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Analysis of the Efficiency of Investment Made on Species of Major Economic Importance

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몇 主要經濟樹種에 對한 經濟効果 分析

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Introduction

The choice of tree species is one of the radical problems encountered in establishing new stands, since the efficiency of investment is greatly influenced by the species selected. Needless to say, site condition must be taken in consideration when making the choice because a particular species can not be relied upon to give the best return on any site.

In analysis of the efficiency of input by tree species here, some assumptions are made. First, labour cost needed in all the kinds of work, namely planting, brush control, pest control, transportation, fertilization and other related tasks are converted to cash input based upon the prevailing price levels. Even that part of the work done by the owner himself is iucluded as cash input. Second, as to forest land, we assumed two different situations, one the rent system, meaning a regular payment for the use of forest land, and the other the purchase of land at the time when the plantation was made. Third, it was assumed the owner knew the skill required in tree planting, pest control and other related in the delivery of planting stocks, forest fire in established stands and other unforeseen circumstances were ignored. Fourth, we assumed the owner had all the equipment needed, viz. duster or sprayer for pest control, for soil work, brush control etc. Fifth, at harvest final age-class trees are sold as they stand. This implies the owner himself does not cut the trees but sells them standing at a stumpage price. Sixth, amongst the possible silvicultural systems, only the clear cutting system was taken up, ignoring soil and waterconservation principles. Seventh, several levels of annual compound rate are adopted for calculating the end value of input.

For some time, the Office of Forestry has been trying to attract capital to reforestation to create forest resources. Of course timber growing is essentially capital management activity. A decision of whether or not to invest requires estimating the profitability of various forest management alternatives. The author attempts to show whether the input-output cost relationship of such investment can be aggregated on private forest land and whether this can be relied upon. The Office of Forestry has also encouraged land owners to adopt forestry practices. To do this successfully, owners or prospective owners must be educated and provided with some forms of direct aid, such as technical assistance or cost sharing. One of the requirements of their education is the effect of investment in forestry. The principal reason land owners avoid investment in forestry is that it is essentially a long term investment that it requires a high initial capital outlay, usually borrowed from banks at high annual compound interest rates. This is particularly so when land has to be purchased, and where brush growth is heavy and transportation difficult. The lower productivity of forest soils may also be a reason for it is generally concerned that low earnings are associated with the practice of forestry. While stand establishment and regeneration do create forest values on non-stocked forest land, they generally require high inputs and mature only after a long period. In the study reported. In the study reported here under this head, the primary objective was to calculate the profitability relatively short term investments make in stand establishment, but for Korean white pine, a final age of 60 years is assumed and its good revenue attributed partly to seed production. The foresters require the maximum economic return from the costs they invest in tree plantations. On of this, at the beginning of plantation establishment foresters assess rent or purchased price of land, traffic situation, soil properties, choice of species, determination of final age, sylvicultural system to be applied for the purpose of production and the cost of forest administration.

It is not easy to evaluate the benefits to be expected from an investment since so many factors are involved in forest management. Even though amounts may be the same in separate management units, different systems of input result in different evaluations of yield. It is also inevitable that errors occur in most assumptions e.g. change in market and interest rates over a long investment period. As already mentioned, a liquidation system is adopted. This means one does not operate on a sustained annual yield basis but instead one plants one hectare of land with seedlings, protects the plantation for 10, or 40 years, and then sells all of the mature timber there from.

As the test of profits, the enterprise is considered to begin from bareland forestry. If not, some problems arise. The forester must consider his potential profit in sustained-yield forestry in relation to the return he might receive from some other method of management. The question is not simply whether or not sustained yield is profitable; it is whether the value of the timberland is greater under this form cultivation than it is for immediate realization. This is because th ecapital is the most important factor in the timber growing process. This is true even if land is considered as a separate factor and not included with capital. The importance of capital in timber growng results from the long term productioin potential.

In the light of possible forest investments at present in Korea, profit analysis of some tree species of economic importance has been made under certain predetermined assumptions.

Study Method

The detailed procedures of analysis are as follows:

1. Some assumptions regarding to the final age, sylvicultural system(mostly the even-aged clear cut system is presumed) planting intensity, caring methods after plantation establishment, size of administration and considerations on possible and prevailing practices of forest management.

2. As a result, the amount of monetary input from the beginning to the year of the final age

could be calculated. The current labour costs and present prices of materials are used in the calculations.

