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Growing and Marketing Lavender

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About Lavender

Lavender, the common name of the genus *Lavandula*, is an herb closely related to rosemary, sage, and thyme. It is a summer flowering perennial shrub with flower colors that typically range from deep purple to pale blue, and also includes some pink, green, and white varieties. Lavender has been used for medicinal, cleansing, culinary, aromatic, horticultural, decorative, and other purposes for centuries. Today, lavender is experiencing a resurgence of popularity, with its many uses ranging from fresh and dried floral arrangements to crafts and aromatherapy. Lavender oil is a staple of the cosmetics and industrial fragrance industries. Lavender has long been used to repel moths and to enhance the aroma of rooms, closets, and linens. For centuries, lavender was a staple herb in many kitchens, and its culinary popularity is returning. As a sedative and disinfectant, the medicinal uses of lavender are well known, and with modern trends toward herbal remedies, it is regaining popularity. Finally, what would a cottage garden be without beautiful and fragrant lavender?

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Lavender Varieties

There are over 30 species of *Lavandula*, with cultivars numbering in the hundreds. The genus *Lavandula* was historically divided into three sections: *Spica, Stoechas*, and *Pterostoechas*. Recently, however, the genus *Lavandula* has been reclassified into six sections: *Lavandula* (formerly *Spica*), *Stoechas*, *Pterostoechas*, *Dentata*, *Chaetostachys*, and *Subnuda*. The most commercially important species, *L. angustifolia, L. x intermedia*, and *L. latifolia*, are all members of the section *Lavandula*, and are commonly referred to as "true" lavender, lavandin, and spike lavender, respectively. *Lavandula angustifolia* cultivars are also referred to as "English" lavender. Nomenclature of lavender is a source of considerable confusion, and care should be taken when purchasing lavender to assure that the proper variety is being purchased. Misidentification and incorrect nomenclature are major problems in lavender propagation and sales.

Lavenders in the section *Lavandula* tend to be the most hardy, and have essential oils with the most desirable characteristics. Lavenders in the other five sections also produce essential oils, but they have limited commercial value due to their harsh, unattractive aromas. Other species, especially those in the sections *Stoechas* and *Dentata*, have significant commercial value in the nursery industry as landscape plants. However, in this publication, the discussion will be limited to lavenders of the section *Lavandula*, and specifically to the species *L. latifolia, L. angustifolia*, and *L. x intermedia*.

Lavandula latifolia

Lavandula latifolia is commonly referred to as "spike lavender," or simply "spike." The Latin word "latifolia" literally means "broad leaved," and the leaves of *L. latifolia* plants are broader and grayer than those of *L. angustifolia* plants. *Lavandula latifolia* is less hardy, and has longer flowering stems than *L. angustifolia*. In its native land, *L. latifolia* tends to grow at lower elevations and to bloom later than *L. angustifolia*. Given that *L. latifolia* is typically not grown much commercially, especially in the United States, this publication will not go into detail about varieties and production information specific to *L. latifolia*.

Lavandula angustifolia

*Lavandula angustifoli*a is also referred to as "English" or "true" lavender, *L. vera*, or *L. officinalis* (both older botanical names are no longer in use). "Angustifolia" is the Latin word for "narrow leaved," and, as the name suggests, its leaves are narrower than those of *L. latifolia*. Flower stems of *L. angustifolia* are unbranched, with a single flower head on each stem, in contrast with *L. latifolia* and *L. x intermedia*, which have branched flowering stems. This species is comprised of many varieties, all of which have a sweet fragrance. Flower colors range from deep purple to white. Overall plant stature and flowering stem length are shorter than either *L. latifolia* or *L. x intermedia*. Lavandula angustifolia are the hardiest of lavenders, and can survive winter temperatures of -15ºC (5ºF), or even colder if they are grown in well-drained soils.

Some common *Lavandula angustifolia* cultivars:

'Alba'—white flowers, long flower stems, attractive, fragrant plant
'Buena Vista'—dark violet-blue, long flower heads, striking plant, can bloom twice (usually June and September)
'Folgate'—bright violet-blue, medium flower heads, bushy plant, common variety often misidentified in nurseries
'Hidcote'—dark purple-blue, a favorite for deep color when dried, popular variety often grown from seed, shows great variability in nurseries
'Irene Doyle'—violet-blue, small plant, can bloom twice, 6 inch flower stems
'Jean Davis'—pink, medium upright plant, green-gray dense foliage
'Maillette'—bright violet-blue, medium plant, long flower heads
'Munstead'—lilac colored flowers, medium size, bushy, very fragrant, often grown from seed and consequently variable in characteristics
'Nana Alba'—white, very small plant
'Royal Velvet'—dark purple, medium-sized striking plant, popular with Washington growers, especially for its dark, attractive dried stems
'Twickel Purple'—dark violet, compact, beautifully shaped plant, long flower heads, nice landscape plant

Some common *Lavandula x intermedia* cultivars:

'Abrialii'—once the backbone of the French lavender industry but now greatly reduced due to disease, bright violet-blue, large well-shaped, elegant flower heads
'Alba'—white, sometimes sold as Hidcote White, large, bushy plant, tends to get woody if not properly pruned
'Dutch'—medium blue-violet flowers, large plant, gray foliage, also known as 'Vera'
'Fred Boutin'—dark violet flowers, large plant, dense gray foliage
'Grosso'—easily the most widely grown lavender in the world, dark blue-violet flowers, long attractive flower heads, good oil quality, high oil yield, medium-sized plant
'Hidcote Giant'—bright violet-blue flowers, large plant, compact/uniquely shaped flower heads, long stems, attractive plant
'Old English'—medium sized plant, lavender-blue flowers, dense green-gray foliage, long slender flower heads
'Seal'—medium violet flowers, large bushy plant, very fragrant, an old favorite

Lavandula x intermedia

Lavandula x intermedia cultivars (lavandins) are sterile hybrids obtained by crossing *L. latifolia* with *L. angustifolia*. As the name "intermedia" suggests, leaf width is intermediate between that of both parent species. Lavandins flower earlier than *L. latifolia*, but later than *L. angustifolia*, and their oil properties are also somewhat intermediate. Lavandins typically have larger flower heads than *L. angustifolia*, with flowers ranging from deep purple to white. While the base plant size of both *L. x intermedia* and *L. angustifolia* are fairly similar, flowering stems of the lavandins are typically much longer than those of *L. angustifolia*.

Site Considerations for Growing Lavender

Climate

Lavender is native to the Mediterranean region; consequently, most lavender species prefer a Mediterranean-like climate. Much of the world's lavender is grown in the Provence region of southern France, where summers are long, sunny, and warm, and where winters are mild. Lavender requires full sun to grow and produce well, but areas with extremely hot summers and/or warm winters may not be suited to commercial lavender cultivation. Extremely hot weather can retard growth and reduce lavender quality. Lavender also requires a cold period to induce good flowering. *Lavandula angustifolia* varieties tend to be the hardiest lavenders, and can typically be grown in USDA Hardiness Zones 5 and above. Lavender grown in well-drained soils can withstand considerably colder winters than lavender grown in more poorly drained soils. Although slightly less hardy than *L. angustifiolia*, most *Lavandula x intermedia* varieties are also relatively winter hardy and they can also be grown in Zone 5. Other lavenders, such as *L. stoechas*, *L. dentata*, and lavenders from the section *Pterostoechas*, range from somewhat hardy to tender.

Lavender does best in a low humidity environment. Lavender grown in areas of high humidity is far more prone to fungal diseases than lavender grown in areas with low relative humidity. If grown in a more humid environment, plant spacing should be increased, and the plants should be placed in an area with good air movement.

Soil

Lavender grows best in soils that are well-drained, with a pH of between 6 and 8. Much of the world's lavender is grown on stony, calcareous soils with a pH range of 7.5 to 8.5. Research has shown that plant health, longevity, and quality are better in somewhat poorer soils than in soils that are considered to be typically ideal for many other plants. This is not to say, however, that any rocky soil will grow excellent lavender. Our test plots showed that plant size, stem length, and yield were all higher when lavender was grown in well-drained sandy loam soil, compared to lavender grown in shallow, gravelly soil with a subsoil of compacted glacial till. Irrigation for both plots was the same, and lavender in the rocky soil undoubtedly would have benefited from additional irrigation.

The most critical aspect related to soil in selecting a site for growing lavender is soil drainage. Lavender is very susceptible to root rot diseases caused by the

fungi *Phytopthora cinnamoni* and *Armillariella mellea*. Lavender does not grow well in clay soils, or in areas with a hard pan, perched water table, or other problems that lead to saturated soils, particularly during the late fall, winter, and early spring, when the plants are dormant. Lavender cannot tolerate saturated soils, and will not survive long in these conditions. If lavender is planted in less than well drained soils, it is important that a drainage system be installed, or that the lavender be planted on mounds, berms, or in raised beds to improve drainage in the root zone.

