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Root Crop Culture in South Dakota

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Contribution From

AGRONOMY DEPARTMENT

A. N. Hume, Head of Department

Root Crop Culture
In South Dakota

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EXPERIMENT FARMS.

Brookings ..... Brookings County
Cottonwood..... Jackson County
Eureka ..... McPherson County
Highmore ..... Hyde County
Vivian ..... Lyman County

SUMMARY.

1. Root crops increase in importance with the growth of the dairy and livestock interests.

2. The common root crops include sugar beets, mangel wurzels, carrots, rutabagas and turnips. Of these, mangels produce the highest tonnage per acre, but sugar beets produce the greatest feed value per acre.

3. A loam soil is best for root crops. Sticky clays increase the difficulty in securing a stand and in harvesting.

4. Root crops make considerable growth during the fall, thus utilizing a part of the season when most crops are dormant. This helps to make them relatively sure.

5. Manuring should be done a year or two before roots are planted and well rotted manure is preferable as it is not likely to introduce weed seeds.

6. Deep thorough plowing is essential. Professor J. H. Shepard recommends subsoiling in addition to the plowing for sugar beets.

7. Seed should be drilled shallow in late April or early May except in the case of turnips and rutabagas which may be either drilled or broadcasted and planted as late as July 15th with some prospect of success.

8. Drill rows should be 24 inches apart and beets six inches apart in the rows for best results, but rows may be spaced as wide as 42 inches if desirable in order to utilize ordinary corn cultivators for the cultivation. Hand thinning and weeding are essential as well as clean cultivation.

9. Roots may be stored either in cool cellars or field pits. Ventilation is essential in either case.

10. Roots are comparable to corn silage as feed crops and should be fed in connection with alfalfa or clover hay or with grass hay and concentrates rich in protein.

ROOT CROP CULTURE IN SOUTH DAKOTA

By Manley Champlin and George Winright

Reasons for Consideration.

As the dairy industry increases in prominence in South Dakota, a demand is created for succulent winter feeding stuff. Some are satisfied with silage alone. Others desire some other form of succulent feed and still others who have no silo and are not in position to get one immediately are looking for some substitute for silage that can be fed in connection with dry feeding stuffs to help keep the cows in good condition and maintain the flow of milk during winter. Root crops of some kind are perhaps the best substitute for silage, in that they furnish succulent feed during winter. Not only cows, but practically all classes of stock appreciate such feed.

It follows then, that if there is a demand for root crops, there is certain to be a demand for information as to the details of their culture and the kind or kinds which are most likely to be cultivated with profit. Such questions as:

"What root crop is most likely to give me the largest yield of feed? Which produce the most sugar per acre? How shall I prepare the ground? How far apart shall I plant the rows? How much thinning is required? How can the crop be harvested to best advantage? How can it be stored?" and many others have already begun to come to this department.

Fortunately a very carefully executed series of experiments have been carried on for a long period of years concerning the culture and breeding of sugar beets, under the direction of Professor James H. Shepard. These experiments have been reported in detail in Bulletins 16, 19, 27, 34, 56, 62, 106, 117, 121, 129 and 142. A summary of all the sugar beet experiments is contained in Bulletin 142, which is still available for distribution. Many of the statements as to culture of root crops contained in this bulletin are based upon results of the above mentioned experiments. In 1914 the agronomy department began a series of experiments which were carried on at

TABLE I.—Annual and average results of root crop tests at Brookings, 1914 and 1915.

Varieties	1914					1915				Averages		
	Percent sugar	Percent dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Percent sugar	Percent dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Pounds roots per acre	Pounds sugar per acre
SUGAR BEETS												
Shepards	11.4	18.2	33000	6006	4752.0	13.3	16.1	18600	3003	2473	25800	3612.9
White Klein	11.2	20.6	33960	6995	4822.0	12.9	18.2	27600	5039	3560	30780	4191.4
MANGELS												
Golden Tankard	5.1	9.5	53520	5084	2729.0	6.2	9.9	39000	3884	2418	46260	2573.7
Mammoth Long Red	3.4	7.2	79080	5693	2388.0	5.1	8.1	39000	3190	1989	59040	2338.8
Red Globe	7.8	12.4	63360	7856	4942.0	8.5	10.7	36600	3938	3111	49980	4026.5
TURNIPS												
Purple Top White Globe	1.9	10.7	30480	3261	579.0	3.2	8.7	1320	116	42	12960	193.3
White Globe	1.0	7.5	42880	3216	428.0	2.5	7.5	3600	271	90	23240	259.4
CARROTS												
Danvers	1.6	10.7	44460	4757	711.4	3.2	8.3	21600	1792	691	33030	701.3
Rubicon	2.3	8.6	25680	22185	590.6	3.2	9.5	21600	2056	691	23640	640.9
Guerande	3.8	10.6	33160	3515	1260.0	3.8	9.0	27600	2484	1048	30380	1154.4
RUTABAGAS												
Sweet German	1.5	11.9	21120	2513	316.8	2.5	11.4	13440	1536	336	17280	326.4
Purple Top Yellow	1.9	10.7	30480	3261	579.1	1.9	10.1	21000	2135	399	25740	489.1

the experiment farms at Brookings, Cottonwood, Eureka and Highmore during 1914 and 1915 to determine the highest yielding root crops for the different sections of the state and also to determine the yield of sugar per acre, obtainable from the various kinds. These experiments form the basis for statements in this bulletin regarding kinds of root crops and variety characteristics. It is the purpose of this bulletin to furnish as definite information as possible regarding the culture of root crops in South Dakota. The comparative yields of root crops on the experiment station farms at Brookings, Cottonwood, Eureka and Highmore are given in the following tables. The sugar determinations in these tables were made by Guy E. Youngburg and the dry matter determinations were made by Henry Shea of the chemistry department.

Table I shows the White Klein to be the highest yielding variety of sugar beets; Mammoth Long Red the highest yielding mangel; White Globe the highest yielding turnip; Danvers the highest yielding carrot and Purple Top Yellow the highest yielding Rutabaga at the Brookings farm as an average for 1914 and 1915. The mangels produced the greatest tonnage but the sugar beets yielded the highest amount of sugar per acre. The Red Globe mangel gave the highest yield of sugar among the mangels. Results of the root crop test at Cottonwood are given in the following table.

The White Klein sugar beet was not in the test both years but gave the highest yield in pounds of roots per acre for 1914. The Red Globe was the highest yielding mangel; White Globe the highest yielding turnip; Guerande the highest yielding carrot and Sweet German the highest yielding rutabaga. During the two years of this trial none of the root crops produced sufficient tonnage to be profitable as stock feed crops. This was due partly to lack of moisture and partly to the nature of the soil. The soil is a sticky gumbo which bakes and cracks after each rain. This baking pinches off the young plants just as they are coming through the surface thus preventing a good stand from being secured.

TABLE II.—Annual and average results of root crops tests at Cottonwood for 1914 and 1915.

