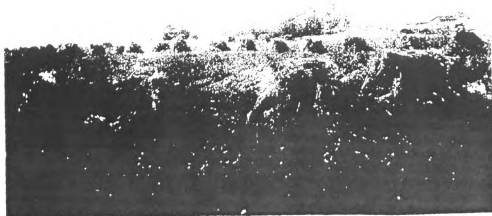


Fig. 33.

secured in this territory.

Soil Is left in Better Physical Condition

The following observations relating to the question, - Why beets improve the soil? - have been made. These are from "The Soil, Fertilizer and Care Necessary to Grow a Good Crop of Sugar Beets," by the writer and published by the Menominee River Sugar Company:

"Grain roots do not penetrate beyond the depth of plowing, which was three to four inches in Europe before the beginning of Sugar Beet culture and in the United States is but five to six inches where sugar beets are not grown. This thin layer flapped over in pancake fashion, year after year, is all the soil from which crops ordinarily draw nourishment. The unstirred soil beneath is too compact for grain roots to penetrate, it contains little or no humus, is not aerated, and hence is not fertile.

Deep Plowing

The sugar beet is a deep rooted plant, and to secure good results, deep plowing and sub-soiling from eight to ten inches is essential in order to make a deep mellow seed bed so that a good long root can develop, and thus produce a large tonnage. By breaking up the soil to twice the usual depth, the lower soil becomes aired out and fertile and permits the roots of cereals and grasses to obtain plant food from twice the usual depth of soil.

secured in this territory.

Soil is left in better physical condition

The following observations relating to the question -

Why does the soil - have been made. These are

from "The Soil, Fertilizer and Cane" written by

Good Crop of Sugar Cane, by the writer and published by

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thin layer flaps over in peninsular fashion, back after rain,

is all the soil which crops occasionally draw nutriment.

The untreated soil beneath is too compact for grass roots to

penetrate, it contains little or no humus, is not aerated, and

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Deep Plowing

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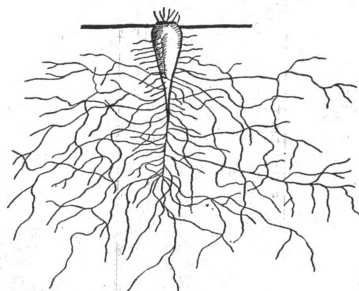
By breaking up the soil to twice the usual depth, the lower

soil becomes rich and fertile and permits the roots of

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depth of soil.

ROOT SYSTEM OF MATURE SUGAR BEET



ONE TON OF ROOTS PER ACRE
REMAIN IN THE SOIL AFTER THE
BEETS HAVE BEEN HARVESTED

THE AIR CHANNELS EXISTING AFTER THE
DECOMPOSITION OF ROOTS PERMITS SOIL
AERATION-MAKES PLANT FOOD AVAILABLE

BEETS ARE NATURAL SUBSOILERS

Fig. 33.

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Roots Penetrate Soil

In preparing a field for beets, the deep plowing increases the amount of soil that can be used by the crops. But this is not all, within three months after the beets are planted, the plant has sent out great quantities of roots which penetrate the lower unstirred hard soil to a depth of several feet.

These roots are from the size of a hair to that of a slate pencil, and when the beets are plowed out in the fall, there is from one to two tons per acre of these fine roots left in the soil. These decay and leave available plant food for the following crops and also leave the sub-soil honey-combed like a sponge with millions of minute channels. Through these channels first the air and then the surface winter moisture penetrated, and it is this moisture and deeper cultivation that aid in increased yields.

During the growing season of plants the amount of moisture in the soil regulates the yield to be obtained and so whatever adds to the conservation and storage of winter moisture in the soil, adds greatly to the yield of the crop. However rich the soil is in plant food, it is of no use unless there is enough moisture so that the roots can absorb it.

In ordinary plowing and cultivation, the soil beneath the top five to seven inches is so compacted that once the surface is full of water the surplus runs away."

Beet Tops and Leaves

Very few other forms of roughage are as good as beet tops to produce milk. They are especially stimulating to the dairy

Roots Penetrate Soil

In preparing a field for seeds, the deep plowing increases the amount of soil that can be used by the crops. But this is not all, within three months after the seeds are planted, the plant has sent out great quantities of roots which penetrate the lower unworked hard soil to a depth of several feet.

These roots are from the size of a hair to that of a small pencil, and when the seeds are plowed out in the fall, there is from one to two tons per acre of these fine roots left in the soil. These decay and leave available plant food for the following crops and also leave the sub-soil honey-combed like a sponge with millions of minute channels. Through these channels first the air and then the surface water moisture penetrates, and it is this moisture and deeper cultivation that aid in increased yields.

