Vegetable Fodder & Forage Crops for Livestock Production:

Fodder Beets

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS053E

There is interest among farmers in western Washington and many other regions of the United States to grow forage and fodder crops to meet their own livestock production needs. Forage is defined in this publication as feedstuff that animals search for and consume, and commonly refers to the non-reproductive portions of plants, while fodder refers to all plant portions which are harvested, stored, and fed to animals (Barnes et al., 1995). Successful local production of forage and fodder crops requires a review of past practices and the latest research on crop varieties as it applies to specific growing conditions.

Historically, livestock production relied on a large diversity of crops to sustain animals year-round, including vegetable root crops such as fodder beets, turnips, rutabagas, carrots, and sugar beets (Delwiche, 1924). Vegetable fodder crops were produced in significant amounts in the maritime Pacific Northwest until 1935, but by 1955 production was limited to a few acres (Schoth, 1957). As the scale of livestock production increased and intensified, livestock and fodder production became separate operations, each located in regions that were most conducive to optimizing production and minimizing costs. New cropping systems arose to best fit large-scale livestock production needs.

Now, new varieties of vegetable forage and fodder crops are available that promise larger yields, better storability, and greater flexibility in use. These new varieties offer the potential for western Washington livestock producers to grow an increasing amount of their own livestock feed that is well-adapted to the growing environment, affordable to produce, and a good source of livestock nutrition.

This fact sheet is part of a series that presents production information for carrots, fodder beets, turnips, rutabagas, kale, and chicory in western Washington. More information can be found at http://whatcom.wsu.edu/ag/.

Family, genus, and species: Chenopodiaceae *Beta vulgaris*

Synonyms. mangel, mangel-wurzel, wurzel, mangold, field beet, cattle beet, fodder beet.

Historic Varieties. Orange Globe, Yellow Globe, Giant Intermediate Mangel, Long Red, Jumbo Mangel, Golden Tankard, Giant Eckendorf Red, Giant Eckendorf Yellow, Champion Yellow Globe, New Goliath.

Currently available varieties. Yellow Cylindrical (Figure 1), Yellow Intermediate Mangel/Beet, Golden Eckendorf Mangel/Beet, Robbos (aka Maestro) Red (Figure 2), Long Red Mangel, also called Colossal Long Red Mangel and Mammoth Long Red Mangel (Figure 3).

The photos shown in Figures 1–3 were taken from field trials in western Washington from 2009 to 2011. More information on the results can be found at http://whatcom.wsu.edu/ag/.

Figure 1. Yellow Cylindrical.

Figure 2. Robbos (aka Maestro) Red.

Figure 3. Mammoth Long Red Mangel.

Seed Sources. Baker Creek Heirloom Seeds (http://www.rareseeds.com), Jung Seeds (http://www.jungseeds.com), R.H. Shumway Seeds (http://www.rhshumway.com), Johnny's Selected Seeds (http://www.johnnyseeds.com), Seeds of Change (http://www.seedsofchange.com/).

Background

The fodder beet is native to the temperate zone of Europe, is thought to have originated from a cross between the red and white garden beet, and was likely first cultivated in Germany (Wilson, 1859). Fodder beets were cultivated throughout Europe from at least the mid-1500s primarily as livestock fodder but were also eaten by people, especially during food shortages.

According to John Wrightson (1889), who wrote about fallow and fodder crops, there were about 2.3 million acres of turnips, rutabagas, and fodder beets cultivated in Great Britain during the late 1800s. Fodder beets remained a popular crop for livestock until the early 1900s due to their drought tolerance, excellent root-keeping qualities, high sugar content, good leaf fodder characteristics, high nutritive value, and large yields per acre compared to other forage crops.

Fodder beets are considered more drought-tolerant than other root crops, and less sensitive to weather variations than turnips and rutabagas (Halligan, 1911; Wrightson, 1889). Fodder beets are well-adapted to cool moist climates and so were seen as a good alternative to grains in climates where grain or silage yields were uncertain due to seasonal weather variations (Halligan, 1911). For farmers who were raising just a few animals, it was often considered more economical to cultivate fodder beets than to build a silo for grain or silage storage (Gullickson, 1943).

