

Lingonberry Cultivation

By

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Introduction

One of the distinguishing features of the Alaskan landscape is the variety and abundance of wild berry-producing plants found throughout the state. Among the most popular of these plants is the lingonberry, *Vaccinium vitis-idaea*, a plant that is common to most northern regions of the world. The lingonberry has long been recognized as a plant of considerable horticultural value, and for at least 20 years efforts have been made to domesticate this plant for sustained-yield, small-fruit production.

Lingonberries were first cultivated in 1789 (Rehder, 1940), but intensive efforts have been initiated only recently to develop a high-quality horticultural fruit crop. In the past, all fruit was collected from wild stands. In Europe, however, urban encroachment and changes in logging practices in major fruit-harvesting regions, lack of sufficient labor to harvest the fruit, uncontrollable fruit quality, and fluctuations in annual yields have combined to stimulate research into methods of lingonberry cultivation and improvement. In Alaska, efforts to increase the utilization of natural renewable resources and to develop potential uses for vast acreages of marginal lands have led to studies on the biology and cultivation of lingonberries.

Domestication of the lingonberry is potentially valuable in providing large quantities of high-quality berries for commercial processing. Cultivation practices can reduce labor costs and provide a reliable supply of berries for domestic and export markets for fresh and processed fruit. For the home gardener, domestication of the lingonberry can lead to the development of an attractive home-landscape plant that will produce an accessible crop of fruit for fall harvesting. However, considerable research is required, both for the development of a small-fruit industry and for home gardening use, if the lingonberry is to be effectively adapted from a wild plant into a cultivated, high-quality, horticultural crop.

The Wild Berry

The lingonberry is a member of the heath family, *Ericaceae*, and is related to the commercially produced cranberry, *Vaccinium macrocarpon*. Lingonberries grow throughout arctic America, extending southward to New England, the Great Lakes region, and British Columbia (Hultén, 1968; Munson, 1901). They are also prevalent throughout northern Europe and Asia.



The lingonberry, one of the most popular wild berry plants in Alaska, has been successfully developed into a major small-fruit crop of some economic importance in other parts of the world and is potentially valuable as such in Alaska.

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Figure 1. Blossoms of lingonberries.



Figure 2. Ripe fruit of lingonberries.

Hultén (1949) divides this circumpolar species into two races relating to adaptations to its ecologically diverse range. The lowland subspecies, *vitis-idaea*, occurs in Europe and northern Asia and joins the arctic-montane subspecies, *minus* in the mountains of Scandinavia. Subspecies *minus* grows in North America and Europe and is the race found in Alaska. Throughout this range, the lingonberry is known by more than twenty-five common names including cowberry, lowbush cranberry, foxberry, partridge berry, and mountain cranberry.

Lingonberries produce upright stems that originate from subterranean, horizontal rhizomes. Stems may appear singly, one or two per square meter, as in many *Sphagnum* sp. or tussock-forming bogs or in dense clones several meters in diameter as in some mixed spruce-hardwood forests. In Alaska, lingonberries have a diverse habitat, growing abundantly from dry roadside slopes with little or no developed organic-matter layer to acid-peat bogs, and from mature, shady forests to fully exposed alpine and arctic tundra slopes. They often occur in greatest abundance on top of decaying tree stumps in mature forests. Throughout its range, lingonberries appear to be most abundant in forested regions that have moist, acid soils, moderate shade, and a well-developed organic-matter layer (Ritchie, 1955; Viereck and Little, 1972).

In interior Alaska, the pink bell-shaped flowers of the lingonberry appear in early June with full bloom lasting from 19 to 27 days (fig. 1). Clusters of green berries ripen to a deep burgundy from late August through September, approximately

78-84 days after full bloom (fig. 2) (Holloway, 1982). The fruit is smaller, a deeper red, and more tart in flavor than the cultivated cranberry and is a source of potassium, calcium, magnesium, phosphorus, as well as carotene, B₁, B₂, folic acid and C vitamins (Heller and Scott, 1962). The fruit is also rich in benzoic acid and tannins and has a pH of 2.5 (Bandzaitene and Butkus, 1977; Stark et al., 1978). Lingonberries are a versatile addition to a variety of prepared foods and have been used successfully for many years in sauces, jam, bread, juice, and even ice cream.

