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RESEARCH ARTICLE

Native blue elderberry in hedgerows bridges revenue and conservation goals

Blue elderberry, a drought-tolerant plant, can be used in hedgerows to achieve biodiversity and increase farm revenue.

by Sonja Brodt, Gwenael Engelskirchen and Katie Fyhrie

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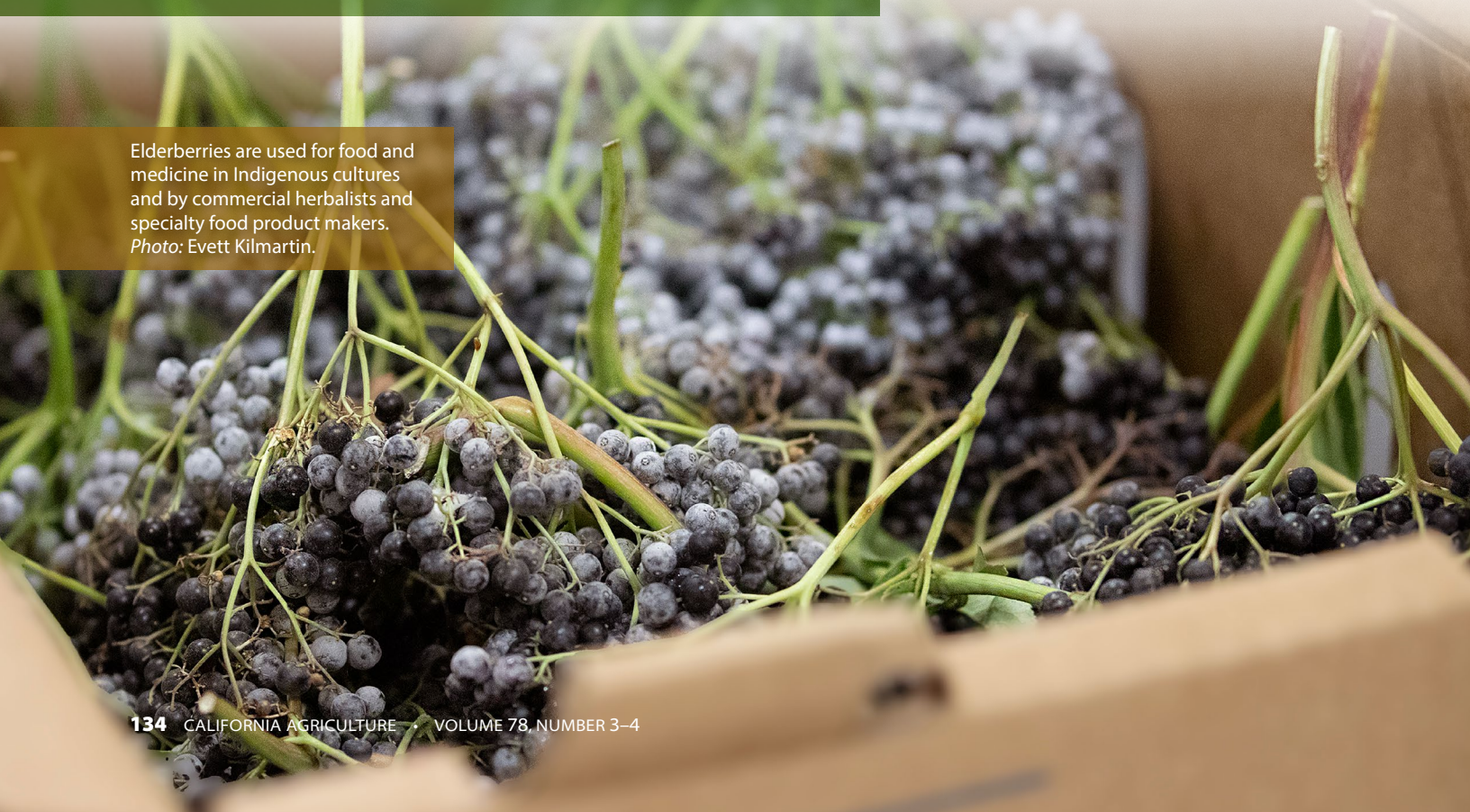
Abstract

