

MSU Extension Publication Archive

Archive copy of publication, do not use for current recommendations. Up-to-date information about many topics can be obtained from your local Extension office.

Root Crops for Forage in Michigan
Michigan State University Agricultural Experiment Station
Special Bulletin
H.C. Moore, E.J. Wheeler, Farm Crops
Issued August 1931
17 pages

The PDF file was provided courtesy of the Michigan State University Library

Scroll down to view the publication.

Oakley Lardie

Special Bulletin No. 216

August, 1931

ROOT CROPS FOR FORAGE IN MICHIGAN

H. C. MOORE and E. J. WHEELER



AGRICULTURAL EXPERIMENT STATION

MICHIGAN STATE COLLEGE

Of Agriculture and Applied Science

SECTION OF FARM CROPS

East Lansing, Michigan

ROOT CROPS FOR FORAGE IN MICHIGAN

H. C. MOORE AND E. J. WHEELER

Root crops for forage are extensively grown in northern Europe and Canada. In the United States, their production is largely limited to the northern States and is especially important in sections where silage corn cannot be grown successfully. Michigan, Wisconsin, Washington, Colorado, New York, and Minnesota lead in the production of root crops for forage. The total acreage of root crops in the United States according to the 14th census report (1920) was 83,333 or about four times the acreage grown in 1909. This growth in acreage indicates that the value of roots for livestock feed is becoming more generally recognized.

In Michigan, root crops are of most importance in the Upper Peninsula and in those sections of the Lower Peninsula that have growing seasons too short for the production of corn. The roots furnish an excellent succulent feed for dairy cows and other livestock and can be used as a substitute for silage. Their production should be especially encouraged in the newer agricultural regions, where farms may not be equipped with silos and where only a few cows are kept. The ease with which roots may be stored and fed makes them ideal as a succulent feed for the small herd of ten cows or less. Usually, one acre planted to such roots as mangels or rutabagas will furnish feed during the winter and spring months for four or five cows.

Feeding Value of Roots¹

Stock feeders consider root crops of great value for their tonic effect in keeping animals in good condition. Therefore, they are being more extensively grown by dairymen who have cows on advanced register tests and by farmers who are producing breeding stock. The advantage of feeding root crops to horses, cattle and sheep in fitting them for fairs and shows is generally recognized and is the common practice of showmen.

Root crops are valuable as substitutes for silage and also as a partial substitute for grain and concentrates. A pound of dry matter in roots has the same feeding value as a pound of dry matter in corn silage. Roots carry about 80-90 per cent water and can be fed in larger quantities than silage which carries about 70-75 per cent moisture.

The value of roots as a feed for livestock is becoming more generally appreciated by farmers many of whom are now considering them an essential part of their crop program.

Mangels, especially, produce a heavy tonnage per acre and possess valuable succulent characteristics. They are especially valuable for dairy cows, particularly for those on high official tests because they have an effect on the digestive system which helps to prevent digestive disorders which might follow heavy feeding of concentrates. Beef cattle and sheep both relish

¹(Reference, "Feeds and Feeding"—Henry and Morrison.)

them and the European feeder of these animals attains some surprising results with a liberal use of roots usually pulped or sliced and mixed with cut or chaffed roughage and meal.

Carrots are especially valuable for growing colts, brood mares, stallions, and idle work horses. In fitting horses for show, there is nothing better than carrots as an aid to digestion when animals are on heavy feeding. The Scotch groom also claims a big advantage in boiled or pulped beets or rutabagas mixed with chopped roughages and crushed or cooked grain for conditioning a show string of horses.

Considerable quantities of roots, mangels and carrots, are produced and fed to Michigan State College livestock each year.

Table I.—The digestible nutrients in different classes of roots and corn silage.

	Total dry matter in 100 lbs.	Digestible nutrients in 100 lbs.				
		Crude prot.	Carbo-hydrate	Fat	Total	Nutritive ratio
Mangels.....	9.4	0.8	6.4	0.1	7.4	8.2
Rutabagas.....	10.9	1.0	7.7	0.3	9.4	8.4
Turnips.....	9.5	1.0	6.0	0.2	7.4	6.4
Carrots.....	11.7	1.0	9.1	0.2	10.6	9.6
Corn silage (well matured).....	26.3	1.1	15.0	0.7	17.7	15.1

Recommended Root Crops for Michigan

The four most important root crops for Michigan are mangels, rutabagas, turnips, and carrots. Mangels and rutabagas are most commonly grown in the Upper Peninsula as they generally outyield turnips and carrots and keep better in storage. In southern Michigan, rutabagas and turnips are often seriously injured by plant lice and many growers are planting more carrots and mangels for stock feed. A brief description of the four classes of roots and a few of the important varieties of each is here given.

