Pruning is arguably the most important cultural practice a grape grower performs. Pruning has a dwarfing (pruned vines are physically smaller) and invigorating effect on the vine. When wood is removed, the roots that previously supported the top growth will have an abundance of hormones, carbohydrate reserves, and water and mineral absorbance capacity. This root abundance or ‘excess supply’ stimulates the remaining shoots to grow and expand at a rapid rate. This rate is called “vigor”, defined as rate of growth, not amount of growth, or overall vine/plant size. While the above ground portion of pruned vines are physically smaller, the remaining shoots grow more rapidly (increased vigor) compared to shoots on an unpruned vine. A term often confused with vigor is ‘vigin’. Vigor relates to vine size, but is a separate concept. Capacity is the total amount of fruit/crop a given vine can support to a desired degree of maturity. Vine productivity and sustainability depends on vine capacity: first, for the vine’s physiological requirements and second, for the economic viability of the vineyard enterprise. At pruning, the following is determined: type, position and number of buds that will produce fruit. Bud number, set at pruning, can impact berry composition i.e. fruit ‘quality’. Thus, pruning plays a crucial role in vine health and productivity.

**Purpose of pruning**: to achieve the desired amount and quality of fruit over a number of years.
1. Set the appropriate fruit load to the size/capacity of each vine
2. Shape and train the vine, integrating the vine to a given trellis system. Direct vine growth into a well-spaced canopy that allows air, sunlight and spray materials into the canopy, to contact the foliage and fruit at the optimum time and degree during the growing season.

**Balanced vine growth begins with pruning**:
1. Weigh pruned, one-year old wood. Leave 30 buds for the first lb. removed and 10 buds for every lb. thereafter. This is called the 30+10 formula, and is applied to the Concord variety. Another formula, leaves 20 buds per 1 lb. of wood removed and is the ‘formula’ for many *vinifera* or European wine grapes. It provides a starting place, matching pruned wood with the fruit crop. Balanced pruning is a technique that uses: cane weight (one-year old wood), node counting and a pruning ‘formula’ for estimating vine capacity. This technique was originally developed by Dr. Nelson Shaulis of Cornell University. It assumes the selection of well-exposed canes with fruitful buds. Each pruning formula or nodes per pound of canes, is driven by growth and fruiting characteristics of the variety. Vine capacity varies between trellis/training systems and even between adjoining vines in a row. The intent of balanced pruning and an appropriate ‘formula’, is to avoid over or under-pruning vines of differing capacity. Balanced pruning is the first step in achieving the annual desired quality level with maintained or improved vine capacity for the following year’s crop (Coombe and Dry, 1992).

<table>
<thead>
<tr>
<th>Variety</th>
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<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabernet Sauvignon</td>
<td>20+20</td>
<td>Concord</td>
<td>30+10</td>
</tr>
<tr>
<td>Cabernet Franc</td>
<td>20+20</td>
<td>Niagara</td>
<td>40+10</td>
</tr>
<tr>
<td>Chardonnay</td>
<td>20+20</td>
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</tr>
<tr>
<td>Riesling</td>
<td>20+20</td>
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</tbody>
</table>
Seyval  
Vidal  
Other Hybrids  

2. Leaf area: fruit ratio

Pn (photosynthetically active) leaf area measured in square centimeters (cm²) to mass, measured in grams (g). This ratio provides a measure of vine’s capacity. This ratio depends on trellis system used. For example, the vertical shoot positioned (VSP) trellis generates a leaf area:fruit ratio of about 0.8 to 1.2 m² leaf area per kg fruit or about 10 cm² of leaf area per 2g of fruit, or about 5-6 mature leaves per each medium sized cluster (Figure 1). Divided canopies can be a bit more efficient...where 0.5 to 0.8 m²/kg are needed to mature fruit (Kliwer and Dokoozlian, 2005).

![Figure 1. The relationship of leaf area to crop weight. Examples of three trellis systems: A1 = vertical, B1 = lyre and C1 = Geneva double curtain, (Kliwer and Dokoozlian, 2005).](image)

3. If vines have 3.5 lbs. of prunings/vine, leave about 42 buds as a default, 6 buds/ft., or 2-3 spurs per foot. What if one must choose between total number of buds/vine and achieving the desired number of shoots per foot? In this case, the number of buds per foot takes precedence over the total number of buds per vine. You do not want a shoot density per foot that results in a dense and congested canopy. Such a canopy leads to increased disease pressure and poor light exposure of fruit clusters.

4. Wood:fruit ratio should be approximately 5-6 lbs. of fruit per lb. of wood removed.
Factors that impact pruning…or, pruning depends on:

1. **Climate**: Is your climate *continental* or *maritime*? If continental (BTW: all of New Mexico has a continental climate), there is an increased chance of winter and/or frost injury. In this case consider:
   - Leaving more buds and shoot or crop thin later in the season
   - Prune late, this will delay budburst and may aid avoidance of frost injury in the spring
   - “kicker canes” these are ‘extra’ canes left on the vine and can enter budburst relatively late and may replace spur borne buds killed by frost. Kicker canes are typically replaced each year and help dissipate excess vigor.

2. **Soil Fertility**:
   - deep soil = vigorous growth, then prune light to increase rate of early shoot growth
   - poor soil = prune severely to stimulate growth in remaining buds

3. **Variety**: pay attention to number bunches/shoot, number flowers/cluster, berry weight, bud position
   - some varieties have sterile basal buds, example: Nebbiolo
   - apical dominance? Phenomenon most evident in the spring, where the buds at cane tips break bud first, and subsequently, more basal buds will burst.

4. **Economic**: winter pruning most economical crop thinning method, but is least precise form of crop control
   - cluster, fruit and shoot thinning during the growing season costs more, but is more precise compared to winter or dormant pruning

**Pruning Procedures**

1. **Timing**:
   - Early prune to finish pruning by budburst. Pruning can be done after budburst, but the risk of bud damage is greater.
   - Early pruning = early bud break, growth advancement can persist through harvest
   - Double pruning, making two passes through the vineyard.
     - First pass, make rough cuts and remove bulk of the prunings from the trellis
     - The second pass, adjust bud numbers to desired number prior to bud break
   - Delayed pruning, cutting off wood as budburst approaches, development of remaining buds will be delayed
     - The delay can persist through harvest
     - Delayed pruning can reduce Eutypa and other wood rotting diseases.

Figure 2. Left: a cross section of a cordon infected with fungal wood rotting disease, evident in the discoloration. Right: end cut cordon revealing fungal wood rotting infection.
2. **Pruning Degree:**
   - Balanced pruning: number of buds retained based on weight of wood removed at annual dormant pruning
     - **SEVERE**: < 20 buds left on the vine
     - **MODERATE**: 20 to 70 buds left on vine
     - **LIGHT**: > 75 buds left on the vine

3. **Cane Selection Criteria:**
   - varietal color: light brown *Vitis vinifera* varieties, with brown coloration to the cane tip
   - 1cm (3/8 inch) in diameter desired, strive for cane uniformity
   - moderate internode length, about 3-4 inches
   - round buds instead of flat buds
   - canes of different length and diameter, should retain different number of buds
   - age or location

4. **Vine Age**: different training goals for different age vines
   - young vines – establishment of framework based on trunk arrangement
   - mature – framework and buds type placement within your trellis system

Pruning affects most vineyard activities and vine growth parameters such as: crop yield, winter hardiness, insect and disease management and ultimately berry composition and resultant juice and wine quality (Chapman et al., 2004). Although pruning can become intuitive once you have practiced a bit, a winegrower with an eye towards the bottom line should maintain good records to supplement and support her pruning decisions.

**REFERENCES**