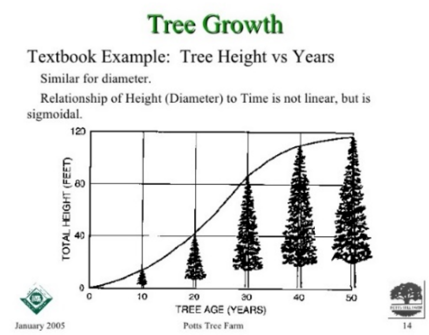
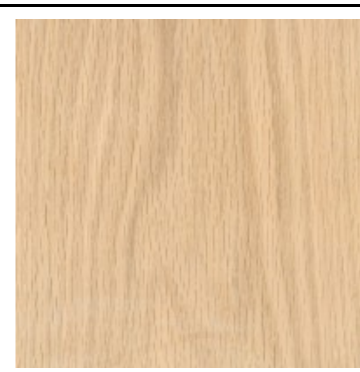
WILHELM FARM

FACTSHEET

Forest Trees as Investments

Trees illustrate how investments work. A tree has a starting point as natural or planted seedling. Over the years it grows in height, diameter and quality. Finally, it is harvested, yielding a financial return. At each age, a tree is an investment. And each year, the forest owner can decide – do I continue this tree investment for one more year? Or harvest?

The simple rule is ***if the tree is growing in value faster than the guiding interest rate***, we keep the tree investment for another year. The tree value growth is determined by increases in tree volume (e.g., board feet or cubic feet) and changes in value per unit volume.

<table>
<tr><td rowspan="2">Tree growth:
• Diameter
• Height</td><td></td><td>
</td></tr>
<tr><td>Total diameter is the key driver to volume and the rate of growth drives volume growth.</td><td>As trees grow in height, they increase in diameter too, and the total volume increases.</td></tr>
<tr><td>• Quality</td><td>
Logs that yield nearly clear white pine boards have the highest value per board feet.</td><td>
The same is true of red oak logs – those that yield clear and consistant color boards have highest the value per board feet.</td></tr>
<tr><td colspan="3">Diagrams and pictures are from (in clockwise order) Colourbox, Slideshow, The Wood Database, Indiamart.</td></tr>
</table>

Increases in tree height and diameter cause increases in volume, which may be measured with a variety of units; e.g., board feet, cubic feet, weight. Increases in volume leads to increases in total value. These value increases may be amplified by price increases per unit volume as tree size increases or other quality factors change (e.g., surface indicators of knots). Prices can also increase as timber becomes scarcer. Scarcity reflects a growing demand for timber as the economy expands, especially as demand for housing increases. The opposite is also true. A depressed economy leads to less demand and shrinking timber prices (see our forthcoming Factsheet No. 6 - *Timber prices and price projections for southern New England*).

The rate of value growth combines:

Volume Increase / Volume	**= Rate (%) of Physical Growth**
Value Increase/unit volume / Value	**= Rate (%) of Value Growth**
If Rate (%) of Value Growth	**> Interest rate, hold tree investment**
If Rate (%) of Value Growth	**≤ Harvest tree**

The rate of real value growth is expressed as a percentage, which can be compared with guiding interest rates. For example, we have observed some fast-growing eastern white pine on Wilhelm Farm. Diameter growth rates of 5% to 10% after harvest are common among middle-size trees following release from competition (see light gray zone in Table1 below).

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Table 1. Percentage rates of volume growth for trees of different diameters and rings per radial inch. The light gray zone illustrates rapid physical growth rates of small to large diameter trees. The darker gray zone are trees that are financially mature. *Source: Adapted from Karl Davis 1991.*

	Growth Rings per Inch								
DBH	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
4	28.20%	22.50%	18.80%	16.10%	14.10%	12.50%	11.30%	10.20%	9.40%
6	18.10%	14.50%	12.10%	10.30%	9.10%	8.00%	7.20%	6.50%	6.00%
8	13.30%	10.60%	8.90%	7.60%	6.70%	5.90%	5.30%	4.80%	4.40%
10	**10.50%**	**8.40%**	**7.00%**	**6.00%**	**5.30%**	4.70%	4.20%	3.80%	3.50%
12	**8.70%**	**7.00%**	**5.80%**	**5.00%**	4.40%	3.90%	3.50%	3.20%	**2.90%**
14	**7.40%**	**5.90%**	4.90%	4.20%	3.70%	3.30%	3.00%	**2.70%**	**2.50%**
16	**6.40%**	**5.20%**	4.30%	3.70%	3.20%	**2.90%**	**2.60%**	**2.30%**	**2.10%**
18	**5.70%**	4.60%	3.80%	3.30%	**2.90%**	**2.50%**	**2.30%**	**2.10%**	**1.90%**
20	**5.10%**	4.10%	3.40%	**2.90%**	**2.50%**	**2.30%**	**2.00%**	**1.90%**	**1.70%**
22	4.60%	3.70%	3.10%	**2.70%**	**2.30%**	**2.10%**	**1.90%**	**1.70%**	**1.50%**

This increase is coupled with height growth so that annual volume growth rate above 5% can last for a few years. Further, the bigger trees often move to higher log grades for lumber and plywood. This jump in value, coupled with volume increases, can lead to annual real value growth rates of well above 12% for a few years.

