Virginia Cooperative Extension

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Specialty Crop Profile: Horseradish

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Introduction

Horseradish (*Armoracia rusticana* Gaertn., Mey, and Scherb.) is an herbaceous perennial. It can grow to two to three feet tall and wide and has a distinct rosette growth habit with numerous erect and long-petioled leaves originating from a central crown (Figure 1). Plants develop a deep root system of multiple branches and many finer rootlets. The roots are thick and fleshy tan to medium brown and smooth to corky on the outside and pure white on the inside. The edible, very pungent roots are grated and used fresh or added as an ingredient to commercially processed condiment products, such as seafood sauce and various mayonnaise based formulations. The intense pungency or "heat" of horseradish is due to iso-thiocyanate (sulfuric) compounds and the naturally occurring enzyme myrosinase found in the plant. When the roots are chopped or ground and exposed to air, these chemicals become volatile, resulting in pungency that opens sinuses and makes the eyes water. Vinegar is added to slow the release of iso-thiocyanates and timed to "capture the heat" at various levels.



Figure 1. Mature horseradish plants in a commercial field.
(Photo by E. Wahle, University of Illinois)

Horseradish is grown in temperate climates around the world, primarily as an annual, and to a limited extent, as a perennial crop. It has long been an important crop in parts of Europe and significant production exists in the U.S. and Canada. When grown as an annual, it requires a long growing season. It needs warm temperatures during the summer growing season and cooler temperatures in the late summer and fall to enhance root development. In the annual system, the crop is usually planted in the early spring, and the entire root mass is harvested after the first killing frost in the fall. In the perennial system, upright, thickened, underground shoots arising from a deeply planted "mother" root are harvested every other year, with the original plant left in the field for regeneration. Perennial fields may stay in production for 10 to 20 years. Perennial culture generally requires more labor and growing skill. It is still practiced in some areas, particularly where there is a short growing season. Once introduced to a farm, horseradish can be difficult to eradicate completely as any size root or piece can readily begin a new plant.

Horseradish has wide climatic adaptation, with the exception of the warmer zones of the far southern United States. Historic areas of U.S. production include Illinois, Wisconsin, California (northern), Oregon, and New Jersey, where 3,500 to 4,000 acres are harvested annually. Reasons for production in these areas include both site conditions (deep loamy soils conducive to root growth and digging) as well as historical reasons related to European immigrant settlement patterns.

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Market Potential

During a single growing season, horseradish plants can develop a large mass of roots of varying lengths and diameters. From a use and marketing standpoint, larger is better as less effort is needed to clean and process one large root than many smaller roots, and larger roots also bring the highest prices. Thus the crop is usually grown in a system that maximizes large root, or "#1," production. Thus the crop is usually grown in a system that maximizes the percentage of large roots, which have USDA grade standards as either "U.S. Fancy" or "U.S. #1."* For U.S. Fancy, roots are described as being well-trimmed and well-shaped, fairly smooth with good head formation, and a minimum length of 8 inches, and no less than 1 1/4 inch diameter (Figure 2). For grade #1, roots are a minimum of 6 inches long and 1 inch in diameter with allowances for less shape, smoothness, and head formation compared to the Fancy grade (Figure 3). Both grades should be free from decay, hollowness, cracks, internal discoloration, mold, fracturing, insects, and other damage. However, all root parts, regardless of size, are marketable and result in a similar final product. There are several other packing grades, used by the industry, including #2 (trimmed primary smaller than #1), "field run" (combines #1 and #2), "wild root" (entire root mass) and "trimmings" (all secondary roots). For fresh-market grocery sales, fancy and #1 roots are washed, packed in five- or 10-pound clear bags, and sold at a premium price. Internal color should always be white with no discoloration, brown streaks, or hollowness.



