

What Is the Value of an Existing Forest Stand?¹

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Traditionally, the land expectation value (*LEV*) formula—the present value of perpetual cash inflows of timber revenues minus the present value of cash outflows of costs (Faustmann 1849)—has been employed as the main indicator of the value of a forest investment. However, when a forest stand is already established, the *LEV* approach is incomplete because it applies only to bare land. Thus, it is necessary to determine the value of a property with an *existing* forest stand. This publication provides the formula to determine the value of an already established forest stand at any stage of its development. This approach, known as the forest value formula, includes the value of the timber and the land.

The Land Expectation Value

The *LEV* for timber production (*LEV*) can be calculated using the following formula:

$$LEV = (-C_0 - \sum_{t=1}^T \frac{C_t}{(1+r)^t} - C_i [\frac{(1+r)^T - 1}{r(1+r)^T}] + \sum_{t=1}^T \frac{A_t}{(1+r)^t}) * \frac{(1+r)^T}{r(1+r)^T}$$

Equation 1.

Where C_0 is the establishment costs¹ (site preparation and planting costs at stand age 0); C_t is the intermediate costs to grow the stand at time t (e.g., fertilization, marking, thinning costs); C_i is the annual management or administrative costs; A_t is the economic revenues due to thinning benefits and final harvest of the stand; and r is the discount rate. Let's analyze the following example for a slash pine stand in Table 1. We assume that the slash pine is planted at year $t=0$ and harvested at age $T=25$ years. The slash pine is replanted

immediately after harvesting. The costs and revenues associated with the activities indicated in Table 1 will remain identical for subsequent rotations².

Table 1. Example of Activities, Costs, and Revenues in a Slash Pine Stand.

Year	Activity	Revenue (Cost) \$ per acre
0	Establishment	(400)
5, 15	Fertilization	(70), (70)
15	Thinnings	232
1–25	Annual administration	(20)
25	Final harvest	4490

Initial planting density=600 trees/acre; stand index=82 ft. Costs obtained from Maggard and Barlow (2017). Prices of sawtimber (\$27), chip-and-saw (\$19.9), and pulpwood (\$10.4) per ton obtained from Timber Mart South (2018). Yields of sawtimber, chip-and-saw, and pulpwood are provided by Pienaar et al. (1996). Thinning yields 4.7 and 18.9 tons/acre of chip-and-saw and pulpwood, respectively. Final harvest yields 85.0, 98.5, and 22.5 tons/acre of sawtimber, chip-and-saw, and pulpwood, respectively. Thinning profits are net of cost of thinning. Cost of thinning is assumed to be a percentage of the stumpage price (20%). Discount rate is 5%.

Thus, the is determined as follows (Table 2):

Table 2. Determination of the Present Value (*PV*) of Costs and Revenues and *LEV*.

Establishment	Intermediate costs	Annual costs	Thinning & harvest revenues
C_0	$\sum_{t=1}^T \frac{C_t}{(1+r)^t}$	$C_i [\frac{(1+r)^T - 1}{r(1+r)^T}]$	$\sum_{t=1}^T \frac{A_t}{(1+r)^t}$
400	$70/1.05^5 + 70/1.05^{15}$	$20(1.05^5 - 1)/0.05(1.05^{25})$	$232/1.05^{15} + 4990/1.05^{25}$
$PV = 400$	= 89	= 282	= 1438
	$LEV = (1438 - 400 - 89 - 282)1.05^{25}/(0.05(1.05)^{25})$		
	$LEV = \$947 \text{ per acre}$		

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The *LEV* approach is useful to determine the optimal decision when comparing two (or more) timber investments of unequal time frames (different rotation ages). The optimal decision, economically, is to choose the project with the highest land-expectation value (all projects assumed to be perpetual projects).

The Forest Value

The forest value is defined as the present value of cash flows arising from the land and the tree crop³. We previously defined that the *LEV* provides the present value of perpetual cash flows from identical rotations starting from bare land. This implies that the *LEV* remains unchanged. Thus, once a forest stand is already established, the value of the forest includes both the value of the land and the value of the timber. We can calculate the forest value of a mature stand that is ready for harvest or that of an immature stand with a harvest set for some point in the future.

Forest Value of a Mature Stand

The first case assumes that the stand is mature, i.e., it is ready to be harvested and regenerated immediately. Under this scenario, the forest value (*FV*) at time *t* can be expressed as:

$$FV_t = -C_t - C_1 + A_t + LEV$$

Equation 2.

Equation 2 simply states that the forest value is the sum of the net value of the stand plus the value of the land. For example, let's consider a 20-year-old slash pine stand with a *LEV* = \$947 per acre. At age 20 years, the intermediate costs $C_t = 0$ and management costs $C_1 = \$20$ per acre. In addition, the slash pine stand yields 28.1, 93.8, and 27.8 tons/acre of sawtimber, chip-and-saw, and pulpwood respectively. Thus, the value of timber $A_{20} = 27 \times 28.1 + 19.9 \times 93.8 + 10.4 \times 27.8 = \$2,913$ per acre. Thus, the forest value at time $t = 20$ is:

$$FV_{20} = -20 + 2,913 \text{ (harvest revenues)} + 947 = 3,840 \text{ per acre}$$

Forest Value of an Immature Stand

The second case assumes that the stand is not ready to be harvested, and thus that the landowner will have to wait until time *T* to clear cut and replant a new forest stand. Assuming an *n*-year old stand ($n \geq 1$), the forest value *FV* can be defined as follows (Davis and Johnson 1987):

$$FV = \frac{-\sum_{n=1}^T C_n(1+r)^{T-n} - C_i \left[\frac{(1+r)^{T-n} - 1}{r} \right] + \sum_{n=1}^T A_n(1+r)^{T-n} + LEV}{(1+r)^{T-n}}$$

Equation 3.

Equation 3 suggests that the forest value is the sum of future value of the remainder of the current rotation if the stand is harvested at age *T* plus the value of the land, discounted back *T*- *n* years. In this case, for a 20-year-old slash pine stand with an optimal rotation age of 25 years, the landowner only incurs management costs between ages 20 and 25 years. Furthermore, she/he receives the timber benefits at the moment of harvesting (25 years, \$4,490 per acre). Thus, the forest value is:

$$FV_{20} = [-20(1.055-1)/0.05 + 4,490 + 947]/(1.05)^5 = \$4,173 \text{ per acre}$$

The *FV* formula also works as indicator to analyze forest management decisions. In our example, it suggests that it is economically convenient for the forest landowner to wait 5 more years to harvest the stand instead of harvesting the stand at age 20 years.

Conclusions

The land expectation value (*LEV*) formula is widely used to determine the profitability of a forest stand. It assumes that the land is bare of trees; thus, it does not consider the possibility of an existing forest stand. The forest value (*FV*) formula is a generalization of the *LEV*, including the value of the land and the value of the tree crop. The *FV* approach can be used to compare the value of the stand when it is immediately harvested or when it is economically immature. Thus, the *FV* formula can be used as a tool for valuing forest management options.

Notes

¹ We assume that the forest stand is artificially regenerated.

² Some silvicultural activities such as thinnings are carried out depending on the marketability of the removed trees, e.g., minimum tree-size specifications (length and diameter) have to be met. However, this type of constraint is not important for this publication because the main objective of this work is to illustrate, in a simple manner, how to determine the value of the forest stand.

³ The forest value can also incorporate nontimber benefits, for example, biodiversity, recreation, habitat, and water production.

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