Varieties	(1) 1914			1915					Averages	
	Percent sugar	Pounds roots per acre	Pounds sugar per acre	Percent sugar	Percent dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Pounds roots per acre	Pounds sugar per acre
SUGAR BEETS										
Shepards	5.3	1440	76.3	16.0	21.6	2140	463.3	342.4	1790	209.3
White Klein	6.1	1710	104.3	.....	.....	.....	.....	.....	.....	.....
MANGELS										
Golden Tankard	.9	1320	11.9	9.5	16.4	3060	501.8	290.7	2190	151.3
Mammoth Long Red	.2	990	2.0	10.1	14.4	3500	504.4	353.5	2245	177.7
Red Globe	1.9	1380	26.2	8.9	15.6	4470	697.3	397.8	2925	212.0
TURNIPS										
Purple Top White Globe	1.3	330	4.3	2.5	13.3	2500	333.0	62.5	1415	33.4
White Globe	.9	330	3.2	3.0	11.9	5750	685.0	172.5	3055	87.9
CARROTS										
Danvers	.....	.....	.....	2.3	12.9	5850	759.0	134.5	.....	.....
Rubicon	.2	180	36.0	2.5	12.2	4625	567.0	115.6	2405	58.0
Guerande	1.7	480	8.2	2.5	11.2	9650	1084.0	241.2	5065	124.7
RUTABAGAS										
Sweet German	1.5	1020	15.3	3.8	17.9	5830	1039.0	220.0	3410	117.8
Purple Top Yellow	.9	630	5.7	2.5	15.2	5450	831.6	136.2	3040	70.9

(1) Roots were not ripe enough to figure the dry matter.

This difficulty is greatest with the beets and mangels. Better yields can doubtless be secured on this type of soil after it is mellowed by repeated manuring.

The results of a test comparing root crops at Eureka are presented in Table III. In this test the White Klein proved to be the highest yielding sugar beet, the Red Globe was the highest yielding mangel; Purple Top White Globe the highest yielding turnip; Rubicon the highest yielding carrot and Purple Top Yellow the highest yielding rutabaga. As at Brookings, the Mammoth Long Red mangel produced the greatest tonnage per acre, the Red Globe showed the highest per cent of sugar among the three mangel varieties tested and the sugar beets produced the most sugar per acre in spite of their lower gross yield.

Results of a root crop trial at Highmore are presented in Table IV. In this test the Shepard was the highest yielding sugar beet; Mammoth Long Red the highest yielding Mangel; White Globe the highest yielding turnip; Danvers the highest yielding carrot and Sweet German the highest yielding rutabaga. Here, the sugar beets produced almost as great a gross tonnage as the mangels and considerably more sugar. The rutabagas gave better results at Highmore than in any of the other tests. This was the only locality where the mangels were exceeded in total yield.

TABLE III.—Annual and average results of root crop tests at Eureka for 1914 and 1915.

Varieties	1914					1915					Averages	
	Percent sugar	Percent dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Percent sugar	Percent dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Pounds roots per acre	Pounds sugar per acre
SUGAR BEETS												
Shepards	19.4	24.5	5202	1274.0	1009.0	15.0	21.0	19610	4123.0	2941.0	12406	1975.3
White Klein	14.8	21.4	10998	2353.6	1627.0	9.9	15.8	20720	3288.0	2051.0	15859	1839.4
MANGELS												
Golden Tankard	7.4	13.8	12600	1738.8	932.4	5.1	10.0	16280	1632.0	830.2	14440	881.3
Mammoth Long Red	.....	.....	15198	.....	.....	4.2	9.2	35520	3278.0	1491.8	25359	.....
Red Globe	9.5	15.1	12798	1932.0	1215.8	6.3	10.7	28120	3008.0	1771.5	20459	1493.6
TURNIPS												
Purple Top White Globe	1.1	12.7	2202	279.7	24.2	1.9	9.7	28860	2816.0	548.3	15531	286.2
White Globe	.8	14.9	8598	1281.0	68.8	1.5	8.6	15170	1313.0	227.5	11884	148.1
CARROTS												
Danvers	3.0	12.8	3600	460.8	108.0	2.8	10.0	24420	2454.0	683.7	14010	395.8
Rubicon	1.9	12.5	9000	1125.0	171.0	2.3	9.7	27380	2677.7	629.7	18190	400.3
Guerande	2.3	12.3	3102	381.5	71.3	3.4	10.1	21830	2224.0	742.2	12466	406.7
RUTABAGAS												
Sweet German	1.5	11.9	3402	404.8	51.0	1.9	11.2	13320	1503.8	253.0	8361	152.0
Purple Top Yellow	1.7	13.4	4998	668.7	85.0	1.5	10.2	21830	2226.0	327.4	13414	206.2

TABLE IV.—Annual and average results of root crop tests at Highmore for 1914 and 1915.

Varieties	1914					1915					Averages	
	Percent sugar	Percent (a) dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Percent sugar	Percent dry matter	Pounds roots per acre	Pounds dry matter per acre	Pounds sugar per acre	Pounds roots per acre	Pounds sugar per acre
SUGAR BEETS												
Shepards	16.3	20.2	1320	266.4	215.2	15.0	20.4	38500	7854.0	5775.0	19910	2995.1
White Klein	15.6	23.4	1392	325.7	217.1	15.7	20.9	33000	6923.4	5181.0	17196	2699.1
MANGELS												
Golden Tankard	10.5	17.0	4680	795.6	491.4	8.3	12.4	39300	4873.2	3261.9	21990	1876.6
Mammoth Long Red	2.4	16.9	6480	1095.0	155.5	9.9	14.6	41400	6077.5	4098.6	23940	2127.1
Red Globe	11.4	19.2	1224	235.1	139.5	9.5	13.5	38500	5201.3	3657.5	19862	1898.5
TURNIPS												
Purple Top White	.6	17.3	420	72.7	2.5	1.8	10.2	21500	2205.9	387.0	10960	194.7
White Globe	.2	14.0	4440	621.6	8.9	2.6	8.9	28500	2556.4	741.0	16470	374.9
CARROTS												
Danvers	6.8	17.7	2640	467.3	179.5	4.5	10.1	27500	2774.7	1237.5	15070	708.5
Rubicon	6.5	19.3	600	115.8	39.0	4.0	10.2	25500	2616.3	1020.0	13950	529.5
Guerande	7.8	20.0	960	192.0	74.9	4.5	9.8	15500	1532.9	697.5	8230	386.2
RUTABAGAS												
Sweet German	1.0	17.7	5400	955.8	54.0	2.8	11.6	48500	5630.8	1358.0	26950	706.0
Purple Top Yellow	2.9	17.4	6480	1127.5	187.9	1.9	13.6	34800	4760.6	661.2	20640	424.5

(a) The roots were slightly withered, making the percentages of dry matter and sugar high.

Kinds of Root Crops.

The common root crops include both shallow and deep rooted types. They may be listed as follows:

I. Shallow rooted crops.
   1. Turnips.
      a. White Globe.
      b. Purple Top White Globe.
   2. Rutabagas.
      a. Sweet German.
      b. Purple Top Yellow.

II. Deep rooted crops.
   1. Sugar beets.
      a. Shepard.
      b. White Klein.
   2. Mangels.
      a. Golden Tankard.
      b. Mammoth Long Red.
      c. Red Globe.
   3. Carrots.
      a. Danvers Long Yellow.
      b. Rubicon.
      c. Guerande.

Turnips.