The Mangel (*Beta vulgaris L.*) was introduced into the United States about the middle of the 18th Century from Germany. Varieties of mangels are classified according to shape as long, half-long, tankard, ovoid, and globe.

The Mammoth Long Red is one of the most important varieties. The roots are very large and comparatively straight. The flesh is white and is tinged with rose. The Giant Feeding Half-Sugar is another leading variety. The roots are bronze-green above the ground and are grayish-white below and the flesh is white. This variety yields well and has a high nutritive value, being especially rich in sugar. The Golden Tankard is a variety that develops large roots and small tops. The bottom of the root is usually larger than the top. The color is light gray above ground and deep orange below. The flesh is yellow and is zoned with white.

The Rutabaga or Swedish Turnip (*Brassica campestris L.*) and the **Turnip** (*Brassica rapa L.*) are supposed to have originated from plants native to the coasts of western and southern Europe. The rutabaga is distinguished from the turnip by having a short neck and smooth bluish-green leaves. The turnip has no neck and its leaves are grass-green and covered with rough, harsh

hairs. The turnip generally matures in about 60 to 90 days while the rutabaga requires 120 days or more. The most important varieties of rutabagas are American Purple Top, Bangholm, and Golden Tankard. The American Purple Top is the variety most commonly grown in Michigan. American Purple Top, White Globe, Cowhorn, and Purple Top Yellow Aberdeen are a few common turnip varieties.



Fig. 1.—Various types of mangels—Globe type on the left; Golden Tankard (center); Mammoth Long Red (right).

The Carrot (*Daucus carota L.*) has been developed from the wild carrot which is native of Europe and Asia. The principal varieties grown for stock feeding are Large White Belgian, Maude S, Danvers Half-Long, and Oxheart. The Belgian and Maude S. have very large white roots. The other two varieties have smaller roots of yellow color.

Comparative Yields of Different Root Crops

In tests conducted at the Michigan State College, mangels have usually given somewhat better yields than other root crops. A summary of the average yields secured from three years tests with miscellaneous roots is presented in Table 2.

In this experiment, the seed was planted in rows two feet apart. The mangels and rutabagas were spaced 12 inches apart; the turnips eight inches and the carrots seven inches. All were thinned and cultivated at the same time. The mangels and carrots were planted about May 15 and the turnips and rutabagas about June 10.

Table II.²—Yield tests of miscellaneous root crops, M. S. C. 1924-1925-1926.

Variety	Average yield per acre—tons
Check (sugar beet).....	13.91
Giant Feeding Half-Sugar mangel.....	21.67
Danish Giant Sludstrap mangel.....	20.61
Kirches Fodder mangel.....	20.46
Mammoth Long Red mangel.....	20.15
Golden Tankard mangel.....	15.08
Mammoth or Tankard rutabagas.....	15.44
Bangholm rutabaga.....	12.99
American Purple Top rutabaga.....	11.05
Amber Globe turnip.....	18.64
Cowhorn turnip.....	17.77
Maude S. carrot.....	17.38
Oxheart carrot.....	16.38
Average of groups:	
1. Mangel.....	19.60
2. Turnip.....	18.20
3. Carrot.....	16.94
4. Rutabaga.....	13.16

In the Upper Peninsula, rutabagas and mangels are the most important root crops. Rutabagas are generally preferred to mangels as the seed often germinates better and gives better stands, especially on heavy soils which are subject to baking. Furthermore, rutabaga plants develop more rapidly than mangels making weed control less difficult. Rutabagas are easier to harvest and do not freeze as readily as mangels. In some of the yield tests conducted, rutabagas have out-yielded mangels.

In Table III are given the results of yield tests conducted on farms in Alger, Gogebic, Houghton and Iron counties in 1925, 1929, and 1930.

Table III.³—Upper Peninsula root crop yield tests, 1925-1929-1930.

	Alger County		Gogebic County	Houghton County	Iron County
	1925 yield per acre—tons	1929 yield per acre—tons	1925 yield per acre—tons	1930 yield per acre—tons	1930 yield per acre—tons
Golden Tankard mangel.....	24.48	19.5	10.77	19.22	16.7
Long Red mangel.....	16.69		12.88		
Suttons Prize Taker mangel.....					15.9
Purple Top rutabaga.....	22.26	30.7	9.85	25.21	15.9
Cowhorn turnip.....	27.03		14.15		

²(Yield tests with Miscellaneous Root Crops, Michigan Quarterly Bulletin—May, 1928—Vol. X, No. 4.)