Field edge hedgerows have long been promoted by UC Cooperative Extension and other organizations as a way to bring needed biodiversity to California farms. However, adoption of hedgerow planting still falls far short of available edge capacity. Our study explores a new multifunctional model of hedgerows that combines production with environmental conservation goals by considering the revenue potential of harvesting blue elderberry. Blue elderberry is a drought-tolerant native species well adapted to multiple microclimates in California and the western United States. The growth of elderberry herbal products and specialty foods markets is currently skyrocketing nationally and globally, and blue elderberry may offer a promising entry into these markets. Blue elderberry is also sought out by Indigenous people as one important component in efforts to restore cultural and food sovereignty. A field demonstration trial in the southern Sacramento Valley found that elderberry yields from 1,000-foot-long multi-species hedgerows could potentially provide from $2,000 to $3,000 in net annual revenue within 3 to 5 years, with much more possible as the hedgerows mature.

Field edge hedgerows have long been promoted by UC Cooperative Extension, federal and state agencies, and environmental organizations as a way to bring much-needed biodiversity to California's farmland. However, some analyses (Brodt et al. 2019) show that total hedgerow mileage falls far short of available field edge space. Uncertainty about farm and ecosystem benefits, as well as planting and maintenance costs, are two of the many factors that contribute to this shortfall (Brodt et al. 2008; Garbach and Long 2017). Public sector incentive programs typically treat hedgerows strictly as conservation features, but new ways of thinking suggest additional avenues to incentivize adoption.

This study presents a new, multifunctional model for hedgerows on farmland — a conception that encompasses new designs and ways of utilizing hedgerows that bridge conservation goals and profit from crop production. While other authors have calculated the dollar value of ecosystem services provided by



Elderberries are used for food and medicine in Indigenous cultures and by commercial herbalists and specialty food product makers. *Photo:* Evett Kilmartin.

hedgerows to adjacent cash crops (Morandin et al. 2016), this study goes further in exploring the capacity for native plant hedgerows themselves to provide a viable cash crop while still being managed for ecosystem services, such as pest management, pollination and carbon sequestration benefits (Chiartas et al. 2022). This study worked with farmers to try different planting designs for elderberry-containing hedgerows, assess establishment and maintenance costs, measure potential berry yields and revenue in the first few years after planting, estimate future revenue at maturity, and assess market demand for California-grown elderberry. It was intended as a pilot test to demonstrate farmer-designed options for real-world implementation of this multifunctional model on farmland.

This study hinges on inclusion and harvest of blue elderberry (*Sambucus nigra* ssp. *cerulea*). This is a distinct subspecies of elderberry related to the eastern North American subspecies (*Sambucus nigra* ssp. *canadensis*) and European subspecies (*Sambucus nigra* ssp. *nigra*), both commonly referred to as "black elderberry." Blue elderberry, which at this time has no bred cultivars, is native to the western United States and occurs widely in California, from arid valleys to coastal regions and up to 10,000 feet (approximately 3,000 meters) elevation (CNPS 2021). It is often already included in planted hedgerows. Blue elderberry has been stewarded for centuries by California's Indigenous people, who use the flowers, fruit and branches for food, medicine, ceremonial instruments, and other uses. (For more information on Indigenous relationships with blue elderberry, see https://ucanr.edu/sites/Elderberry/Indigenous/.) Since Euro-American colonization of California, Indigenous people have experienced devastating loss of access to traditional gathering lands (Joseph A. Meyers Center 2021; Karolyi 2021; Lindsay 2012). Promotion of elderberry planting on farmland, most of which is privately owned, and sale in commercial markets inherently raise questions about cultural access and Indigenous sovereignty. Commercialization risks decontextualizing elderberry from the kinship relationship that Indigenous people have developed with this plant that is so integrally embedded in their cultures. On the other hand, with market demand for elderberry already increasing exponentially, planting elderberry on private farmland may prevent large increases in non-Indigenous wildcrafting on forest lands, which would be more likely to diminish Indigenous access to elderberry. The history of Indigenous people's relationships with elderberry and the land more broadly, as well as the implications for researching, planting and commercializing this sub-species, are further explored in the Outlook article on page 110.