Turnips are used as feed crops in the British Isles and in northern Europe. They are comparatively shallow rooted, producing their growth near the surface of the ground. As a rule they do not compare favorably with sugar beets or mangels in yielding power as a full season crop. The carbohydrates consist of sugar, gums, pectoses and cellulose. As compared with beets the percentage of sugar is very low and they do not furnish as much nutritive matter, pound for pound as do the beets. On the other hand, turnips are a quick growing crop and can be grown as a half season or catch crop to better advantage than the other roots. For example, a crop of turnips can be grown early in the spring and removed in time to plant millet or a crop of peas may be grown early and removed in time to plant turnips by the middle

of July. The turnips can be grown at either end of the season. The other root crops require the entire season for their growth. There are two types of turnip, globe and flat. Two varieties of the globe type were included in the comparative yield tests above reported.

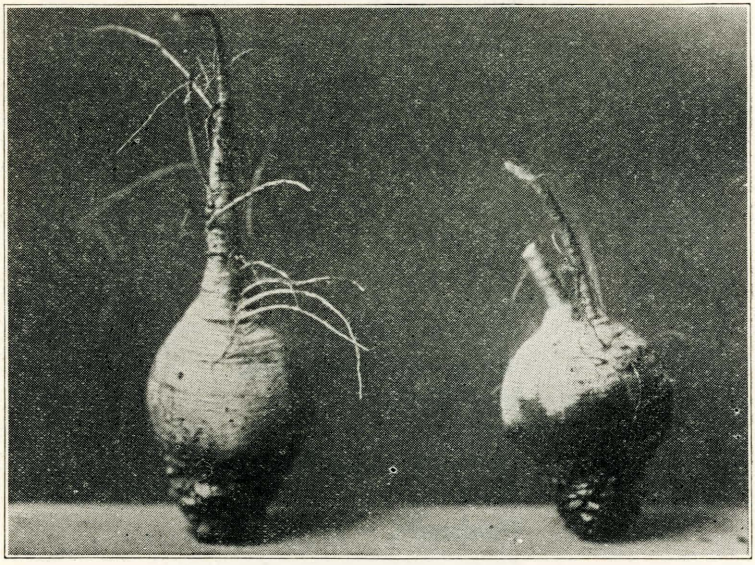

FIG. 1.—PURPLE TOP WHITE GLOBE TURNIPS.

This variety has a white flesh and white skin except that the upper surface which grows above ground is purple. The roots are suitable both for table use and stock feed, but the White Globe has usually produced a greater yield in our tests. The White Globe is similar in appearance except that it is all white.

Rutabagas.

Rutabagas are closely related to turnips both in appearance and in uses. Their flesh is usually of a yellowish color and they have a very distinct flavor. This flavor is likely to become strong and the flesh to become woody if seasonal conditions are unfavorable. They form root somewhat deeper than turnips. Their place as a farm crop is similar to that of turnips. They do not compare favorably with beets either in yield or nutritive value as a full season crop.

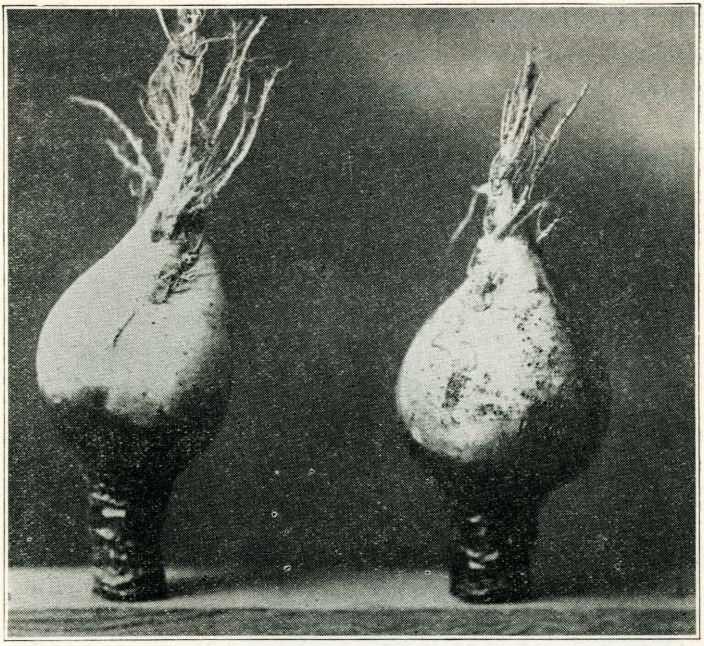

FIG. 2.—PURPLE TOP YELLOW RUTABAGA.

This variety has yellow flesh and yellow skin except at the top which is purple. Its keeping qualities are good.

Sugar Beets.

Sugar beets grow rather deeply in the earth, very little of the root being exposed above the surface. Their flesh is of a yellowish color and their shape that of a cone. They have been selected for many years with the idea of securing a beet with a high per cent of sugar. As beet sugar is readily digestible, the percentage of sugar and the total sugar produced per acre as shown in the accompanying table is a fairly good index of their relative feeding value. It can be stated with considerable assurance that sugar beets are the most profitable root crop to grow for feeding purposes, and this is particularly true if the soil is well prepared. Some of the

other root crops having roots growing near the surface are better when for some reason the soil can not be properly prepared for beets.

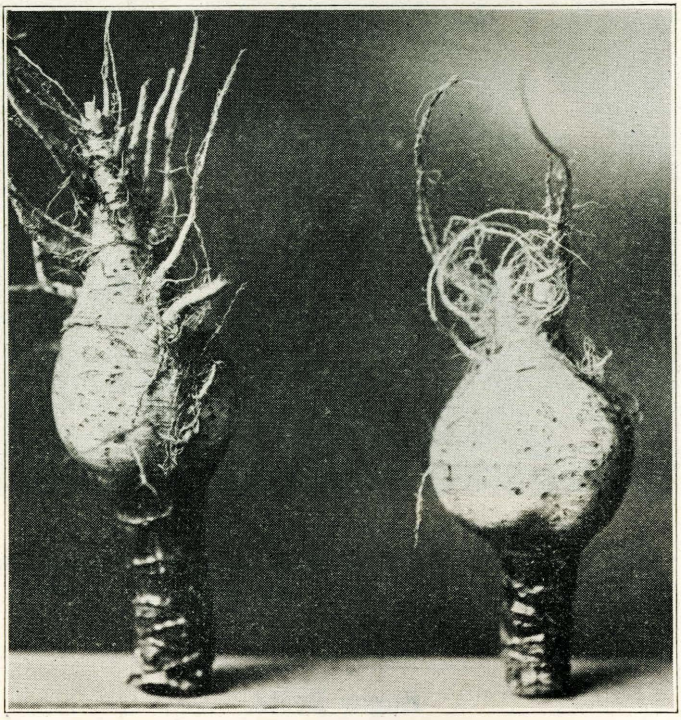

FIG. 3.—SWEET GERMAN RUTABAGA.

This variety has white flesh which is milder and sweeter than the flesh of the yellow varieties. It has globe shaped roots, upright leaves and a small neck.

The varieties included in this trial were the White Klein, one of the best commercial sorts and one of Professor Shepard's pedigreed varieties which was originated by selection for high sugar content at the experiment farm at Brookings. This variety is here designated as the Shepard.