Figure 2. Bulk packing of USDA Fancy grade horseradish roots.
(Photo by E. Whale, University of Illinois)



Figure 3. Film packaged #1 root. Note white root interior.
(Photo courtesy of Melissa's World Variety Produce, *http://www.melissas.com/*)

The primary market for horseradish is commercial processing. Condiment makers usually work on a contractual basis with larger-scale growers (>25 acres) to buy various grades as large-volume lots. Most processors have modern equipment that easily washes and grinds any size root and can process large, tangled masses of root as they are delivered. A few processors have equipment that can clean only a larger root, so growers must separate and trim out the fancy, #1 and #2 roots from the field-run harvest, but they do obtain a higher price for the effort. Grower/processor relationships generally have a long history, with the processor used to a certain quality of root, which can vary greatly among varieties and the farms that raise them. This results in few opportunities for open-market sales of bulk-packed root by new growers. Thus it is a relatively closed market and difficult to break into because existing growers are protective of their established market outlets.

For new growers, the greatest potential for marketing horseradish exists with more specialized and/or smaller scale marketing. With a small planting of less than an acre, direct marketers who have approved kitchen facilities can add processed, fresh horseradish sauce to their line-up of value-added products. They can also make sales at farmers markets and roadside stands. In urban areas, a unique ethnic niche exists for horseradish as a bitter herb in the Jewish Passover celebration. Another outlet example is the sale of prebagged (five to 10 pounds), well-cleaned, and tumbled Fancy and #1 roots to grocery chains either direct locally or through produce brokers. Fresh horseradish roots also can be marketed to smaller, independent grocers and specialty food stores (Figure 4) and to smaller, specialized food-processing companies.

Varieties and Propagation

Varieties

There are numerous strains of horseradish. Depending on the site, one or more may perform better than others. Little is known about how various horseradish

**U.S. Standards for Grades of Horseradish Roots, Effective July 27, 1936 (Reprinted -January 1997),* http://www.ams.usda.gov/standards/horserad.pdf)



Figure 4. Grocery display of whole roots.
(Photo courtesy Food Resource site, Oregon State University, *http://food.oregonstate.edu/*)

strains will perform in the diverse growing regions of Virginia, and growers should make observations on adaptability, selecting only the top producing types for continued planting. Important indicators to gauge this performance include the development of large primary root diameters and a solid white root interior with no discoloration or hollowness. The outer root surface should not be too rough, but smooth skinned and straight, with little crevicing, corking, cracking, or rootlet "fuzzing." A smooth aboveground crown (head) texture and low shoot (knob) numbers are also desirable. Roots should be hot, but slow in developing, with some hint of sweetness. As superior strains become evident, it is important to make an effort to keep planting stock sorted and separated, as roots have a similar appearance and are easily mixed.

Horseradish is classified botanically by leaf shape, size, and texture with many variations. A key distinguishing character is the angle and shape of the leaf base as it attaches to the petiole. The two main forms are acute (tapering) and cordate (obtuse, rounded). In addition, leaves can be smooth or crinkled or have only slightly wavy leaf edges (Figures 5a, b). Historically, production in the U.S. has included several important varietal types. There can be many strains or selections within these types as over the years growers save their own material, selecting for good overall yields, set production, large primary roots, and disease resistance. These strains are often identified by a common name of the grower, farm, or area where they originated.

Three main varieties are used in commercial production. Though they are known as distinct varieties, it could be argued that they are also distinct types fitting



Figure 5a. Crinkled leaf texture, 'Common' variety.
(Photo by A. Bratsch)



Figure 5b. Smooth leaf texture, 'Big Top Western' variety.
(Photo by Calvin Hamilton, ScienceViews.com, *http://scienceviews.com/photo/plants/Horseradish1.html*

known leaf-shape groupings from which many selections have been made.

'Common' is a broad, crinkle-leaf variety with a cordate (<60°) leaf base attachment to the petiole. It is known for its high-quality, large roots, but it is susceptible to virus and white rust diseases (Turnip Mosaic 1; White-rust, *Albugo canadensis*). Crinkle-leaf types are also referred to as 'Maliner Kren,' though this term has also been used to identify some smooth-leaf types.

