Growing Elderberries on the Cumberland Plateau

This final report presents the results of a 3-year specialty crop block grant (SCBG) awarded to The University of the South Farm in conjunction with 6 local farms. The grant proposal focused on three areas of interest:

1. To determine whether modern elderberry cultivars can be grown successfully on the South Cumberland Plateau in quantities that can contribute to the displacement of imported elderberry products,
2. To provide no or low-cost educational programming for farmers related to elderberry production, by hosting the workshops and field trips, and
3. To provide no or low-cost educational programming for farmers about food safety issues regarding Good Agricultural Practices (GAP) and shelf stable products.

Background: Nutritional supplements and syrups made from elderberry plants (Sambucus species) are in high demand due to their perceived immune boosting properties. U.S. sales of these products exceeded 300 million dollars in 2020 according to industry marketing sources (citation). However, domestic production has not kept pace with demand and the majority of elderberries used in U.S. products are imported. Improved cultivars of elderberry plants selected by the University of Missouri yield better than native elderberries, but their performance on the Cumberland Plateau was unknown at the time of planting. These new varieties also have distinct characteristics that might make them more manageable than wild elderberries, such as a reduced harvest window, higher yield or sugar content or drought resistance.

Our USDA specialty crop block grant (SCBG) enabled a partnership between the University Farm at The University of the South in Sewanee, TN and 6 local farmers to establish trial orchards that were observed and monitored for 3 years to determine the viability of the new varieties of Elderberry. Elderberry plantings of 5 different cultivars. “Bob Gordon,” “Adams,” “Wyldewood, and “Ranch” are the improved varieties and we collected dormant hardwood cuttings from the Cumberland Plateau for the wild type. The orchards were established across a range of conditions in 2019 and observed for 3 years. Each trial orchard consisted of 25 plants, 5 plants of each variety.

The grant period began in December of 2018 before the SARS-CoV-2 pandemic and objective number 1 is largely complete. We were able to establish 6 orchards and gather data about growth, yield and pests. Four events were held before the pandemic became limited gatherings. Most of the workshops and events outlined in objective 2 & 3 were cancelled due to labor shortages, school disruptions, and risk reduction protocols. No grant money was requested or dispersed for events that did not occur.
**Establishment and Growth**: Improved elderberries are robust shrubs that can grow 7’ tall and wide in a single season after being pruned to the ground in winter. First year growth of rooted cuttings is rapid in fertile soils.

Young plants benefit from standard orchard practices of keeping the rows mulched and free of weeds with the aisles seeded into a cover crop mix and mowed to limit weed pressure. In subsequent years, the established plants shoot up rapidly in high fertility soils and will create a dense canopy to outcompete most weeds within the row. In order to harvest efficiently, the aisles between the rows need to be wide enough to accommodate the plant growth and equipment for mowing and harvesting. The plants in these trial orchards were spaced about 2-3’ within the row and 12-15’ between the rows. At 30 sq ft per plant, including the aisle space, approximately 1,500 plants per acre are needed. Wild elderberry patches are often located in damp locations near drainage ditches and alongside stream banks, but elderberries don’t tolerate more than 2-3 days of standing water. “Ranch” is a variety that is more tolerant of dry conditions.

Unrooted stem cuttings can be obtained in bulk for about $2 each. After a trial orchard is established, dormant cuttings of about 16” in length can be taken in late winter; they root easily using the direct stick method where the spring season is wet. This enables an orchardist to create their own cuttings from stems that are pruned anyway. Based upon our height and stem count data, most individual plants can produce at least 20 dormant hardwood cuttings each year. If the grower has a market for the cuttings, this translates to $60,000 in income per acre (1,500 plants per acre x 20 cuttings per plant x $2 per dormant cutting). This type of extreme revenue during broadscale adoption of a new crop is a typical pattern, but it doesn’t last. Each new farmer that plants elderberries can make their own cuttings the following year.
Growth patterns seen in year one continued throughout years 2 & 3. If first year plants appear spindly, or fail to achieve an average height of 3’ or lack a dark green color, soil tests should be undertaken to correct the problem.