In the Sacramento Valley, blue elderberry can grow to heights of 30 feet (10 meters) with no supplemental irrigation once established, especially in riparian zones or in proximity to irrigated fields. It has strong potential as a climate change–adaptive crop because it is very heat tolerant and is able to re-sprout after fire. Within the Central Valley, it is host to the threatened valley elderberry longhorn beetle and thus provides critically needed habitat. To our knowledge, no known studies to date have documented the berry yield potential of blue elderberry.

The popularity of elderberry products in U.S. mainstream herbal product markets surged to over $107 million in 2019, more than doubling each year from 2017, and then grew to over $275 million in 2020, during the COVID-19 pandemic (Smith 2020; Smith et al. 2020; Smith et al. 2021). This interest is likely driven by the health-promoting properties of elderberry, with studies showing that berries of the European subspecies have anti-viral properties effective against flu and cold viruses (Uhl et al. 2022). Traditional medicinal knowledge from many California Indigenous tribes also recognizes blue elderberry's importance as a cold remedy, fever reducer, cathartic and other medicinal uses (Moerman 2009). Recent analyses have demonstrated that blue elderberries have overall similar levels of total phenolic compounds to European elderberries, with lower levels of anthocyanin but higher levels of flavonol, both of which are known to play health-promoting roles (Uhl et al. 2022). They are also high in vitamin C and fiber.

A mature blue elderberry shrub with an 8-foot orchard ladder for scale. Shrubs of this size can yield from 20 pounds to over 170 pounds of berries in a season. *Photo*: Katie Fyhrie.

Trials on farmland

Elderberry seedlings and cuttings were planted in hedgerows on three farms in the Sacramento Valley, with three distinct designs determined by the collaborating farmers. These designs were a multi-species hedgerow with deep pre-plant tillage (Hedgerow 1), a high-density hedgerow with shallow pre-plant tillage (Hedgerow 2), and a low-density hedgerow with no tillage prior to planting (Hedgerow 3) (table 1). Hedgerow 1 consisted of a wide hedgerow planted along the east side of a pre-existing row of mature poplars, with many small shrubs, forbs and grasses planted in two separate rows parallel to a single row of elderberry. Hedgerow 2 consisted of a single row of elderberry planted along a field border interspersed amongst occasional pre-existing small and tall trees. Hedgerow 3 consisted of elderberries interplanted into an existing vegetated border, including occasional widely spaced tall trees, along field borders and the edge of a canal. All three farms are currently certified organic and located within 25 miles of each other in Yolo and Solano counties on

TABLE 1. Field site planting design, preparation and early management

	Planting design		
	Hedgerow 1 (multispecies deep tillage)	**Hedgerow 2 (high-density shallow tillage)**	**Hedgerow 3 (low-density no tillage)**
Spacing	**10 feet**	**6 feet**	**Variable, 27 feet average**
Weed control	Cardboard and 6" aged asparagus fern over entire hedgerow area	Woven black plastic landscape fabric over entire hedgerow area	Cardboard and 6" aged asparagus fern in circles around each plant
No. elderberry shrubs per 1,000 feet of hedgerow	96	167	36
Tree protection tubes	12" plastic with bamboo stake		
Irrigation system	Poly tube with emitters installed next to plants		
Pre-planting tillage			
Shallow	Rototilled 3x	Disced, rototilled 1x, hilled a raised bed	None, mowed weeds and dug planting holes
Deep	3' deep rip	None	None
Early management			
Fertilization	None	3-6-2 foliar feed (applied May, June, Aug 2018)	None
Irrigation (2018)	Weekly May–Sep (216 gal/plant total)	Every other week May–Aug (155 gal/plant total)	Every other week May–Oct (450 gal/plant total)
Irrigation (2019)	Weekly Jun–Aug (83.5 gal/plant total)	Monthly May–Aug (24 gal/plant total)	Monthly Jul–Sep (100 gal/plant total)
Tree protection tube removal	July 2018	Not removed	October 2018

silty clay loam and loam soils, classified as prime farmland. For more information on planting, harvesting and marketing elderberries in hedgerows, see Fyhrie et al. (2021).