Fertilization

Prior to planting, soil should be tested to determine if major or minor nutrients are lacking in the soil. If so, those nutrients should be supplemented before planting. In general, lavender requires relatively low levels of soil fertility. However, new lavender plantings can benefit from extra nitrogen to encourage more rapid vegetative growth during establishment. Providing up to 100 lbs of supplemental nitrogen per acre, split between spring and post-harvest applications, can be beneficial for the first three seasons. After that, no more than 50 lbs N per acre should be applied, if any. Incorporating a little blood meal, bone meal, and lime in the fall may be all that is needed to meet plant fertility requirements, and to keep soil pH in the proper range. Over-fertilization with either nitrogen or phosphorus can actually lower oil and flower yields, reduce oil quality, and diminish plant health.

Irrigation

Lavender is considered a drought-tolerant plant. However, adequate water is still required for plants to perform well, especially at key points in their life cycle. It is especially important to irrigate young plants, particularly in hot, dry, windy areas. Because lavender is best grown in well-drained soils, young plants must be irrigated often enough to maintain adequate soil moisture. Once mature, plants are much more able to withstand prolonged dry periods, and some growers in areas with adequate summer rainfall do not irrigate mature stands of lavender. Nevertheless, research from New Zealand (McGimpsey & Porter, 1999) suggests that in almost all cases, lavender quality and yield can be improved with timely irrigation. Drought stress can reduce stem length, the number of flower heads, and the number of flowers per flower head, resulting in a reduction in oil yield and a

Figure 1. Newly planted lavender with drip irrigation.

reduction in the number of marketable flower stems and buds. The New Zealand research has also shown that irrigating after harvest can help boost shoot growth and stimulate more flowering shoots for the next growing season. The amount of irrigation needed will vary significantly, depending on factors such as rainfall, soil type, wind conditions, aspect of the site, and stage of growth of the crop. It is important to note, however, that over-watering can also lead to significant problems, especially increased fungal diseases.

Drip-type irrigation and overhead sprinkler irrigation systems have both been used successfully in commercial lavender production. However, drip irrigation has several advantages to overhead irrigation. In addition to conserving a considerable amount of water, drip irrigation has the added advantage of only providing water to the plants' roots. Overhead irrigation wets the foliage and can lead to fungal disease problems, especially in more humid environments or in situations with poor air movement among the plants. Due to the weight of the water on the foliage, overhead irrigation can also cause plants to fall open in the center, contribute to curved stems, and make harvesting more difficult. With long-stemmed lavandins, overhead

irrigation can sometimes cause the outer stems to lie on the ground, contaminating flower heads with soil and causing some flowers to rot. As a general rule, overhead irrigation should not be used after stems are fully elongated and flower heads are at least half-formed. Overhead sprinkler irrigation can also damage young plants that are not fully rooted by eroding and destabilizing the soil around the roots. Finally, a major advantage of drip irrigation versus overhead irrigation is that by watering only the areas surrounding the lavender plants, weed pressure during the growing season can be reduced, and labor for weeding can also be reduced.

Propagating Lavender

Propagating from Seed

Most cultivars of *L. latifolia* and *L. angustifolia* can easily be propagated from seed. However, this is not recommended, due to lack of uniformity in appearance, fragrance, and quality in lavender plants grown from seed. Since lavender is commonly planted in rows or hedges, plants grown from seed will have significant variability in color and plant size, thus creating an uneven and often unattractive lavender hedge. Lavender grown commercially for oil, dried stems, or other products where uniformity is imperative should never be grown from seed, because the variability can make quality control and marketing difficult. *Lavandula x intermedia* cultivars are all sterile hybrids, and cannot be propagated from seed.

When propagating lavender from seed, plant the seeds in flats filled with a gritty, soilless planting medium that is moist, but not saturated. Do not plant the seeds too deeply—lavender seeds need light to germinate. Cover the trays with plastic wrap, and stratify the seeds for at least three weeks by placing them in a cold frame or similar outdoor environment during cold (but not freezing) weather, or by placing them in a refrigerator. Once stratified, place the trays in a warm, well-lighted area. Germination rates will vary by variety, and even within varieties, but germination typically takes from two weeks to two months. Bottom heat provided by heat mats or other means can shorten the germination time and speed the initial growth of seedlings. It is important not to over-water new seedlings, as they are very susceptible to fungal diseases.

Propagating from Cuttings

The most common method of propagating lavender is via cuttings. Propagation from cuttings results in new plants that are clones of the parent plant, thus guaranteeing that new plants maintain the true characteristics of the chosen cultivar. Lavender can be propagated by

Figure 2. Softwood propagation (left to right): 1) taking cutting from parent plant; 2) close-up of cuttings; 3) stripping base of cutting; 4) applying rooting hormone; 5) placing cutting into planting mix; 6) growing cuttings using bottom heat (heated greenhouse floor).

using either softwood tip cuttings or semi-hardwood cuttings. Large-scale propagators tend to use softwood tip cuttings, as this method is less expensive and has higher success rates, especially if the operation is equipped with a heated greenhouse and/or propagation bench with bottom heat. Semi-hardwood cuttings are easier for home gardeners, and for small-scale propagators who do not have the facilities or time to work with softwood cuttings. Whether using softwood tip cuttings or semi-hardwood cuttings, only mature, healthy parent plants should be selected. Never take cuttings from diseased or unthrifty parent plants. It should also be noted that some lavender varieties are harder to propagate than others.

Softwood tip cuttings can be taken in the spring or fall from young shoots. For fall cuttings, it is advisable to remove flower buds as they form on the parent plants in the spring or early summer. This will stimulate parent plants to produce new shoots suitable for softwood tip cuttings. Tip cuttings should be 2 1/2 to 3 inches in length. Leaves from the bottom inch of the new cutting should be removed, wounding the base of the tip cutting in the process. Dip the base of the cutting in a softwood rooting hormone and insert into a sterile planting medium. Planting mixes can be made from various combinations of freely draining materials, such as sand, pumice, vermiculite, perlite, or peat. The key is to find a well-drained planting medium that holds enough moisture to stimulate root formation. Highly saturated planting mixes often lead to high mortality of cuttings due to fungal diseases.

Commercial propagators often use 72-cell propagation trays for propagating softwood tip cuttings, which speed the propagation process and make handling of the cuttings much easier and more efficient. With a bottom heat of 72ºF applied to the cuttings, rooting typically takes three to five weeks. The hardier varieties of lavender take longer to root than the less hardy varieties. Lavender softwood tip cuttings can be propagated without bottom heat, but may take considerably longer. Most commercial propagators use a misting system to keep the foliage cool and to minimize moisture loss. Misting should be done with care, however, as warm, moist conditions can lead to increased problems with disease. Survival rates of softwood tip cuttings should be over 90% with good management practices.

Semi-hardwood cuttings can be taken in either the late spring, or more commonly in the fall. Cuttings of 4 to 6 inches should be taken from new side shoots. Some growers prefer to take semi-hardwood cuttings by pulling the small branches away from the parent plant and breaking them off with a small portion of the union or heel from the main branch. Cuttings taken in this manner are sometimes easier to root than those cut with a pruner. Remove the leaves from the lower portion of the cutting, moisten it, and dip in a rooting hormone. Semi-hardwood cuttings can either be rooted in a gritty planting mix or rooted directly in the soil. About two-thirds of the cutting length should be inserted into the planting mix or loose, friable soil. Fall cuttings can be placed in a cold-frame, but may need to be covered during hard freezes. Semi-hardwood cuttings usually take about twelve weeks to root, and survival rates are typically 50–80%, but will depend on careful management practices.

Layering

Although not really practical as a commercial method, lavender can be easily propagated by layering. In the spring, select healthy, mature parent plants and water thoroughly around the plants. Select an outside branch with young, pliable wood, and bend it down to the ground. Measure 8 to 12 inches from the growing tip, and mark the area where this part of the branch touches the ground. Remove all leaves and foliage from this section of the branch, leaving about 6 inches of foliage at the end of the branch. Dig a 3- to 4-inch deep trench in the area you have marked. Moisten the area of the branch that has been defoliated, and dust with a rooting hormone. Pin the branch down in the trench with a wire, and then bury the branch with soil, leaving the end with foliage exposed. Stake the branch tip so that it stands upright. Keep the layered branch watered and weeded throughout the growing season, and check in the fall for roots. If it has rooted, cut it off from the parent plant, but leave it in place until spring when it can be dug and replanted. If it is not rooted in the fall, do not cut it, but recheck it in the spring. Several branches on each parent plant can be layered.

Tissue Culture

Tissue culture is a fast way to propagate large numbers of lavender plants by using callus tissue taken from lavender leaf buds. Tissue culture requires considerable

skill, as well as an expensive laboratory and specialized equipment. A small amount of callus, grown on an agar-based medium, can generate many new plants. When the tiny new plants are large enough they are transferred to a potting mix, gradually acclimated to the outside environment, and finally grown and treated as any other propagated lavender plant.

Purchasing Plants

Although propagating lavender is relatively simple, most people find it easier and cheaper to buy lavender plants. Lavender plants at all stages, from recently propagated plants to mature potted specimens, are sold in many nurseries and garden stores. However, if purchasing a large number of lavender plants, it is important to know that the price at retail nurseries is usually high, and it is unlikely that they will have large numbers of plants of the varieties needed by commercial growers. Therefore, it is best to find a wholesale supplier of lavender when planting large numbers of lavender plants.