If the guiding rates of real interest are 3% after adjusting for inflation[1], keeping young trees makes financial sense because they are not financially mature. A bigger tree – e.g., an 18-inch tree growing at 8 rings per inch – is growing at 2.9%. If the total volume growth and quality change are similar, the value growth rate says the tree is financially mature and ready for harvest.

Interest rates

Interest rates are determined by commercial lending rates, alternative investment opportunities, or the time preference of the landowner. Commercial rates have been historically low since the recession of 2008, but rates increased in recent months. Rates are expected to increase in coming years as the Federal Reserve adjusts its discount rates upward, inflationary pressures push commercial rates up, and global forces reflect similar forces in most other economies.

We use estimates of real interest rates. These estimates eliminate the impact of inflation. For example, if the inflation rate is 2% and the commercial interest rate is 5%, the real interest rate in 3%. Recent interest rates have been low because of low inflation rates, sluggish economies and deliberate policies of central banks worldwide.

Investment Criterion

Wilhelm Farm uses ***Present Net Value*** to guide its investment decisions. All projected costs and revenues are discounted back to the present:

$$\textbf{Present Net Value} = \frac{(\text{Revenue–Cost})_{year1}}{(1+\text{interest rate})^1} + \frac{(\text{Revenue–Cost})_{year2}}{(1+\text{interest rate})^2} + \ldots + \frac{(\text{Revenue–Cost})_{yeart}}{(1+\text{interest rate})^t}$$

Where year ***t*** is the final year of the investment (e.g., harvest age of tree or forest stand)

This basic model is used for analyzing many kinds of business investments. In forestry, this basic model often is modified to separate land from trees because the land continues as an investment after harvest. This model, often called the soil rent or Fautstmann model (after the German forester who developed it in 1849), attributes the present net value to land. As delaying harvest postpones future net revenues, the soil rent model reaches its maximum value at shorter rotations than the simple present net worth criterion. In general, the difference of optimal rotation age is not significant in context of uncertainty and risk in timber production.

Some farm owners prefer ***Internal rate of return***. To calculate the internal rate of return, use the present net worth model (PNW), set PNW at zero and solve for the interest rate. This used to be tedious calculation – taking the root of a complex equation to the t^{th} power – but today can be easily and quickly calculated using Excel or similar spreadsheet.

Financial maturity, following the PNW logic, occurs when the internal rate of return drops to the guiding rate of interest. However, it could be defined by the maximum internal rate, which will occur at an earlier age than the traditional understanding of financial maturity.

[1] Both interest rates and inflation have been historically low for the past decade, but both are changing in 2018.

Financial maturity of individual trees

Two examples from our experience on Wilhelm Farm over the past 20 years illustrate financial maturity in practice.

> ***White Pine Example***: We harvested our pine unit in 1997, 2007, and 2015. In each harvest, we removed selected individual trees. We did not clear-cut stands but did use group selection where several larger trees near one another were harvested. This released nearby younger or smaller trees from competition for light, moisture and nutrients. Our site for white pine is high, averaging 80 to 85 feet in height at 50 years. Consequently, one result of our harvesting pine was immediate diameter growth responses, with half an inch growth per year or being common. Height growth also increased following release, so the physical volume increased following harvesting. As Table 1 demonstrates, diameter growth alone can lead to physical growth rate above 5% for trees that are 10 to 20 inches in diameter.
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> ***Red Oak Example***: We have red oak scattered over our 35 acres of woods, but the best oak sites are on the granitic Berkshire uplift at the west end of our property. The individual trees started from natural seedlings in the late 1800s and early 1900s as American Chestnut stems succumbed to the blight. Our financially mature red oak stems were removed in 1997, which removed competition for nearby smaller trees. In 2014, we harvested trees that had reached financial maturity. Red oak can remain biologically healthy for 200 or more years, but well before that time stems reach financial maturity. The physical growth rates dip below 3% in the 75 to 80-year range (roughly 16 to 18-inch diameters – see dark shaded area in Table 1). The value per unit volume may continue to rise if the market for veneer grade logs is high, but generally red oak real prices are slowly falling (see Factsheet No. 6).

The Peculiarity of Trees as Investments

In most production processes, the product and the machine that makes it are separate. If you buy milk at a dairy, you do not also buy a cow. Purchasing an apple does not involve buying an apple tree. Buying a white pine log, however, means you must harvest a white pine tree. Investments in planting or tending a pine tree produce logs, but liquidating the investment is also liquidating the production mechanism. Therefore, tree sustainability requires reinvesting in new trees after harvest, either through planting or silvicultural systems that favor natural regeneration.

A forthcoming factsheet, ***Forest investments – Connecticut Examples*****,** deals with understanding financial, maturity for groups or stands of trees. These are the units of management in both forests and agroforestry systems. The factsheet lays the ground work for future guides to investments in complex small farm systems and the investment perspectives of families.

Summary

Forest trees are an investment. They can be managed sustainably and be profitable investments for small farm owners. Sustainability does require reinvestment in new trees, be this a process of managing natural regeneration or planting seedlings following harvest.

References[2]

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Hibbs, D. E. and W. R. Bentley. 1987. *White pine management: volume and volume growth*. North J. Applied Forestry 4(4):197-201.

Hibbs, D. E. and W. R. Bentley. 1984. *A growth model for red oak in New England.* Can. J. For. Res. 14:250-254.

[2] Most of these references are available through the UConn Library.