Hedgerow management in all cases was limited to weeding and irrigation during establishment years. The purpose was to maintain consistency, both with traditional hedgerow management (retaining the habitat conservation benefits of hedgerows) and with the yield investigations of elderberry shrubs in mature, essentially unmanaged or minimally managed hedgerows (see below). In keeping with this conservative, mostly hands-off management model, we did not conduct any pruning during the establishment phase. Preliminary observations suggest that the effects of different pruning regimes on blue elderberry yield are uncertain at this time. Finally, growers should note that the federally threatened status of the valley elderberry longhorn beetle restricts pruning of large branches and removal of entire shrubs once planted, outside of Programmatic Safe Harbor Agreements. These restrictions only apply to the floor of the Central Valley in California, which is the only known habitat area for the beetle. For more information on federal regulations and how landowners can join Safe Harbor Agreements to ease regulatory liability in managing elderberry, see https://ucanr.edu/sites/Elderberry/Growing/VELB/. No restrictions exist on harvest of fruit or flowers, and it is not necessary to join any Safe Harbor Agreement to engage in these activities.

In the Central Valley, blue elderberry provides critically needed habitat for the threatened valley elderberry longhorn beetle. *Photo*: Jon Katz and Joe Silveira, U.S. Fish and Wildlife Service.

All three hedgerows were planted with blue elderberry seedlings averaging 4 to 6 inches (11–16 centimeters) in height in late April 2018. Seedlings were chosen over cuttings because they are available from commercial nurseries, which report more success with propagating from seed than from cuttings (Fyhrie et al. 2021). Pre-rooted cuttings of two common commercialized cultivars of American elderberry (subspecies *canadensis*), Johns and Adams, were also planted in the same hedgerows. However, due to poor performance and high mortality rates (likely related to poor heat tolerance), this article focuses exclusively on blue elderberry. Growth and yield data for the American cultivars can be found in Fyhrie et al. (2020).

Materials and labor

Quantities and costs of material and labor inputs were tracked for 2 years by project personnel (for one-time inputs) and by the growers (for recurring inputs such as irrigation) via standardized data sheets. Costs for each site, limited only to the elderberry row, were standardized to a 1,000-foot (305 meter) hedgerow, and standard labor and equipment operation costs were applied to complete preliminary studies of the cost of establishment (Brodt et al. 2020a; Brodt et al. 2020b; Brodt et al. 2020c). For this article, for better comparability to other literature on hedgerow establishment costs, we added site analysis and design costs, as well

as native grass and forb seed costs, as detailed in Long and Anderson (2010). Total time to accomplish hand harvest and hand destemming of frozen berries was measured repeatedly with a timer over the course of the second season by multiple different workers at one of the participating farms, to calculate average harvest and destemming labor costs on a per-pound basis.

Growth and yield

Growth (total height and basal stem diameter) and berry yields of all elderberry plants were tracked for the first two growing seasons (2018 and 2019). During the third season, due to higher yields and personnel shortages, each hedgerow was divided into four linear blocks and three trees were randomly selected within each block for harvest every two weeks, for a total of 12 elderberry trees per hedgerow. During the fourth and fifth seasons, yield data were only recorded in Hedgerow 1. No growth measurements on any hedgerows were taken after the 2019 season.

To document the yield potential of large, already mature blue elderberry plants, project personnel harvested ripe berries on a weekly basis from nine mature shrubs growing in three un-irrigated Sacramento Valley hedgerows of known ages (with planting dates of 2008, 2012 and 2014) for two seasons (2018 and 2019). We randomly chose three healthy individuals at each hedgerow site to harvest. One of the mature hedgerows, with 4-year-old plants, was on one of the three farm sites noted above, and the others were located within a 25-mile radius on other organic farms. These unpruned shrubs had reached heights of 15 to 30 feet (4 to 9 meters), so only the cymes of fruit safely reachable by hand from an 8-foot orchard ladder were harvested. To date, no mechanical harvesters for elderberry are known to exist.