3. The end-values to the year of predetermined final age, the corresponding inputs made in each year, are calculated and sumed-up. In these calculations with eight levels of annual compound interest rates were adopted.

4. The end-values for interim income, if any, possibly from thinning or not productions, are also calculated by annual compound interest rates.

5. The end-values of interim income were added to the stumpage price expected in the final year.

6. For referrences or alternative comparisons, the increased land value made throughout the management period was deducted sometime from the end-value of input.

7. Comparing the total income including interest obtained from the intermediate income with the end-value of input, the profit rates in percentages were read from graphical figures. Then, finally, profit rate curves by rates of annual compound interest applied to investment ane intermediate income, and by timber productivity per hectare of area, were obtained.

These procedures of calculation are nothing more than calculating the p-value interest rate in the principle equation of economic balance. If the p-value is fixed, for earnings, either the increase of harvesting age and thinning age or the decrease of the amount of cost must result. Naturally, the application of proper sylvicultural practices in agreement with the cost of input, must also be assumed. In other words, this means no mistake in appling silvicultural techniques were presumed.

Results

1. Earnings from hybrid poplar plantation.

Hybrid poplars produced from crossing of *Populus deltoides* and *Populus nigra*, X *P. euramericana* clones, have become increasingly popular since 1957. It is fast growing hybrid appealed tree planters. Suitable growing sites are however limited to the alluvial soils of river sides and other almost flat land where even upland crops are able to be cultivated. This makes selection of the planting areas difficult. Some farmers plant rooted cuttings along the stream banks or around the boundaries of fields as row-planting. But in the present study only the arealy planted plantation is hypothesized.

1) Inputs and end-values

a) Soil rent;

The prevailing rate of soil rent per hectare and year to the alluvial distributed over Han-river bed-site is 1,000 wons.

b) Planting stocks;

The price of planting stock for hybrid poplar depends upon the size. Usually in Korea, stumps two-year old root and one year old stem system are planted. These cost 13 wons each. The planting density is 500 stocks per hectare This spacing greatly facilitates cultivating operations increases productivity and returns against corresponding input. As will be seen from the table 1 in the second year, 100 cuttings were planted as replacement planting. This indicates roughly 20 percents mortality on average.

c) Fertilization;

Usually the fast growers demand higher fertility of site. In other words, fertilization is especially important if popletum is to make rapid growth. It is said that poplars are calcium demanding but in Korea calcium fertilizer is seldom applied. Usually artificial compound fertilizer a mixture of nitrogen, phospours and potassium is used. The rate applied per tree at planting time varies widely by practioners.

The Yung-Young Industrial Company fertilizes popletum for the first four years following planting. The amount given increases by the way of geometrically as shown in table 1.

Table 1. The content of input in poplar plantation made by Yung-Young Industrial Co. (ha)
(the final age of 10 years)

Item \ Year	Soil rent (ha)	Planting stocks	Fertilizer	Planting	Planting guide and staff	Wage for after-dressing	Pest control including wage	Pruning operation	Brush control and cultivation	Protection and supervision	Total
	w	w	w	w	w	w	w	w	w	w	w
1		13w × 500s	17w/kg 300g × 500s	25s/p day 250w × 20p	500/guid 1,000/ staff	250w × 2p			250w × 10p		
	1,000	6,500	2,550	5,000	1,500	500	1,500		2,500	12,000	33,050
2		13w × 100s	17w/kg 600g × 500s	50s/p/day 250w × 2p		250w × 5p			250w × 10p		
	1,000	1,300	5,100	500		1,250	2,000		2,500	12,000	25,650
3			17w/kg 1,200g × 500s			250w × 7p		250w × 10p	250w × 10p		
	1,000		10,200			1,750	3,000	2,500	2,500	12,000	32,950
4			17w/kg 2,400g × 500s			250w × 9p			250w × 8p		
	1,000		20,400			2,250	4,000		2,000	12,000	41,650
5								250w × 15p	250w × 6p		
	1,000						4,000	3,750	1,500	12,000	22,250
6									250w × 6p		
	1,000								1,500	12,000	14,500
7								250w × 15p			
	1,000						4,000	3,750		12,000	20,750
8											
	1,000									12,000	13,000
9											
	1,000						4,000			12,000	17,000
10											
	1,000									12,000	13,000
Total	10,000	7,800	38,250	5,500	1,500	5,750	22,500	10,000	12,500	120,000	233,800

d) Fertilization, application method, costs.