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In ordinary plowing and cultivation, the soil beneath the top five to seven inches is so compacted that once the surface is full of water the surplus runs away.

Best Tops and Leaves

Very few other forms of roughage are as good as best tops so produce milk. They are especially stimulating to the dairy

cow. Coming at the time in the fall when pastures are short, they fill an important place for the dairy farmer who is looking for a larger milk yield. In many cases when these tops and leaves are properly cared for and properly fed, they more than pay for the hand labor on the beets.

To secure the most good from this feed, it should not be pastured off in the field but should be piled in bunches about two feet in height and fed out as needed. They may be ensiled by running through an ensilage cutter with an equal amount of straw. They may also be pitted for winter use.

Sugar Beet Seed Production

Previous to the World War practically all the sugar beet seed used in the United States was imported from foreign countries, - Germany supplying the largest amounts. During the war the supply was partially cut off and to insure enough seed to plant the usual acreage, the sugar beet companies started in the seed growing enterprise. The three pictures shown here give some characteristic views of this industry. After the seed beet stalks are cut and cured, they are then threshed with a grain thresher with some of the concaves removed. The seed is then recleaned and bagged for spring shipment.

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To secure the most good from this food, it should not be pastured off in the field but should be dried in a machine about two feet in height and fed out as needed. They may be ensiled by running through an ensilage cutter with an equal amount of straw. They may also be dried for winter use.

Sugar Beet Seed Production

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Fig. 33. A field of Dipy Stecklings on the farm of Wm. Van Den Heuvel, Seymour, Wisconsin. These beets are cared for the same as the regular sugar beets only they are thinned to a plant every four inches instead of every twelve inches. This secures a smaller beet. These beets will be pitted in the fall and used as mother seed beets the following spring.



Fig. 33. A field of Dity Escallonia on the farm of
 Mr. Van Den Heuvel, Oeynawick, Wisconsin. These seeds are
 raised for the same as the regular sugar beets only they
 are thinned to a plant every four inches instead of every
 twelve inches. This secures a smaller head. These beets
 will be given in the fall and used as another seed beets
 the following spring.



Fig. 34. A fifteen acre field of sugar beet seed on the farm of Henry Housman, Seymour, Wisconsin, nearly ready for harvest. The mother beets are planted very early in the spring in rows 36 inches apart each way.



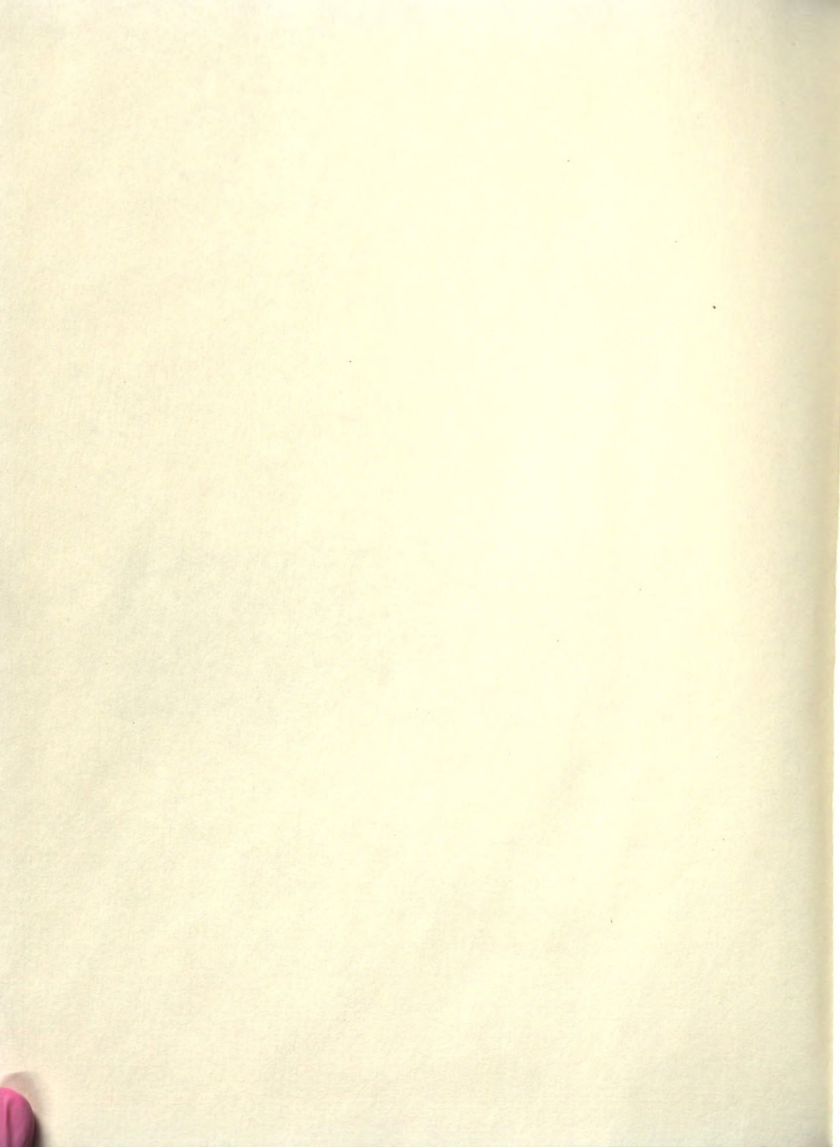
FIG. 34. A fifteen acre field of eight foot seed corn
the farm of Henry Housman, Belmont, Wisconsin, nearly
ready for harvest. The mother plants are planted very
early in the spring in rows 36 inches apart each way.