There are literally hundreds of lavender cultivars, and many look alike at early stages of growth. It is therefore common for plants to be misidentified and mislabeled. Some lavender growers have gone to considerable time and expense to purchase, plant, and nurture hundreds of new plants, only to discover they were not growing the variety they thought they had bought. Only purchase lavender plants from knowledgeable wholesale nurseries and propagators who have a good reputation for high quality, properly identified plants. Ask the nursery if they guarantee that the plants you are buying are indeed the variety you have requested; if not, find another supplier.

Lavender is often propagated in plug trays with either 72 or 128 cells per tray. Some growers purchase plug trays and transplant directly from the tray to the field. Others prefer to purchase larger plants that have been transferred from plug trays into 2 1/2- or 4-inch pots. Generally speaking, the smaller the plant, the lower the price. The biggest advantage to purchasing larger plants is that survival rates upon transplanting should be good, even if management is not the best. Planting small plugs directly to the field can save money, but without excellent care, survival rates may be poor. If you choose to buy lavender plants in pots, make sure they are well-rooted, and not plugs recently transferred to pots. Also, never purchase lavender plants that are severely root-bound, yellow, wilted, or stunted in appearance.

Establishment of New Plants

Hardening and Transplanting. Whether from seed or from cuttings, lavender that has been started in a greenhouse or other sheltered environment should be carefully hardened off to avoid shocking and stunting plants during transplanting. Placing plants in a cold frame, hoop house, or some other environment that tempers cold temperature and low humidity for a week or two prior to transplanting can improve survival in the field. Before transplanting, make sure your plants are healthy and vigorously growing.

Fall is generally the best time to transplant lavender, but only in areas that do not have severe winters. In such areas, spring transplanting may be the only option. When transplanted in the fall, plants will have more established root systems and be better able to thrive when the hot, dry days of summer arrive. Spring transplanting can be successful, but more watering is typically required. It is usually a good idea to propagate or purchase extra plants to replace the plants that do not survive transplanting.

Plant Spacing. When growing lavender as a commercial crop, it is important to know what types of products you will be making from your lavender before you establish your plants in the field. If growing lavender strictly for oil production, plants can be spaced somewhat more densely than if you intend to

Figure 3. Proper plant spacing is critical when establishing a new lavender planting.

cut the lavender by hand and create high-quality lavender bundles from the stems. Since most lavender produced worldwide is harvested mechanically, row spacing and plant spacing within rows is dictated by the requirements of the machine harvester. Typically, spacing between rows ranges from 4 1/2 to 6 feet for machine harvesting, and spacing of plants within rows ranges anywhere from 1 1/2 to 3 feet. Some smaller *L. angustifiolia* plants, such as the variety 'Munstead,' should be planted more closely, while larger *L. x intermedia* varieties, such as 'Grosso,' should be planted farther apart. The French tend to plant their lavandins relatively densely within rows for two reasons. Denser plantings produce larger harvests in the first year or two of production, and planting more densely also tends to limit ultimate plant size, which reduces the tendency of older plants to break open in the middle where woody stems tend to droop outward.

Lavender growers in Sequim, Washington have utilized a variety of plant spacings. However, growers who have spaced their rows of lavandins such as 'Grosso' closer than 6 feet, and who have planted their lavandins closer than 3 feet within rows, have indicated that they should have utilized wider spacings. When mature, large varieties like 'Grosso' can easily reach a span of 5 feet or wider, even with aggressive pruning. Most Sequim area growers are producing lavender to be marketed as dried bundles or dried buds. All harvesting in the area is done by hand. Spacing rows less than 6 feet apart makes traveling between rows to harvest or do other work difficult as the plants reach maturity. Spacing plants within rows closer than 3 feet apart increases harvest time, because stems from adjacent plants become intertwined and are then difficult to quickly grasp, bunch, and cut by hand.

Depending on the species and variety to be planted, harvesting methods, and ultimate product usage, lavender can be planted in a variety of spacings. Smaller growers, who harvest by hand, market much of their lavender as high-quality dried bundles. Consequently, they plant larger lavandins 5–7 feet between rows, and 30 to 42 inches between plants, with the most common spacing being 6 feet between rows and 36 inches between plants. Smaller *L. angustifolia* varieties such as 'Munstead' or 'Martha Roderick' can be planted more closely, but larger *L. angustifolia* varieties such as 'Folgate' need similar spacing to the *L. x intermedia* varieties. A spacing of 5 feet between rows and 30 inches between plants results in a planting density of approximately 3,400 plants per acre, while a spacing of 6 feet and 36 inches results in approximately 2,400 plants per acre.

Planting. Before plants are placed in the field, it is important that the ground be properly prepared.

Figure 4. Planting sequence: 1) adding starter fertilizer mix (left to right); 2) thoroughly incorporating starter fertilizer into planting area; 3) plant prepared for planting by removing root-bound roots; 4) soil firmly pressed in around new plant.

Weeds should be controlled, especially tenacious perennial weeds such as quack grass, field bindweed, and Canada thistle, and the soil tilled to a depth of at least 10 inches. Any amendments such as lime or fertilizer (other than starter fertilizer) should be applied prior to planting. Many growers in the Sequim area use a woven landscape fabric as a weed barrier prior to planting to dramatically reduce future weeding. More about weed barriers will be presented in the section on weed control. Holes are cut in the weed barrier at the desired spacing, using a propane heated burner to burn holes in the fabric.

Planting is done by hand, using a small garden spade or some other tool to dig a planting hole. Many growers mix a small amount of starter fertilizer into the immediate planting area. About 1 to 2 cups of composted chicken manure, along with about 1/4 to 1/2 cup of bone meal, is commonly used as a starter fertilizer. After the starter fertilizer is thoroughly worked into the planting area, the lavender plant is placed into the planting hole, and soil is backfilled by hand and pressed firmly around the plant. The new plant should be positioned at or slightly above the level of the surrounding soil. Planting too deeply can lead to poor survival rates for new plants. As stated above, fall planting is preferable in many areas. If fall planting is timed to receive sufficient rains, then no additional watering of the new planting will be required until the following spring. If spring planted, it is important that an irrigation system be in place at the time of planting so that fragile new plants can be watered on a timely basis as warm weather arrives.

Whether planting small plugs or larger plants, it is critical that healthy, properly started plants be selected. Never select plants that show yellowing, bronzing, or blotchiness. Always inspect the root system of the plants to make sure roots are healthy and well-established. Plants that are severely root-bound should be also be avoided. If plants are root-bound to any degree, it is important to tear away any circling roots at the base of the root system. This will encourage the development of new, properly formed roots.

Weed Control

Almost without exception, when asked what is most difficult about maintaining lavender in a field setting, growers tend to respond, "Controlling weeds!" Lavender does not compete well with weeds, and serious weed infestations can dramatically decrease the yield and quality of lavender stems, flowers, and oil. And, since beauty and aesthetics are very important to many lavender growers, serious weed infestations can also detract from the attractiveness of a lavender farm, and negatively impact marketing and the ability to attract visitors.

Figure 5. If weeds are not controlled before planting and while plants are young, weed problems can become extremely serious and difficult to control as plants mature.

Pre-emergent herbicides have proven fairly effective in controlling many weeds in Europe, New Zealand, and other major lavender producing areas. However, because lavender is a minor crop in the United States, there are no herbicides currently registered for use on lavender.

A critical step in establishing lavender is to make sure the plot is as free of weeds as possible before the lavender is planted. This can be done with herbicides, tillage, hand weeding, or black plastic mulches. Eliminating tenacious perennial weeds such as quackgrass, field bindweed, and Canada thistle prior to planting is especially important.

The key to weed control in lavender is to not allow weeds to become a severe problem from the start. If a relatively weed-free site is developed, and if weeding is done diligently after planting, weed control will get

easier with time. Once lavender plants are mature, they will effectively shade weeds within the row. However, if weeds are not controlled early within rows, then weeding can become extremely difficult.

Landscape Fabric. Some growers use a synthetic woven weedmat or landscape fabric as their primary weed control method. This product allows air and water to penetrate to the soil, but suppresses weed growth. Although this may not be practical for large fields of lavender, many smaller lavender growers have found the product to be convenient, effective, and affordable compared to the annual costs of weeding over a long time period. Some growers cover the entire area, including the spaces between rows, with landscape fabric. Others lay a narrow strip, usually about 2 to 3 feet wide, in the planting row, and plant grass in the strip between rows, which is then periodically mowed. When installing landscape fabric, it is important to anchor it securely to the ground to prevent it being lifted or damaged by wind. However, the fabric should not be stretched too tightly, as it will shrink a little over time as it is exposed to sun. There are several manufacturers of landscape fabrics, which are available in widths from 3 to 15 feet. When selecting a landscape fabric for use with lavender, remember that this product will likely be in place for many years. Select a heavy fabric that is resistant to ultraviolet light. The cost for landscape fabric typically ranges from $.06 to $.10 per square foot.

Holes are cut into the fabric at the desired plant spacing. Holes can be cut in a variety of ways, but the best method is to burn 4- to 6-inch holes in the fabric using a propane heated burner (see Figure 8). Burning the holes has several advantages over cutting. Once familiar with using the burner, it is faster than cutting, and can be done while standing. Burning the holes also melts the edges of the fabric, thus preventing the woven fabric from fraying. Burned circular holes are also more uniform and attractive.