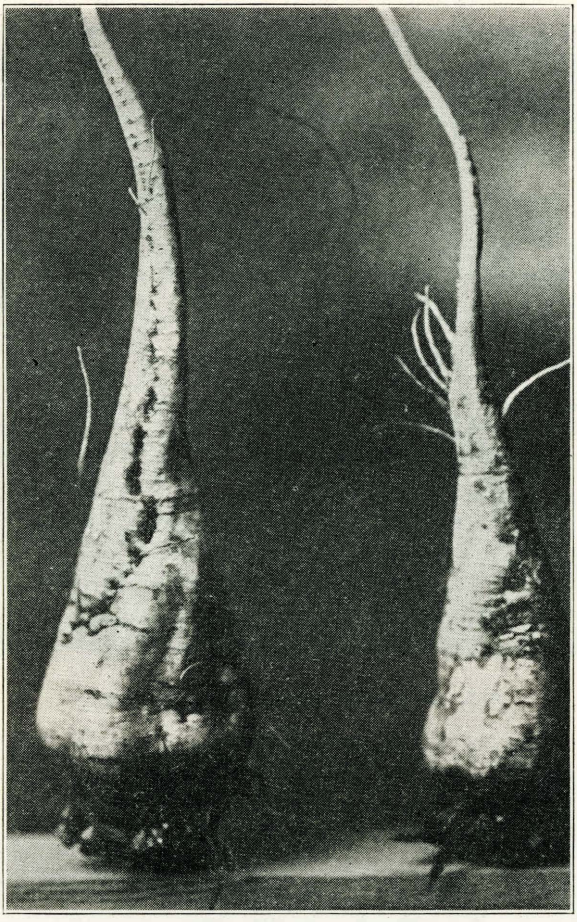

FIG. 4.—SHEPARD SUGAR BEET.

Mangel Wurzels.

Mangel wurzels have many points in their favor as farm crops. Their total yield per acre is greater than that of any of the other root crops. The mangels produce greater tonnage per acre but the sugar beets usually exceed them in yield of dry matter and yield of sugar per acre. Mangels are of two distinct colors, yellow and red and of two distinct shapes, the long tapering and

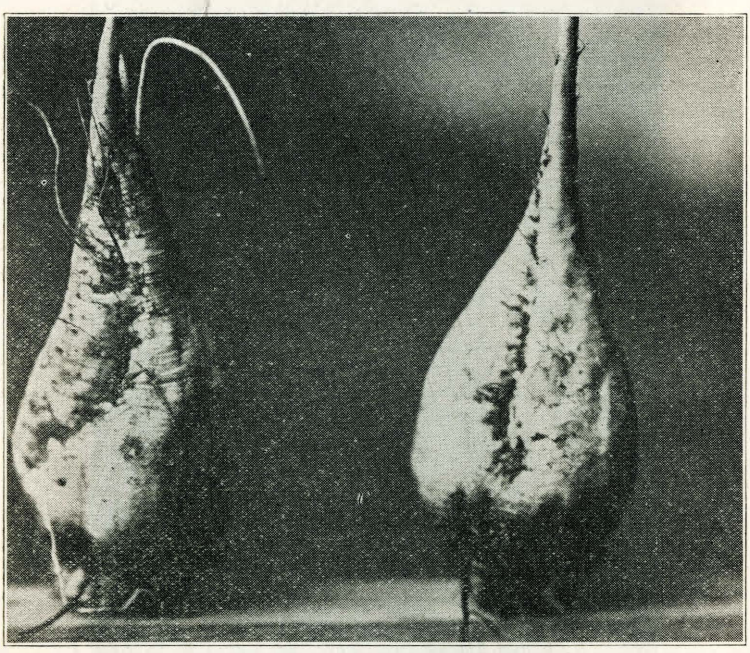

FIG. 5.—WHITE KLEIN SUGAR BEET.

Fig. 6.—Sugar Beet Plants Bearing Seed, Brookings, 1914. Sugar beets require two years to grow a crop of seed from seed.

the globe. The three varieties tested include representatives of each type, namely, the Golden Tankard, the Mammoth Long Red and the Red Globe. Of these, the Mammoth Long Red has produced the highest yields. Mangels resemble sugar beets in that they are capable of utilizing the entire season for their growth. The months of September and October are rarely thought of as growing months. Nevertheless, these valuable root crops continue growing until near the end of October.

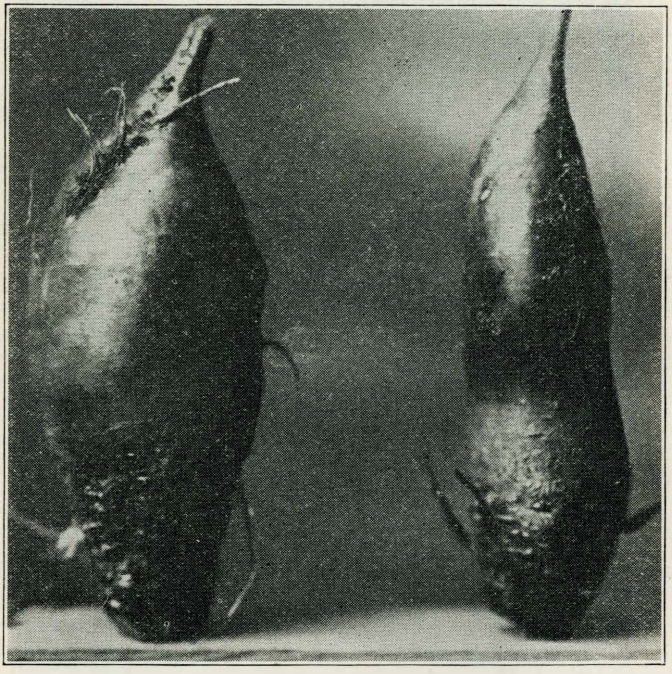

Fig. 7.—Golden Tankard Mangel Wurzel.

Some of the leading dairymen prefer this variety because of its excellent quality in spite of the fact that it usually produces less than the Mammoth Long Red. The stock seem to relish it better.

CARROTS.

The carrot has finely divided leaves and roots of various shapes and colors. Most varieties taper from

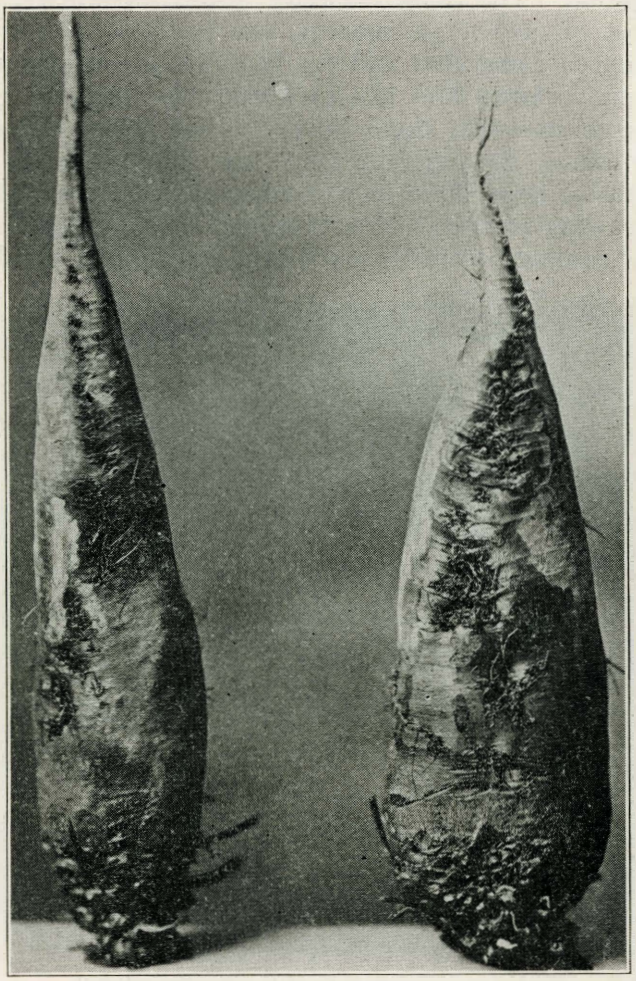

FIG. 8.—MAMMOTH LONG RED MANGEL-WURZEL

This is the highest yielding variety tested and also ranks well in nutritive qualities. The roots are straight and well formed. Its skin and flesh are deep red in color, the tops are small. It keeps well in a cool cellar. The Red Globe variety is similar in color but more nearly globular in shape and as a rule is not as productive.

the crown to the tap root though some are cylindrical for most of their length. The color of the flesh and skin may be white, yellow, orange, or red. The feeding value of carrots is about the same as that of mangels. Carrots are not commonly grown for feed but are considered excellent by some of the best horsemen for keeping horses in good condition. When fed to horses carrots are usually chopped up and mixed with the grain.

The three varieties tested have orange colored flesh and represent both the long rooted and the stump rooted types.

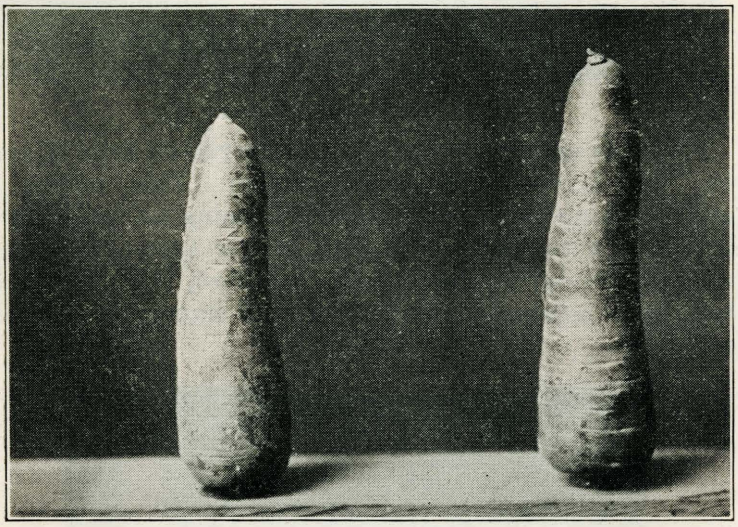

FIG. 9.—DANVERS LONG YELLOW

This is a long cylindrical variety of good size and of a rich, dark orange color. Its flesh is very close in texture and has very little core.

GROWING THE CROP.

The most desirable soil for root crops is a well drained rich loam or sandy loam. A clay soil is not desirable as the young plants may be pinched off when the soil dries after a rain, thus giving a poor stand, the roots do not develop well and it is difficult to harvest them.

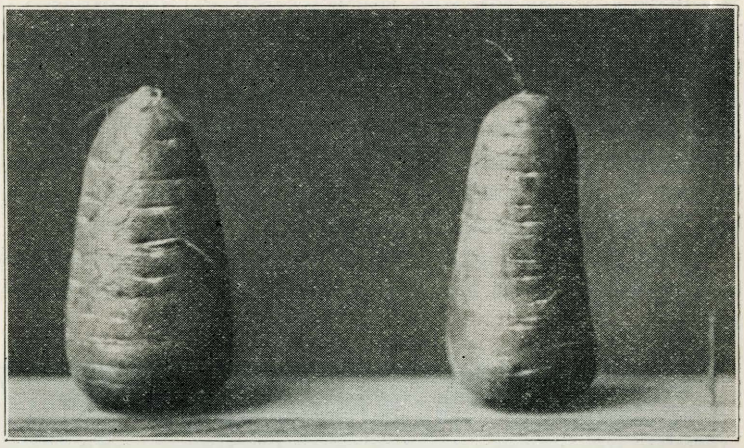

FIG. 10.—GUERANDE CARROT

This is an early maturing stump rooted type of carrot. The leaves grow close together. This makes it possible to grow a crop without thinning as much as is necessary with varieties having larger tops. This variety is excellent for table use as the flesh is of fine quality and it retains its tenderness and flavor remarkably well.

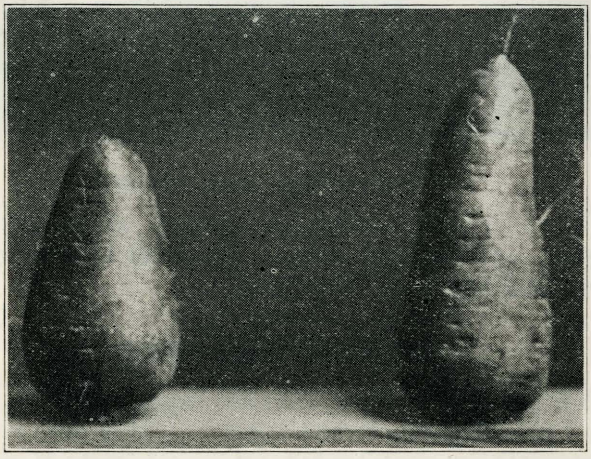

FIG. 11.—RUBICON CARROT

This variety is of the half long type, being some-

what thicker than the Danvers. The skin is very clear and the flesh is deep orange in color.

The usual method of preparing land for root crops is to plow it about seven inches deep in the fall and double disk and harrow it thoroughly the following spring. It is considered advisable to subsoil four or five inches deeper than the ground is plowed for the deep rooted crops, especially where the ground has been plowed at the same depth for several years.

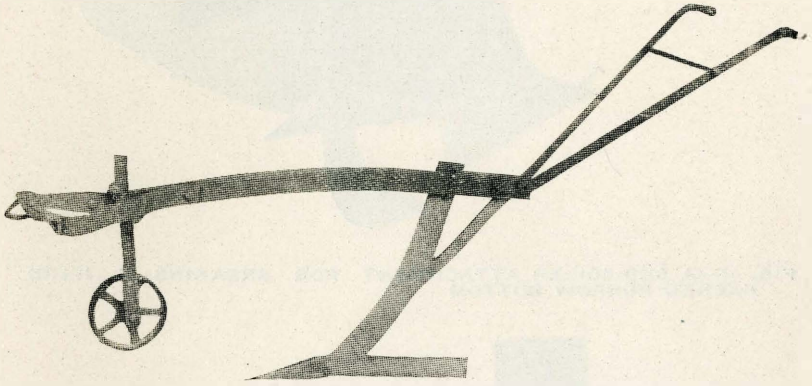

FIG. 12.—A COMMON SUBSOILER

METHODS OF SEEDING.