A few methods of fertilizer application are practiced. The method used by the company is to dig a shallow trench encircling the tree then to spread a predetermined amount of fertilizer in trench and cover it with soil.

e) Planting.

In order to avoid from wind damage planting is done in holes 70～80 cm deep. This method is practiced to accommodate and protect the long slender poplar stems. The planting rate is 25 trees per man/day.

f) Planting guide and travelling.

In view of large area of popletum planting laid down each year by the company, a planting crew has been organized. This means that planting costs are higher than they would be if ordinary labour were employed.

g) Pest control, including wage.

The worst enemy in popletum is rust caused by *Melampsora laricipopulina* Kleb. In infected trees photosynthesis, cellulose formation, is markedly curtailed. From the beginning of summer, fungicide (exclusively bordeaux mixture) is sprayed.

h) Pruning operation.

Pruning is essential even in closed stands for production of the high quality logs. It is understood that in Europe the practice is to prune poplar at set periods to one third of their total height, but in Korea where fuelwood is in high demand pruning usually consists stripping the tree to all but feather duster tops. However, the company operates an organized pruning cycle for its plantations of three set prunings to the final felling age of ten years.

i) Brush control and cultivation.

Quiteinten sive soil cultivation treatment is undertaken by the company to enhance the effect of fertilizers.

j) Protection and supervision.

The Company employs a supervisor for every 20 hectares of the plantation on a monthly salary of 10,000 wons. In other words, 500 wons per month per hectare. Under this head, stationery, survey, furnishings, equipment and other miscellaneous costs are included.

k) End values

The end values of input at final age of 10 years are calculated and presented in figure 1 by annual compound interest rates, starting with 1 percent to 26 percents. Concurrently money deposited in bank is shown as attracting an interest of 20 percents. This implies that if all the inputs made each year are put in the bank, and that after 10 years the company gets a little over 110 thousands wons. This, of course, assumes no change in the interest during the 10 years investment period.

2) Profit

As previously mentioned, the responses of soils to the prduction of timber are not constant with a fixed amount of input. Naturally, the higher the yield the higher profit rate. See figure 2, the planter who realised a yield of 160m^3 of timber per hectare (0.4m^3 per tree on an average of 400 trees per hectare) could have earned a profit rate of nearly 18 percent. Unless the yield is 269m^3 per hectare the profit rate does not exceed an interest rate of 26 percents.

The price of timber per cubic meter is assumed at 4,500 wons. As a timber volume unit, sai is customarily used in Korea. One cubic meter is equivalent to about 300 sai. Poplar trees show very sensitive response to soil fertility and soil moisture and other environmental conditions. This means the variations in poplar tree growth even in a small area are significantly large. To elucidate this point, the measurement of D. B. H. was taken in six small sample plots, each plot containing 31 trees, within the area of two hectares in Nov. 1969. The plantation is located on alluvial deposits along the upper stream of South Han-river. In 1966, I year cuttings of clone I-214 had been planted at 4m x 5m spacing. At the time of planting soil brought from the nursery and the mountain foot had been used to fill the holes dug about 1.5m deep as a measure of improvement. The plantation site was flat with no apparent soil variation. In the following table the average D.B.H. and standard deviations are shown following three and a half years growth. The F-value indicates the distinct variations of microenvironment. It may be said the within plots resulted almost from genetic variation except in one plot which had site variations. Within the scale of 31 trees, the value of variance implies that site variation can be ignored.

Throughout these investigations, local differencies in productivity were confirmed. Where good soil is not introduced at the time of planting more marked differencies between plots may be

Table 2. The average D.B.H. and S.D. by plot in popletum.

(unit: cm) 4/4 cuttings.

Plot No.	sample size	average D.B.H.	S.D.
1	31	6.7	1.05
2	31	5.9	0.76
3	31	5.8	0.99
4	31	8.5	1.11
5	31	8.8	1.29
6	31	6.3	1.09

Table 3. Analysis of variance of D.B.H.

s.v.	df.	ss.	ms.	F-value
among plot	5	274.64	54.928	($F0.05(5,180)=2.26$
within plot	180	202.78	1.127	($F0.01(5,180)=3.12$
total	185	477.42		

expected. The conclusion reached is of significant variations between plantations as well as within plantations. The scale of variation is an indication of the enterprise risk. Only by paying sufficient attention to the choice of site and by the applicati n of proven techniques can foresters hope to minimise losses and then the risk.