³(Reported by C. E. Skiver, B. D. Kuhn, and D. L. Clanahan, Farm Crops Extension Specialists, Michigan State College.)

Costs of Production

*In 1919, a cost account was kept of producing and harvesting one acre of rutabagas at the Upper Peninsula Experiment Station, Chatham. The cost per acre for growing the crop was \$38.10; the cost of harvesting and



Fig. 2.—The two roots on left are Maude S. Carrots. The large root at right is Giant Feeding Half-Sugar Mangel.

storing was \$34.50, making the total cost \$72.60. The yield was 20 tons per acre and the total cost per ton was \$3.68.⁴ Delwiche kept cost records in growing rutabagas at Superior, Wisconsin. The average for 10 years was

*The costs here reported do not include overhead charges, such as taxes and interest.

⁴(Upper Peninsula Exp. Sta. Report—B. W. Householder.)

\$41.20 per acre; the average yield per acre was 11.76 tons and the cost per ton was \$4.32. In three years tests in Wisconsin, the production cost of rutabagas was \$4.06 per ton at Ashland and \$5.49 per ton at Conrath.⁵ On the heavier soils in northern Wisconsin, it was reported that root crops can usually be grown more cheaply than corn silage. In sections where corn does well, however, corn silage can be produced more cheaply than roots. Good cultural practices to help insure high yields will materially reduce the costs of production per ton and make root crops more profitable.

Climatic and Soil Requirements

Usually root crops thrive best in sections having cool, moist growing seasons, and plenty of sunshine. Mangels and rutabagas are better adapted to the more northern districts while turnips and carrots have a wider climatic adaptation. Mangels seem to withstand drought conditions better than the others.

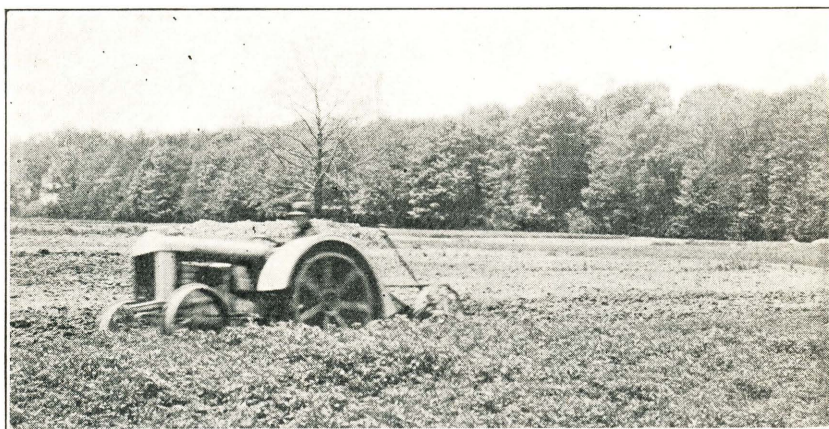


Fig. 3.—Fall plowing permits earlier fitting of the seed bed in the spring.

Root crops thrive best on deep, fertile, well-drained clay loam or sandy loam soils that are well supplied with humus and are retentive of soil moisture. Rutabagas grow better than the other root crops on heavier clay soils, provided the drainage is good, while carrots grow better than mangels on comparatively light soil. Carrots and turnips withstand acid soil conditions better than mangels. All root crops, however, prefer soils that are sweet or alkaline. Good drainage is especially important for large yields, as the roots do not recover if checked by excessive moisture early in the season. If the water table is very high, the roots may be ill-shaped.

Root Crops in the Rotation

In order to secure the best yields and to check fungous diseases, root crops should not be grown on the same ground more often than once in three years. They can be grown to good advantage after alfalfa, sweet clover, or clover;

⁵(Profitable Root Crops, Wisconsin bulletin 330.)

however, if old sods are broken up, it is better to precede root crops with a cultivated crop such as potatoes or beans in order to have the soil comparatively free from weeds. Oats and barley are good crops to follow the roots. Clover or alfalfa can be seeded with the oats or barley.

The following rotations are suggested:

A—

First year, clover; second year, corn, beans, or potatoes; third year, roots; fourth year, oats, barley, or rye seeded to clover.

B—

First year, clover; second year, corn, beans, potatoes, or roots; third year, oats, barley, rye, or wheat seeded to clover; fourth year, clover; fifth year, roots, beans, or potatoes; sixth year, oats, barley, or rye seeded to clover.

C—

First year, corn, beans, or potatoes; second year, roots; third year, oats or barley seeded to alfalfa; fourth year, alfalfa; fifth year, alfalfa.

Preparation of the Seed Bed

For high yields, it is necessary to prepare the seed bed thoroughly so that it is deep and mellow and well firmed. Fall plowing of land for root crops is particularly desirable as it allows the clover or alfalfa sod that is turned under to decompose better and permits earlier fitting of the soil in the spring. The depth of plowing will be determined largely by the depth to which it was previously plowed. Generally a depth of 6-10 inches is desirable. It is not a good plan, however, to turn up much of the sub-soil at any one plowing.

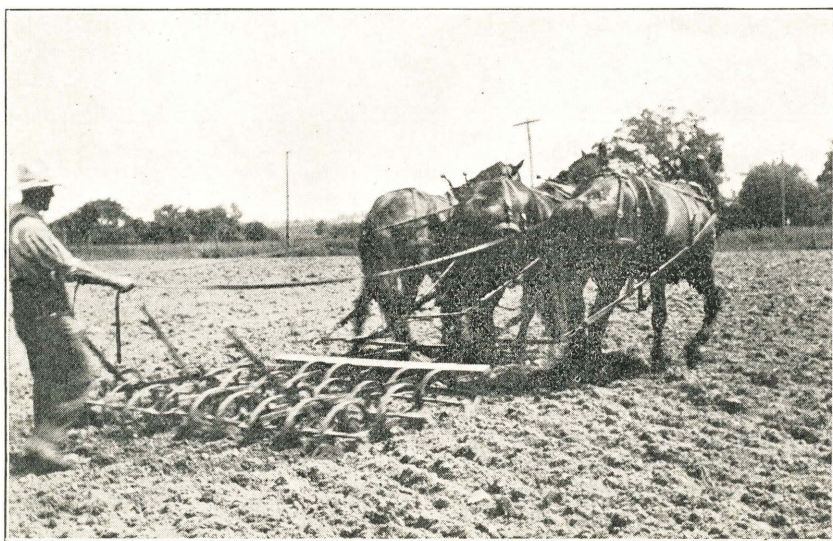


Fig. 4.—Frequent disking and harrowing will make the soil fine and mellow.

If plowing is delayed until spring, it should be done early, just as soon as the soil is in good working condition. In case a sod is broken up in the spring, it is advisable to disk it well before plowing, this helps in making a fine mellow seed bed and prevents the formation of air pockets which cause the soil to dry out. The fitting of the seed bed should be done as early as possible in the spring to conserve moisture. Frequent disking and harrowing will make the soil fine and mellow and will be an important factor in killing weeds and grass, thereby saving much of the expense of hand hoeing later in the season. On lighter soils and especially if plowing has been delayed until spring, the use of a cultipacker or roller will firm the soil and make a better seed bed.



Fig. 5.—The use of a cultipacker will firm the soil and help insure a good stand.

Just before planting, a plank drag should be used to break any crust that may have formed and to level the surface soil and make it free from lumps. Heavy clay soils should not be pulverized too finely as they are then more liable to form a crust when wet. This hardening of the surface soil causes poor stands.

Fertilizers for Root Crops

Stable manure adds plant food and organic matter to the soil and promotes the action of favorable soil bacteria. It should be applied at the rate of 8 to 10 loads per acre, one year previous to the planting of root crops to permit it to rot thoroughly. This lessens the risk of a serious infestation of weeds. It should never be applied in the spring previous to planting unless it is thoroughly rotted.

Well rotted stable manure may be applied to rough fall-plowed land during the winter and disked thoroughly in the spring. After the first crop of weeds has started growth, the field should be disked again and prepared for the seeding of root crops. This practice oftentimes is an aid to good germination of root crop seed, as the rotted manure holds moisture at the surface of the ground and prevents baking of the soil, thus favoring the rapid growth of the young plants. Killing the weeds previous to planting may lessen materially the hand hoeing later in the season and reduce production costs.

On soils that are acid, lime should be applied at the rate of one to two tons of ground limestone or six to eight loads of marl per acre and thoroughly worked into the soil as the seed bed is being prepared, or it may be applied before the land is seeded to alfalfa or clover when these crops are included in the rotation.

High analysis commercial fertilizers applied broadcast or with a fertilizer drill just previous to seeding generally give increased yields. The usual rates of application recommended are 400-600 pounds per acre, and some of the best analyses of fertilizer are 4-16-4; and 4-16-8. When applied broadcast, the fertilizer should be harrowed into the soil to the depth of several inches.