By the late 1800s in the United States, fodder beets were primarily cultivated on the East Coast where land prices were comparatively high. In the Corn Belt where land was cheaper, grain silage was more economical to produce for livestock feed (Smith, 1905). Although fodder beets yielded twice as much as corn per acre on a fresh weight basis, on a dry weight basis, fodder beet yield was only 75% that of corn (Smith, 1905; Halligan, 1911). A major barrier to fodder beet production was the hand labor needed for harvest. As cereal grains and livestock became increasingly cost-effective to produce due to technology improvements in transportation systems and storage, lack of production mechanization for harvesting root fodder crops resulted in a dramatic decline in use of non-grain livestock feeds in the United States and Europe (Halligan, 1911).

As economic conditions drive up the cost of grain feed, it is worthwhile for livestock producers to again consider alternative fodder crops such as vegetable roots. With modern cultivation and harvest implements, the need for hand labor is greatly reduced. Modern fertility management and irrigation practices continue to increase yields compared to those reported in the most current variety trials in the United States which were conducted almost 100 years ago (Table 1).

Fodder Beet as Livestock Fodder

Bath et al. (1980) evaluated a number of alternative feed sources for livestock, including fodder beets. The following is their information in combination with relevant historical details.

Nutritive value. Fodder beet protein was estimated by Bath et al. (1980) at 11.3% for roots and 17.0% for shoots. Historical references (Shepard, 1918) calculated the aver-

Table 1. Average yield (pounds per acre) of vegetable root crops evaluated in a variety trial in 1914 and 1915 at three locations in South Dakota (Hume, 1918).

		Pounds of Roots per Acre			
Crop	**Variety**	**Brookings**	**Eureka**	**Highmore**	**Overall Average**
Fodder Beet	Golden Tankard	46,260	14,440	21,990	27,563
	Mammoth Long Red	59,040	25,359	23,940	36,113
	Red Globe	49,980	20,459	19,862	30,100
Sugar Beet	Shepard	25,800	12,406	19,910	19,372
	White Klein	30,780	15,859	17,196	21,278
Turnip	Purple Top White Globe	12,960	15,531	10,960	13,150
	White Globe	23,240	11,884	16,470	17,198
Rutabaga	Sweet German	17,280	8,361	26,950	17,530
	Purple Top Yellow	25,740	13,414	20,640	19,931

Figure 4. Beef cow feeding on fodder beets in 2010 field trials in western Washington.

age closer to 1%. This disparity might be attributed to more effective production practices (i.e., soil fertility) and modern fodder beet varieties. The digestible energy of fodder beets is estimated at 0.16 and 1.60 Mcal/lb as-fed or moisture-free, respectively (Ensminger and Olentine, 1980). Due to their high protein concentration, sugar beet pulp and by-products are commonly fed to livestock as a concentrated energy source.

The dry matter of fodder beets is estimated at 11% (Ensminger and Olentine, 1980). Root vegetables in general are low in fat (less than 1%), have a crude fiber content of 7.5–11.4%, ash content of 9.7–19.2%, total digestible nutrient content of 79.2–60.7% (root and shoot, respectively) (Bath et al., 1980), and almost no starch, as the carbohydrates are present in sugar form (Shepard, 1918).

It is the sugar content of fodder beets that makes them palatable to livestock (Figure 4). However, fodder beets do not form a complete diet (act more like a concentrate), and so should be supplemented with a high protein fodder such as alfalfa or clover hay. If fodder beets are fed with grass hay, it is necessary to supplement the feed ration with a high protein additive such as bran or oil meal.

According to multiple historic records (Gullickson, 1943; Sleeter, 1916; Smith, 1905; Wrightson, 1889), fodder beets are palatable to cattle, hogs, sheep, horses, and poultry, and were used extensively to fatten cows and hogs and to feed brood sows. However, all root vegetable crops have laxative properties, so it is important to control the amount given to livestock or they will develop scouring (diarrhea as a result of intestinal infection). In sheep, large quantities of fodder beets can cause renal and urinary calculi (kidney stones). Fodder beets were rarely fed to horses, though this appears to be due to cultural reasons rather than scientific ones (Gullickson, 1943; Sleeter, 1916; Smith, 1905; Wrightson, 1889). When fed in proper amounts, fodder beets maintain healthy livestock digestive systems, promote growth in young stock, and stimulate milk production without imparting flavor in milk (Bull, 1916).