'Bohemian' has smooth, medium-sized leaves that have a more rounded (60° to 90°) attachment angle. It is also susceptible to virus, but has some white rust tolerance. Roots are not as large as 'Common,' but are smooth and of good quality. Two important commercial strains of the 'Bohemian' type include 'Swiss' and 'Sass.'

'Big Top Western' is a third variety with smooth, large upright leaves that taper at the base. It exhibits resis-

tance to both diseases. Roots tend to be large and of good quality, but are rough or corky on the outside.

Both the 'Common' and 'Big Top Western' groups have been the focus of new varietal development through breeding efforts at the University of Illinois. These new varieties are often identified by breeding line number. Because of crossbreeding, leaf shapes and character are often difficult to distinguish, with root quality a primary focus.

Obtaining Stock

Horseradish is usually grown from a small root piece, and not from seed. Thus it is a "vegetatively" propagated crop. Initial planting stock can be obtained from a handful of specialty nurseries (Table 1). Usually nursery-offerings are limited to only a few varieties. Roots sold in the grocery store can also be a viable means of obtaining planting material, as they are not treated in any way to affect growth. The disadvantage of grocery-obtained stock is a lack of knowing the variety you are planting and its relative merits, and there may also be traces of disease local to the site where it was grown present in the root. However, material obtained in the grocery store is likely a prominent commercial variety, known to perform well, that can be tested for its performance on your site. Keep in mind that a few varieties may have plant patent protection, and cannot be propagated without permission of the patent holder.

Planting stock may also be obtained through an established grower who is willing to sell it. For plantings of an acre or more, growers should develop a program to increase their initial planting stock, and propagate their own plants from year to year. Though horseradish seed is not available commercially, seed production/collection is possible when crosses are made between compatible varieties. Because seed sterility has been noted, successful crosses are often made with some difficulty. To induce flowering, large roots with crowns should be kept in cold storage for two to three months after harvest. The crown should be trimmed closely off the root, then potted and allowed to grow in a greenhouse through the winter months. They will soon form masses of small white flowers on a large raceme. Rubbing their respective flowers together by hand can make crosses between varieties. Collected (and viable) seed is easy to grow and has no dormancy requirement. With this system, seed should be ready to sow in trays by late spring to early summer. Seedlings will be variable in characteristics.

Table 1. Nursery sources for horseradish

Name/Location	Contact Information
Nourse Farms, Deerfield, Mass.	413-665-2658; *http://www.noursefarms.com/catalog/horseradish.html*
Daisy Farms, Dowagiac, Mich.	269-782-7131; *http://www.daisyfarms.net/horseradish.html*
Nichols Garden Nursery, Albany, Ore.	1-800-422-3985 *http://www.nicholsgardennursery.com/index.htm*
Peaceful Valley Farm and Garden Supply, Grass Valley, Calif.	530-272-4769; *(organic sets) http://www.groworganic.com/default.html*
Bert's Gourmet Horseradish, Sagamore hills, Ohio	216-544-7757; *http://horseradishplants.com/cgi-bin/store/index.html*
Johnny's Selected Seeds, Winslow, Maine	877-564-6697; *http://www.johnnyseeds.com/Home.aspx*

Handling and Storage of Planting Materials

As indicated, obtaining adequate quantities of quality planting stock is a major concern in horseradish production. It will take a growing season or more to increase stock from the initial source, depending on planting needs. Where initial stock is limited, small root cuttings (one-quarter to one-half inch in length and diameter) can be started in two- to three-inch pots in a greenhouse and set out in raised beds for the growing season. By year's end, these plants will supply abundant planting material for the following year. After the initial stock is increased, planting stock can be taken from harvested roots each fall and set aside for the next season.