Fig. 35. Cutting sugar beet seed on the farm of Wm. Van Den Heuvel, Seymour, Wisconsin. A shock may be seen on the right foreground of the picture. Seed beets ripen unevenly and so three or four different cuttings must be made to obtain the best results.



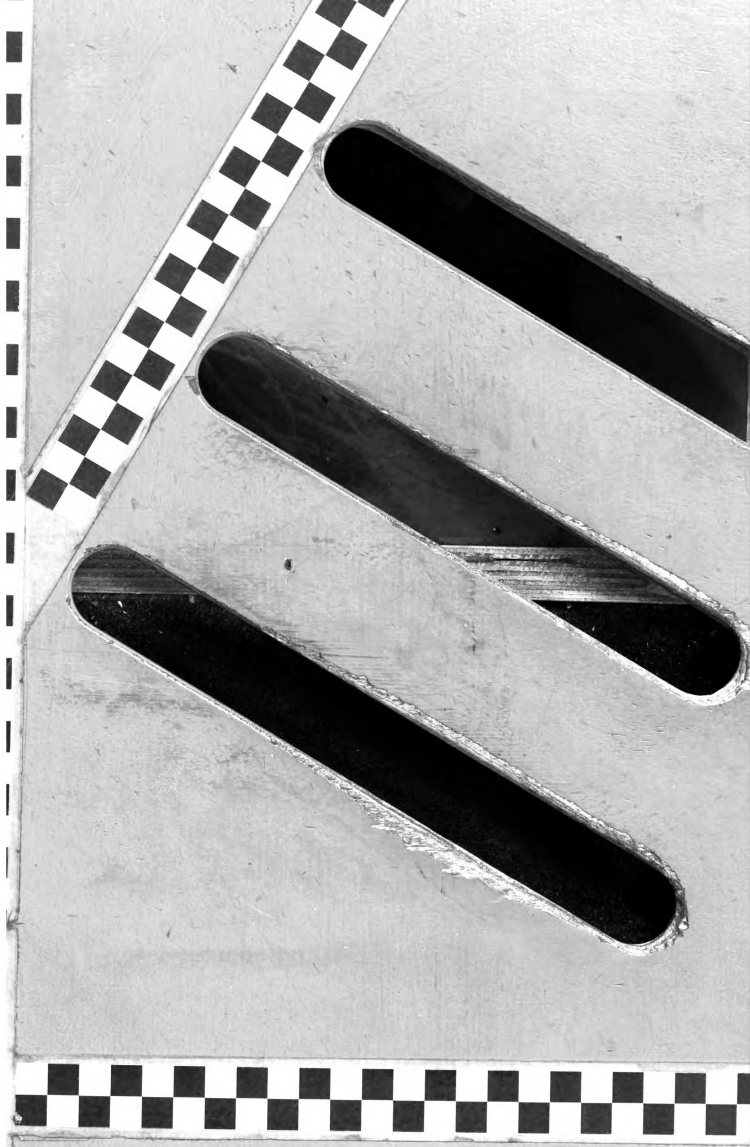
Fig. 33. Cutting edge, based on the line of
 W. Van Den Heuvel, Seymour, Wisconsin. A shock may be
 seen on the right foreground of the picture. Red dots
 appear unevenly and so three or four different settings
 must be made to obtain the best results.



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