This photo and that on cover illustrate a high value ponderosa stand in Arizona. Large volume and high quality are the determinants of a high value stand. (Photos courtesy of USDA Forest Service.)

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Rate of Value Increase. . .

A Decision Guide for Timber Management

Rate of value increase, an application of the concept of financial maturity, can be used as a guide in deciding when to harvest an individual tree.

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Our purpose is to demonstrate this technique.

Trees grow in volume of wood over time, but eventually volume growth levels off and then decreases. At any point during the life of a tree, the timber manager has the alternatives of: 1) allowing the tree to grow, making a capital investment; or 2) of harvesting the tree, disinvesting and obtaining the returns on past investments. If the goal of management is to attain a certain rate of return on investment, the tree should be ha vested when it reaches financial maturity, that age beyond which the tree's rate of value increase is less than the desired rate.

Other factors also enter into timber harvesting decisions. The timber manager must consider joint production relationships between timber and water, forage, aesthetics, and recreation. For the purpose of simplifying the example, we will consider timber in isolation from these other forest-based products.

The factors that determine a tree's rate of value increase are: 1) the present value of the tree; 2) the future value of the tree, and 3) the time period between the present and future points in time. Given estimates of these three factors, the rate of value increase can be calculated from the compound interest formula and a table of values of $(1+r)^n$.

$$(1+r)^n = \frac{V_n}{V_o}$$

Where: r = rate of value increase
V_n = future value of tree
V_o = present value of tree
n = time period in years

The data used in the example are based on a sample of cutover ponderosa pine stands in Arizona. These stands average 2,000 cubic feet per acre, and are of medium site quality.

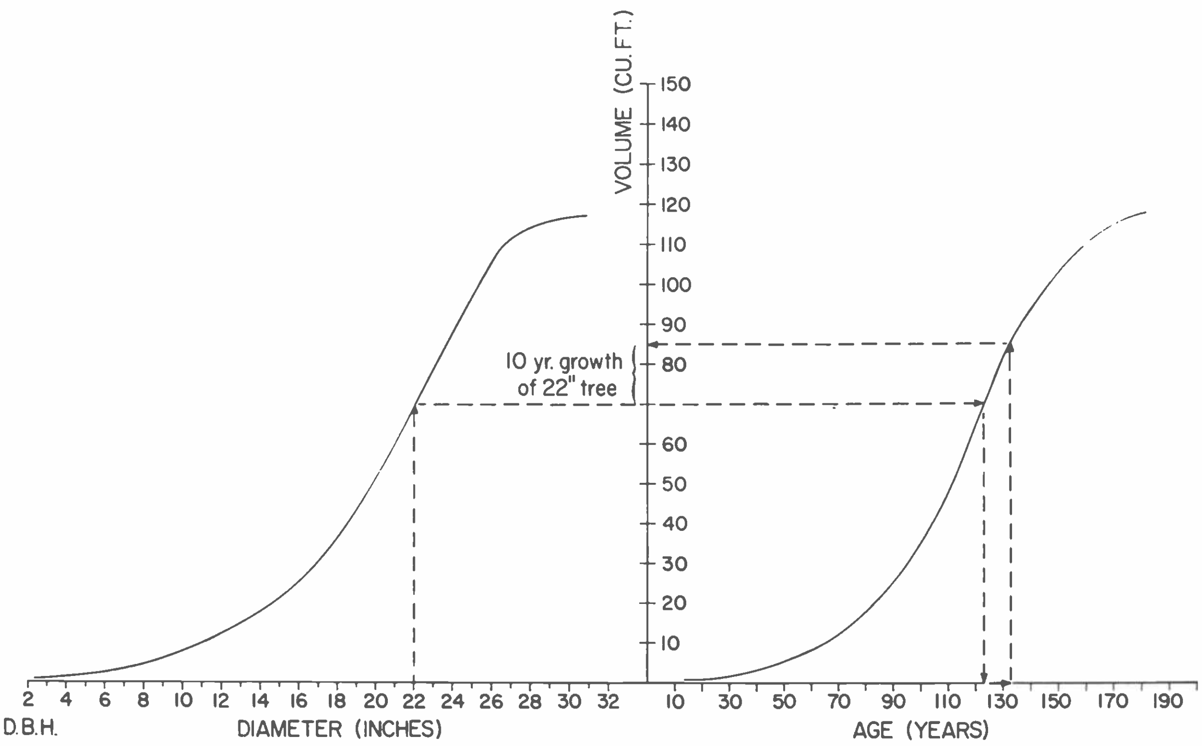
Factors Determining Value

Three factors determine the present value of a tree for timber products: 1) present volume; 2) quality; and 3) unit value or price.

The present volume and quality of a tree may be estimated directly from inventory techniques based on standard mensurational and sampling procedures. Here, a multiproduct timber inventory system** was employed to derive estimates of volume and quality.