Time of Planting

Mangels and carrots require a full growing season and should be planted as soon as danger from severe frosts is past and the soil is in good working condition. For the Upper Peninsula and the northern section of the Lower Peninsula, the usual date is from May 10-20. For the southern section of the State, the planting date is about the same as that for corn.

Rutabagas for winter feeding are generally planted the last week in May or the first week in June. When wanted for an early crop, they should be planted early in May. Turnips do not require as long a growing season as the other roots and are generally planted about June 10-15. For a catch-crop, they may be planted as late as July 5. In wet, cold seasons, especially on heavy soils, the seeds are likely to rot in the ground and it is, therefore, advisable under these conditions to delay planting until the soil is moderately warm and in good working condition.

Methods of Planting

The best yields of good quality roots are secured by sowing the seed in drills. Sometimes rutabagas and turnips are sown broadcast on new land or turnips may be sown broadcast in oats using 1-2 pounds of seed per acre. After the oats are harvested, the turnips are pastured with sheep or hogs. The broadcast method of sowing, however, generally gives poor results, especially if the soil is foul with weeds or if the season is very dry.

The hand drill is one of the best tools for seeding root crops, as it can be set to sow the seed evenly and lightly. Sometimes grain drills with seed sowing attachments are used, the seed being placed in the compartments so that the rows will be the right distance apart. To lessen the labor costs of weeding and cultivation the rows should be long and straight and from 30 to 36 inches apart to allow horse cultivation. If hand cultivation is practiced, the rows may be 18-24 inches apart. Where a sugar beet or root crop cultivator is used, the rows can be spaced 22 to 24 inches apart. With the common cultivator it is necessary to have the rows spaced 30-36 inches apart.

Depth of Planting

The depth of planting will depend upon the type of soil and its condition. Mangels and rutabagas should be planted one-half to three-fourths inch deep. The shallower planting being recommended for heavy soils or those that are wet. Turnips and carrots should be planted one-fourth to one-half inch deep. Shallow planting generally gives the best germination, provided the soil is moist and the seeds are covered to a uniform depth.

Rate of Seeding

Good yields depend largely upon good stands, so it is necessary to use plenty of seed to insure a good stand. When sown in drills 30 to 36 inches apart, the following amounts of seed per acre are recommended—mangels six to eight pounds; rutabagas and turnips one and one-half pounds; carrots one and one-half or two pounds.



Fig. 6.—Root crops should be hoed at frequent intervals to control weeds and grass in the rows.

Blocking and Thinning

Proper thinning is very necessary to get good yields of well-shaped roots, and it is important that the thinning be done early when the plants have developed three or four true leaves. If thinning is delayed, the plants become leggy and get a set back from which they do not fully recover. Mangels, rutabagas, and carrots are generally ready to be thinned in about 30 days after the seed is sown. Turnips are ready for thinning in about 20 days.

The first process of thinning is to bunch or block the plants. A sharp hoe five or six inches wide should be used to cut out all plants except little bunches spaced eight to 12 inches apart. After the bunching is done, the plants should be thinned so that only one plant is left in each bunch. Care should be taken to leave the largest, most thrifty plant. In a week or two, it may be necessary to go over the rows again and thin out any surplus plants that are left. Two or more plants should never be left in the same bunch as it will result in small, ill-shaped roots.

The distance between the plants depends somewhat upon the variety and the distance between the rows. With rows 30 inches apart, the following

distances are recommended: Mangels (long varieties) 12 inches; rutabagas 10-12 inches; turnips 10 inches; carrots 6-8 inches. If the rows are farther apart than 30 inches, the distance between plants can be somewhat less than above given and somewhat greater if the rows are closer than 30 inches.

Thorough Cultivation Essential

Root crops must have frequent and thorough cultivation to control weeds and to maintain a soil mulch. This is particularly important during the first month or so when the plants are small, as it is very easy for them to be seriously checked in growth by weeds or a crusted soil. The first cultivation should be made as soon as the rows can be seen, though some growers have



Fig. 7.—Harvesting a field of rutabagas with a potato digger.

obtained excellent results with two-wheel hand cultivators equipped with surface scraping blades used before the plants are up. The second cultivation should be given whenever weeds are present. If the soil is properly prepared before planting, cultivation to loosen the soil is not necessary.

In small fields, hand cultivators are often used for the first two or three cultivations. However, horse-drawn two-row cultivators are more economical of time and labor if the rows are 30-36 inches apart. Other types of cultivators that may be used are the ordinary walking cultivator and the sugar beet cultivator.