To ensure a certain percentage of the harvested roots have a large diameter and size, a large root cutting, or "set," one-half to three-quarters inch diameter and seven to 15 inches in length should be planted (Figure 6). In the annual system, this set is the primary root, and it grows and enlarges and becomes the main, and most valuable marketable product at season's end. The many secondary roots forming along the length of the set are also marketed, but are not as valuable as the larger primary root, which can reach up to two pounds or more in size. At fall harvest, selected secondary roots are



Figure 6. Planting sets of varying sizes.
(Photo by E. Wahle, University of Illinois)

"pulled" or cut from the original set. Saved sets are trimmed to the desired length, and hand-stripped of tertiary rootlets and end-of-root forks. They are then stored over the winter for the next season.

Because horseradish roots exhibit distinct polarity (head, point of attachment versus the tail end), and the diameter narrows only slightly for the length of the root cutting, the grower needs a means of keeping track of this orientation. Trimming sets straight across at the top (head) and obliquely (slant cut) at the lower end (tail) will mark this polarity. Sets are packed uniformly by head/tail orientation in wooden or plastic storage crates lined with heavy plastic (Figure 7). Loosely sealed plastic covers the sets and they are kept in cold storage at 33° to 38°F until spring. Underground storage pits or caves can be used in lieu of modern coolers. Note there is no vernalization (chilling) requirement before sets start to grow. Thus sets can be planted anytime after separation from the main plant and provided soils have warmed sufficiently, will start to grow.

Site and Preparation



Figure 7. Untrimmed sets packed in boxes for storage. Larger sets will be trimmed to size or cut in half to obtain two sets prior to planting.
(Photo by E. Wahle, University of Illinois)

Horseradish grows best on rich, moist, deep friable loam or sandy loam soils rich in organic matter. It needs good drainage to produce quality roots. Horseradish grown on soils with shallow, hard subsoils frequently produces highly branched roots of poor quality and poor useable set numbers and sizing. Horseradish tolerates a wide soil pH range of 5.5 to 6.8. The crop has high potassium (K) and moderate phosphorous (P) needs, with low to moderate annual nitrogen (N) requirements. A balanced application of NPK should be broadcast and incorporated prior to planting. Apply at least 50 pounds per acre of nitrogen as a starter fertilizer, with phosphorus and potassium levels adjusted depending on a soil test. One to two pounds per acre of boron also should be broadcast with the fertilizer. If sulphur levels test low on the site (<10 pounds per acre), apply 15 to 25 pounds of elemental sulphur per acre. Though this is a low level of sulphur application, it may decrease soil pH, which should be monitored for future crops.

Planting

Standard production consists of using sets as the primary harvested product. A range of 6,000 to 9,000 sets per acre is needed, depending on the between- and in-row spacing used. Following deep plowing and discing, row and set spacing in the field should be marked before sets are laid out and covered. This can be accomplished using a tractor attached paddlewheel implement (or adapted vegetable transplanter), which creates a "pillowed" or "dished" indentation in the soil, marking the set placement sites at desired spacing. Rows can be spaced three to four feet apart, with 18 to 24 inches between plants in the row. Sets are manually planted by laying them on the soil surface horizontally at a slight angle, with the head-end placed slightly higher as the set is placed in the dished out pillow (Figure 8). The same set orientation or direction is maintained for several rows (usually four rows), depending on the cultivation equipment used. This is done to facilitate field cultivation later, and to avoid working the soil "against the grain" (approaching the sets "head first"), which can cause the head end to be lifted out of the soil as the cultivator passes and loosens the soil. After laying out the sets, use a disc-hiller to cover the sets with a soil ridge to depth of approximately five to eight inches and 18 to 24 inches across.



Figure 8. Sets placed by hand into marked "pockets." Note the orientation of the head end for all sets in the row, and the placement of the set with the head elevated in the pocket.
(Photo by E. Wahle, University of Illinois)

Keep in mind that just about any size root piece will result in a viable plant. An alternative production system is to simply drop small pieces of root by hand or with a potato drop-transplanter in rows. With this system, in-row density can potentially be increased to 12 to 15 inches apart. This system will result in a more carrot-like root system with several medium-sized primary prongs, and a significant number of smaller, secondary roots. If the grower is not interested in growing a large Fancy or #1 root, and in mass only, experimentation with this system has merit, as the increased number of plants per acre will result in greater tonnage. Success with this planting scheme has been shown when using plasticulture (black plastic and raised beds with drip irrigation). Whether or not plastic is used, a raised bed will help facilitate harvest for small "piece" planting. This is also a good system to use when increasing planting stock.