2. Earnings from chestnut plantation.

Chestnut grafts have been planted for multiple purposes i.e. fruit and honey production and for timber. Planting sites for fruit production must have deep fertile soils with a moderate moisture content if good returns are to be expected. Sites of this kind are generally to be found along river sides at low elevation and never on reclaimed mountain land. The chestnut trees grown in Korea are largely divided in two groups: strains from *Castanea crenata* Sieb. et Zucc. and *C. mollissima* Blume. It is said that Chinese strain was introduced almost 2,000 years ago from San dong-sung, and Habuk-sung in China to the lower part of the Tae-dong river. So called, Japanese strain is indigenous, in Korea. In recent years many chestnut trees have been killed or damaged by chestnut gall wasps (*Dryocosmus kuriphilus*). It is considered that replacement of harmed trees with insect resistant strains is urgent. During the past few years, insect resistant chestnut grafts have been imported from Japan. The introduction of these pest resistent species is being sponsored by the Government as a means of increasing the farmers income. Under this head, the earnings from a plantation with a considerable area has been calculated, taken the yield of fruit into account.

1) Some basic data

In treating the earning capactiy of tree plantations, the yield of timber and fruit and any other by-products must be included. As a matter of necessity the amount of fruit yield per unit area and by year must be known in advance. However, the yield varies greatly due to many factors; variety, planting density, site conditions, age of tree, intensity of cultivation, etc. It should be noted that basic data on chestnut fruit production in Korea is not sufficient. For this reason, confidence in estimating yield is poor. And data previously compiled in Korea does not now exist. Table 2-1 shows the yield per hectare by variety and age of tree reported by Japanese anthors. These observations were made mostly on trees of an age class less than 10 years.

Of the total average as may be seen from table 2 production was 834*kg* per ha in a 5 year-old plant and 3,913 kg per hectare in 10 year-old one. In general, fruit production gradually decreases after an age of 15 years. It is also true that there is an abrupt decline in fruit yield after a tree has reached an age of 20 years. Peak fruit yield is in general attained on the 7~8th year after planting in early maturing species and 10~15th year in

Table 2—1. Chestnut yield by races and tree ages (unit;kg per hectare).

Investigator / Year	Kurada	Nishiyama	Tanaka	Heido race			Okayama Agr. Exp. Exp. race						Average yield
				Kinyose	Tanpa	Taisho-wase	Mori-wase	Tan-sawa	Tukuba	Kinyose	Rihei	Mixed plant	
1	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	280	80	110	230	90	220	220	160	50	140	159
4	—	—	420	150	230	380	500	1,080	950	580	270	760	532
5	1,875	260	1,400	300	450	750	560	1,210	1,170	1,260	380	990	834
6	—	560	2,810	600	900	1,500	1,530	2,670	2,950	2,090	1,850	2,530	1,845
7	—	1,050	4,22.	1,300	1,500	2,250	2,300	4,280	4,660	4,010	2,110	3,670	2,850
8	—	1,690	5,630	1,700	2,060	2,250	2,590	4,280	4,860	3,600	2,450	3,820	3,175
9	—	3,000	7,030	2,250	2,630	2,250	—	—	—	—	—	—	3,432
10	3,750	3,600	8,440	2,810	2,630	2,250	—	—	—	—	—	—	3,913
11	—	4.125	—	—	—	—	—	—	—	—	—	—	—
12	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
13	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
14	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
15	6,560	(4000)	11,250	—	—	—	—	—	—	—	—	—	7,270
16	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
17	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
18	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
19	—	(4000)	—	—	—	—	—	—	—	—	—	—	—
20	6,560	(4000)	—	—	—	—	—	—	—	—	—	—	—
25	4,625	—	—	—	—	—	—	—	—	—	—	—	—

middle or late maturing varieties. If all the figures on the table 2 are ploted, fig. 3 is obtained. The present author inserted 3 lines on the fig. 3, the upper one shows an extraordinarily successful production level, the middle on a very successful one and the lower one a moderately successful one. By intensive cultivation growers can in some cases raise the average production yield to level of 4,000 kg per hectare though 2,500 kg may be taken as a general average. As regards individual tree production, at the age of 15 years the yield should be 60*kg* per tree for the poor productive species and 80 *kg* per tree for abundant fruiting varieties.