One problem associated with all wild stands of lingonberries is the wide fluctuations in yield of ripe berries. Seasonal losses of flowers or immature fruit can be as high as 94 per cent of the total number of flowers produced in a stand. Losses may be attributed to cold temperatures, rain, or drought during flowering (Tear, 1972) and self pollination (Hall and Beil, 1970). In Alaska, hail storms during flowering can account for substantial losses of flowers and green fruit. Insufficient pollination by insects, principally bumble bees and honey bees, is also a factor in limiting fruit production. In a comparison of lingonberries that were caged to exclude insect pollinators and plants that were open-pollinated, fruit set was significantly higher in open-pollinated plants (table 1). Open-pollinated plants also produce larger fruit with a greater number of seeds per berry than caged plants (Holloway, 1982).

The initial attempts to improve lingonberries and to alleviate the wide fluctuations in yields involved the eradication of

Table 1. Effects of insect pollination on fruit set and development in lingonberries at two sites in the Fairbanks, Alaska, area.

Site	Treatment	Average number per stem		Average berry diameter (cm)	Average berry weight (g)	Number of seeds per berry	Per cent fruit set
		Flowers	Fruit				
Chena Pump Road (elevation approximately 400')	Open-pollinated	5.7	2.2**	0.80**	0.27**	12.7	39.6**
	Caged	5.1	0.1	0.52	0.16	5.2	0.6
Gilmore Trail (elevation approximately 1200')	Open-pollinated	5.3	0.4**	0.39	0.13	8.9	9.4**
	Caged	4.9	0.0				0.0

**Means differ significantly, P = .01.

competing vegetation and the fertilization of wild stands. This research was begun in Alaska in 1965 by Dr. Arvo Kallio at the Agricultural Experiment Station in Fairbanks. Similar studies were reported in Finland by Dr. Aaro Lehmushovi. Both researchers found that fruit yield in wild stands can be improved substantially with fertilization. However, if these stands contain appreciable quantities of grasses and broad-leaved herbs, lingonberries often disappear from the area due to competition with those other plants that also benefit from fertilization (Kallio, unpub.¹ Lehmushovi, 1977 a, b). Crop improvement through manipulation of wild stands will require a vigorous program of weed control.

Commercial Interests

In Scandinavia, Germany, and the Soviet Union, the lingonberry is a major small-fruit crop. Total annual consumption of berries in Sweden is estimated at 12 million kg (Fernqvist, 1977), while in Finland annual yields of up to 20 million kg may reach the marketplace (Lehmushovi, 1977a). The major exporting countries in Europe are Sweden, Finland and the Soviet Union, and the primary importer is Germany (Statistical Offices of the European Communities, 1979). Sweden also exports fruit to the United States, but most of this is processed rather than fresh fruit. A liter of lingonberry sauce from Sweden sells in Alaska for \$9.00-\$12.00.

Berries are also collected commercially in Nova Scotia and Newfoundland, but production is low in comparison to Scandinavia. A small amount of fruit from these areas is imported into the United States, especially into east-coast and northern-midwest markets.

Lingonberries are commercially harvested on the east coast of Newfoundland, primarily on the Avalon and Bonavista Peninsulas (Hall, 1978). Prices paid to pickers in 1977 ranged from \$0.22 to \$0.27 per kg (Stark et al., 1978). Approximately one-third of the crop is retained in Newfoundland, while the remainder is exported to Europe and the United States. Exports for 1976 were 37,825 kg (Hall and Beil, 1970).

In 1914, berry harvesting in Newfoundland was a family enterprise with an average, daily, hand-picked yield of 113.6 kg. Following a cleaning process by winnowing, the berries were packed in water in 90-liter barrels (Torrey, 1914).

Currently, most of the crop is still hand harvested from wild stands, but in some regions a small hand rake is used (Hall, 1978). Some of the fruit is cleaned, frozen, and exported to the United States in plastic-lined cardboard cartons. In Minnesota, these frozen berries are thawed and packed in water in cottage cheese-type cartons. This process is an apparent attempt to emulate the more old-fashioned method of packing in water in wooden barrels.

Commercial harvest of lingonberries in Alaska averages less than 5000 kg annually. Several processors in southcentral Alaska produce such items as jam, sauce, and candy that are sold locally, chiefly to tourists. Fresh berries are sold sporadically at farmer's markets, but no measurable amount is exported. The fruit for processing is hand harvested from wild stands

throughout Alaska, but primarily on the Kenai Peninsula. Processors rely on word-of-mouth to recruit pickers or advertise for fruit in local newspapers beginning in August and pay pickers from \$0.78 to \$1.00 per kg. An annual problem for many processors is finding enough pickers to harvest large quantities of clean fruit.