The time of seeding and the amounts to sow vary with the different kinds of root crops The amount to sow also varies with the distance apart at which the rows are planted. Sugar beets are usually sown at the rate of from 10 to 15 pounds per acre early in May. The most practical method is to drill the seed in rows 24 inches apart as this makes it possible to cultivate them with a one horse cultivator or a regular beet cultivator. If necessary the root crops may be sown in drills 36 to 42 inches apart in order to use an ordinary corn cultivator for cultivating them. The yields reported in this bulletin were obtained from drill rows planted three feet apart. Higher yields per acre are obtained by planting the drill rows closer together however.

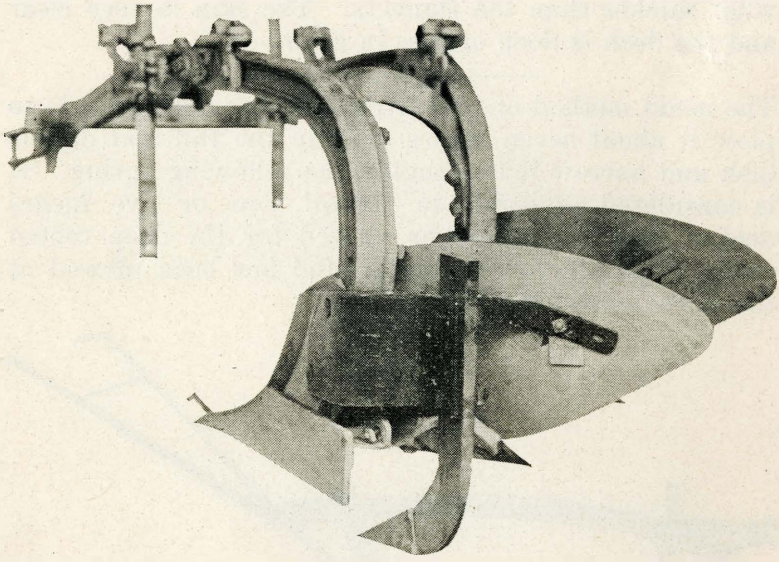

FIG. 13.—A SUB-SOILER ATTACHMENT FOR BREAKING. A .HARD PACKED FURROW BOTTOM

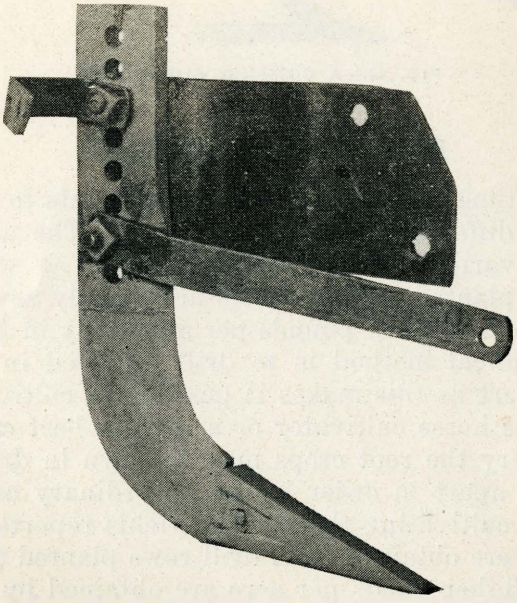

FIG. 14.—AN ENLARGED CUT OF THE SUBSOILER ATTACHMENT SHOWN IN FIGURE 14

The land used for root crops should be fertile and possess an abundance of organic matter. This condition can be brought about by the liberal use of well rotted manure. Barnyard manure which is not well rotted is likely to contain viable weed seeds. It also makes cultivation of the young plants very difficult. The

FIG. 15.—SUGAR BEETS IN ROWS 30 INCHES APART AT BROOKINGS

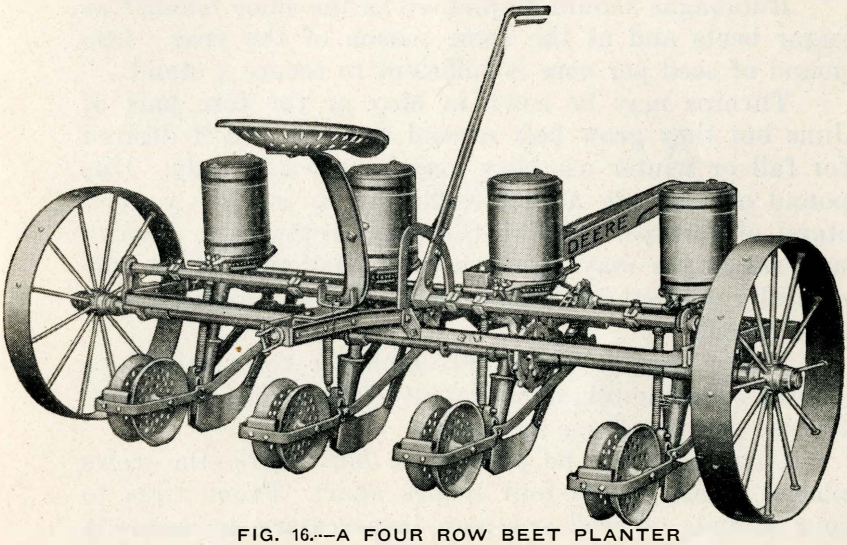

FIG. 16.—A FOUR ROW BEET PLANTER

most practical method is to carry on a crop rotation which makes it possible to apply the manure a year or two before the root crop is grown. For example, well manured land which has grown a crop of corn silage would be very desirable for root crops.

FIG. 17.—SUGAR BEETS IN ROWS 24 INCHES APART AT BROOKINGS

Rutabagas should be planted in the same manner as sugar beets and at the same season of the year. One pound of seed per acre is sufficient to secure a stand.

Turnips may be sown in May or the fore part of June but they grow best in cool weather and if desired for fall or winter use they may be sown in July. One pound of seed per acre is sufficient to secure a good stand of turnips. Unlike the other root crops, turnips and rutabagas may be sown broadcast and raised successfully without cultivation if the land is unusually free from weeds.

If the crop is to be cultivated the rows should be spaced wide enough, about twenty-four inches, to permit the use of a one horse cultivator.

Carrots should be planted in May with the rows placed about twenty-four inches apart. From three to four pounds of seed per acre is necessary to secure a

stand.

Mangel-wurzels are usually planted during late April or early in May in rows from twenty-eight to thirty-six inches apart and from six to eight pounds of seed per acre is required. The seed should not be covered more than one inch deep unless it is necessary to plant deeper in order to secure moisture enough for germination.

CULTIVATION.

The root crops should be cultivated as soon as it is possible to follow the rows. If the rows are only 24 inches apart a one horse cultivator or a beet cultivator is used. It is frequently desirable to mark out the rows with a hand cultivator before beginning cultivation with horse implements. The cultivation should be continued until the leaves are large enough to be injured by the machine. Considerable hand work is necessary to keep the crop free from weeds in the rows and to thin the plants so that the roots can develop.