The unit value or price of standing timber we have selected is the most recent quarterly average of stumpage prices paid for ponderosa pine timber

Figure 1. Relation of diameter, volume and age for individual ponderosa pine trees.



sales on National Forests in Arizona and New Mexico.

The future value of a tree depends on: 1) volume growth over time, 2) quality changes over time; and 3) future unit values or prices. The volume growth over time is estimated from inventory techniques. With respect to quality change over time, it has been shown that for ponderosa pine in the Southwest, individual tree quality does not change greatly with growth.***

An Illustration

In our example, we assume no change in relative prices in the economy. That is, stumpage prices ten years hence will bear the same relationships to other prices in the economy as they do now. Since quality does not change, present stumpage and future stumpage prices are equal in terms of constant dollars. Therefore, rate of value increase is equal to the rate of volume increase.

Using a tree having a diameter of 22 inches for illustration, the calculations for determining annual rate of value increase over a ten year period are:

1. The present volume of a tree with a diameter of 22 inches, 70 cu. ft., is read from the curve on the left side of the vertical axis in figure 1.
2. The average age of a tree with a diameter of 22 inches, 122 years, is read from the curve on the right hand side of the figure.
3. The future volume, 10 years hence, when the tree is 132 years old, is read from the curve on the right hand side of the figure. The future volume is 85 cu. ft.
4. We then substitute these figures in the formula to calculate a value for $(1+r)^{10}$.

$$(1+r)^{10} = \frac{V_n}{V_o}$$

$$(1+r)^{10} = \frac{85}{70} = 1.21$$

5. From a compound interest table we find that a value for $(1+r)^{10} = 1.21$ corresponds to a rate of value increase of approximately 2.0%.

(Please turn to Page 16)

**Barger, Roland L., and Peter F. Ffolliott. 1970. Evaluating product potential in standing timber. USDA Forest Service Res. Paper RM-57, 20 p.*

***Ffolliott, Peter F., and Roland L. Barger, 1967. Occurrence of stem features affecting quality in cutover southwestern ponderosa pine. USDA Forest Service Res. Paper RM-28, 11 p.*

Timber Value

(from Page 13)

Annual rates of value increase over a ten year period for various tree diameter classes are as follows:

Diameter (inches)	*Rate of Value Increase (percent)*
10	3.7
12	4.0
14	3.9
16	3.2
18	3.0
20	2.7
22	2.0
24	1.1
26	0.5
28	0.1

Interpretations of the Concept

It can be seen from the table that the rate of value increases and then declines. The timber manager decides upon or is given a guiding rate of return. Considering only timber values, a tree should be cut when its rate of value increase is decreasing and is less than the guiding rate of return. For example, if the guiding rate of return is 3.5 percent, then trees 16 inches in diameter and larger should be cut.

The financial maturity concept may be applied to entire forest stands as well as to individual trees. In uneven-aged stand management, when individual trees are selected for harvest, the approach described here will aid the manager in reaching that level of investment in growing stock that will provide a rate of return equal to the guiding rate of return.

In even-aged stand management where all trees are harvested at one time, the financial maturity concept may be used to determine the rotation age that will provide the desired rate of return.

When values of other products and services of forests must be given consideration, knowledge of rates of value increase provides the forest land manager with an estimate of the timber opportunity costs of providing these other goods and services. For example, if aesthetic considerations lead the manager to increase the diameter and age at which trees or stands are harvested, these rates tell him what this will cost in terms of a lower rate of return.

New Grain Barley

(from Page 3)

early at low rates. It has averaged three inches shorter than Arivat and it stands better for combining than most other varieties of barley grown in Arizona.

Characteristics

Bartel has very uniform growth, superior shattering resistance, nodding heads, predominately white seeds, and very long, rough awns. It matures at about the same time as Arivat.

Breeding and Testing

Bartel is a six-row, spring barley developed by crossing the following parents: Arivat, Atlas, California Mariout, C.I. 1227, Harlan, Mars and Trebi. Selection for the variety was made at Mesa in 1963. The original plant was identified as Arizona 6210-5. Yield tests were conducted at Mesa, Phoenix, Tucson and Yuma, Arizona.

Seed

Breeder Seed will be maintained by the Arizona Agricultural Experiment Station. Foundation Seed may be obtained through the Arizona Crop Improvement Association, Department of Agronomy and Plant Genetics, University of Arizona, Tucson, Arizona 85721.

Table 1 Average yield of grain from Arivat and Bartel barley planted in November at rates of from 25 to 35 pounds of seed per acre at Mesa, Phoenix, Tucson, and Marana, Arizona from 1968 through 1971.

Variety	*Yield in pounds per acre* 1968 Mesa	1970 Tucson	1970 Phoenix	1971 Mesa	1971 Marana	*Average five yie tests*
Arivat	**5611**	**3669**	**5481**	**4765**	**4960**	**4897**
Bartel	**7308**	**4660**	**6358**	**6522**	**4590**	**5888**
Yield of Bartel in % of Arivat	**130**	**127**	**116**	**137**	**93**	**120**

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to: