Regular Article
ISSN 1226-8267
Journal of Forest Science
Vol. 28, No. 1, pp. 24-29, February, 2012

Analysis of the Stumpage Valuation for *Pinus koraiensis* Stands in the Research Forest of Kangwon National University

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Abstract

This paper assesses the stmpage value of Korean white pine (*Pinus koraiensis*) stands in the Research Forest of Kangwon National University. Assessment was done by means of the cost value method (Faustmann formula) for age class Ⅰ, Glaser method for age class II-V, and inversion market method for age class over VI. Generally the value of stumpage is calculated by the inversion market method in the market. However, immature trees and middle age class trees are not assessed in market, and the Korean forest is not old enough to harvest. So, when forests are damaged by attacks from forest fire, blight and harmful insects, the forest cannot be compensated for the loss from the government or insurance company. For this reason, the value of all-age class trees are calculated by using appropriate methods. As a result, the value of age I class stands (0.3 ha) is calculated as 1,786,305 (won), age II-Vclass stands (22.1 ha) 206,677,975 (won) and age VI class and over stands (24.8 ha) 523,789,603 (won).

Key Words: forest valuation, cost value, glaser, inversion market, *Pinus koraiensis*

Introduction

Korea was ruined during the colonization by Japan and the Korea War, but continuous restoration policies have recovered the Korean forest. As a result, Korea is one of the successful afforestation countries of the world. However, timber harvest profitability is very low due to the relatively low timber prices of wage growth in the forest industry.

For this reason, the economical value of forest is underestimated by the people. In addition, economic valuation of forest has not been standardized, so calculating national statistics and forestry household incomes are not properly evaluated.

Usually, forestry valuation is assessed by using the inversion market method. stumpage valuation method exists for each age class but actual estimation factors are not recorded so those methods cannot be used in forestry valuation.

In this study, stumpage valuation is based on *Pinus koraiensis* stands in the research forest of Kangwon National University. Proper estimation methods were used for each age class. As a result, a better forest valuation method was found.

Materials and Methods

Study site

The 32nd compartment covers 4.2% (132 ha) of the re-

Received: January 25, 2012. Revised: February 10, 2012. Accepted: February 13, 2012.

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search forest of Kangwon National University (KNU) (3,146 ha). 65 ha of broadleaves and 73 ha of coniferous trees occupy the Research Forest of KNU and *Pinus koraiensis* occupies 47.2 ha (33.6%) of the coniferous trees (Table 1).

Methods

The stumpage valuation by using cost value method (Faustmann)

The Faustmann formula gives the present value of the income stream for forest rotation. It was derived by the German forester Martin Faustmann in 1849. The rotation problem, deciding when to cut down the forest, means solving the problem of maximising Faustmann's formula and this was solved by Bertil Ohlin in 1921 to become the Faustman-Ohlin theorem, although other German foresters were aware of the correct solution in 1860 (John, 1995).

However, the Faustmann formula does not include data for forest planting expenses. For this reason Faustmann formula is not suitable for the calculation of immature forests. The formula has the following problems.

First, Faustmann formula is based on the development costs of timber so that it needs data on the annual cost and revenue of thinning and reforestation over long terms.

Second, Faustmann formula uses the same high bank interest rates and price increases as in the Glaser method, so the stumpage value is overestimated.

To solve these problems, reforestation fee was calculated from the fee difference of 2010 and 2011, and then the increased or decreased cost was averaged and that average change rate was used in this paper.

Table 1. Area of *Pinus koraiensis* in each Age Class in the 32 Compartment of Research Forest of KNU

Age class	Area (ha)
Ⅰ	0.3
Ⅱ	4.0
Ⅲ	0.9
Ⅳ	11.5
Ⅴ	5.7
Ⅵ	0.5
Ⅷ	24.3
Total	47.2

The land rental fee was calculated by using the officially posted land cost. Since the officially posted cost were available for years of 1997 and 2011, the land costs for 80 years ago were estimated from the average cost gap 2.5 (won) and 4% land rental fee for when the government compensated for forest fire (Fig. 1).

Calculating stumpage valuation by using Glaser formula

Glaser formula (G. formula) is the appropriate method for evaluating stumpage value of trees in middle age G. formula doesn't use interest rate, which makes the evaluation problem less prone to subjectivity and also very simple because it doesn't need to compute at compound interest.

Generally on young age forest which cost high in establishment. This thesis also evaluate forestry value by using G. formula on 32 nd *Pinus koraiensis* occupies compartment. stumpage value of felling age applied 1,995,335 (won) to all age class, which of stumpage value that result of Inversion market formula and cost of establishment applied result of Faustmann formula either (Fig. 2).

Calculating by inversion market method to felling age stands

There are some factors are needed when calculating with I.M method.

Those factors are volume of Ⅵ-class, assessd stadard about expecting sale price of national forest product. These factors are put as well as value. Then these values could make evaluation of 4 sub compartment through the Factor Research of Price Estimation.

Calculating order as following;

First, cutting down the targeted tree, then make some wood product like furniture.

