1. Assume that a red pine plantation can be established for $220 per acre. The annual property taxes on the plantation are $1 per acre. The table below indicates the likely yields in cords per acre from the plantation if it is clearcut for pulpwood at age 60, 70, or 80. Assume that the real price for red pine stumpage will be $26 per cord, regardless of which rotation is selected.

a. Calculate the present value of the first rotation and a land expectation value (LEV) for each rotation shown in the table using a 3 percent real interest rate.

<table>
<thead>
<tr>
<th>Rotation Age</th>
<th>Yield (cd/ac)</th>
<th>Present Value of the First Rotation</th>
<th>Land Expectation Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>62</td>
<td>$25.93</td>
<td>$31.24</td>
</tr>
<tr>
<td>70</td>
<td>77</td>
<td>$3.72</td>
<td>$4.26</td>
</tr>
<tr>
<td>80</td>
<td>89</td>
<td>-$32.74</td>
<td>-$36.13</td>
</tr>
</tbody>
</table>

Example Calculations for Age 60:

\[
PV_{R1}(60) = -\frac{220}{ac} - \frac{1}{ac} \left[ (1.03)^{60} - 1 \right] + \frac{26}{cd} \cdot \frac{62cd}{ac} \left[ (1.03)^{20} - 1 \right] = \frac{25.93}{ac}
\]

\[
LEV(60) = \frac{25.93}{ac} \left( \frac{1.03}{1} \right)^{30} = \frac{31.24}{ac}
\]

b. Now, assume that the red pine stand will be thinned at age 60 and clearcut at age 80, with the following yields: 1) 22 cords/acre thinned at age 60, and 2) 18 cords/acre and 7 mbf/ac from the final harvest at age 80. Assume that the price for red pine sawtimber is $386/mbf. What is the LEV of this prescription? (Again, use a 3 percent real interest rate.)

Using Method 3:

\[
FV_{R1} = -\frac{220}{ac} (1.03)^{80} + \frac{26}{cd} \left[ (1.03)^{20} - 1 \right] + \frac{26}{cd} \left[ (1.03)^{80} - 1 \right] + \frac{386}{mbf} \left[ (1.03)^{80} - 1 \right] = \frac{1,862.10}{ac}
\]

\[
LEV = \frac{1,862.10}{ac} - \frac{1}{ac} \left( \frac{1.03}{30} - 1 \right) = \frac{159.81}{ac}
\]

c. Recalculate the LEV in part 1b assuming that the annual property tax was eliminated and replaced with a severance tax of $2 per cord and $10 per mbf.

Again, using Method 3:

\[
FV_{R1} = -\frac{220}{ac} (1.03)^{80} + \frac{26}{cd} \left[ (1.03)^{20} - 1 \right] + \frac{26}{cd} \left[ (1.03)^{80} - 1 \right] + \frac{386}{mbf} \left[ (1.03)^{80} - 1 \right] = \frac{1,676.63}{ac}
\]

\[
LEV = \frac{1,676.63}{ac} \left( \frac{1.03}{80} - 1 \right) = \frac{173.91}{ac}
\]
2. Establishing an oak plantation will cost you $0.60 per tree, plus $220 per acre to put up an electric fence to keep the deer out. The stand will also need a precommercial thin after 40 years of growth. At age 82, you expect to do a shelterwood cut, followed by an overstory removal at age 90. Your yields will depend on the number of trees you plant. Prices will depend on the rates of inflation for oak sawtimber, and harvest costs may also change over time. Current harvest costs and yields for different initial planting densities are given in the following table.

Table 2. Costs and yields for two planting densities in an oak plantation.

<table>
<thead>
<tr>
<th>Number of trees planted per acre</th>
<th>Precommercial Thinning Cost ($/per ac)</th>
<th>Shelterwood Cut Yield (mbf/acre)</th>
<th>Shelterwood Cut Cost ($/mbf)</th>
<th>Final Cut Yield (mbf/acre)</th>
<th>Final Cut Cost ($/mbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 trees/acre</td>
<td>190</td>
<td>6</td>
<td>60</td>
<td>8.5</td>
<td>55</td>
</tr>
<tr>
<td>500 trees/acre</td>
<td>240</td>
<td>7</td>
<td>67</td>
<td>10</td>
<td>48</td>
</tr>
</tbody>
</table>

a. Calculate the LEV for each planting density assuming that there will be no real change in harvest costs (thinning, shelterwood and final) or in the price of oak sawtimber any time in the future. Assume that oak prices are $490 per mbf, that the general rate of inflation will be 2.5% for the next 90 years, and use a real alternate rate of return of 3%.