(2) Inputs.

(a) Purchase of land.

A purchase price of 60,000 wons per hectare is assumed. This is some what higher than the prevailing price for ordinary land because high fertility is necessary and the site should have

Table 2-2. The average yield of chestnut per hectare

(unit;kg)

Year	Level of production, site condition plus investment intensity		
	extraordinary success	very success	fairly success
1	—	—	—
2	—	—	—
3	400	200	—
4	900	500	100
5	1,600	950	300
6	2,700	1,600	550
7	3,800	2,300	850
8	4,300	2,730	1,150
9	4,650	3,050	1,450
10	4,900	3,270	1,650
11	5,050	3,400	1,750
12	5,150	3,500	1,850
13	5,180	3,550	1,930
14	5,200	3,570	1,950
15	5,200	3,560	1,930
16	5,150	3,500	1,850
17	5,080	3,400	1,750
18	4,950	3,300	1,650
19	4,780	3,100	1,450
20	4,550	2,900	1,250
Total	73,540	48,380	23.410
Average	3,677	2,419	1.171

reasonably good transportation facility. The higher price input should show a correspondingly higher profit margine.

(b) Fertilizer

A high fertilizer application input is essential to sustain a high fruit production yield output. The higher cost of fertilization is reflected in Japanese practices.

(c) Fruit collection and treatment.

it is estimated that a man can harvest and extract 100 liters per day. Wages and materials needed in packing amount 1.25 won per kg.

A straw-bag (kamani in Korean) contains 100 liters of chestnut and it weighs 50 kirogams on average.

(3) Adjusting end-value of input with increased land value.

The method of obtaining the end value of input is the same as with poplar but here the increased price of land assuming accumulation of annual compound interest of 3 percent for the investment period is deducted from the end-values of inputs. The increased land value is epuivalent to 60,000 $(1.03)^{20}$=108,367 wons. Hereafter let us call this end-value an adjusted end-value. If it is increased at the rate of 3 percent, the adjustment influences the evaluating profit rate. Unless the annual compound interest exceeds 10 percent as seen in fig.4 where the broken line corresponds to the adjusted figure.

(3) Profit.

Taking the two yield levels, middle and low, the profit rate curves according to the non-adjusted end-value curve of input are illustrated in fig. 5. The final settlement of accounts was made 20 years after plantation establishment and this is taken as the final age of the crop. The price of chestnut is assumed at 50 wons per kg. or about 25,000 wons per straw-bag (one kamani) on the site. For the simplicity, the presentation of end-value of interim income by year is omitted (see fig. 5). As seen from the fig.5, a break-even point is found when annual income earned accumulates with the annual compound interest of 9 percent and the input costs borrowed at 17 percent, in the case of a very sucessful chestnut yield. This means the possibility of 8 percent net profit as the annual compound interest. If the production yield is at the lower level (moderately successful) the net profit rate becomes 2.5 percent (11.5 percent-9percent). At present the bank interest rate is 22 percent. Should this situation continue the yield between middle and low the profit rate would disappear. In fig. 5, X mark shows this

Table 3. The content of input in chestnut orchard at the 20 years after establishment (ha) (240 trees/ha)

Item / Year	Purchasing cost of land	Site preparation	Planting Stock	Planting Cost	Compost	Chemical fertilizer	Fertilizing cost	Pesticides	Wage for pest control	weeding	Pruning	Collection and treatment of fruit	Administration cost	Packing material and wage	Total
		300w × 15P	60w × 240S	300w × 8P	7w × 20kg × 240S	45g × 240s 1.65w/kg	300w × 7P								
1	60,000	4,500	14,400	2,400	33,600	180	2,100						1,000		118,180
2								500	300	600	500w × 1 일 500		1,000		2,900
3						180	600	500	300	600		600	1,000	250	4,030
4								1,000	600	600		1,500	1,000	625	5,325
5					33,600	900	2,100	1,000	600	600	1,500	2,850	1,000	1,188	45,338
6								1,000	600			4,800	1,000	2,000	9,400
7						1,800	600	1,000	600			6,900	1,000	2,857	14,775
8								1,000	600		2,500	8,190	1,000	3,413	16,703
9					33,600	2700	2,100	1,000	600			9,150	1,000	3,813	53,960
10								1,000	600			9,810	1,000	4,088	16,498
11						2700	600	1,000	600			10,200	1,000	4,250	20,350
12								1,000	600		2.500	10,500	1,000	4,375	19,975
13					33,600	2700	2,100	1,000	600			10,650	1,000	4,438	56,088
14								1,000	600			10,710	1,000	4,463	17,773
15						2700	600	1,000	600			10,680	1,000	4,450	38,803
16								1,000	600		2,500	10,500	1,000	4,357	19,975
17					33,600	2700	2,100	1,000	600			10,200	1,000	4,250	55,450
18								1,000	600			9,900	1,000	4,125	16,625
19						2700	600	1,000	600			9,300	1,000	3,857	19,075
20								1,000	600			8,700	1,000	3,625	14,925
	60,000	4,500	14,400	2,400	168,000	16,200	13,500	18,000	10,800	2,400	9,500	145,140	20,000	60,478	569,208