Second, assume one transportation that transport the product to neighboring market. then estimate harvesting cost of the product.

Third, estimate market price of like product to this product then deduct harvesting cost from like product's market price. This value is the stumpage price.

Pinus koraiensis' price was substituded 136,500 won (November. 2011 market price of Yuju forest product market). And the Standard of Estimated Price of National Forest Product (28. August. 2009. established rule of Forest Service, No 566), the report of Research forest of

Year	Age	Afforesatation fee (won)	Icreasing rate	Land rental fee (won/ha) $\frac{v(1.0P^m-1)}{0.0P}$
1932	80	88	1.146685302	₩ 325,000
1952	60	1,353	1.146685302	₩ 825,000
1962	50	5,318	1.146685302	₩ 1,075,000
1977	35	41,437	1.146685302	₩ 1,450,000
1982	30	82,150	1.146685302	₩ 1,575,000
1983	29	94,200	1.146685302	₩ 1,600,000
1984	28	108,018	1.146685302	₩ 1,625,000
1985	27	123,862	1.146685302	₩ 1,650,000
1986	26	142,031	1.146685302	₩ 1,675,000
1987	25	162,865	1.146685302	₩ 1,700,000
1988	24	186,755	1.146685302	₩ 1,725,000

Calculating program of Faustmann Formula

Fig. 1. Calculating stumpage by using Faustmann formula.

					Glaser Method
Year	Age	Timber value at felling age (ha)	Afforestation Fee	Felling age(r)	Stumpage value(ha)
1932	80	₩19,953,351	₩49,053	60	₩35,471,054
1933	79	₩19,953,351		60	₩34,589,718
1934	78	₩19,953,351		60	₩33,719,470
1935	77	₩19,953,351		60	₩32,860,310
1936	76	₩19,953,351		60	₩32,012,240
1937	75	₩19,953,351		60	₩31,175,261
1938	74	₩19,953,351		60	₩30,349,374
1939	73	₩19,953,351		60	₩29,534,582
1940	72	₩19,953,351		60	₩28,730,885
1941	71	₩19,953,351		60	₩27,938,288
1942	70	₩19,953,351		60	₩27,156,792
1943	69	₩19,953,351		60	₩26,386,401
1944	68	₩19,953,351		60	₩25,627,117
1945	67	₩19,953,351		60	₩24,878,946
1946	66	₩19,953,351		60	₩24,141,891
1947	65	₩19,953,351		60	₩23,415,958
1948	64	₩19,953,351		60	₩22,701,153
1949	63	₩19,953,351		60	₩21,997,481
1950	62	₩19,953,351		60	₩21,304,951
1951	61	₩19,953,351		60	₩20,623,571
1952	60	₩19,953,351	₩7,116	60	₩19,953,351

Fig. 2. Calculating forest valuation by using Glaser formular.

Kangwon National University's estimating factors on sales were used too.

Application proper forest valuation formulae for each age classes

Using the cost of establishment silviculture from the interest rate -4%, the stumpage price of immature forest stands were evaluated by applying F. formula.

The last and middle aged forest stumpage price was calculated by inputting stumpage prices of final aged and young aged stands in the G. formula.

Table 2 shows the formulae for evaluating the stumpage price 2 types of aged stands. Each formula needs various factors.

Standardizing these factor values was the most difficult problem in this study.

To solve this problem, something with generality was needed. So, in this study we referred to the 'Forest-tree cost' case of Korea Forest Service (KFS) Reseach forest of KNU.

Results and Discussion

Valuation by F. formula.

Maintenance-cost and thinning-income was excluded in the evaluation process by F. formula. The Research forest is run for non-profit. Maintenance-cost was excluded for objectivity, because not enough data exists for this factor.

To evaluate a practical value, thinning income and maintenance cost need to be considered. Since the purpose of this research is finding out the difference between each aged-stand's value among the evaluation systems, costs calculated from the evaluating system were not considered.

Hkm in Table 3 is the value of each area were estimated in won/ha for comparison of the stumpage price of each age-class (Table 3).

As shown in Table 3, the cost of class I and II are similar.

On the other hand, comparing class-VII and class VI, class VI was evaluated to be more valuable.

Stumpage valuation by G. formula

The cost evaluated by G. formula also estimated by won/ha for comparison.

As a result, the value of class VIII is 14times valuable than that of class I. The results by the G. formula showed the largest gap among the age class and valuation (Table 4).

Value estimation of each age class using the appropriate evaluating system

The values of class I, classes II-V and classes VI and over were estimated by F. formula, G. formula and Inversion Market formula, respectively (Table 5).