Rapid early growth

Blue elderberry plants grew vigorously during the first two years in Hedgerow 1 and Hedgerow 2, achieving an average height of 8.9 feet (2.7 meters) in Hedgerow 1 and 7.3 feet (2.2 meters) in Hedgerow 2. Many of the seedlings in Hedgerow 3 were overtopped by weed growth during the first winter but reached an average of 6 feet (1.8 meters) after the second growing season. The reduced area of mulching — only immediately around each individual plant — seemed inadequate to protect the new plants from early weed competition. Growth may also have been reduced in the first summer season due to greater soil density with no tillage. As perennials, elderberries are best planted in the fall in tilled soil to ensure they get well established with strong root systems before hot, dry summers set in.

Blue elderberries appear blue due to a waxy white surface bloom that forms on the bluish-black berries just as they approach full ripeness. *Photo*: Katie Fyhrie.

Varying yields

Blue elderberries began bearing flowers and fruit in the second summer after planting. Hedgerow 1, with relatively wider spacing, tilled soil, and thick mulch for weed control, bore the largest yields in season 2, averaging 11.2 pounds destemmed berries per tree, standardized to 1,075 pounds for a 1,000-foot hedgerow (96 plants) (table 2). Hedgerow 2 yielded an average of 2.2 pounds per tree, or 367 pounds for a 1,000-foot hedgerow (167 plants). With delayed growth, as noted above, the third hedgerow did not produce significant berry yields in the second growing season.

In the third growing season, early season irrigation issues reduced yields in Hedgerow 1 to levels below year 2 yields, but yields increased in Hedgerows 2 and 3 (table 2). Interestingly, the single largest yielding

TABLE 2. Average annual berry yields for blue elderberry in 1,000-foot hedgerows (pounds destemmed berries)

Growing season since planting	Hedgerow 1 (multispecies deep tillage)		Hedgerow 2 (high density shallow tillage)		Hedgerow 3 (low density no tillage)	
	Per plant	Per hedgerow	Per plant	Per hedgerow	Per plant	Per hedgerow
	pounds					
Season 2 (2019)	11.2	1,076.2	2.2	367.4	0.34	12.2
Season 3 (2020)	8.8*	845.0	3.9	651.3	1.6	57.6
Season 4 (2021)	2.1	201.6				
Season 5 (2022)	12.1	1,161.6				

* Yields were lower than expected due to irrigation shortfalls in this year.

plant of all three sites in year 3 was in Hedgerow 3, at 14.7 pounds, indicating substantial resilience in individual genotypes. However, several other plants in this hedgerow yielded as low as 0.2 pounds, for a total estimated yield of 58 pounds for a 1,000-foot hedgerow (36 plants). During the fourth season, when measurements were taken only in Hedgerow 1, the cessation of irrigation corresponded with a severe drought, causing yields to decline precipitously. However, yields bounced back to year 2 levels in the fifth season, despite continuing drought and absence of irrigation, demonstrating the resilience of blue elderberry (table 2).

Yields of much larger plants in 4- to 11-year-old hedgerows ranged from 20 to 172 pounds per plant (table 3), one to two orders of magnitude higher than the early yields in the hedgerows planted for this study. This was the case even though only the reachable berries were harvested, leaving many more unharvested and available to wildlife. However, these mature plants showed tremendous variation from one year to the next, as well as between individual plants, even in the same hedgerow. For example, plant #3 planted in 2008 yielded 190% more fruit in 2019 compared to 2018, while plant #2 planted in 2012 yielded 9% less in 2019 compared to 2018. Within the same hedgerows, plants of the same age showed up to an eight-fold difference in yields, from 20 pounds per plant to 172 pounds per plant (2012 hedgerow).

The data, however, indicate a clear increase in overall yields as the hedgerows matured from 4 years to 8 years of age. Refining vegetative propagation techniques to achieve higher success rates, and using them to establish defined cultivars, could improve the uniformity and reliability of yields. However, growers may want to balance considerations of greater uniformity with biodiversity conservation goals, which might be better served by planting a hedgerow with a more diverse and preferably locally sourced wild genome.

TABLE 3. Annual blue elderberry yields* in mature, unirrigated hedgerows (pounds per plant, destemmed)

Year hedgerow was planted	Plant ID	2018 harvest		2019 harvest	
		Pounds destemmed berries	Average	Pounds destemmed berries	Average
2008	1	135	108	126	118
	2	61		58	
	3	128		171	
2012	1	40	77	116	105
	2	172		156	
	3	20		42	
2014	1	35	36	43	63
	2	43		78	
	3	30		68	

* Only berries within safe reach from an 8-foot orchard ladder were harvested, leaving many berries above that height unharvested.

TABLE 4. Establishment costs of elderberry hedgerows (per 1,000 feet)

	Hedgerow 1	Hedgerow 2	Hedgerow 3	Long and Anderson 2010
Site analysis and design	$253	$253	$253	$253
Field preparation	$246	$89	$76	$262
Grass seed and planting	$291	$291	$0	$291
Forb seeds and planting	$200	$200	$0	$200
Elderberry seedlings, planting, tree tubes, fertilizer	$580	$1559	$474	$832
Weed control (initial mulching plus 3 yrs hand weeding)	$1,413	$99	$197	$1,065
Irrigation (3 yrs)	$498	$894	$1050	$715
Vertebrate pest control	$0	$0	$0	$229 (tree tubes)
TOTAL	**$3,481**	**$3,385**	**$2,050**	**$3,847**

Pest considerations

We have found neither anecdotal nor documented evidence of any major pest issues in the study hedgerows, nor in blue elderberry growing in other parts of California, including spotted wing drosophila, which appears to affect berry yields of American and European elderberry in the northeastern and midwestern United States. Blue elderberry, however, has been identified as a viable host for spotted wing drosophila in field and laboratory studies in Oregon (Lee, Dreves, Cave et al. 2015; Lee, Dreves, Isaacs et al. 2015).

Establishment costs

Establishment costs, which include planting costs plus the first three years of irrigation and weed and pest control, varied widely between the three hedgerow styles, from $2,050 to $3,481 for 1,000 feet (305 meters) (table 4). The largest cost increases came from the larger number of plants and organic-approved foliar fertilizer applications in Hedgerow 2, and extensive use of manual labor for mulching and hand weeding in Hedgerow 1. We assumed none of the hedgerows would require irrigation after three growing seasons and only minimal weed control once the plants filled out the space.

Harvest and postharvest costs

Destemming is an important step prior to selling berries or utilizing them for value-added products. Each harvested cyme has a large mass of stems, and these stems may also contain a cyanogenic glycoside that should be removed prior to processing the berries. (For more information, see https://ucanr.edu/sites/Elderberry/Harvesting-Post/Harvest/.)

In our study, the collaborating producer destemmed by hand, which entails freezing whole cymes in large Ziplock plastic bags immediately after harvest, then massaging the bag to separate out the brittle frozen

stems. Data collected by this farm indicated that hand-destemming requires an average of 2.8 minutes per pound of berries. Combined with harvesting, which was also logged at an average of 2.8 minutes per pound, total cost comes to $1.65 per pound for both operations at a labor rate of $12.50/hour plus 42.56% payroll overhead (for a total of $17.82/hour).

Mechanical destemmers could result in cost savings over time. A destemmer that agitates berries on a screen, developed in the Midwest for American elderberry, costs around $9,000. A producer on California's Central Coast equipped a grape destemmer with a metal basket with smaller hole sizes suitable for elderberries at a total cost of approximately $3,000–$5,000 for equipment plus refabrication. (For more information, see https://ucanr.edu/sites/Elderberry/Harvesting-Post/Harvest/.)

Prices and revenue potential

Farmgate prices for domestically grown elderberry vary significantly and are influenced by the type of buyer, degree of processing, and product attributes (such as organic certification). In 2020, the Midwest Elderberry Cooperative in Minnesota paid producers $4.50 and $5.00 per pound, respectively, for non-organic and organic frozen, destemmed berries (C. Patton, Midwest Elderberry Cooperative, personal communication) while a small regional California wholesaler paid producers $16 per pound for fresh and $23.25 per pound for dried elderberries (Avery 2020).