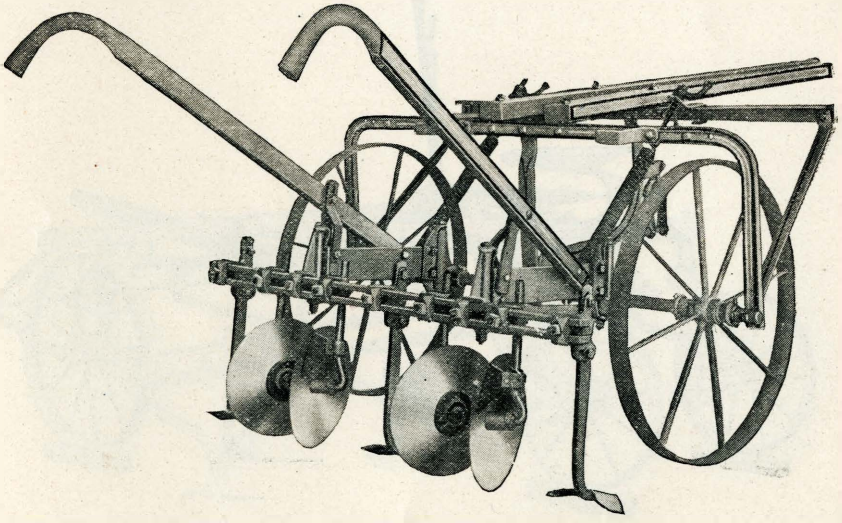

FIG. 18.—A TWO ROW BEET CULTIVATOR

HARVESTING.

Root crops should be harvested when growth stops in the fall, which is shown by withering of the outer leaves. A light frost will not injure beets, carrots or rutabagas. Turnips are more exposed because much of their growth is above ground. Ordinarily, mid-October is the best time for harvesting and storing these crops.

Care should be taken in removing the roots from the ground to prevent injuring any of them, for bruised roots are likely to decay. It is customary to loosen the roots by plowing a furrow close beside the row or by using a beet digger which runs under the row and loosens the roots so that they may be pulled by hand easily. The tops are then cut off and the roots thrown in piles to be hauled to the cellar or pit for storing. Beet tops may be thrown in windrows and cured as they make excellent feed for cattle, sheep or hogs.

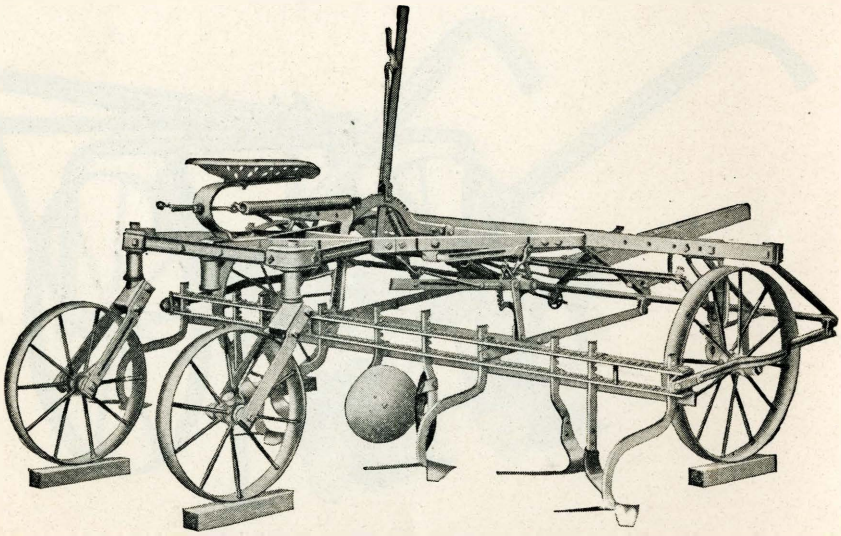

FIG. 19.—A THREE ROW BEET CULTIVATOR

STORAGE.

Root crops should be stored as soon as they are dug to avoid danger of freezing. The three conditions necessary for successfully storing root crops are, good ventilation, freedom from dampness and a temperature just above the freezing point. A cool cellar is the most convenient place for storing but ordinary pits can be used, if necessary. If a pit is used the roots should be placed in the pit and covered with alternate layers of straw and earth. The depth of covering should be increased as the weather becomes colder and a ventilator should be placed in the pit and covered with alternate layers of straw and earth. The depth of covering should be increased as the weather becomes colder and a ventilator should be placed in the center of the pit.

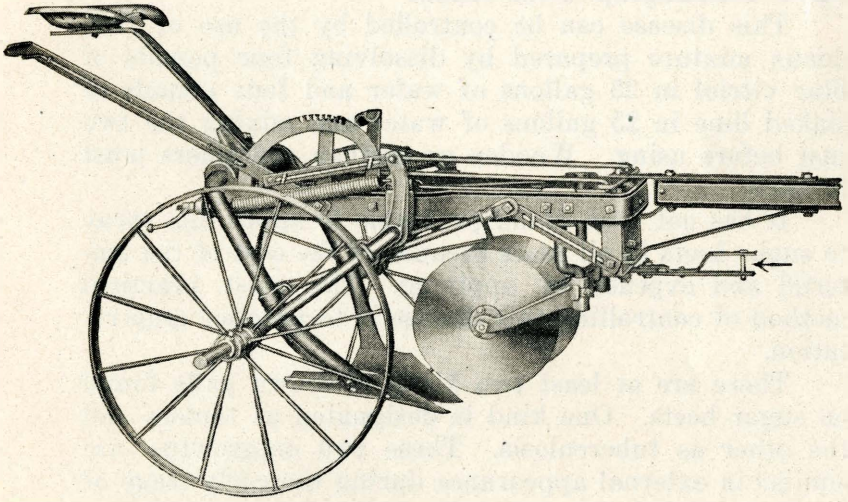

FIG. 20.—A MODERN BEET PULLER

DISEASES OF BEETS.

Sugar beets like potatoes are subject to disease both on the leaves and underground parts. The disease affecting the leaves of the sugar beet is known as the

leafspot. It is caused by a mold called *Cercospora beticola*. The fungus penetrates the tissues of the leaf and leaf stem of the beet thus impairing growth and reducing both the tonnage and the sugar content of the beets affected. The first appearance of leaf spot is a tiny point which is nearly white, indicating that the destruction of the tissue of the leaf has begun. These spots increase more or less rapidly in size and become brownish in color. The spots are nearly round at first but soon become irregular in shape thus indicating the length of time the plant has been affected with the disease. This disease always attacks the outer leaves first. Thus the plant always has a few of the newest leaves in the center of the whorl which are healthy. For this reason a plant is seldom completely destroyed by the leaf spot disease. An affected plant always has an elongated crown with a number of dead leaves at the top and a few healthy leaves standing up in the centre.

This disease can be controlled by the use of Bordeaux mixture prepared by dissolving four pounds of blue vitriol in 25 gallons of water and four pounds of slaked lime in 25 gallons of water and mixing the two just before using. Wooden or earthen containers must be used.

It has not been found profitable to apply this spray to sugar beets in all cases because of the cost of the material and expense of applying. The most practical method of controlling this disease is to practice crop rotation.