Seasonal Field Care

Lifting and Suckering

For market, large, straight primary roots with low "crown" separation (or low head shoot numbers) are the best quality and bring the highest prices (USDA. grades Fancy and #1). To obtain a large percentage of these roots, growers often practice "lifting and suckering" to enhance the size and development of the set. Once the sets are covered and the plants begin to grow, the head end or "crown" will grow one to five shoots. Most roots will form under the crown and at the tail or "distal" end of the set; few secondary roots will form in the middle of the set.

Root growth location can be influenced by "lifting." After the shoots and new roots have begun to grow, early in the season the crown end is lifted an inch or two with a short jerk. This can be done by grasping the top growth by hand and pulling gently, but often a metal rod, which is bent at the end into a U-shape, is used to do the job. It is inserted in the soil to hook the set under the crown and then lifted. Lifting breaks early roots forming below the crown (Figure 9a), forcing more rooting at the distal end, and ultimately, a larger main root. Also at this time the multiple shoots forming the crown are hand-thinned or "suckered" to one or two (Figure 9b). This will enhance the smoothness of the crown and its appearance, a top grade attribute. Lifting and suckering is not done for wild-root and field-run production and sets are allowed to grow randomly, resulting in less primary root size. For some varieties under ideal conditions, large, primary root size is easily obtained, and lifting and suckering are not required.



Figure 9a. Lifting breaks new roots forming below shoots on the head end. Note exposed roots below each of the three shoots arising from the head end.
(Photo by A. Bratsch)



Figure 9b. Suckering removed all but one of the three shoots on this set.
(Photo by A. Bratsch)

Supplemental Fertilization

Supplemental nitrogen application of 50 to 75 pounds per acre should be made eight to 12 weeks after planting. It can be broadcast or banded near the row for greater efficiency. Over application of nitrogen may lead to hollow roots and can promote top growth at the expense of root development, particularly when applied too late in the season. Plants of large stature, such as many 'Common' type varieties are prone to this.

Irrigation

Depending on soil moisture-holding capacity, irrigation during dry periods, particularly in late summer to fall, can improve marketable yield. Studies have shown that most primary-root sizing occurs during the mid- to late fall period, and not during the summer.

Pest Management

The *Commercial Vegetable Production Recommendations*, Virginia Cooperative Extension publication 456-420, has weed, insect, and disease control guidelines. This publication is available online at *http://pubs.ext.vt.edu/456-420/* or in print through local Extension offices. As compared to other vegetable crops, relatively few herbicides, insecticides, and fungicides are available for use in horseradish.

Application of pre-emerge and postemerge herbicides are recommended in horseradish to control weeds. Because of short residuals and the long growing season, supplemental weed control with tractor cultivation and/or hand hoeing is often needed.

Horseradish is susceptible to various foliar diseases. As noted earlier, resistance to certain diseases is variety dependent. White rust is an important disease that limits root growth due to foliar infection. Because white rust is a systemic disease, a program of rouging infected plants is recommended, as is taking only healthy sets from the basal (distal) end of the primary root. This disease can be managed effectively with fungicides and the use of resistant varieties. Foliar diseases include Cercospora (*Cercospora armoraciae*) and Ramularia leaf spot (*Ramularia armoraciae*), as well as bacterial leaf spot (*Phytomonas campestre armoraciae*). Proper application of recently registered fungicides (Quadris™ and various copper formulations) can help keep these diseases in check when they become problematic.