In order to calculate the revenue potential of our hedgerow production models, we conservatively took the low price of $5.00/pound, coupled with $1.65/pound hand harvest and destemming costs, calculated above, and the average yields as detailed in table 2. We then applied a 5% discount rate per year, to account for the changing value of money and opportunity cost over time (with dollars expected in the future generally considered less valuable than dollars received today). At these rates, Hedgerow 1 could earn net revenue of $3,429 for a 1,000-foot (305 meter) hedgerow in the second growing season, with similar revenue levels in the fifth growing season, after recovering from drought stress (table 5). The year 2 revenue alone was almost enough to cover the three years' worth of establishment costs. Hedgerow 2, with lower yields, could earn $1,171 in the second growing season, and $1,976 in the third season, for a 1,000-foot (305 meter) hedgerow. The combined year 2 and year 3 revenues would come to within about $200 of covering three years' establishment costs. Hedgerow 3 had the lowest establishment costs, but also very low initial yields, providing revenue of $39 and $175 in the second and third growing seasons, respectively, standardized to 1,000 feet (305 meters); this would only cover approximately 10% of establishment costs. However, this hedgerow also experienced the largest increase (over four-fold) in average per-plant yield from the second to the third season of all three sites. This suggests the possibility that yields could catch up and allow for a positive net return over a longer timeframe.

Strategies to increase returns

For growers looking for early returns, the substantial per-plant yield differences across the three hedgerow models in their initial years indicates the importance of adequate weed control throughout the hedgerow and regular irrigation during establishment, as well

Hedgerows with native blue elderberry show significant potential to perform multiple functions, including commercial production, environmental conservation, and ecosystem services such as pest control and pollination.

TABLE 5. Potential revenue for a 1,000-foot hedgerow from sale of elderberries as frozen berries over first several years*

Growing season since planting (season 1)	Gross revenue†	Hand harvest and destemming cost‡	Net revenue (net of harvest and destemming costs only)	Net revenue with 5% discount rate applied each year
Hedgerow 1				
2	$5,381	$1,780	$3,601	$3,429
3	$4,224	$1,398	$2,826	$2,564
4	$1,008	$334	$674	$583
5	$5,808	$1,922	$3,886	$3,197
Hedgerow 2				
2	$1,837	$608	$1,229	$1,171
3	$3,257	$1,077	$2,179	$1,976
Hedgerow 3				
2	$61	$20	$41	$39
3	$288	$95	$193	$175

* These figures do not include costs of freezing, transport of berries from hedgerow to freezer, or any other costs, nor do they include potential increases in labor costs or elderberry prices over the 3 years. Freezing costs are estimated at approximately $0.05/lb, depending on electricity rates.

† Farmgate price of $5/lb of frozen, destemmed berries.

‡ Labor costs of $17.82/hr.

Syrup is the most common elderberry product sold at retail. Over $275 million in elderberry products were sold across the United States in 2020, up from $107 million in 2019. *Photo*: UC Sustainable Agriculture Research and Education Program staff.

as the value of deep soil preparation, especially in areas with compacted or dense soil.

While all three hedgerows had a row consisting exclusively of elderberry, a higher diversity of species might achieve more balance between production and environmental goals. If other woody species were integrated as every third or fourth shrub, elderberry yields might accordingly be reduced by 25% to 30% (due to fewer elderberry trees), thus reducing the revenue potential. However, these losses might be offset to some extent by higher per-plant yields, as demonstrated in the yields measured in mature hedgerows in this study, where elderberry were more widely spaced and interspersed with other species (table 3). Alternatively, if a wide space and adequate funding were available, a good balance could be achieved by the design used in Hedgerow 1, which entailed a 100% elderberry row surrounded by a large variety of other species occupying separate planting rows within the 30-foot-wide hedgerow.