Properly installed landscape fabric will almost eliminate the need for weeding most areas. However, it is critical to keep the planting holes weeded. Weeds, especially grasses, have a tendency to grow through lavender plants, and if not controlled early, weeds can be very difficult to remove once the lavender plants are mature and the weeds well established.

Another possible benefit of using black landscape fabric is that it absorbs heat and warms the soil. In cooler areas, this can facilitate earlier harvests, and

Figure 6. Lavender farm using landscape fabric for weed control: top left—first year; bottom left—fourth year; right—fifth year, at harvest time.

Figure 7. Lavender farm using landscape fabric in strips for weed control: top left—first year; bottom left—fourth year; right—fifth year, at harvest time.

Figure 8. Left: planting hole burned into landscape fabric. Right: propane burner used to burn planting holes.

Figure 9. Top: gravel mulch over landscape fabric. Bottom: oyster shell mulch.

Figure 10. While a tiller can be used between rows, hand labor is required to weed within rows.

possibly increase production. However, in areas with hot summers, black landscape fabric may absorb too much heat, stressing and possibly harming plants.

Some growers object to the look of covering the ground with landscape fabric. Although expensive, it is possible to cover the fabric with a mulch. However, it is important to use a mulch that does not encourage weed germination. The roots of many weeds will easily grow through landscape fabric if allowed to germinate in mulches like sand or ground bark. Inorganic mulches, such as gravel, work well for covering fabric, and coarse organic mulches should be considered only if they don't encourage weed growth.

Mulches. A variety of materials can be used to mulch around lavender plants. The traditional organic mulch used in areas where lavender oil is produced is the plant residue remaining after the lavender oil has been extracted in the distillation process. Other organic mulches can also be used, but organic mulches should not be applied too deeply around the base of plants. This is especially true in more humid climates or in areas with very wet winters, because the mulch can contribute to disease problems. In dry climates, organic mulches are more practical, and have the added advantage of conserving soil moisture, reducing the requirement for irrigation, and adding nutrients to the soil over time.

White sand or other light colored mulches can stimulate plant growth and production, due to the increase in reflected light around the plants. Crushed oyster shells have been tested as mulch on plots in Sequim. At a depth of 3 to 4 inches, oyster shells provided good weed control, with the added advantage of being attractive and increasing reflected light.

Mechanical and Hand Weed Control. Most weed control for lavender is done mechanically or by hand. Some growers maintain mowed strips between rows. This not only reduces the need for weed control between rows, but also reduces mud problems during rainy periods. However, invasion of weeds and grasses from the grass strips into the lavender rows can be a problem. Often, the space between rows is weeded using a rototiller or other mechanical tillage tools. Weeding within the lavender rows is typically done using hand tools. Sometimes there is no alternative to getting down under the lavender plants and

hand-pulling the weeds growing near the base of the lavender plant.

Pests and Diseases

Lavender has relatively few serious pests and diseases in the United States. This is especially true if lavender is grown in well-drained soils and in areas with a Mediterranean-type climate.

Spittle Bugs. Spittle bugs (sometimes referred to as "frog hoppers") are a common pest of lavender, but seldom cause serious damage. They are evident in spring when they secrete foamy "spittle" on plants. Although this spittle can be unsightly, spittle bugs rarely reach a level of infestation that causes serious damage. However, stems upon which the spittle bugs are located wither, and sometimes die. The best means of dealing with this problem is to periodically wash off the spittle bugs with a strong spray of water. This may not be practical, however, on large plantings.

Aphids. Aphids are rarely directly harmful to lavender. They are, however, a common vector for spreading Alfalfa Mosaic Virus in lavender.

Alfalfa Mosaic Virus (AMV). Alfalfa Mosaic Virus (AMV) is one of the most common diseases of lavender. Bright yellow patches develop on leaves and shoots, with the affected tissue sometimes becoming twisted. AMV will not typically kill plants, but will reduce their vigor and production. Although the visibly affected portions of a lavender plant may be minor, the virus is present throughout the plant. Therefore, pruning away the symptomatic portions of the plant is not an effective cure.

Once a plant is infected with AMV, it should be removed immediately and burned. This virus is most commonly spread by aphids, but can also be spread by unsanitary cutting tools, and even hands. This is why it is critical that infected plants be identified and destroyed right away.

Root Rot (Phytophthora cinnamoni and Armillariella mellea). Lavender is very prone to root rots caused by certain soil-borne fungi. This is especially true of lavender grown in poorly drained soils. Roots are infected and begin to rot during wet periods, and plants then subsequently die when they can no longer receive adequate water during the growing season.

Figure 11. Spittle bugs on lavender in spring.

Figure 12. Alfalfa Mosaic Virus on lavender.

Figure 13. Lavender dying from root rot.

Entire plants may wilt and die suddenly, but, more commonly, a portion of the plant will die one season, followed by the rest of the plant over the next year or two. Infected plants rarely recover. The disease is easily spread from one plant to another in very wet soils; thus, infections are common over large patches in wet areas.

The key to minimizing or preventing this disease is to plant only in well-drained soils. Installing drainage systems and/or planting in raised mounds or beds can also help. In areas where lavender has died from root rot, it is often best not to re-plant, unless the area has been adequately drained or otherwise improved to prevent water-logged soils. Infected plants should be removed and burned, removing as much of the root system as possible. Often, it is best to remove adjacent plants as well, even if they are not yet showing symptoms. Removing soil from the root zone may help reduce the number of fungal spores remaining in the vicinity, and some references suggest a fungicide drench to further reduce levels of pathogens. However, it is important to realize that this is not a cure; the fungal organisms are ubiquitous in most soils, and if the environmental conditions that favor their growth are not changed, then any subsequent lavender plants placed in that environment are likely to be infected and die.

Lavender Leaf Spot (Septoria lavandulae). Lavender Leaf Spot is a fungal disease that causes leaves to develop spots and a yellowish tinge, and even drop. The disease is most common in greenhouses, where young plants are in a high humidity environment and are watered often. This is also a common disease of lavender grown in high humidity climates, or in areas where rainfall is common during the growing season. Even in areas of low relative humidity and rainfall, this disease can show up if the spring is unusually wet. Plants will recover without treatment if the moist conditions are remedied.

Bacterial Blast (Pseudomonas syringae). Bacterial Blast is a bacterial disease that is also rare or non-existent in lavender grown in a favorably dry climate. In wet, humid climates, however, this can be a very serious disease, causing die-back of new shoots and dramatically reducing yields. If this disease is a serious problem, it is best not to attempt growing lavender (at least commercially) in that area.

Shab (Phomopsis lavandulae). Shab is a fungal disease of lavender that is common in Europe, but has not been reported in the United States. It causes wilting, yellowing, and die back of shoots, and eventually plant death. *L. x intermedia* cultivars grown in areas that are sunny, well-ventilated, and with well-drained soils, are less likely to be affected by Shab. *L. angustifolia* cultivars are not affected by Shab.

Yellow Decline. Yellow Decline is another lavender disease that has not made it to the United States. Caused by a mycoplasm and spread by leaf hoppers, this disease decimated much of Europe's commercial lavender oil industry, until the resistant cultivar *L. x intermedia* 'Grosso,' was discovered. 'Grosso' has become the major lavender grown for oil in Europe and worldwide.

Longevity of Commercial Lavender Plantings

Typically, commercial lavender plantings should last between 10 and 15 years—even longer with proper management and good site conditions. However, if grown in poorly drained soils and/or in a humid, wet climate, the productive life of lavender plants can be five years or less. The longest-lived lavender in field settings tends to be in areas with low summer rainfall, and where lavender is located mid-slope (rather than at the top or bottom of slopes). Plant longevity is longer in low organic matter soils, with a high level of stone/gravel, low available calcium, a stable soil structure with no soil compaction, low available phosphorus, medium available magnesium, and low to medium available potassium. Severe water stress can dramatically decrease the life of lavender plantings, and nitrogen applications greater than 50 lbs per acre also have been shown to reduce the commercially viable life of lavender plants.

Harvesting

There is perhaps no part of the lavender production process more rewarding than harvest. However, harvest can also be a stressful and difficult time if a lavender grower is not prepared. The window to harvest the lavender at the peak of its quality is relatively short, and since most growers will be harvesting by hand, this can mean very long hours. Most lavender growers with more than a few hundred plants hire extra help at harvest. Harvesting and

moving the lavender into the drying shed or the lavender still in a timely manner can mean the difference between success and disaster.

Timing. Proper timing of lavender harvest depends upon the desired end product for the lavender. Lavender grown for either fresh-market bundles, or for dried bundles to be marketed with flower buds still attached to the stems, should be harvested when the first one or two flowers have bloomed on the spike (Stage 2; Table 1). If a large portion of the flowers are in bloom at harvest, quality of the final bundles will be reduced, and there will be significantly more dropping of flowers and buds from the stems after drying. If the intended end product is flowers and buds that will be stripped from the stems, then lavender should be harvested when approximately one-quarter to one-half of the lavender flowers on the spikes are blooming, but no flowers have begun to wither (Stage 3; Table 1). The best time to harvest most lavenders for oil production is when approximately half of the flowers on the spike have withered (Stage 5 or Stage 6; Table 1).