Turnip mosaic virus occurs everywhere horseradish is grown, and has alternate hosts in many weeds and other species. It is transmitted by insects (aphids) or by mechanical means. Symptoms include foliar mosaic mottling, yellow rings of the leaf, and black streaking of the petiole. Often this disease is tolerated at low levels with varietal resistance the primary means of control.

Another important destructive disease is known as Brittle Root (*Spiroplasma citri*), a virus-like disease that is transmitted by the beet leafhopper. Symptoms include poor growth and chlorotic leaves, which eventually collapse and dry. The disease gets its name from the root symptoms. Roots turn dark brown with a darker ring in the center, and a have a distinct brittle character when snapped in two. Where it occurs, a program of scouting for beet leafhoppers and the application of approved insecticides will reduce or eliminate the disease incidence.

In recent years, areas of commercial production have also been affected by incidence of root discoloration with the primary causal agent identified as a *Verticillium* fungal species. Care should be taken to inspect planting stock for any indication of discolored, streaked or dark internal flecking (Figure 10); these sets should be discarded. There is no "clean seed" program in this country as is done with other vegetatively propagated crops. For new growers increasing stock, observation of the health of the roots is imperative, and any root that is not clean and white internally should not be introduced to the farm.



Figure 10. Internal discoloration and flecking (peppering) caused by *Verticillium* spp. results in unmarketable root.
(Photo by E. Wahle, University of Illinois).

While many insect species feed on horseradish, only a few are economically important. In general, foliage feeding by insects is of minimal concern, as horseradish can tolerate a significant amount of early damage before yield is decreased. However, defoliation by in-

sects late in the season can be detrimental to yield and should be monitored. Flea beetles (horseradish flea beetle) and cabbage worms/loopers are the most common foliar feeders. They are easily controlled by timely insecticide application. Two-spotted mite populations can build when certain insecticides such as carbamates are overused. The imported crucifer weevil has been an important insect problem. Larvae feed on the surface of developing roots, rendering them unmarketable. A program of good crop rotation, inspecting sets, and insecticide sprays to control adults will limit damage from this insect.

Detailed scouting procedures for key insect and disease problems and their images can be found in Scouting Horseradish for IPM, a University of Illinois College of Agricultural, Consumer, and Environmental Sciences publication, *http://web.aces.uiuc.edu/vista/pdf_pubs/944.PDF*.

Harvest and Packing

Harvest begins once the tops are frozen back, usually starting in November and continuing through the winter when soils are not frozen and dry enough to support machinery. Prior to digging, the dried tops are mowed if still green. If the foliage has been frozen and is matted to the ground, a common hay rake can help lift it from the crown, and windrow it away from the row. This helps to keep the root mass cleaner as it is dug and handled. A single-row potato digger can be used to harvest roots (Figure 11), undercutting the ridges as deeply as possible to lift the root mass, recovering the primary and as much of the lateral root system as possible. The soil/root clump then travels over the digger chain and a conveyor system that shakes off excess soil. A trailing, open wagon can catch the roots as they drop off the conveyor, or they can fall on the ground for later pick-up onto a flatbed wagon. On smaller plantings, a moldboard plow can also be used to kick plants out of the ground for pick-up by hand. Because of weather, soil, or market conditions, harvest is often delayed until spring. This may result in the unique situation in which digging of the old crop and planting of the new crop occur at the same time.



Figure 11. A single-row potato digger works well for horseradish.
(Photo by A. Bratsch)

For small-scale growers/processors without cold storage, roots can be left in the ground and dug when needed, as long as the ground is not frozen. Primary roots derived from sets should be dug by early spring, or they will begin to regrow, enlarge, and become woody and hollow. Over time, a neglected planting will spread, and gradually become disorganized into new and old crowns, with most useable roots of narrow diameter.

The advantage of lighter textured soils quickly becomes evident during harvest. Lighter soils dry more quickly, allowing field access in wet winter months and they are less likely to adhere to the root mass. Harvesting usually leaves many broken root pieces behind. These overwinter and sprout the following season as volunteers. Control of volunteer horseradish in successive crops is important. If not managed, they become a serious weed problem and negate benefits of effective crop rotation.