Plants from site 1 (left image above) show robust growth and dark green well expanded leaves. Notice the lighter color and narrower leaves in the middle photo above. The bottom photo shows plants from site 4 which attained about ½ the height of site 1 in the first year. In our trials, sites 4, 5 & 6 were all 2’ tall or less at the end of the first year and each of these sites had relatively low blossom count and little or no fruit production in year 2 & 3. However, the best yield in our trial came from site 1, which had healthy growth but was rarely above 5’ tall. Looking at the chart below, you can see that site 1 had well branched plants with a lower height to width ratio than site 2 & 3.
Harvesting and Yield: Elderberries produce a cyme that contains many individual blossoms. Each blossom becomes a small berry. As you can see in the photo below, the perimeter flowers are open now, but the center is still in bud. These flowers were harvested for drying and thus, reduced the amount of fruit set on that plant. Even within a single cyme, the blossoms open over a period of several days, with a concurrent spread of fruit ripening a few weeks later. Growers need to harvest fruit at least twice a week when the cymes are ready, else some of the ripe berries fall off.

Some portion of the cyme is likely to be underripe at harvest because of uneven ripening. The strategy that yields the highest rate is to harvest the cyme at the “goldilocks” stage when a few center berries are
still green, with the majority of the berries at the dark purple stage that is still firmly attached. At this stage a few berries on the outer portion of the cyme may have fallen off.

Five of our 6 trial orchards produced fruit, but only site 1 & 2 produced sufficient quantities to warrant harvesting. Growers at sites 3, 4 & 5 found that birds overwhelmed their small orchards and the birds were observed to select ripening fruit from the cymes nearly every day, leaving only unripe green berries attached to the cyme. For these growers, there never was a goldilocks moment. In contrast, site 1 was able to harvest the equivalent of 1.9 tons per acre in 2020.

Fresh elderberries can be sold into local markets for about $8/lb, but the local demand for fresh fruit is often very limited.

Frozen fruits (de-stemmed from the cyme) can be sold into the wholesale market at $2/lb. with strong demand. This is the equivalent of about $7,600 of revenue per acre if plants produce at the best rate found in our trials. Selling large quantities into the wholesale market requires significant infrastructure such as a stainless steel de-stemmer and wash sink and a walk-in freezer to hold the product until shipping.

Dried elderberries are another option, with a wholesale price of about $18/lb. The process starts the same as frozen berries, but after freezing, the berries are allowed to thaw. The cracked skin allows some juice to leak out, which can be collected for syrup making. Dehydration adds additional labor, but results in a lower weight, shelf stable product. Dried elderberries weigh ⅓ as much as fresh or frozen berries, but they sell for 9 times more. Total revenue per acre for dried berries if plants produce at the best rate found in our trials is $22,800.

Birds are unlikely to overwhelm an orchard of commercial size, but if a trial orchard is planned, then selling the flowers instead of the fruit is one way to outwit the birds. Elderflowers appear to be completely free of pests and diseases on the Cumberland Plateau. Fresh elderflowers sell for $12/lb in our area, but the market is very limited. It takes about 8 lbs of fresh elderflowers to make one lb of dried flowers. The retail price for a lb of elderflowers in 2021 is $37/lb according to prices published by the midwest elderberry cooperative. Wholesale dried flower prices paid to growers are closer to $18/lb. Large purchasers of dried flowers are paying about $25/lb. From distributors. Keep in mind that harvesting flowers leads to reduced quantities of fruit harvest. As an estimate, you can calculate a loss of 9 lbs of fruit for each lb of flowers you harvest. At these ratios, the best orchard in our trial is calculated to produce the equivalent of 53 lbs. of dried flowers per acre for $950 revenue/acre when wholesale dried flowers are selling at $18/lb.