Table 1. Lavender Maturity Scale*

1. Flower head with no open flowers—all still in bud.
2. First one or two flowers open.
3. Several flowers open, but none withered. Still many buds.
4. Several flowers open, some beginning to wither.
5. Approximately equal quantities flowers and buds; some open flowers.
6. Few buds left, some open flowers, but mostly withered flowers.
7. No buds remaining, few open flowers, most flowers withered.
8. All flowers withered.

8+. Capsules starting to open and shed seed.

A sample of at least 50 flowers should be randomly collected, with each assigned a score between 1 and 8+. The overall maturity of the lavender is based on an average of all the flower heads in the sample.

* This is the scale used at the Redbank Research Station, Clyde, New Zeland, to assess the maturity of individual flower heads at harvest (McGimpsey and Porter, 1999).

Oil accumulation in the flower heads at this point is at its maximum, and quality is typically at its peak.

Mechanical Harvesting. Today, virtually all lavender grown in large fields for oil production is mechanically harvested using various types of machines. Some machines cut and bundle lavender into large bundles, others cut and chop lavender heads in preparation for distillation, and others cut and use air flow to blow lavender heads into a collection container. Economic viability and efficiency in large-scale lavender oil production demand a high level of mechanization to reduce harvest times and, most importantly, to reduce costs.

Hand Harvesting. In the United States, almost all lavender producers are too small to justify the cost of a mechanical harvester. Moreover, since much of the lavender grown in United States is used for floral, craft, culinary, and other uses that demand high quality end products, most lavender producers hand-harvest their lavender. Hand harvesting is typically done with a curved sickle-like knife (Figure 14). If this knife is sharp, an experienced harvester can remove all lavender stems from a plant in 2 to 3 minutes. When using this knife, the off hand should be gloved to prevent injuries. The knife should be sterilized to prevent the spread of disease, such as Alfalfa Mosaic Virus.

Cut lavender stems are bundled, and a rubber band is used to secure the bundles. Bundles should be about 1 1/2 inches in diameter at the point where they are banded. Larger bundles will dry too slowly and may mold during the drying process. Bundles are typically placed on top of harvested plants until taken from the field.

If lavender is being harvested for bundles, maximizing stem length is important, because many buyers demand long stems. This requires harvesting stems with some leaves on them; however, these leaves should be removed in the processing of the bundles prior to sale. Lavender produced for the production of loose dried lavender buds can be harvested with somewhat shorter stems.

Harvesting for Oil Distillation. Lavender harvested for essential oil distillation should be harvested with enough stem attached to properly pack the stillpot.

Figure 14. Harvesting lavender by hand. Left: bundles are temporarily piled on top of plants. Right: close-up of curved sickle-shaped knife used for harvest.

Usually, about 4 to 6 inches of stem should be left attached to the flower head. Harvesting lavender with stem lengths shorter than 4 inches can result in the flower heads being packed too densely in the stillpot, resulting in the steam not flowing uniformly through the lavender, thus reducing oil yields. Since lavender stems contain some oil, and because that oil contains harsh notes not wanted in high-quality lavender oil, the key is to harvest lavender with the minimum amount of stem needed for efficient distillation, but no more than necessary, so as to not significantly reduce oil quality.

Harvesting for Quality. Lavender should never be harvested when wet. Allow any moisture from rain or dew to completely evaporate before harvesting. Harvesting wet lavender may lead to discoloration and mold in bundled lavender, and it can lead to chemical changes in the essential oil that can reduce quality. It is also best not to harvest when the weather is very hot, which can lead to wilting and oil loss. The best harvest time is typically from mid-morning (after dews have gone) until early afternoon. However, since harvest windows are typically short, sometimes there is no choice but to harvest late into the afternoon or evening, even when it is hot.

Lavender bundles tend to generate more revenue than loose lavender buds. However, this is only true if the bundles are of high quality. Consequently, many lavender growers now segregate "center-cut" lavender from "side-cut" lavender at harvest, and dry the two types of bundles separately. Center-cut bundles are those bundles harvested from the top and center of the lavender plant. These stems tend to be the longest, straightest, and best quality for bundles. Side-cut stems are often curved, and tend to be shorter and of lower quality. Bundles from these stems are used by many growers to process into dried lavender buds. Another benefit of segregating center-cut and side-cut lavender bundles is that this can lengthen the harvesting period. Lavender cut for dried bundles should be cut at an earlier maturity stage than lavender cut for dried buds, so the center-cut bundles can often be harvested several days before the side-cut bundles.

Yields. Yields of bundles and dried lavender buds will vary considerably from variety to variety. As a reference point, yields will be presented here for *L. x intermedia* 'Grosso,' the most common variety grown for commercial purposes. Yields for most other lavandins will probably be somewhat lower than 'Grosso,' and yields for most *L. angustifolia*

varieties will undoubtedly be considerably lower than 'Grosso.' Healthy, mature 'Grosso' plants should yield between 4 and 6 bundles per plant (bundles averaging about 150 stems per bundle). Assuming an average of 5 bundles per plant, and assuming a planting density of 2,400 plants per acre, a well-managed acre of 'Grosso' should yield approximately 12,000 bundles. It takes between 12 and 15 dried bundles of 'Grosso' to yield a pound of dried lavender buds. Another way to look at yield of dried buds is that one 'Grosso' plant should yield between 1/4 and 1/2 lb of dried buds. This equates to a little over 1,000 lbs of dried 'Grosso' lavender buds per acre.

Drying. It is very important that lavender be dried as quickly as possible after harvest. The more quickly and effectively the lavender is dried, the better the quality of the dried lavender, especially color. Lavender is typically dried in bundles hung upside down in a dark, dust-free, well-ventilated area to encourage stems to dry as straight as possible. Bundles are typically hung using small 'S' shaped wires that can easily be created by making a simple bend in a large paper clip. One end of the 'S' is inserted under the rubber band, while the other end is used to hang the lavender. Many different types of buildings and shelters are used to dry lavender, and growers have typically used either wires strung horizontally or chains hung vertically to hang their lavender to dry (Figure 15).

Figure 15. Hanging lavender to dry (fans used for air movement shown at bottom left of photo).

Regardless of how the lavender is hung, it is important to leave enough space between bundles to allow air movement. The use of strong fans or other means to adequately circulate air in the drying area is very important, especially when drying large amounts of lavender. Some growers have experimented with supplemental heat to accelerate the drying process, but this is usually an unnecessary expense, and can even damage the lavender if heat exceeds 100ºF (40ºC). If dried lavender bundles are to be stored for any length of time, it is important to maintain a dark, dust-free, low humidity environment. High humidity in storage can cause lavender to mold. If the dried lavender is intended for production of loose lavender buds, then the lavender should be de-budded as soon as possible after it is dry, and the buds placed in sealed containers.

Processing Lavender Flowers

Some growers sell their dried lavender bundles unprocessed after harvesting and drying. However, these "field-run" lavender bundles do not bring a premium price. They are also becoming more difficult to market, as many buyers expect bundles to be groomed to some degree. Similarly, lavender buds that have not been cleaned of stem pieces and other debris also bring low prices, and are difficult to market. Therefore, cleaning and processing dried lavender is essential.

Processing of loose lavender buds begins by removing them from their stems. Many small producers do this by hand by vigorously rubbing and manipulating bundles over 1/4-inch hardware cloth until most of the buds are stripped from the stems and have fallen through the 1/4-inch screen. This is a laborious, time-consuming process. Some larger growers have developed various types of home-made machines using opposing rotating brushes that strip lavender buds from stems in a few seconds. Once buds are separated, they must be cleaned of stem pieces and other debris. Small producers often use a combination of various sizes of screens and fans to winnow and clean their lavender buds by hand—another laborious, expensive, and time-consuming process. However, larger producers have found that with just a little tweaking, used seed cleaning machines can be adapted to rapidly and very effectively clean lavender buds. One local Sequim lavender farm now not

only cleans its own lavender using a retrofitted seed cleaner, but has also developed a side business cleaning lavender buds for many other farms.

Preparing or "grooming" a lavender bundle is done in various ways, but the goal is to produce lavender bundles that are beautiful and uniform in quality. Dried field-run bundles are first unbundled, and loose leaves and many of the shorter secondary stems or side shoots are removed. This can be done by hand, but some producers have found that the same machine that strips buds from stems can be used to clean the stems simply by inserting the stem ends of bundles into the machine for a few seconds to remove leaves and short side shoots. Once the stems are cleaned, they are carefully turned upside-down and placed on the processing table with the flower heads down and the stems being held loosely in the hands. The stems are lifted and very gently dropped once or twice to get most of the flower heads to align fairly uniformly on the table. Damaged or very short stems are removed, and, if necessary, additional stems are added to bring the bundle up to the desired size. After aligning flower heads and removing damaged, short, curved, or inferior stems, the bundles are once again banded to hold them together, and then taken to a cutter to cut the ends of the stems squarely for a finished look. Many buyers demand long stems, so it is important to retain as much stem length as possible throughout harvesting and processing. Finished bundles are typically placed in a plastic sleeve for storage, shipping, and sales.

Essential Oil Production

The bulk of lavender grown commercially around the world is grown for its essential oil. As mentioned earlier, large-scale operations producing lavender oil must be highly mechanized and have access to inexpensive land and readily available, inexpensive labor. Most U.S. lavender producers are small-scale operations that depend upon agritourism and development of high-value lavender products as their source of revenue. Although there is growing interest in producing lavender oil as a commercial agricultural commodity in some areas of the United States, for most U.S. lavender growers, this crop will remain a small-scale, "boutique" type of farming that produces high-value products and aesthetically pleasing experiences for customers and tourists.

World Production of Lavender Oil. Statistics on lavender oil production around the world are difficult and sometimes impossible to obtain. By far, the largest and best-known lavender production area is southern France. France produces about 1,000–1,500 tons of *L. x intermedia* oil annually, and about 50–75 tons of essential oil from *L. angustifolia* lavenders annually. A significant tourism industry has also developed around the lavender fields of southern France. England was historically a significant producer of lavender oil, but in recent decades, production has declined to a few tons of oil produced on farms that, like U.S. lavender farms, are now more dependent on tourism and product development than on producing bulk lavender oil. Other countries are rapidly expanding lavender production. China is now estimated to be producing 50–60 tons of lavender oil per year. Australia is a significant lavender producer, with the center of their production in Tasmania. Other countries producing significant amounts of lavender oil include Russia (25–50 tons per year), Ukraine and Moldovia (20–30 tons per year), Bulgaria, Yugoslavia, Hungary, Argentina, and New Zealand.

What is Essential Oil? Essential oils are volatile oils that can be extracted from plants using a simple steam distillation process. They are called essential oils not

Table 2. Acceptable ranges of percentages of the four major constituents of lavender oil, as reported by the International Standardizaton Organizaton (ISO).

	L. angustifolia		*L. x intermedia 'Grosso'*		*L. latifolia*	
	Min.	Max.	Min.	Max.	Min.	Max.
Linalool	25	38	24	35	34	50
Linalyl acetate	25	45	28	38	trace	2
Camphor	0	2	6	8	8	16
1,8-cineole	0	2	4	7	16	39

Figure 16. Left: table-top essential oil still used for small-scale distillation (also used for the trials reported in Tables 3 and 4). Right: larger, mobile commercial essential oil still.

because they are in any way essential or necessary for any given purpose, but because they are considered the "essence" of the plant. Essential oils have been used for many centuries for a wide variety of purposes. Lavender and lavandin essential oils are today used primarily in cosmetics, perfumes, soaps, detergents, air fresheners, cleaners, and, increasingly, for aromatherapy and homeopathic medicine.

Lavender essential oil is extracted from the fresh flower heads of various cultivars of *L. angustifolia*, *L. x intermedia*, and *L. latifolia*. The oils of these three lavender species vary greatly in their composition, with oils from *L. angustifolia* being the sweetest smelling, and oils from *L. latifolia* being the harshest smelling. *L. x intermedia* oil is intermediate in nature between the oils of its parent species. The nature of the essential oils from these three lavender species differ significantly in the amounts of desirable and undesirable compounds they contain. Desirable compounds include linalool and linalyl acetate, while camphor and 1,8-cineole are less desirable compounds that give lavender oils a harsh, medicinal smell. Table 2 presents the ISO (International Standardization Organization) ranges in percentages of these four compounds for standard *L. angustifolia*, *L. x intermedia* 'Grosso,' and for *L. latifolia* oils.

Oil Extraction. Like most other essential oils, lavender oil is easily extracted using steam distillation. Because it has a low boiling point, and is held on the external surfaces of the lavender flowers, a very simple still can be used to extract lavender oil. It is beyond the scope of this publication to go into technical detail on the distillation process, but the basic process will be described below. For a more complete discussion on distillation, see Denny (2002) or McGimpsey and Porter (1999).

The Distillation Process. A steam distillation unit has four basic components: a source of steam, a stillpot, a condenser, and a separator. Most larger commercial stills have a boiler which generates steam that is piped to the bottom of the stillpot and forced up through the lavender in the stillpot. Smaller stills often have water located at the bottom of the stillpot, which is heated to boiling with a heating element or other heat source. The steam then rises up through the lavender, which is suspended above the water in a basket or cartridge contained within the stillpot.

Stillpots are the container that holds the lavender. The lavender is typically loaded into some type of basket or cartridge and lowered into the stillpot. The stillpot must be sealed tightly so that no steam escapes; if

steam escapes, lavender oil is escaping with it. The cartridge that holds the lavender must also be sealed within the stillpot so that all of the steam is forced to pass through the lavender, and none is allowed to bypass the lavender. This is important because the steam tends to find the path of least resistance as it moves up through the stillpot, and if allowed to bypass the lavender, it will do so. This is also why the lavender must be packed tightly (but not too tightly) and uniformly in the stillpot. If some areas are packed tighter than others, the steam will tend to bypass these more compacted areas and make its way up through the less compacted lavender, leading to incomplete oil extraction. As the steam moves through the lavender, the oil glands on the lavender flowers are ruptured, and the oil is quickly vaporized and moves with the steam.

After the steam (which is laden with volatilized lavender oil) reaches the top of the stillpot, it is piped to the condenser. The function of the condenser is to remove enough heat to allow the water vapor and the vaporized lavender oil to condense and re-liquefy. The condenser is typically a long coiled tube that is bathed in cool water, which removes heat. By the time it reaches the end of the condenser, the liquid should be cooled to at least 113ºF (45ºC). This temperature facilitates rapid separation of water and oil when the condensate reaches the separator.

Since lavender oil is lighter than water, it floats to the top of the water in the separator. The basic function of the separator is to allow enough time for all of the oil to separate from the water and float to the surface. The oil layer on the surface of the water is then skimmed off via an upper outlet on the separator, while the water is removed from a lower outlet. Large scale lavender oil distillation operations dispose of the water, but smaller lavender operations often save some of this water, or "hydrosol," and use it to make various products.

Treatment and Storage of Lavender Oil. There will typically be some residual water in the distilled oil. This residual water must be removed before the oil can be sold. The easiest way to remove water from lavender oil is to freeze the oil and then pour off the oil, with the water droplets typically adhering to the glass surfaces. If additional water needs to be removed, anhydrous sodium sulfate can be added to the oil for a day or two, stirring occasionally. The solid sodium sulfate will absorb the water, and the oil can then be decanted into clean glass jars.

Oil should be stored in a cool, dark place in containers that are filled to capacity, and that have inert caps that will not cause oxidation of the essential oil. Some aging of the oil in storage may be beneficial for a few months, as this can reduce harsh and "green" notes in some oils. However, essential oils stored for long periods of time will eventually deteriorate in quality.

Oil Yields. Table 3 presents data on essential oil yields collected by the author in 2004 from test plots grown in Sequim, Washington. For comparison purposes, Table 4 converts those yields to per acre equivalents, and also presents data from research done in New Zealand (McGimpsey and Porter, 1999). Ten cultivars were tested; four *L. x intermedia*, and six *L. angustifolia*. Lavender was harvested when each variety reached a maturity score between Stage 5 and 6 (Table 1). Flower heads were harvested from between 6 and 10 plants for each variety (more plants were harvested for smaller varieties). Approximately 4 inches of stem was harvested with the flower heads. Ten lbs of flower heads for each variety were placed in a table top still designed and built by Robert Seidel of the Essential Oil Company in Oregon.

Oil yields varied greatly between varieties, with the lavandin 'Grosso' out-yielding all others, as expected. A surprise in this test was the relatively poor performance of the *L. x intermedia* 'Super.' This cultivar is touted as a variety that rivals 'Grosso' for oil production, but the 'Super' grown in this plot and used in this test did not perform well. Particularly surprising was the low yield of flower heads harvested per 'Super' plant. Another surprise was the outstanding performance of the *L. angustifolia* 'Folgate,' which yielded as many pounds of flower heads per plant as did 'Grosso.' 'Folgate's' oil production was better than the *L. x intermedia* varieties, other than 'Grosso.' This data is from only one year, but it does provide interesting findings, and generates many questions for further study.

Pruning

Proper pruning is absolutely essential for the long-term health and productivity of lavender plants. This pruning begins with newly propagated and

Table 3. Lavender yields in pounds of flowers per plant, ml of oil per pound of flowers, and ml of oil per plant for 10 lavender varieties at Robin Hill Demonstration Farm, Sequim, WA, 2004.

L. x angustifolia	lb. flowers/plant	ml oil/10 lb. flowers	ml oil/plant
'Folgate'	3.2	34	10.9
'Wyckoff'	1.7	39	6.7
'Royal Purple'	2.0	20	4.0
'Martha Roderick'	1.8	31	5.5
'Royal Velvet'	2.2	23	5.1
'Maillette'	1.1	47	5.3
Lavandins			
'Super'	1.3	64	8.6
'Provence'	2.3	34	7.8
'Grosso'	3.2	91	30.9
'Old English'	1.6	41	6.5

Table 4. Lavender Oil Yields for New Zealand and Clallam County, Washington.

New Zealand—2,670 plants/acre (Munstead 5,340), 5th Season

***L. angustifolia* Cultivar**	**Oil—Liter/acre**
'Munstead (Clyde)'	3.8
'Munstead (Omarana)'	13.0
'Munstead (5/14)'	2.2
'Tarras'	13.5
'Twickel Purple'	7.1

Lavandin Cultivar

'Grosso'	97.5
'Super'	65.4
'Old English'	25.9
'Bogong'	98.5
'Impress Purple'	76.2

Clallam County—2,900 plants/acre 5th Season*

***L. angustifolia* Cultivar**	**Oil—Liter/acre**
'Folgate'	21.2
'Martha Roderick'	13.6
'Wycoff'	16.2
'Royal Velvet'	13.6
'Royal Purple'	9.0
'Maillette'	15.7

Lavandin Cultivar

'Grosso'	76.6
'Super'	27.3
'Old English'	21.2
'Provence'	21.2

*Yield extrapolated to a per acre basis from sample plants harvested

Figure 17. Proper pruning leads to healthy, compact lavender plants.

Figure 18. Without proper pruning, Lavender will become open and woody.

transplanted lavender plants. It is best to remove flower stems for the first year after transplanting, and if very small plants are planted directly to the field, then it may be best to remove flower stems for the first two growing seasons. This will improve plant vigor and allow the plant to develop better foliage and root structure from the beginning.

If lavender is not properly pruned, it will often break open in the middle, becoming woody, unsightly, unproductive, and difficult to harvest and manage. Overhead irrigation can contribute to this condition, especially if pruning is not done properly. In most cases, harvesting of lavender does not remove enough of the plant to maintain the compact plant canopy desired. This is especially true when harvesting for oil production, since oil yield and quality are higher when the amount of stalk harvested is kept to a minimum. When harvesting lavender for stems (dried or fresh), much more of the flower stalk is typically taken, thus reducing the amount of material to subsequently prune away.

Removal of the flowering stalks and upper growth points through pruning stimulates development of new flowering buds for the next year's production. Lavender can and should be pruned quite hard, but it is important not to prune back into old wood, as this procedure does not reliably produce new shoots, and a lavender plant can sometimes be killed by radically pruning into the old wood. Old wood is identified by its gray to black coloration. A good rule of thumb is to leave two or three nodes of the current season's wood for most lavender varieties. Plants that have been neglected for several years may take several years of careful pruning to get them back into a desirable shape, and for some plants that are extremely woody and open, it may be best to replace them, as pruning may not ever bring about the desired compact shape. Pruning is best done in the fall; in areas with harsh winters it is best to prune in the early fall before the first hard frosts. New flowering buds, and even a small second flush of flowers, may develop after harvest. If these are not removed, the next year's production may be reduced. This is more common for some lavender varieties than for others.

Pruning equipment should be sharp and clean. It is a good idea to sterilize pruning equipment often to minimize the risk of spreading diseases, such as Alfalfa Mosaic Virus. Hand shears are often used for pruning, especially by smaller growers. A gas powered hedge trimmer may prove useful for larger growers, but care should be taken not to prune too deeply or otherwise damage the canopy structure. Large commercial lavender growers around the world have developed specialized tractor-mounted pruning equipment.

Marketing

There is no established market in the United States for lavender oil, as there is in other parts of the world where lavender is a more common crop. Even if there were a market for bulk lavender oil, most U.S. lavender farms would find that their costs of production far exceed the world market prices they would be paid for bulk oil. There is also no established and easily identifiable U.S. market for lavender bundles (fresh or dried), or for dried lavender buds, or even for various other value-added lavender products. This is not to say that there are no markets for these products. Demand for lavender products is increasing annually, and some lavender producers find that demand far outstrips their ability to supply that demand. On the other hand, other lavender growers are not able to sell what they grow, and some do not even harvest most of their lavender because they have no market for their products.

Marketing and selling are the keys to lavender farming, as with many other types of farming in today's world. Given appropriate soils and climate, lavender is not a particularly hard crop to grow. It is labor and capital intensive, but lavender is a fairly forgiving and easy plant to grow. Marketing, on the other hand, is far more difficult. Good lavender producers develop their own markets; this is not easy, but it is absolutely necessary to success as a small-scale lavender producer in the United States.

Customers

Women buy more lavender products than men. Most lavender products are "luxury" products to some degree, and are purchased by those who want to pamper themselves. The average lavender customer tends to be upper middle class, with adequate discretionary income. Lavender is increasingly in demand in aromatherapy, homeopathic medicine, and for culinary purposes. Therefore, customers who are interested in mental health, natural medicine, and those who are innovative in the kitchen are buying more and more lavender products.

Lavender Products

Part of marketing is understanding the marketplace, and developing products that will move in that marketplace. A wonderful thing about lavender is that almost limitless products can be developed using lavender oil and lavender flowers. It is impossible to list all of the potential lavender products, but here are some of the ways innovative lavender growers are tapping into the market.

Fresh Bundles. Bundles of fresh lavender are easy to sell at farmers' markets, street fairs, and many other places with good foot traffic. Adding a decorative ribbon and a plastic sleeve makes the bundles easier to handle and sell. Confronted with a beautiful booth or street cart covered with deep purple, fragrant lavender, many people simply can't resist. There are only a few weeks during the year when lavender can be sold as fresh bundles, but this can be a great way to move a lot of lavender quickly, and to generate instant cash flow right after harvest.

Dried Bundles. The process of developing beautiful dried lavender bundles was described in an earlier section. Dried bundles are a staple product for many U.S. lavender producers. Florists, craftspeople, boutique stores, and many others buy lavender bundles, but they must be of very high quality, consistent and uniform, with good color and fragrance. Adding raffia, ribbons, or other personal touches helps make bundles unique and appealing. When shipping dried bundles, they must be placed in individual sleeves and carefully packed to prevent damage in shipping. Boxes must be marked as "Very Fragile," and whoever is doing the shipping should be educated about the fragile and delicate nature of dried lavender bundles.

Loose Lavender Buds. Lavender buds are sometimes referred to as "rubbed lavender." Loose buds are used in making other products, but can also be sold in bulk in various sized containers. Some buyers purchase large quantities of lavender buds wholesale, which they use to create their own value-added products. While selling 10, 20, or 50 lbs of lavender buds wholesale might not be the most profitable way to sell lavender, it can help to move lavender that might otherwise go unsold. Lavender buds must be clean, dust-free, and should have good color.

Potpourri. One common way to market loose lavender buds at a good profit margin is to turn them into beautiful and unique potpourris. By adding elements such rose petals, cloves, attractive dried leaves,

fragrant wood chips, cinnamon, lemon verbena, thyme, mint, lemon balm, other aromatic herbs, or blossoms, unique mixes can be created to add fragrance to rooms. Selling potpourri is also a good way to sell essential oil. A few drops of oil can be added to the potpourri once its fragrance begins to fade. Selling the potpourri and essential oil as a package deal can be an excellent way to market lavender.

Sachets. Putting lavender in decorative pouches or bags is an easy way to create high-value products that can be used to freshen linen closets, drawers, shoes, and other items.

"Lotions and Potions." The list of lotions, creams, body butters, massage oils, bath oils, bath salts, and other personal care products that can be created with lavender is virtually endless. Be creative, look at what others have done—then improve upon their ideas, or, better yet, find a niche they haven't filled, and fill it.

Aromatherapy. This is a huge and growing industry. Many aromatherapists, as well as those who treat themselves using aromatherapy, buy high quality lavender essential oil and other lavender products. Selling lavender oil, from 10 ml vials up to pints, can be a great way to market your lavender, especially if your product is differentiated by developing unique blends.

Soaps and Shampoos. Multi-billion dollar companies are based on these products, because they are products that people consume quickly, and consequently buy often and readily. Creating unique lavender-based soaps, shampoos, crème rinses, body washes, face cleansers, etc., can be a great way to develop products that consumers will buy again and again.

Scented Candles. Many people love candles, which can be both fragrant and beautiful. Attractive candles scented with lavender often sell very well.

Herbal Pillows. Eye pillows, neck pillows, and travel pillows can be filled with lavender and other complementary materials. Add buckwheat hulls or flax seed to produce pillows that can be heated in the microwave for warmth, relaxation, and aromatherapy.

Medicinal products. The therapeutic value of lavender essential oil in treating minor skin abrasions and insect bites is well known. Lavender oil can be mixed with other medicinal essential oils and substances to create various soothing wound and skin treatments. Many medicinal and therapeutic products are being created with lavender (see Buchbauer 2002 for an extensive discussion of lavender's many medicinal and therapeutic uses). If you choose to make medicinal lavender products, however, be careful not to not make unsubstantiated claims about health benefits. Also, base your products on established formulas or consultation with health experts to make sure that your products are safe.

Floral Products. A wide variety of wreaths, swags, and other decorative pieces can be made with dried lavender, together with various other flowers, stalks of grain, vines, twigs, leaves, and many other materials—the limit may only be your artistic creativity. If you don't have the time or skill to create distinctive floral products, you can find people who do, and partner with them to make and market floral products created using your lavender. For inspiration in creating unique lavender floral products, see Evelegh (1996).

Culinary Lavender. This is an area of lavender use that is growing rapidly. Many home chefs are just discovering the unique flavor that a little bit of culinary lavender can add to many foods. Culinary lavender buds are typically taken only from *L. angustifolia* cultivars, and some cooks claim that certain varieties are better than others. Culinary lavender buds must be extremely clean, fresh, and fragrant. Some people insist that their culinary lavender be organically grown. Culinary lavender can be used in many types of foods, and can be used to create herb mixes such as herbs de Provence, as well as dry rubs for barbecue and various other seasonings. The foliage of lavender can be used as a substitute in most recipes that call for rosemary. Even the stems of lavender can be used to create a savory smoke that can add a unique flavor to barbecued foods. Finally, there is no end to products such as honeys, mustards, vinegars, salad dressings, and other condiments that can be developed by using lavender to add a distinctive, unique flavor.