point.

In the course of his travels through chestnut growing districts the writer has frequently been asked for advice on production techniques and on the characteristics of chestnut varieties. He has found local knowledge on the latter point frequently incorrect and the following may help to clarify this:

(4) The characteristics of chestnut races.

1. Toyotarawase : very early ripening fruit, (ripening from middle to late of Aug.); fruit yield not light; fruit small weight 13～14 grams; vigor, relatively weak open headed tree form ; insect resistant; good for intensive cultivation on fertile soil in the warmer zone.

2. Moriwase; fruit ripening late of Aug. to early Sep., vigor, moderate; insect resistant fruit yield not abundant, good for intensive cultivation on fertile soil; fruit size small 17 grams.

3. Taisho-wase; fruit ripening late of Aug. to early of Sept., vigor, strong; fruit size; 18 grams; fruit yield, abundant; susceptible to insect attack.

4. Tansama; hybrid Otumune Taisho-wase; fruit matures, early to middle of Sept.; fruit size 20 grams; liable to damage during overwintering storage; tree vigor; moderate; tree form: round; suited to intensive cultivation on fertile soil; insect resistant, bred after the War.

5. Ibuki, hybrid Kinyose Toyotamawase, fruits mature around the middle of Sept., tree vigor, moderate; fruit yield, abundant; suited for intensive cultivation on heavy fertile soils, fruit size, 20 grams; insect resistant.

6. Yamatowase, fruit ripening middle of Sept; fruit yield, abundant; fruit size; small (12～17 grms); fruit quality, medium; tree form, erect type; tree vigor, strong, suitable for intensive cultivation on fertile soil,

7. Riheiguri; reputedly a natural hybred a cross beeween Japanese and Chinese species selected after the War, fruit ripening late Sept. to early of Oct.; fruit size, 20～25 grams; tree vigor, healthy; coarse branching system, fruit yield light when young but increasing in later years; insect resistant, suited for extensive cultivation.

8. Arima. fruit maturity, late of Sept. to early of Oct.; fruit size, 20 grams; tree vigor, medium; fruit yield, abundant; suited for overwintering storage; good for extensive cultivation.

9. Kinyose; tree form. open headed; tree vigor. string become large tree. fruit maturity late of Sept. to early of Oct.; fruit size 20-25 grams; one of the best races; insect resistant; sensitive to canker; fruit yield, relatively abundant; liable to damage at over-wintering storage; suited for intensive cultivation.

10. Akachu, tree form, erect type; tree vigor, strong fruit maturing same as Kinyose; fruit size, 20 grams; abundant yield; insect resistant, suited for intensive cultivation in warm regions.

11. Tajiri-kinyose, tree form, erect; tree vigor, strong; fruit size, 20～25 grams; fruit yield, medium; fruit bearing in alterate years; not popular; suited for extensive cultivation; fruit ripening, early Otc.; more adaptable to infertile soil than Kinyose, insect resistant.

12. Imakita, good pollentor to Kinyose, tree vigor, strong; fruit size, 10 grams; maturing, middle of Oct.; abundant yield; susceptible to insect, damage but resistant to gall wasp.

13. Tukuba. hybrid, cross between Kanne and Hayatama, fruit ripening late Sept. to early of Oct. ;fruit size, 20-25 grams; yield abundant; tree form, erect; tree vigor, strong; good for overwintering storage for intensive cultivation on fertile soils, insect resistant.