Feeding rate. Historic records show that milk and beef cattle were fed up to 30 pounds of fodder beets per day. Smith (1905) observed that adding 10 pounds of fodder beets to other fodder effectively fattened steer. The general recommendation was to slice or shred the fodder beets to prevent animals from choking on large pieces, and mix with green fodder or grain for feeding (Smith, 1905; Gullickson, 1943). Wrightson (1889) suggested feeding horses 2–3 roots per day if they are eating straw rather than hay. According to Card and Henderson (1933), feeding whole fodder beets to poultry can prevent aggression and cannibalism among the flock.

Production

There is little current information specifically geared towards fodder beet cultivation. The following information has been compiled from historical sources and current sugar beet and rutabaga production information where we believe it is relevant, as the three crops are very similar in terms of growth habit, plant size, and seeding rates.

Varieties. Fodder beets occur in four different shapes (flat globe, globe, spindle, or cylinder; Figure 5) and three colors (yellow, orange, or red). Though there are also white and purple fodder beets, these types are not commonly grown and yield appears to have been very low.

Yellow Tankard or Golden Tankard was the most popular fodder beet variety throughout England in the late 1800s and was prized for its consistent cylindrical form that narrowed at both ends. A hardy variety suitable for colder northern climates and heavier soils, it was generally considered more drought-tolerant than Long Red (Wickson, 1897). Seeding density in the row is heavier than for other varieties.

Long Orange is very similar in growth habit to Long Red (see below), but was generally considered more hardy.

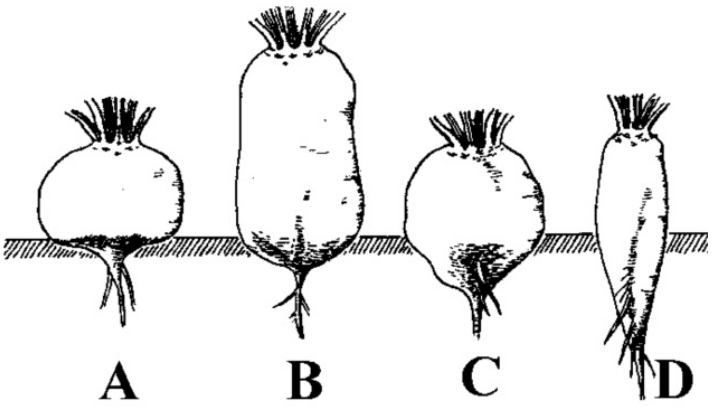

Figure 5. A) Flat Globe; B) Cylinder (Yellow Tankard, Golden Tankard); C) Globe (Yellow, Orange, and Red Globe); and D) Spindle (Long Orange and Red) (Schuchert, n.d.).

Long Red was the highest yielding variety and so was preferred by beef and dairy producers. It requires good soil due to its deep rooting potential, and tends to break if pulled without being first loosened or undercut.

Yellow Globe is shaped like a rutabaga but has lower water content than other fodder beets. It is well-suited to sandy or gravelly soils, but does best if additional organic matter is added.

Orange Globe was the most extensively cultivated fodder beet variety in England in the mid-1800s. The root has an orange skin color but the flesh is yellow to white. It is easier to pull than Long Red varieties.

Red Globe is generally the least productive variety but is better suited for poor, shallow soils.

Seedbed preparation. For strong root production, fodder beets require a fine, deeply plowed, well-drained soil free of clumps or rocks. Prepare the soil for planting as early as possible (Halligan, 1911; Malden, 1891; Wrightson, 1889). Use light spring tillage, 1–2 inches deep, to prepare a firm level seedbed where good soil-to-seed contact will improve germination (Cattanach et al., 1991). In areas where wind erosion is an issue, prepare the field in the fall and plant a fall cover crop that can be mowed or killed in the spring (Kurp et al., 2001).