Pet and Veterinary Products. Lavender pillows for cats and dogs, lavender scented pet shampoos, and insect repellents for pets are just a few of the ideas

for pet products. Some pet owners will spend money on luxuries for their pets before they'll do so for themselves.

Lavender Plants. Many lavender farms, especially those open to the public, find that visitors want to buy lavender plants—especially unique varieties that they can't find elsewhere. Having some started plants for sale at the farm, at farmers' markets, and at other locations can add to sales and generate revenue.

This list is meant only to stimulate the imagination. The key is to develop products you understand, have a passion for, and of course, that you can sell. Try different things, talk to others in the business, talk to customers and potential customers, go to trade shows, visit other lavender growers' web sites, and read publications about herbal, floral, culinary, and other types of markets that interest you. In short, do your homework, and never stop listening and learning about ways to better serve customers and fill market niches.

Marketing Outlets

Most successful lavender farms have multiple means to market and sell their products. However, what works for one farm may not work for another. Location, personality, skills, passion, available capital, time, and other factors vary from farm to farm. Each lavender producer needs to realistically assess his or her skills, available time, location, resources, interests, and other factors in determining how best to market lavender products.

Making the Lavender Farm into a Destination

A question that will determine a large part of anyone's marketing plan and strategy is, "Do I want my lavender farm to be a destination for customers and tourists?" This is not a simple question. Making your farm a destination means giving up a certain amount of privacy. It may mean losing control of your time during peak tourism periods due to the chaotic nature of dealing with the visiting public. Deciding how many weeks or months the farm will be accessible to the public each year, and then deciding which days of the week and what hours the farm will be open each day can be difficult. Deciding to make your farm open to the public also requires that the farm be a beautiful, well-maintained, safe, and relaxing place to visit. You are selling the experience of visiting the farm as much as you are selling the farm's products. If you intend to open a farm store or gift shop, make sure local zoning and other regulations allow for this and that your neighbors are aware of your plans. If neighbors have concerns, do what you can to remedy those concerns; disgruntled neighbors can cause many problems for agritourism businesses. Finally, make sure that your farm insurance covers the risks and liabilities that are incurred from operating a business open to the public.

U-Pick Lavender

Some lavender can be marketed as "U-Pick" lavender bundles, but don't assume that you'll sell most of your lavender in this way. Some people love the experience of cutting their own lavender, but if you have a sizable

Figure 19. Lavender farms make wonderful destinations for tourists. However, owners need to be prepared for the inconveniences that come from having many visitors at the farm.

Figure 20. U-pick is a good way to market some of your lavender, and makes a great experience for customers.

lavender planting, U-Pick will not likely be your primary marketing method. Never allow U-Pick customers to use the curved sickle-knife used for harvesting by professionals because it is too dangerous. Instead, give them a pair of large scissors for harvesting, and twist-ties to band their bundles together. Also, be prepared to have some of your lavender look like it's had a bad haircut after being U-Picked. It is a good idea to have U-Pick areas clearly marked, and to keep U-Pick customers out of areas you intend to harvest yourself.

Marketing on the Internet

Most successful lavender farms have great web sites. These web sites are eye-catching, easily navigated, functional, and regularly maintained. There is a lot of competition for web traffic. Consequently, it often pays to work with a reputable professional web site developer and/or marketing specialist to design and maintain your web site to make sure it is accessible when relevant key word searches are done. When orders or inquires are posted to your web site, they must be dealt with quickly and professionally. Never promise more than you can deliver on your web site. Finally, some smaller lavender producers have found they can collectively market on one web site, thus sharing costs and workload. This cooperation also allows the web site to offer a wider array of products.

Craft, Culinary, and Garden Shows

A presence at trade shows can be an important venue for learning what other growers are doing, as well as the latest trends in the industry. These shows can also provide networking and sales opportunities. Find out which shows are the best for your specific purposes, and then go to at least one or two each year as part of your marketing effort.

Farmers Markets, Street Fairs, and Festivals

Some of these marketing venues are great, but others are not. You can ask around, but often the only way to find out whether attending various farmers markets, street fairs, and festivals works for you is to try them. If you do, make sure your booth is unique, distinct, and attractive. There are often hundreds of vendors at these events and you need to stand out. More important than the "look" of your booth, however, is how you present yourself to the public. If you're proactive in meeting, greeting, smiling, handing out brochures and/or samples, you'll likely be successful.

Wholesale

Some larger lavender farms with a wide assortment of products have been successful at attracting brokers who can market their products to high-end department stores and other outlets. While this is a way to move a lot of product at wholesale prices, it is only possible once your products are well-established in the marketplace via other means. You need to have size, scale and longevity in the business to assure the broker and major stores that you can meet their needs. Smaller producers can broker their own products to smaller stores and outlets by going around with samples, brochures, business cards, information sheets, and enthusiasm. However, as with the larger stores and chains, if you promise someone you can deliver products regularly and on time, you must honor that commitment or risk seriously damaging your reputation.

Host Your Own Festival

In 1996, a few early lavender pioneers in Sequim, Washington started the Sequim Lavender Festival. Although they had only a few lavender plants producing at that time, they had a vision that has today grown into a festival that draws over 30,000 visitors annually. Held for three days on the third weekend

of July each year, this festival features farm tours of participating lavender farms, a major street fair, music, entertainment, lots of food, and an accompanying educational lavender conference. The weekend of the festival is a hugely important marketing opportunity for local lavender farms, especially those on the tour. Many farms that are not on the tour have street fair booths and other activities that are a major part of their farms' marketing efforts.

Other lavender festivals are popping up around the country. The Northwest Lavender Growers' Guild of Eastern Washington and Northern Idaho started their own festival in 2005, which drew over 1,000 visitors their first year, and its members are enthused about the future of this new Northwest lavender festival. Other lavender festivals are held in Oregon, Pennsylvania, Texas, New Mexico, Tennessee, California, North Carolina, and British Columbia, and there will undoubtedly be others in the future. Some festivals are put on by organizations or groups of farms. Some individual lavender farms hold their own festivals to attract large numbers of visitors and customers directly to their farms. Publicity for festivals is crucial, and they involve a huge amount of work, often requiring large numbers of volunteers. Nevertheless, festivals are a great way to market your products, and, even better, to raise the visibility of the lavender farm, or even the region. Festivals will often pay off with future marketing opportunities.

Figure 21. The Sequim Lavender Festival has become one of the major tourism attractions for the Olympic Peninsula in Washington State. It is also a significant part of the overall marketing campaign for Sequim lavender growers.

About the Author

Dr. Curtis E. Beus is the WSU Extension Director for Clallam County, Washington. He came to Clallam County in 1996, and has worked extensively with the lavender industry around Sequim, WA. Curtis and his wife Kim also have their own lavender farm that they started developing in 2004.

For Further Reading

Barrett, Patti. 1996. *Growing and Using Lavender.* Storey Communications, Pownal, VT.

Buchbauer, Gerhard. 2002. Lavender Oil and Its Therapeutic Properties. In *Lavender: The Genus Lavandula*, ed. Maria Lis-Balchin, p. 124–139. Taylor and Francis, New York.

Denny, E. F. K. 2002. Distillation of the Lavender Type Oils. In *Lavender: The Genus Lavandula*, ed. Maria Lis-Balchin, p. 100–116. Taylor and Francis, New York.

Evelegh, Tessa. 1996. *Lavender: Practical Inspirations for Natural Gifts, Country Crafts, and Decorative Displays*. Lorenz Books, New York.

Kourik, Robert. 1998. *Lavender Garden: Beautiful Varieties to Grow and Gather*. Chronical Books, San Francisco.

Lawless, Julia. 1994. *Lavender Oil: The New Guide to Nature's Most Versatile Remedy*. Thorsons, London.

Lawrence, Brian and Art Tucker. 2004. Essential Oil Production and Other Commercial Uses. In *The Genus Lavandula*, ed. Tim Upson and Susyn Andrews, p. 78–85. Timber Press, Portland, OR.

McGimpsey, J. A., and N. G. Porter. 1999. *Lavender: A Grower's Guide for Commercial Production*. New Zealand Institute for Crop and Food Research Limited, Christchurch, New Zealand.

McLeod, Judith. 1989. *Lavender, Sweet Lavender*. Kangaroo Press, Kenthurst, Australia.

McNaughton, Virginia. 2000. *Lavender: The Grower's Guide*. Timber Press, Portland, OR.

Spector Platt, Ellen. 1999. *Lavender: How to Grow and Use the Fragrant Herb*. Stackpole Books, Mechanicsburg, PA.

Tucker, A. O. 2001. Standards for Lavender, Lavandin and Spike: Commercial Oils and Cultivars. *Lavender Bag* 15:11-14.

Tucker, A. O., and T. DeBaggio. 2000. *The Big Book of Herbs: A Comprehensive Illustrated Reference to Herbs of Flavor and Fragrance*. Interweave Press, Loveland, CO.

Upson, Tim and Susyn Andrews. 2004. *The Genus Lavandula*. Timber Press, Portland, OR.

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