In the early 1920s, berries from Alaska were shipped to Seattle for \$0.56 per kg, but prices were not competitive with European fruit selling for \$0.18 per kg (Moore, unpub.).² Subsequent attempts to market fresh berries outside Alaska from Dillingham and Kokhanok Bay in the 1940s and 1950s also proved to be uneconomical (Marsh, unpub.).³

Products such as sauce, preserves, candy, jelly, juice, syrup and pickles are processed and marketed in Japan (Iwagaki et al., 1977), throughout Europe (*International Fruit World*, 1957; Liebster, 1975) and in Alaska. In Siberia, berries have been fermented and distilled with barley or rye or combined with honey to produce a wine (Munson, 1901). Combinations of berries with dairy products such as yogurt have not been accepted by European consumers (Muller, 1977), but lingonberry ice cream has been successfully test marketed (Pillsbury, unpub.).⁴

The leaves and stems of lingonberries are used as a source of pharmaceutical arbutin. In Rumania, arbutin is manufactured under the name, Idalbina, and is used to cure human intestinal disorders (Racz et al., 1962).

In most northern regions of the United States the plant is known commercially as an ornamental ground cover rather than a fruit crop (Rehder, 1940). However, no selections have been made for plant improvement.

Cultivation

The first cultivation experiments in Finland began in 1968 at the Institute of Horticulture in Piikkio (Lehmushovi and Hiirsalmi, 1973; Liebster, 1975). These experiments showed that plants growing in cultivated fields could yield nearly five times those growing in the wild (Liebster, 1975). Milled peat is a better substrate than sand or a 1:1 mixture of sand and peat. Mulching increases fruit yields, with a sand mulch being more effective than milled peat, gravel, straw, and unmulched mineral soil. Application of an 11-11-22 fertilizer at 10 kg per acre increases fruit yield but decreases berry size (Lehmushovi and Hiirsalmi, 1973; Liebster, 1975).

Trials in Sweden have shown that the best substrate is sandy, acidic (pH 5-6) soils with at least a 2 per cent organic matter content. Research with fertilizers has shown that the mineral nutrient requirements of lingonberries is very low, and fertilizer needs, in general, are very small. Large quantities of nitrogen (up to 12 g per m²) decrease shoot growth, yield, and berry weight on most soil types, and only positively influence lingonberry growth on nutrient deficient sandy soils (Fernqvist, 1977; Ingestad, 1973).

In 1979 research was begun to determine the optimum substrate for cultivation of lingonberries in Alaska (Holloway et

¹Kallio, Arvo. 1965. Agricultural Experiment Station, University of Alaska, Fairbanks.

²Moore, J.D. 1958. Kokhanok Bay, Alaska.

³Marsh, C.F. 1966. Agricultural Research Center, Agricultural Experiment Station, Palmer.

⁴Pillsbury, H.W. 1958. Cooperative Extension Service, USDA, Palmer.

al., 1982b). Vegetative growth was observed for 3 years on plants grown in four unsterilized, native Alaskan substrates: coarsely-ground Lemeta peat; Fairbanks silt loam soil; a mixture (1:1) of peat and silt loam soil; and washed, Chena, very fine, sandy loam soil. Plants grown in peat showed the greatest increase in vegetative growth as exemplified by plant dry weight (table 2). The leaves on plants grown in peat remained green throughout the entire experiment, while the leaves of plants in all other treatments showed varying degrees of chlorosis followed by reddening and necrosis. High pH and low organic-matter content of the silt loam soil, sandy soil, and soil-peat mixture probably contributed to poor growth on these substrates. This study showed that agricultural soils, as exemplified by the silt loam soil, and sandy alluvial soils are not appropriate for lingonberry cultivation. Incorporation of peat into agricultural soils improves growth only slightly. Future experiments with lingonberry cultivation should be conducted on a substrate composed entirely of peat.

Table 2. Dry weight of lingonberries grown in four Alaskan substrates for three growing seasons.