Soil fertility. No fodder beet-specific fertility guidelines exist, so included here are recommendations for sugar beets and rutabagas. Prior to applying fertilizer, collect a representative soil sample from the field and send to a soil lab for analysis. Indicate on the soil analysis form that your crop will be either sugar beets or rutabagas, as it is unlikely any soil test lab will be familiar with fodder beets.

A soil pH range of 6.0 to 8.0 is needed; if your soil tests lower than pH 6.0, apply lime to reach a soil with pH 7.0. For sugar beets, fertilizer recommendations are based on optimizing sucrose content in the root (Table 2). If nitrogen levels are too high, vigorous leaf production will reduce the sucrose content in roots, while low nitrogen levels can lead to poor leaf development and reduced yields. Sugar beet seed is very sensitive to fertilizer salts and if there is contact between seed and fertilizer, germination can be greatly reduced (Cattanach et al., 1991). Fertilizer is generally applied prior to seeding to reduce risk of contact in the seed furrow.

Fertilizer recommendations for rutabagas include nitrogen at 50–75 lbs N per acre, phosphorus at 100–150 lbs P_2O_5 per acre, and potassium at 50–150 lbs K_2O per acre (OSU, 2004). In addition, if soil test results indicate either boron or sulfur are low, broadcast apply boron at 2–4 lbs per acre and disc in before planting. For sulfur, broadcast apply 15–25 lbs per acre and disc in before planting.

Seeding. The suggested spacing between rows is 18–40 inches (Wrightson, 1889; Halligan, 1911; OSU, 2004). While narrower row spacing produces a higher yield per acre than wider spacing, it is important to select a row spacing that best accommodates your equipment, especially if you will be mechanically cultivating and harvesting the crop (Figures 6 and 7). Seed at a depth of 0.75–1.5 inches (Cattanach et al., 1991), with an in-row spacing of 4–6 inches; thin seedlings to 6–10 inches apart (Halligan, 1911). The seeding rate should be 1–2 lbs per acre (Kurp et al., 2001).

Fodder beet seeds are protected by a thick coat. For more rapid and consistent germination, soak seed for 12 hours in warm water, spread seeds on a screen or cloth, and dry just enough to prevent them from sticking together (Wrightson, 1889). However, this method can have limitations with modern seeding equipment.

Seeds can be planted as early as February if weather is conducive, and as late as May if necessary for summer harvest. However, the main crop is normally sown in April. While earlier sowing dates generally result in heavier yields, there is also more risk due to unseasonably cold or wet weather

Table 2. Nitrogen, phosphorus, and potassium fertilizer application rates based on various sugar beet yield goals and soil test levels (Cattanach et al., 1991).

Sugar beet yield goal	Soil N plus fertilizer N needed	Phosphorus				Potassium			
		P soil test levels (lbs/acre)				K soil test levels (lbs/acre)			
		Low 0–9	Med. 10–19	High 20–29	Very High Over 30	Low 0–99	Med. 100–199	High 200–299	Very High Over 300
tons/acre	lbs/acre	P_2O_5 lbs/acre				K_2O lbs/acre			
16	95	60	35	10	0	85	50	15	0
17	100	60	35	10	0	90	55	20	0
18	110	65	40	15	0	95	55	20	0
19	115	70	40	15	0	100	60	20	0
20	120	75	45	15	0	105	65	20	0
22	130	80	50	15	0	115	70	25	0

Figure 6. Fodder beets seeded with a grain drill.

Figure 7. Fodder beets seeded with a vegetable planter.

(Wrightson, 1889). Sugar beets planted after mid-May in the Midwest have shown yield reductions of 1.5 tons for each week that planting is delayed (Cattanach et al., 1991). In the south of England, fodder beets were sown in September or October and grown as a winter crop (Halligan, 1911). Sugar beet plants are tolerant to temperatures down to 25°F.

Irrigation. Irrigation is required throughout the summer months for the crop to attain its maximum yield. A total of 8–12 inches may be needed depending on the variety. The total amount of water that should be applied need not vary with soil type, but irrigation frequency and rate should. For example, irrigate light sandy soils more frequently but at a lower rate per application than heavier soils.