LEV calculation for 300 tpa (Method 2/3 (w/o annual cost both methods are same)):

\[
FV_{R1, 300\ tpa} = -(0.6 @ 300 + 220)(1.03)^{90} - 190 (1.03)^50 + [(490-60) @ 6](1.03)^8 + [(490-55) @ 8.5] = $412.64
\]

\[
LEV_{300\ tpa} = \frac{412.64}{(1.03)^{90} - 1} = $31.02
\]

LEV calculation for 500 tpa (Method 2/3):

\[
FV_{R1, 500\ tpa} = -(0.6 @ 500 + 220)(1.03)^{90} - 240 (1.03)^50 + [(490-67) @ 7](1.03)^8 + [(490-48) @ 10] = -$317.47
\]

\[
LEV_{500\ tpa} = \frac{-317.47}{(1.03)^{90} - 1} = -$23.87
\]
b. Now, calculate the LEV for each planting intensity, assuming that harvest costs (thinning, shelterwood and final) will increase over the next 90 years at a real rate of 2% per year and that oak sawtimber prices will increase at a real rate of 1% per year over the next 90 years. Even though it is not entirely accurate, assume that future rotations will produce the same cash flows (costs and revenues) as the first rotation.

Table 2a. Inflated costs and prices for two planting densities in an oak plantation.

<table>
<thead>
<tr>
<th>Number of trees planted per acre</th>
<th>Precommercial Thinning Cost ($/per ac)</th>
<th>Shelterwood Cut Price ($/mbf)</th>
<th>Shelterwood Cut Cost ($/mbf)</th>
<th>Final Cut Price ($/mbf)</th>
<th>Final Cut Cost ($/mbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 trees/acre</td>
<td>419.53 =190(1.02)^{40}</td>
<td>1,108.02=490(1.01)^{82}</td>
<td>304.34</td>
<td>1,199.83</td>
<td>326.87</td>
</tr>
<tr>
<td>400 trees/acre</td>
<td>529.93 =240(1.02)^{40}</td>
<td>1,108.02=490(1.01)^{82}</td>
<td>339.85</td>
<td>1,199.83</td>
<td>285.27</td>
</tr>
</tbody>
</table>

LEV calculation for 300 tpa (Method 2/3):

\[
FV_{R1, 300 \text{ tpa}} = -(0.5 \times 110 + 110)(1.03)^{90} - 419.53 \times (1.03)^{50} + [(1,108.02-304.34) @ (1.03)^{5} + [(1,199.83-326.87) @ 5] = $5,969.24
\]

\[
LEV_{300 \text{tpa}} = \frac{-5,969.24}{(1.03)^{90}} = $448.80
\]

LEV calculation for 500 tpa (Method 2/3):

\[
FV_{R1, 500 \text{ tpa}} = -(0.5 @ 110 + 110)(1.03)^{90} - 529.93 \times (1.03)^{50} + [(1108.02-339.85) @ (1.03)^{5} + [(1,199.83-285.27) @ 9] = $6,197.87
\]

\[
LEV_{500 \text{tpa}} = \frac{-6,197.87}{(1.03)^{90}} = $465.99
\]

(2EC)

3. How do your LEVs in part 2b change if the real alternate rate of return is 4%?

LEV calculation for 300 tpa (Method 2/3):

\[
FV_{R1, 300 \text{ tpa}} = -(0.5 @ 110 + 110)(1.04)^{90} - 419.53 \times (1.04)^{50} + [(1,108.02-304.34) @ (1.04)^{5} + [(1,199.83-326.87) @ 5] = -$2609.71
\]

\[
LEV_{300 \text{tpa}} = \frac{-2,609.71}{(1.03)^{90}} = -$78.80
\]

LEV calculation for 500 tpa (Method 2/3):

\[
FV_{R1, 500 \text{ tpa}} = -(0.5 @ 110 + 110)(1.04)^{90} - 529.93 \times (1.04)^{50} + [(1108.02-339.85) @ (1.04)^{5} + [(1,199.83-285.27) @ 9] = -$5,003.43
\]

\[
LEV_{500 \text{tpa}} = \frac{-5,003.43}{(1.03)^{90}} = -$151.07
\]