The harvested root mass is brought into a sorting area. The roots can be shaken clean by hand or washed with a hard water spray. For innovators, a revolving drum with holes can be fashioned which tumbles soil from the roots. For commercial processing markets, roots are generally not washed, but adhering soil clumps are removed prior to delivery. For local grocery markets, they are well cleaned. For large Fancy and #1 roots, leaf and petiole residues remaining on the crown are trimmed closely by hand with a knife, and the rest of the root mass trimmed off. Lateral roots are harvested for sets, and placed in boxes for storage.

Once trimmed, any roots of, Fancy, #1, #2, and field-run (#1 and #2 mixed) grade should be packed and marketed separately to receive a higher price. They are packed differently from wild-root or trimmings, using 50- or 100-pound burlap sacks lined with heavy plastic. The large Fancy and #1 roots can be cleaned even further, and tumbled with water to smooth the rough outer layer, and then packed in small, breathable plastic bags (usually five to 10 pounds) for specialized retail grocery/restaurant trade or other direct-market outlets.

For wild-root or trimmings sold for processing, the entire root mass is bundled and marketed by weight. By

using a retractable, hinged box, masses of root can be formed into 500- to 1,200-pound cubes, film wrapped, and shipped on wooden pallets (Figure 12).



Figure 12. Shrink-wrapped field-run root packed in cubes and handled with wooden pallets.
(Photo by A. Bratsch)

In direct-market settings, fresh roots should be washed, set out for display, and moistened periodically. Roots should be kept under cold storage (see below) and pulled out as needed. For small-scale processing, roots should be chopped and ground in a well-ventilated room. Limit product exposure to air, and use sealed containers that limit air contact. Grind small lots on a regular basis to ensure a fresh product. Over time, ground horseradish will slowly lose its pungency, depending on how well sealed the package is.

Horseradish can be easily stored for long periods, provided adequate cooler space is available:

Storage as quoted from USDA Ag. Handbook #66: "Horseradish should keep satisfactorily for up to 10 to 12 months at 30º to 32ºF and relative humidity of 90 percent to 95 percent. A high relative humidity is essential for minimum deterioration during storage. Perforated plastic bags or bin liners can aid in maintaining the high humidity. Roots should be kept in the dark because they can become green when exposed to light. Roots dug when the plant is actively growing do not keep as well as those conditioned by cold weather before they are dug. Frequent inspection in storage is advisable. Horseradish can also be stored overwinter in cool cellars or in deep outdoor pits or trenches."

Research has not determined potential yields for Virginia. Yield will vary by site, variety used, and culture, but expect 3,000 pounds on the low end up to 12,000 pounds of harvestable root mass per acre on the high end. Prices are variable from year to year with field-run, wild-root ranging from $0.25 to $0.50 per pound and Fancy and #1 root up to $1.00 or more per pound. Specially packed, washed, and tumbled large roots can bring significantly more in the grocery trade, depending on current market demand and negotiations with local buyers. For farmers markets or other direct sales, expect $2.00 to $5.00 per pound for cleaned and packaged Fancy and #1 roots.

Summary

For smaller scale growers, horseradish has potential marketing outlets through fresh sales to local restaurants, grocery and specialty food stores, and to specialized food processing companies. Direct marketers who have approved kitchen facilities can add processed horseradish to their line-up of value-added products for sale to customers. For larger-scale production, it is common for condiment processors to work on a contract basis with growers. These markets can be competitive and difficult to break in to. Potential does exist for targeted marketing of large, top-grade roots through wholesale brokers for fresh-market produce sales.

Producing horseradish successfully means maximizing the yield of larger, quality grade roots, which allows easier and more efficient processing, and brings a higher price on the market than root marketed in mass (wild root). Growing good, large, single roots that are Fancy or #1 grade, requires attention to detail, the use of special techniques, equipment, and adapted varieties that perform well in a given climate and soil condition.

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