The first two cultivations should be close to the plants and quite deep. Shields should be used on the cultivator to prevent soil being thrown on the young plants. Subsequent cultivations should be shallow to avoid injury to the feeding roots. Row cultivations should generally be discontinued about the middle of August when the plants are large and fill the middle of the rows.

To reduce labor costs, every effort should be made to eliminate as much hoeing as possible by thoroughly preparing the seed bed and by destroying

all weeds with a harrow before planting. However, to keep the field free of weeds, it is usually necessary to hoe between the plants two or three times. The first hoeing should be done soon after the plants are thinned and other hoe cultivations made when grass or weeds start growth. In hoeing and cultivating, care should be taken not to cover the rows; it is better to draw the soil away from the rows than to hill them up. The grower should remember that frequent careful cultivations are necessary for good yields.



Fig. 8.—Topping mangels with a knife. The tops may also be twisted off by hand.

Control of Insects

Rutabagas and turnips are often subject to serious attack by the turnip aphid or louse. The lice congregate on the undersides of the leaves and on the tender leaves at the center of the plant. Badly infested plants are stunted or killed outright.

Complete control of this insect is very difficult as the curling leaves of the plants protect it from contact sprays that may be applied. The best control measure for lice is to spray with one pint nicotine sulphate to 100 gallons of water in which five pounds of soap have been dissolved. Spraying should be done early, as soon as the lice appear and should be repeated whenever the lice again begin their attacks. A good sprayer preferably a potato sprayer carrying 250 pounds or more pressure should be used and the nozzles directed so as to wet the undersides of the leaves.

Flea beetles often severely injure turnips, rutabagas, and mangels by eating small shot-like holes in the leaves. The injury is most severe when the plants are small. The most effective control for flea beetles is to spray the

plants thoroughly with Bordeaux mixture and arsenate of lead, using five or six pounds of arsenate of lead to 100 gallons of Bordeaux mixture. The first spray should be applied when the flea beetles first begin their attack. It may be necessary to make other spray applications at intervals of 7-10 days depending upon the severity of the flea beetle attack.

Harvesting

Root crops should be harvested before severe frosts occur. Mangels and carrots will not withstand as much frost as turnips and rutabagas, and are usually harvested the last week in September, while turnips and rutabagas should be harvested before October 10.

In harvesting mangels, a common plow is often used to throw the soil away from one side of the row or a beet lifter may be used to loosen the

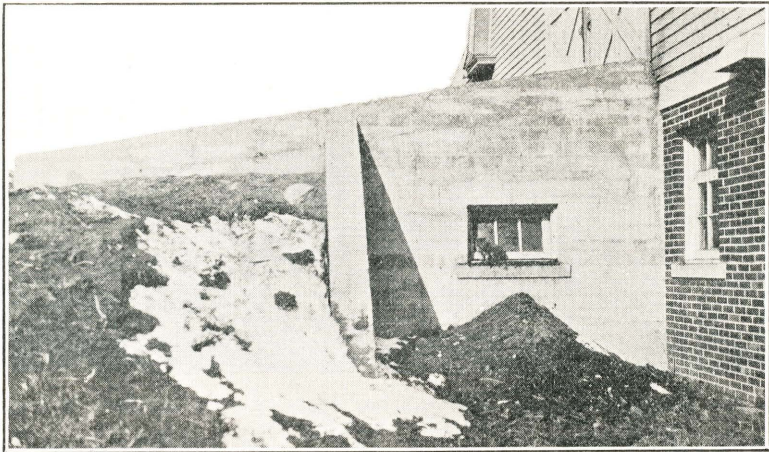


Fig. 9.—This root cellar under the driveway to the dairy barn is conveniently located.

roots so they may be pulled out by hand. Generally roots from two to four rows are thrown together in a windrow from which they are loaded into a wagon and hauled to storage.

Topping is generally done as the roots are pulled or from piles in the windrow. The usual practice of removing the tops is to twist them off by hand, though they may be cut off with a heavy-bladed knife. Sometimes topping is done with sharp hoes before the roots are dug. Mangels are generally fed late in the winter and must, therefore, keep well in storage. Care in harvesting is essential to prevent bruising them. They should be dug and stored with a minimum amount of mechanical injury.

Carrots are harvested in much the same manner as mangels. Careful handling is of utmost importance as bruised carrots may break down quickly with soft rot when stored. If the carrots are topped with a sharp knife so that a thin slice is taken from the top of the crown they will not sprout so easily and will keep better in storage.

In harvesting rutabagas and turnips, it is not so necessary to prevent

bruising. These roots may be topped before being dug by using sharp hoes and if the soil is comparatively dry they may be dug with a potato digger.