Environmental services

Although not included in our multi-year revenue analysis, it is worth noting the potential returns on investment from ecosystem services provided by hedgerows to adjacent crop fields, in order to complete the picture of total potential returns. In Yolo County, for example, Morandin et al. (2016) measured crop pest populations in processing tomato fields and seed set in canola plants that were bordered by mature, multi-species hedgerows, and also in fields without hedgerows. By bolstering the populations of both pollinators and natural enemies of pests, hedgerows led to reduced pest populations and increased seed set, resulting in estimated pest control savings of $6.50 per acre for tomatoes, and revenue increases of $61 per acre for canola pollination. Morandin et al. (2016) also estimated the maximum feasible extent of benefits, which would arise when one 1,000-foot (305 meter) hedgerow is planted between two adjoining crop fields owned by the same farm and measuring 39.5 acres (16 hectares) each (as often observed in their study area). Assuming that pest control benefits occur annually, while pollination enhancements occur every third year (with a pollinator-dependent rotation crop like canola), an estimated annual profit increase of $2,128 could be attributed to a mature hedgerow. As such, a hedgerow that is at least three or four years old can be expected to generate additional financial benefits beyond those accrued directly from harvest and sale of elderberries.

Demand outstrips supply

Survey results of California-based elderberry buyers and product makers indicate a rising demand for elderberry and a desire for more supply (Engelskirchen and Brodt 2020). A 2019 online survey of herbalists and home users in California found that 67% of 63 respondents could not find enough supply to meet their needs, and 88% said they would definitely purchase California-grown elder (berries and/or flowers) if available. When asked about current trends, 81% were seeing an increase in customer demand for elderberry products.

A complementary survey of 23 northern California retail establishments conducted by interview and on-site inventory observations similarly indicated sales growth potential for products made from California-grown elderberry. Ninety-three percent said they could see a niche for products made from California-grown elderberry, and 30% indicated that they already carried products made from California elderberries. Syrup is the most common product type sold at retail. Local or regional-scale value-added product makers are also looking to purchase fresh berries or dried flowers locally, and dried berries are the dominant commodity in the global elderberry market. Engelskirchen and Brodt (2020) provide more information on product types and buyer interests.

Producers may find opportunities for making value-added products under Cottage Food Laws or with a co-packer. A large commercial market exists for elderberry as a featured ingredient in branded nutraceutical products; however, this market channel may be challenging for smaller producers to enter due to low price points, high volume requirements, and regulations. Cooperative arrangements to share equipment — such as dehydrators or walk-in freezers for storage — could ease some of these barriers by offering access to post-harvest infrastructure.

Diverse benefits from hedgerows

Hedgerows with native blue elderberry show significant potential to perform multiple functions, including commercial production, environmental conservation, and ecosystem services such as pest control and pollination. Moreover, these different functions might even support each other in ways that make the entire model more robust. For example, farming with undomesticated plants like blue elderberry requires a greater tolerance of variability and risk, due to the large variation in yields between individual plants. However, if the hedgerow simultaneously provides quantifiable ecosystem services to nearby crop fields, these services could function as insurance that the cost of hedgerow establishment will eventually pay off, regardless of future fluctuations in yields, prices or harvest and

marketing capacity on the farm. A farm enterprise may also choose to capitalize directly on diversity and hedge against risk by planting other marketable species, such as other native or Mediterranean herbs, flowers and fruits. The design and operationalization of such species associations in specific settings merit further investigation.

Furthermore, the possibility of leasing or informal lending of hedgerows may provide avenues for landless young farmers and herbalists to gain access to productive land with relatively minimal start-up capital and input costs. The Savanna Institute, a nonprofit organization focused on facilitating widespread adoption of agroforestry in the Midwest, is pioneering formal agreements, such as leases or licenses, whereby multiple users can use different aspects of the same piece of land, such as trees versus spaces between trees for other crops (Hannum 2017). Such agreements could be adapted for farmers and landowners so that other users, such as herbalists, can access and harvest hedgerows.

The hedgerow can thus play a very different role in the life of a farm than a typical field block, becoming a mechanism to support aspiring farmer and herbalist entrepreneurs and to steward the land, in addition to producing crop revenue. This multifunctionality may increase the incentives for planting hedgerows, given that landowners and managers come with diverse aspirations and priorities. CA

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