Cultivation. Fodder beets are slow to germinate and if planted too early or in cold wet weather, weed seeds will germinate first and out-compete the seedlings (Halligan, 1911; Wrightson, 1889; Malden, 1891). Halligan (1911) suggested sowing a small amount of a quick-germinating crop such as buckwheat at either end of the fodder beet row as a marker. When the buckwheat emerges, which will occur up to several weeks prior to fodder beet emergence, cultivate between the rows to control weeds.

Early in the season, do not cultivate or throw soil into the fodder beet row, as this will bury and kill seedlings. Fodder beet growth habit is such that the growing point will extend above the soil surface over time, and by harvest one half or more of the root will be exposed (though this is based on variety). Once the crop growing point is an inch or so above the soil surface, it is effective to throw soil into the row for weed control. However, it is not necessary to cover the root with soil.

Yield. Yields tend to increase in wetter climates or with irrigation by as much as 30% (Cattanach et al., 1991). The average fodder beet yield in England in the early 1900s was reported as between 20 and 40 tons per acre (Halligan, 1911). A variety trial in South Dakota in the early 1900s found an average yield of 16 tons per acre (Table 1). A more recent field trial from Pennsylvania found yields to range from 13 to 48 tons per acre (Ross et al., 2008). The most current sugar beet yields on record in North Dakota and Minnesota average 13 to 25 tons per acre (Cattanach et al., 1991), while in eastern Washington, sugar beet yields range from 30 to 40 tons per acre (Kurp et al., 2001).

Harvest

Fodder beets are injured by heavy frosts, so while they can remain in the ground through October, they should be harvested by November (Halligan, 1911; Wrightson, 1889). Sugar beets are harvested in late September and October in the Midwest and from September to November in eastern Washington (Kurp et al., 2001; Cattanach et al., 1991). Fodder beets that have been frozen in the field will quickly rot in storage.

Top the crop (remove leaves) to within 2–4 inches of the top of the root or allow animals to forage the tops off, but ensure that the animals do not uproot the beets. Complete leaf removal is important to prevent resprouting if you are

storing in piles (Cattanach et al., 1991). It is not necessary to remove all the soil from the roots, as some soil can improve root storability, but it does need to be removed prior to feeding. Fodder beets that are cut or damaged by harvesting equipment will likely rot in storage. Similarly, if tops are cut too close to the root, the root will be more susceptible to rot (Wrightson, 1889). Sugar beet lifter-loader harvesters pull beets from the soil, remove much of the soil from the root, and load roots onto trucks. Large-scale modern sugar beet harvesters are expensive, so you may want to consider older used equipment which is often available in traditional sugar beet production areas.

Storage

Because fodder beet palatability increases with age, roots should be stored for a few months before being used. They will reach optimal palatability the summer after harvest. Historic records show they can be stored for a second winter and still maintain nutrient content and palatability (Wrightson, 1889).

In areas where soil does not become saturated over the winter, dig a shallow pit and fill with harvested fodder beets; cover with 4–6 inches of soil and an additional 6 inches of straw to protect from freeze damage (Wrightson, 1889). Another recommended storage option is to stack roots in a long pile, 6–14 feet wide at the base and 4–10 feet high at the apex, on level or unpaved ground either against a building or in the open. Ventilation systems may be incorporated into piles to reduce sugar loss through root respiration and rot (Cattanach et al., 1991). Dig an 8-inch deep trench around the pile for drainage; place the soil over the fodder beets. Cover with straw to a final thickness of at least 10 inches.

Resources

Albert R. Mann Library. 2009. The Core Historical Literature of Agriculture. Cornell University, http://chla.library.cornell.edu.

Barnes, R.F., D.A Miller, and C.J. Nelson, eds. 1995. *Forages, Volume I: An Introduction to Grassland Agriculture.* 5th ed. Ames, IA: Iowa State University Press.

Bath, D.L. 1980. By-products and Unusual Feedstuffs in Livestock Rations. Western Regional Extension Publication No. 39.