The University Farm conducted trials and found that a fully loaded rack (about 12 lbs.) of elderflowers were dried to a crisp texture in under 36 hours when enclosed in plastic and subject to 2 small home dehumidifiers. The test rack shown below is assembled from ¾ PVC and is not glued together. Assembly requires 36 horizontal pieces 28” long, 24 horizontal pieces 18” long and 24 vertical pieces that are 8” tall. In addition, the rack uses these pvc fittings. 4, 3-way corner elbows, 24, 4 way corner elbows, and 20, 5-way elbows. PVC pipe is available at local hardware stores, the fittings were ordered online from specialty suppliers. Baskets for the rack were also made from ¾ PVC pieces and the baskets are glued together. ⅛” plastic hardware cloth was secured to the basket frame with a monofilament line, producing a basket with no hidden crevices and which is easy to wash and sanitize. Each basket required 4 24” long pieces, 4 32”long pieces, 4 6” tall pieces and 8 3-way elbows. Complete cymes were loaded into the baskets and the flowers held on to the cymes well during drying. The dried flowers were separated from
the cymes by rubbing 3 to 4 brittle cymes in one hand against the basket for 1-3 seconds. The dried flowers which fell from the basket rubbings were collected onto a clean, impervious sheet or bin below the basket. They were then weighed and sealed in plastic or mylar bags with a food safe desiccant package inside.

Selling quantities of dried flowers into the wholesale market requires an investment in stainless steel racks ($820 for a 7 rack unit, 48” wide and 8” deep, which is about ¾ the volume of our test rack) and welded stainless steel screens ($1.20 sq foot).

On the Cumberland Plateau, the varieties we planted had several weeks of difference between their start, peak and end dates for fruit production. For clarity, harvest data shown in the chart below is shown only from Site 1, 2nd year of production, but we observed a similar flowering sequence across the orchards that did produce blooms.
The inherent variability of Wild Type Elderberry is not represented well on the above graph. Our wild-type sample in the trial orchard was cloned from a single wild patch. Wild Types are some of the first and last to bloom on the Cumberland Plateau and they are found in a wide range of growth patterns from short and squat to 9’ tall and 12’ wide when unpruned. They are strong bloomers and set a lot of fruit but the lag from first ripe berry to last ripe berry on the same cyme is a few days longer than the improved cultivars, requiring more intense observation at harvest and making the cyme more susceptible to bird predation. Most of the improved cultivars also have berries that are larger or sweeter than wild types. In the 3rd year of production, 2021, our best producing farm found it very efficient to harvest elderberries from wild plants in addition to their orchard grown plants. In some cases the wild types produced better than their orchard grown 3rd year plants. Note: many wild elderberries did not perform better than their orchard plants, but the farmer was able to choose which heavily fruiting wild plants were producing well and were convenient to access, while ignoring those that had poor fruit set, were eaten by birds or that were located in awkward settings. This points to the potential for local farmers to identify and catalogue new selected cultivars that are well suited to local conditions.

**Fruit Pests:**
The spotted wing drosophila (SDW) is a relatively new pest in the southeast. Our project used standard vinegar and yeast traps to bait fruit flies. And the traps were deployed during the time ripe fruit was in the elderberry orchards.

Unlike a typical fruit fly, which prefers to lay its eggs on rotting, damaged, or overripe fruit, the SWD has a serrated ovipositor that enables her to lay eggs in intact fruit. Insects caught in the traps were strained and frozen and then inspected for fruit fly forms plus spotted wings (males) or serrations on the
ovipositor (females). The females can use their egg-laying appendage to pierce intact fruit that is just coming ripe. This is different from other fruit flies that prefer to lay eggs in bruised or overripe fruit. The hazard is that the farm crew may pick fruit that looks fine, but eggs can hatch during shipment, so that tiny maggots are infesting the fruit at distributors or retail outlets. Cooking the berries into jams or syrups at the farm is one way to deal with the pest. Freezing is another way to kill the eggs.

The number of SWD caught per week in 2021 is shown in the chart below. When comparing the fruiting patterns of elderberry varieties in the graphs above with the incidence of SWD sightings in our area it appears that most of the improved cultivars finished fruiting before SWD numbers became large. Wyldewood is the only improved cultivar that was still producing berries when SWD numbers were starting to build. Only the wild type was still producing fruits during the highest rates of SWD trapping. SWD timing and geography outbreaks are changing as this insect expands its range.