Whenever possible, roots should be harvested on cool, bright days when the soil is fairly dry. Less dirt will then stick to the roots and they will require very little knocking together to remove excess dirt. If the harvesting is done on clear days, the roots may be left on top of the ground for a few hours to dry. The soil can then be shaken from them more easily.

Some growers consider it a good practice to leave the roots in small piles in the field for a week or so after they are harvested and topped, claiming that they cure better this way and keep better in storage. The piles are covered with just enough soil to prevent frost injury.

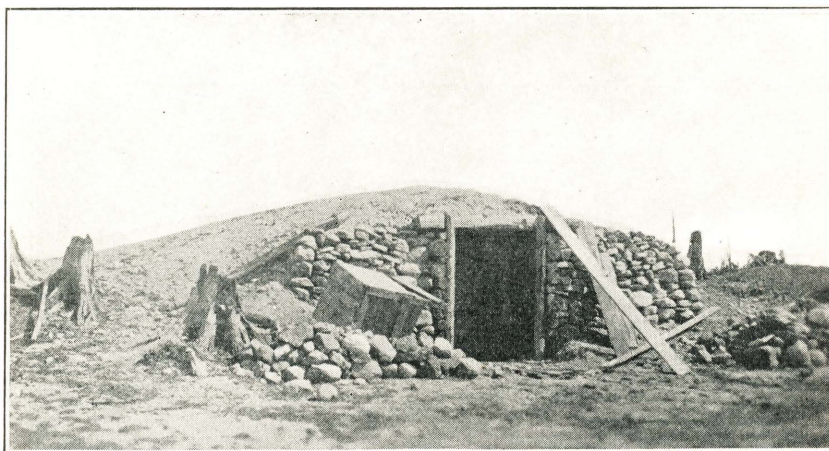


Fig. 10.—This type of root cellar can be built very economically. It is easily constructed and durable.

Storing

Roots are easily stored. The main point is to put them in a convenient place so that they may be easily accessible during the winter months. The best place for the root cellar is in the basement of the barn where they are to be fed. Oftentimes, a root cellar can be located under the driveway to the hay loft. If possible, it should be placed so that most of it is below the ground level, as a more uniform temperature can then be maintained.

The temperature of the root cellar should never reach the freezing point 32° F. and should preferably be kept at 36° to 40° F. The ceiling and walls should be insulated to prevent fluctuations in temperature. There should be ventilating flues provided so that the moist, heated air can escape and fresh air be admitted.

If no cellar is available, roots may be stored in pits. They should be located near the barn and on high ground that is well drained. The pits should be 8-10 inches deep and the roots be placed in a cone-shaped pile, the sides of which are steep enough to drain the water away quickly. After the roots are piled up they are covered first with a six-inch layer of straw over which is placed six inches of dirt. If the roots are to be kept well into the winter, another layer of straw and another layer of dirt should be added.

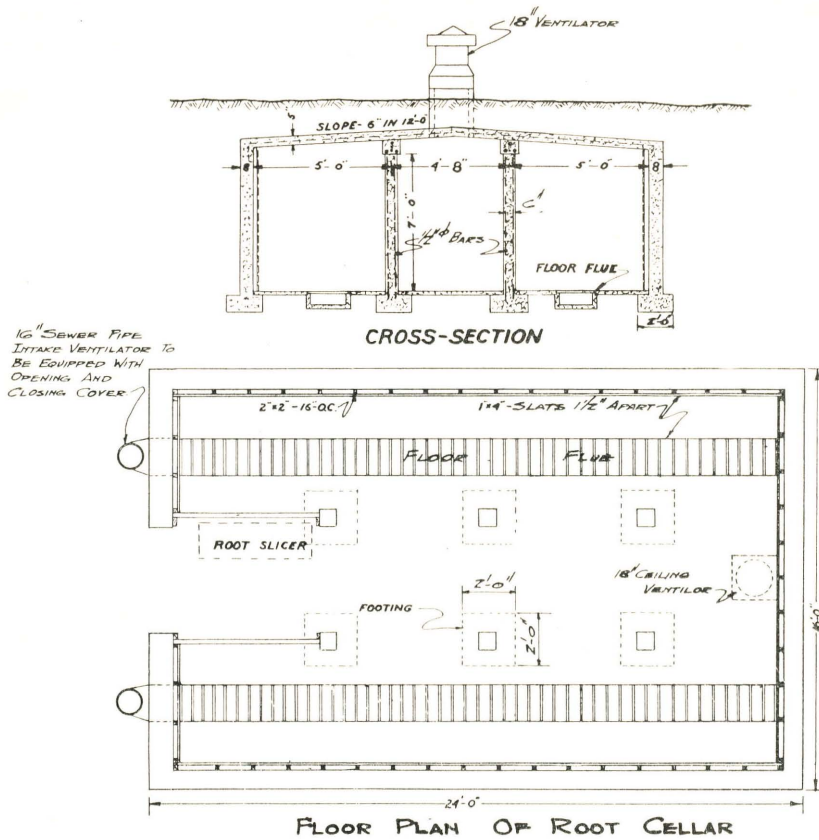


Fig. 11.—Plan of Root Cellar (50 ton capacity). (Design by C. H. Jefferson, Agricultural Engineering Dept., M. S. C.)