Bull, Sleeter. 1916. *The Principles of Feeding Farm Animals*. New York: Macmillan, http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2727054.

Card, Leslie E. and Melvin Henderson. 1933. *Farm Poultry Production*. Danville, IL: The Interstate Printing Co., http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2802506.

Cattanach, A.W., A.G. Dexter, and E.S. Oplinger. 1991. Sugarbeets. *Alternative Field Crops Manual*, http://www.hort.purdue.edu/newcrop/afcm/sugarbeet.html.

Cornell University. 2006. Rutabagas. Cornell Vegetable Growing Guides, http://www.gardening.cornell.edu/homegardening/scened5c9.html.

Delwiche, E.J. 1924. Root Crops are Profitable. *The University of Wisconsin Agricultural Experiment Station, Bulletin 330*.

Ensminger, M.E. and C.G. Olentine. 1980. *Feed & Nutrition–Complete*. Clovis, CA: Ensminger Publishing Co.

Gullickson, Thor. 1943. *Feeding Dairy Cattle*. Saint Paul: Webb Book Publishing Company, http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2802598.

Halligan, James. 1911. *Fundamentals of Agriculture*. New York: D.C. Heath & Company. http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2741178.

Hume, A.N. 1918. Root Crop Culture in South Dakota. *South Dakota State College of Agriculture and Mechanical Arts, Bulletin No. 180*, http://pubstorage.sdstate.edu/AgBio_Publications/articles/B180.pdf.

Kurp, E.L., C.H. Daniels, D. Bowers, J. Bair, and E. Bair. 2001. Crop Profile for Sugar Beets in Washington. Washington State University, http://www.ipmcenters.org/CropProfiles/docs/WAsugarbeets.html.

Malden, Walter J. 1891. Tillage. London: George Bell & Sons, http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2716292.

Ohio Vegetable Production Guide. 2009. Radishes, Turnips, and Rutabagas (Swede Turnips). Ohio State University, http://ohioline.osu.edu/b672/pdf/Radishes.pdf.

Oregon State University (OSU). 2004. Rutabaga (Swede) and Turnip. Commercial Vegetable Production Guides, http://hort-devel-nwrec.hort.oregonstate.edu/rutabaga.html.

Ross, G.G., D. Buffington, C. Houser, and M. Antle. 2008. Evaluation of Fodder Beets as a Feedstock for PA Ethanol Production. Crop Management Research Report 02-2008, http://downloads.cas.psu.edu/RenewableEnergy/FodderbeetReport08.pdf.

Schoth, H.A. 1957. Root Crop Production for Livestock. *U.S. Department of Agriculture, Leaflet No. 410*.

Schuchert, W. n.d. Fodder Beet (*Beta vulgaris L. var. alba*.) http://www.biologie.uni-hamburg.de/b-online/schaugarten/varalba/Fodder_beet.html.

Shepard, James H. 1918. Sugar Beets and Other Roots as Stock Feed. In *Root Crop Culture in South Dakota*. South Dakota State College of Agriculture and Mechanical Arts, Brookings. Bulletin No. 180, pp. 850-853, http://pubstorage.sdstate.edu/AgBio_Publications/articles/B180.pdf.

Smith, Howard Remus. 1905. *Profitable Stock Feeding: A Book for the Farmer*. St Paul, MN: University Farm, http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2709049.

Undersander, D.J., A.R. Kaminski, E.A. Oelke, J.D. Doll, E.E. Schulte, and E.S. Oplinger. 1992. Rutabaga. *Alternative Field Crops Manual*. University of Wisconsin Extension and Minnesota Extension Service, http://www.hort.purdue.edu/newcrop/afcm/rutabaga.html.

Wickson, Edward J. 1897. *The California Vegetables in Garden and Field: A Manual of Practice, With and Without Irrigation, for Semitropical Countries*. San Francisco: Pacific Rural Press, http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2717761.

Wilson, John. 1859. *Our Farm Crops*. Vol. I. London: Blackie and Son.

Wrightson, John. 1889. *Fallow and Fodder Crops*. London: Chapman & Hall, http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2920861.

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