Table 2. Proper stumpage valuation formulae for each age classes

Immature	Young matured stand	Felling age
F. Formular	G. Formular	Inversion market formula
$H_i = \sum_{k=1}^{i} C_k \times (1+r)^{i-k}$	$A_m = (A_r - C_o) \times \frac{m^2}{r^2} + C_o$	$X = v \cdot f(\frac{A}{1+lr} - B)$
H_i=value C_k=Total inputed cost of afforestation and growth at K =(forest age at stumpage valuation) r=rate i=present forest age	A_m=value A_r=felling age value C_o=estimated value by using F. formulat at 10 years old r=felling age m=present forest age	X= value v= timber volume (m^3) f= cutting rate A= timber market value each volume (m^3) B= total cost for timber manufacture (m^3) l= Payback period (month) r= rate of return

Table 3. Stumpage valuation using the F. formula (won/ha)

Year	Age	Age class	Area (ha)	Land rent	Interest rate (1.0P)	Afforestation cost (won/ha)	Hkm (won/ha) -Faustmann (1984)-
1932	80	VIII	24.3	₩174,138,288	1.04	₩2,019	₩ 7,168,203
1952	60	VI	0.5	₩3,926,846	1.04	₩14,232	₩ 7,867,925
1962	50	V	5.7	₩37,418,702	1.04	₩37,791	₩ 6,602,476
1977	35	IV	11.5	₩49,126,034	1.04	₩163,513	₩ 4,435,342
1982	30	III	0.9	₩3,180,016	1.04	₩266,444	₩ 3,799,795
1992	20	II	4	₩8,695,199	1.04	₩707,482	₩ 2,881,282
2002	10	I	0.3	₩298,952	1.04	₩1,878,557	₩ 2,875,064

Table 4. Stumpage valuation using the G. formula (won/ha)

Year	Age	Age class	At rotation age cost (ha)	Afforestation cost (won/ha)	Rotation period	Forest valuation (won/ha)
1932	80	VIII	₩19,953,351	₩2,019	60	₩35,471,054
1952	60	VI	₩19,953,351	₩14,232	60	₩19,953,351
1962	50	V	₩19,953,351	₩37,791	60	₩13,868,041
1977	35	IV	₩19,953,351	₩163,513	60	₩6,897,555
1982	30	III	₩19,953,351	₩266,444	60	₩5,188,171
1992	20	II	₩19,953,351	₩707,482	60	₩2,845,912
2002	10	I	₩19,953,351	₩1,878,557	60	₩2,380,635

Table 5. Value estimation using the evaluating-system for each age class in 32nd compartment (won/ha)

Method	Age	Age class	Area (ha)	Stumpage valuation (won/ha)	m^3/ha
Cost value method	I	10	0.3	₩2,875,064	-
Glaser method	II	20	4.0	₩2,845,912	66.6
Glaser method	III	30	0.9	₩5,188,171	146.9
Glaser method	IV	35	11.5	₩6,897,555	269.1
Glaser method	V	50	5.7	₩13,868,041	310.0
Inversion market method	VI	60	0.5	₩19,953,351	381.0
Inversion market method	VIII	80	24.3	₩21,210,255	405.0

Table 6. Comparison of value in each evaluating system (won/ha)

Year	Age	Age class	Area (ha)	Cost value	Glaser	Proper
1932	80	VIII	24.3	₩7,168,203	₩35,471,054	₩21,210,255
1952	60	VI	0.5	₩7,867,925	₩19,953,351	₩19,953,351
1962	50	V	5.7	₩6,602,476	₩13,868,041	₩13,868,041
1977	35	IV	11.5	₩4,435,342	₩6,897,555	₩6,897,555
1982	30	III	0.9	₩3,799,795	₩5,188,171	₩5,188,171
1992	20	II	4	₩2,881,282	₩2,845,912	₩2,845,912
2002	10	I	0.3	₩2,875,064	₩2,380,635	₩2,875,064

This table shows the stumpage price of class I, estimated by F. formula is larger that of class II, estimated by G. formula.

And the stumpage price of the class VI and over, estimated by the inversion market formula is similar to the sale price in the real market.

Comparison of the values from each evaluating system

As shown in this table, the value by F. formula is larger than that by G. formula concerning the evaluation of the stumpage prices of class I and class III and over. Also, the value by inversion market formula, the most practical method, is smaller than the value by G. formula.

In other words, G. formula overestimates the value of the age class VII compared to the real market (Table 6).

Conclusions

The kind of hardwood that is currently in sales in Korea is timber wood, plywood and pulpwood. The forest products of timber wood won't be expected practically due to the

circumstances of immature forest and middle age forest.

Especially, the majority of immature forest is young growths. This makes computing young growth price accompany many errors.

In this study, the value of class I by F. formula evaluated higher than that of middle aged forest (class II), even only considering the cost of establishment. That is to say, it makes a large difference in the value when the same formula is applied to forests of different age. In other words, evaluating forest tree by one formula lacks objectivity.

Applying only one standardized value is the problem in the aspect of making big gap in price due to region position characteristic or the accumulation.

The most immediate issue to solve under this difficult situation is establishing a standardized method, suitable for difference in region/position character and the accumulation when evaluate young age forest and matured forest.

If approaching in the view of the value evaluation of forest tree, 'Value' of immature forest, middle age forest and felling age forest could be evaluated but if approaching in the view 'price' of forest tree that considered market, the formula would be adduced that calculate with same calculating factor to each stands. Under the current circumstances, it is important to establish a standardized method to evaluate the costs of forests of each age.

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