14. Kanne, fruit ripening, middle to late of Oct., (late maturing variety). fruit size, 25～30 grams; yield medium, tree form, open-headed; vigor, strong coarse; branching system, insect resistant, suited for warm region cultivation; fruit

good for overwintering storage fruit susceptible to insect damage.

15. Otumune, fruit ripens, middle to late of Sept., fruit, 15-16 grams; vigor medium; yield abundant, insect resistant, good for intensive cultivation on fertile soils but grows well on poorer soils.

16. Kanotume, vigor strong, large tree; fruit 20~22 grams, matures during early of Oct., yield abundant; tree insect resistant but fruit

17. Kinseki, vogor medium, branching system, short and compact; yield, small; ripening early to middle of Oct. (slow ripening), insect resistant, good for home-use planting rather than for commercial purposes.

18. Shimogatugi, vigor, strong; fruit 32 grams, ripening middle to late Oct.; yield prolific; tree form, large; suited to overwintering storage.

19. Chohe, vigor strong; coarse branching system; fruit 40 grams, ripening late of Oct.; easy to cultivate, trees insect resistant; fruit relatively liable to insect damage, suited to overwintering storage.

20. Chiyotawase, early ripening species, (earl yof Sept.) fruit 15~19 grams, suited to dense planting system.

21. Hojiguri, this is not a specie or indeed a properly recognized hybrid. It originated form several species of Chigin through the selection of seedlings produced form open pollenated seeds.

22. Tamatukuri, early ripening hybrid middle to late of Aug.; produced from cross of (Yamato x Nanahuku) x Moriwase, fruit 20~22 grams, yield abundant.

23. Izumo, early ripening hybrid, early to middle of Sept.; fruit 25~28 grams, yield abundant; produced from the cross combination, Miyaji No. 6 x Nanahuku x Kinyose x Moriwase.

24. Senri, early ripening hybrid early Sept. fruit 25 grams, yield abundant: produced from the cross combination Miyaji No 6 x Kanne, Tamatukuri, Izumo and Senri. still has short cultivation history. In the descriptions of each species insect resistance-including gall wasp is a dominent feature. In general, the early ripening varieties are the late ripening ones reach the fruit bearing age a few years later According to characteristics species are grouped and shown in following tables.

Tab.4. Fruit bearing age by race

Fruit bearing age	Speices
3	Osaya, Obiwase, Taishowase
4	Toyotawase, Imakita, Otumune, Bonguri
5	Kingyose, Katayama, Kinseki, Kanne, Tajiri Kinyose
6	Chokoji, Yoro
7	Shimokatugi

Tab.5. Fruit yield by race

Yield	Fruit maturing in season		
	early	intermediate	late
high	Toyotamawase Taishowase, Kasarawase, Ibuki, Tansawa Yamatowase	Kinyose, Tukuba, Kinseke, Tajirikinyose, Kanotume, Imakita, Kenaga, Arima,	Katayama. Shimokatugi Banaka
medium	Bonguri, Otumune Moriwase, Kinrei	Mino, Riheiguri, Tanabeguri, Obuse No. 2	Chokoji. Kanne

Note;

early maturing; from the middle of Aug. to the early of Sept.

middle maturing; from the middle of Sept. to the early of Oct. late maturing; from after the middle of Oct.

It should noted that here early and late ripening fruit seasons are not fixed and do change with the locations in which they are grown.

Late in the northern latitudes and earlier in the southern regions. Early ripening species should in general be planted in the warmer regions.

Tab.6. Overwintering ability during storage by variety

good	Shimokatugi, Chobe, Kanne, Kinseki, Imakita, Shogatu, Mino, Banaka.
medium	Kinyose, Tajirikinyose, Yoro
poor	Chokoji, Toyotam awase, Taishowase, Kanotume

3. Earnings from larch plantation.

The larch which is general planted in Korea was introduced from Japan about 70 years ago. Because of its rapid growth with a straight stem it

Tab.7. Fruit size by race

Size	Fruit maturing in season		
	early	intermediate	late
large		Mino, Shogatu, Tukuba, Tanabe-guri, Kenega	Chokoji, Kanne, Shimokatugi, Chobe, Katayama, Banaka.
medium	Taisho-wase, Kasaw-arasase Tansama Ibuki, Kinrei,	Kinyose, Tajiri, Kinyose, Riheiguri, Obuse No.2 Arima, Kanotume, Akachu Shogatu.	Kinaeki
samall	Toyotm-awase, Otumune, Moriwase, Yamatowase,	Imakita	