Directions for Feeding Roots⁶

Roots should be sliced or cut before feeding. They may be cut by hand or with a root cutter. Feeding such roots as rutabagas or turnips whole is not advisable as it may cause choking. The chopped roots may be mixed with the hay or with the concentrates and grain and fed in the mangers.

It is advisable to delay the feeding of rutabagas and turnips to cows until after they are milked. If fed at time of milking, they may taint the milk. Mangels should not be fed until after Christmas. When fed soon after harvest they may cause diarrhea or scours. Turnips, rutabagas, and carrots may be fed during the fall months. Frozen or spoiled roots should not be fed to any class of animals as they may cause colic.

In feeding dairy cows, from 40-60 pounds of mangels may be fed per animal per day. Rutabagas have about the same feeding value as mangels and may be fed in the same quantities. Turnips are not a very popular feed

⁶(Information on feeding roots furnished by Prof. E. L. Anthony, Dairy Department; Prof. R. S. Hudson, Animal Husbandry Dept., and Prof. C. G. Card, Poultry Dept., Michigan State College.)

for dairy cows. If carrots are fed to cows, the daily allowance per animal is about 30 to 40 pounds.

Root crops are low in protein and should be properly supplemented with protein concentrates such as linseed oil meal, cottonseed meal, soybean meal, or corn gluten feed, unless they are fed with plenty of good alfalfa hay.

The rate of feeding roots to beef cattle is two or three pounds per day for each 100 pounds of live weight.

For sheep, the rate is from two to four pounds per day per head; a heavier feeding may cause weakness in the lambs.

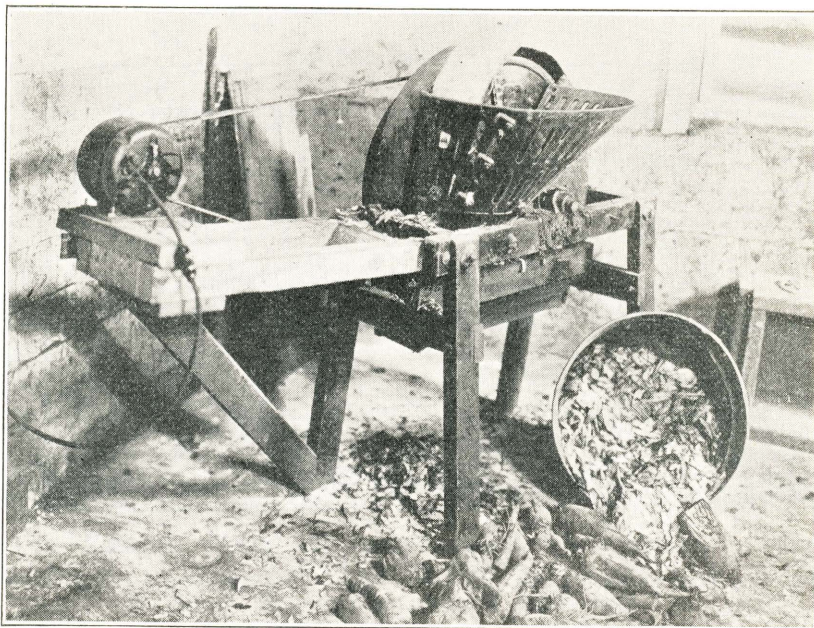


Fig. 12.—Roots should be cut or chopped before they are fed to livestock. A motor-driven root cutter is here shown.

For horses when idle or at light work, or for brood mares and colts, one pound per day maximum per 100 pounds of live weight is about right. Roots are not considered good for horses that are at steady work as they are likely to cause loss of weight.

Root crops are well adapted as a succulent feed for poultry and are often used when green feed such as alfalfa, clover, or vetch are not available. Carrots are considered the best root crop for feeding poultry as they are relatively rich in vitamins A and C and are believed to be equal in feeding value to field-grown greens. Fowls should have all the green feed they will eat at all times.