![Weekly Counts of Spotted Wing Drosophila](image)

**Economic viability of improved elderberry as a driver of economic growth:**
In our trials, only site one achieved a commercially viable yield. This site was located near Coalmont, TN. The trial orchard was installed on a terraced slope of a former strip mine. In the year prior to planting the orchard, the area was used to enfold poultry at night and the area was heavily manured, presumably with high organic matter and high phosphorus (P) levels as well as nitrogen (N) and potassium (K), as birds are known to excrete high ratios of phosphorus. At this location, the varieties “Bob Gordon,” “Adams,” and “Wyldewood” all yielded at least 3 times more than the wild type which was used as a control group. “Ranch,” which is a shorter, multi-branching plant with known drought tolerance yielded almost 6 times higher than the wild type. Cymes are produced at the end of a branch, so more branches leads to more flowers and fruit. None of the elderberry varieties in the trial had a bloom size that was dramatically different from the other varieties. At this site, a harvest attempt was made 2-3 times weekly in both years, and the results were much higher than growers who attempted to harvest once a week. Bird predation decimated 3 out of the six trial orchards. The two orchards that were able to
harvest in year 2 and year 3 of our trials also saw significant differences between the years, with both orchards seeing year 3 harvest less than 20% of year 2.

Analysis and recommendations
As of the summer of 2020, the Midwest Elderberry Co-operative is still estimating that 90+% of elderberries used in the U.S. made elderberry products are imported from overseas. The co-op reports that the hand labor required to harvest and process elderberries is still a bottleneck. If this issue can be solved, rapid adoption of elderberry as a specialty crop may follow. If so, there is likely to be a short period of time when established, early adopters of elderberry plantings can sell dormant cuttings to farms that are establishing new plantings. Dormant cuttings sold into rapidly developing markets might produce revenue up to $60,000/acre. It is unlikely that this will recur for more than a few years, because each new farm can make its own cuttings after just one year.

Comparing three market approaches using a tons/acre approach, our highest producing trial sites reveal that dried berries can produce more revenue per acre ($22,800) than fresh frozen berries ($7,600) or dried flowers ($950). However, to achieve a frozen or dried berry harvest, the grower must plant enough acres to get past bird predation issues and to justify the cost of the destemming infrastructure ($8,000), washing setup ($500), walk-in freezer rental ($3,000/mo) and if selling frozen berries, adding the cost of frozen rate freight to a midwest terminal ($3.50 per mile by the tractor/trailer full load). If selling dried berries, the grower needs to add a commercial scale dehydrator ($1,000) and will be shipping ¾ the weight of frozen berries, at a dry freight rate of $2.50/mile. These figures were calculated from the data in our best producing trial orchard. Five out of the six trial orchards failed to achieve harvest levels that can justify the purchase of commercial harvesting equipment, but might produce enough to justify the purchase of equipment if used cooperatively. All of the trial orchards had harvests that varied from year to year. Even with good fruit production, growers need to harvest 2-3 times a week in order to achieve a commercially viable harvest.

A trial plot grown for dried flowers can provide a small revenue and help a new grower estimate the potential yield at their location with only a small investment in infrastructure. Potential yield data is necessary when applying for a loan for equipment or plant cuttings.

When a grower is ready to grow elderberry fruit, it is prudent to establish a large enough planting (probably several acres) that is sufficient for the farmer and the birds. Choose a single variety or group of varieties that produce near the same time, while keeping in mind the labor and freezer capacity needed to process berries the entire crop during 3-5 weeks. In our area Ranch was the heaviest producer by far (the equivalent of 1.9 tons/acre at the best site), but this data was from a single trial orchard. The second
trial orchard that produced fruit found that wyldewood produced better at their location, but the overall harvest was lower at this orchard.

Based upon our trial data we expect that “Ranch” is the variety that offers the lowest risk to elderberry growers on the Cumberland Plateau. It produces a crop of berries before the spotted winged drosophila pest is problematic. It tolerates the drought conditions that sometimes occur in our area.

In addition to the data collected from our trial orchards, the following sources were used as a source of pricing, flower yield to berry ratios, and food safety regulations.

Stainless shelving:
https://www.globalindustrial.com/

Stainless steel welded wire:
https://www.amagabeli.com/

Commercial and industrial dehydrators
https://www.dehydratorsamerica.com

Walk-in or trailer freezer leasing:

Midwest Elderberry Co-op (Buyers of frozen and dried elderflowers and elderberries):
https://www.midwest-elderberry.coop/grow/index.html

Center for agroforestry market report (2011):

Elderflower production and its effect on berry harvest:
https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/63543/research.pdf?sequence=2&isAllo wed=y

Tennessee domestic kitchen regulations

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