Substrate	Dry weight (mg)			
	Vertical Stems	Leaves	Rhizomes	Roots
sandy loam soil	35.3b*	66.3b	119.8b	12.4a
silt loam soil	44.4b	55.9b	119.7b	3.5b
silt loam-peat mixture	38.7b	68.7b	121.5b	7.0b
peat	70.8a	176.1a	161.9a	17.5a

*a,b. Mean separation by Duncan's new multiple range test, 5 per cent level.

Additional experiments were designed to determine if lingonberries could be grown in full sunlight in cultivated fields (Holloway et al., 1982a). Lingonberries were grown under four treatments: 0, 44, 56, and 73 per cent shade provided by various thicknesses of polypropylene shade cloth. Following three growing seasons, the greatest vegetative growth occurred in the unshaded plants (table 3). The only measurable increase in growth that occurred in any of the shaded plants was an increase in plant height in the 73 per cent shade treatment. This study has shown that it should be possible to grow lingonberries in full sunlight in cultivated fields without provisions for shading to enhance plant establishment. In addition, in modification of wild stands to promote maximum vegetative growth, cover by shrubs and trees should be eliminated and weed growth minimized.

Table 3. Dry weight of lingonberries grown under 0, 44, 56 and 73 per cent shade for three growing seasons.

Per cent Shade	Dry weight (mg)			
	Vertical Stems	Leaves	Rhizomes	Roots
0	191.5a*	474.3a	309.6a	53.4a
44	92.8b	223.2b	142.7b	21.2b
56	103.0b	241.8b	170.5b	16.4b
73	108.8b	266.6b	165.4b	17.1b

*a,b. Mean separation by Duncan's new multiple range test, 5 per cent level.

Propagation

Investigations into methods of lingonberry propagation are necessary for this plant's establishment in cultivated fields. Requirements for seed propagation are well established (Densmore, 1974; Hall and Beil, 1970; Lehmushovi, 1975), however, experimental broadcast seeding in Fairbanks has been unsuccessful. Greater benefits are obtained when seed is germinated and grown in controlled environments from which seedling transplants are obtained. Seeds germinate slowly when extracted from ripe berries and sown onto a finely milled peat substrate. They should be stratified for 30 days at 4°C prior to sowing to enhance germination which generally takes 10 to 14 days. Plants from seeds will flower and produce fruit 3 to 6 years after seedling establishment.

Propagation by vegetative cuttings is generally an effective method of obtaining genetic uniformity and high-quality plants. Stem cuttings taken during the dormant period root in about 2-3 weeks. However, rooted stem cuttings fail to produce rhizomes from which new shoots arise. Growth seems to be limited to increased branching and development of the original stem with little vegetative expansion (fig. 3). Propagation using rhizome cuttings shows no such disadvantage, and may be the only method of effectively propagating lingonberries vegetatively.

The quickest method for planting a cultivated field is by transplanting clumps of established lingonberry plants from wild stands. The size of the transplants determines their subsequent survival, with those containing few individual stems exhibiting the greatest mortality. The use of larger sections increases plant survival but also increases the chances of transplanting unwanted native vegetation into the cultivated field. Establishing cultivated fields by this method should be used only when breeding experiments or selection for superior strains is anticipated since much of the variability in the growth and fruit production exhibited in wild stands will be transferred to the cultivated field.

Conclusion

In general, the basic criteria for beginning a cultivated field of lingonberries include acid peat substrates, plenty of moisture, and little or no shade. Plants should be started from seed or rhizome cuttings in the greenhouse and transplanted into the field in spring. The fields should be irrigated throughout the summer to increase transplant survival and promote rhizome production. Fertilizer should be used sparingly, and applied only in several small quantities spread out over a long period.

These studies have just begun to penetrate the complexities of adapting the wild lingonberry into a cultivated crop. Much has been learned from the research in Alaska, Scandinavia, and the Soviet Union. Studies should be continued to determine specific cultural requirements for local growing conditions. Further experimentation with fertilization, irrigation, weed control, and identification and control of diseases is necessary to provide complete knowledge into the development of this plant. Intensive investigations through controlled-environment experimentation are also necessary to determine mineral nutrient requirements and general physiological adaptations of the lingonberry. This research will enhance its domestication into a high-quality, sustained-yield horticultural fruit crop for Alaska. □



Figure 3. Lingonberry plant on the left is a 2-year-old stem cutting while plant on the right is a 2-year-old seedling.

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