There are at least two kinds of crown galls found on sugar beets. One kind is designated as tumors and the other as tuberculosis. These two outgrowths are similar in external appearance during the early stage of development but they are easily distinguished during the later stages of growth. Both galls are usually smooth during the early stages but the tuberculosis galls eventually become decidedly rough, cracked, dark, and finally decay. The tumor gall remains comparatively smooth, seldom cracks, does not usually decay and often retains its firmness until the beets are harvested. The

gall disease is very widely distributed over Europe and is rapidly increasing in this country. The galls do not appear until the beets are from one-fourth to one-half grown which is usually about mid-summer. They may push out from the beet and appear to be a part of the beet itself or they may occur on slender necks, but the connections are always short so that the gall lies close to the beet. There may be any number of galls on a beet. It was thought for a long time that this disease was the result of a mechanical injury which the beet received from cultivation but it has since been proved conclusively that the disease is produced by a bacterium. The organism producing "tumors" is known as *Bacterium tumefaciens* and the one producing "tuberculosis" is designated as *Bacterium beticolum*. Analytical work has been done on beet galls; also on beets affected with galls and on pure beets. The purpose of this work was to determine the effect of galls on the purity and composition of the beet on which they occured and also the purity and composition of the galls themselves.

The results showed clearly that the galls were lower in sugar content than any part of the beet on which they occured and further indicated that gall formations have a tendency to reduce the sugar content of the beets to which they are attached. The total yield of beets per acre does not seem to be appreciably affected by this disease except in those cases in which the galls cause the beet roots to decay. (a) This disease can be controlled by a proper system of crop rotation which changes grass or grain crops with the root crops, thus removing the host plant for a time from the crown gall organism.

SUGAR BEETS AND OTHER ROOTS AS STOCK FEED.

By James H. Shepard, Chemistry Department.

During the development of high sugar content beets at this station, much interest has been awakened in sugar beets as a feeding crop, especially where it is difficult to grow corn for silage.

(a) Townsend C. O. Field studies of the crown gall of sugar beets. U. S. Dep't. of Agriculture, Bureau of Plant Industry.

The characteristics of roots as feed are not well understood, especially in this country. First of all, roots are very low in protein, rarely carrying much over one percent. The fat content is also low, scarcely reaching that figure. The crude fibre averages around five percent. The ash content runs from one to two percent. Sugar beets and mangels carry no starch, their carbohydrates being almost entirely cane sugar.

The nutritive ratio of sugar beets is wide, running about 1 to 20. From these facts it follows that roots alone are unsuitable for feeding. They go best with high protein bearing fodders like alfalfa or clover hay. In case ordinary hay is fed, some narrow ratio concerntrate like bran or oil meal must be a part of the ration. When fed in this way there is no other feed that excels sugar beets. This is also true to a much less extent of mangels and other root rcops. Sugar is very fattening for stock, and as it is possible to grow sugar beets running from 15 to 20 percent sugar with a tonnage of from 15 to 25 tons per acre, it is readily seen that there are great possibilities in sugar beets as a feeding crop.

One thing must be borne constantly in mind, however, and that is that all root crops are laxative. Consequently, care must be used not to feed too many at one time, in order to avoid purging. When fed in proper amounts, roots are both tonic and laxative and will therefore be found most useful during the long season from grass to grass. Roots are easily kept during winter either in root cellars or in pits in the field.

Many experiments have shown that roots may be grown for $25.00 per acre ready to feed. In the case of sugar beets this means that they will cost the grower from $1.00 to $2.00 per ton. This means that sugar beets can be grown more cheaply than silage. No costly machinery is required. The acreage is only half as great for the beets and the ordinary farm help can harvest and store the crop. As to the nutritive value of the two feeds, there is not so much difference as one would sup-

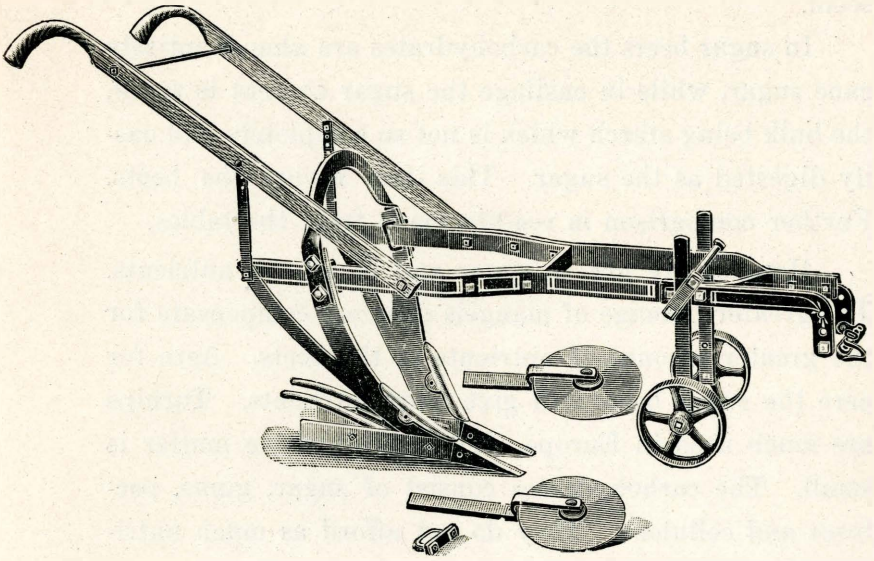

FIG. 21.—A SIMPLE TYPE OF BEET PULLER

pose. The following analysis is for an average corn silage grown on the college farm at Brookings:

Moisture	68.1
Ash	1.70
Ether Extract (Fat)	1.80
Crude Protein	2.86
Crude Fibre	5.40
Carbohydrates (starch and sugar)	20.86

From statements made and from root analyses given on previous pages it appears that there is a close resemblance between silage and sugar beets. Some chief differences are the following. In silage the protein is about twice as great as in beets. Moreover the protein in corn is more suitable for animal nutrition, owing to the kinds of protein present. Some of the small amount of protein in beets is not used by the animal. But in both cases a protein bearing supplement is required, therefore the difference is not so striking as it might

seem.

In sugar beets the carbohydrates are almost entirely cane sugar, while in ensilage the sugar content is small, the bulk being starch which is not so completely and easily digested as the sugar. This item favors the beets. Further comparison is readily made from the tables.

Mangels are low in sugar and in all the nutrients. The greater tonnage of mangels does not compensate for the greater amount of nutrients in the beets. Acre for acre the sugar beets will give more nutrients. Turnips are much used in Europe. The dry nutritive matter is small. The carbohydrates consist of sugar, gums, pectoses and cellulose. They do not afford as much nutriment as beets.

Carrots are much relished by animals. The carbohydrates are sugar, starch, pectoses and cellulose. They are much poorer in sugar than beets. Rutabagas have little sugar. As compared with beets they are inferior. It is almost certain that for our conditions beets are hardier and more productive and more nutritious than any of the roots mentioned.

It does not pay to grow large roots. Not only is the yield of nutritive matter per acre decreased, but extra expense harvesting and storing are incurred. Moreover the animal is forced to eat much larger quantities of the large roots. The size of the roots is governed by the width of the rows and the spacing in the row. Probably the best distances for horse cultivation for this country are rows 24 inches apart with spacing in the row of 6 inches. Any increase of these distances causes loss in sugar and dry matter.