Table 8. The content of input in larch plantation at the final age of 40 years (*ha*)

Item / Year	Purchasing cost of forest land	Site preparation	Planting stocks	Fertilizer	Planting	For planting guide	Brush control	Transportation and servey cost	Protection and supervision	Total	Accumulated costs by year
		300 w × 15p	2,095 w × 3,000s	15g × 3,000s = 45*kg*, 16.5 w × 45k	300 w × 24p	500 w × 2p	300 w × 6p				
1	30,000	4,500	6,285	743	7,200	1,000	1,800	665	600	52,793	52,793
2							1,800		600	2,400	55,193
3～40									600w × 38y 22,800	22,800	77,993
Total	30,000	4,500	6,285	743	7,200	1,000	3,600	665	24,000	77,993	
* Adjusted end value	= (Each end value) − (30,000(1.03)^{40}=97,861)										
End-value by purchasing	0	4,500	6,285	743	7,200	1,000	3,600	665	24,000	47,993	
	3,000	〃	〃	〃	〃	〃	〃	〃	〃	50,993	
	6,000	〃	〃	〃	〃	〃	〃	〃	〃	53,993	
Cost of forest land	9,000	〃	〃	〃	〃	〃	〃	〃	〃	56,993	
	15,000	〃	〃	〃	〃	〃	〃	〃	〃	62,993	
	21,000	〃	〃	〃	〃	〃	〃	〃	〃	68,999	
	30,000	〃	〃	〃	〃	〃	〃	〃	〃	77,993	

has many uses for construction, poles, and pulp wood, it is being planted increasingly. The following table shows the numbers of larch seedlings planted by year in both the national and private forests.

Tab 9. Quantities of larch seedlings planted.
(unit; 1,000 seedlings)

Year	57	58	59	60	61	62	63	64	65	66	67
Quant.	64,044	36,892	35,295	46,992	87,348	13,216	6,171	47,386	30,256	54,690	66,579

The total seedlings planted in 1967 was about 316,000,000 of which larch represents 36 percent of the total. Throughout the country, 3,000 1-1 stocks are generally planted per hectare.

(1) Inputs

Seven price levels in purchasing forest land are assumed, o, 3,000, 6,000, 9,000, 15,000, 21,000 and 30,000 wons per hectare. In prevailing practice, generally 15 laborers are needed for the site preparation per hectare. Fertilizer is applied only at planting time, and brush growth is controlled for two successive years. As for protection and administration, an out-lay per hectare of 600 wons is spent every year. In larch plantations, pruning operations are seldom practiced. The details of input are shown in table 8 and fig.6. As seen from fig. 6 seven end-value curves correspond to each level of land price and the slope is quite steep. In fig.7, the curve is figured on an assumed purchase price of 30,000 wons per hectare and is compounded at an interest of 3 percents for 40 years. The broken line indicates that part in which the increased land price at 3 percents annual compound interest is deducted from the end-value of input. Beyond 8 percents the two lines are too close to be read separately.

(2) Profit.

In test of profit, the assumptions that thinning takes place on the 21st year and that thinning volume is equivalent to 20 percents of the final harvest. In other words, on a planting site that has an increment of 300 m³ per hectare at maturity the thinning of 60 m³ (20 percents of 300 m³) is taken for granted in accordance with reported studies of the subject. The timber volume obtained from thinnings is capitalized and compounded with several interest rates for 20 years till the final felling. The sum of the return including interest earned from thinnings and by soil productivity is shown in table 10.

Tab 10. The end-value of output (wons, m³)

Final harvest	Thinning	Interest rate to thinning income(%) 3	10	20	26
100	20	411,617	703,650	2,600,256	6,403,260
150	30	617,426	1,055,475	3,900,384	9,604,890
200	40	823,234	1,407,300	5,200,512	12,806,520
250	50	1,029,044	1,759,125	6,500,640	16,088,150
300	60	1,234,852	2,110,950	7,800,768	19,209,780
350	70	1,440,661	2,462,775	9,100,896	22,411,410

Where stumpage price is 10 wons per sai, i.e. 4,500 wons per m³ in figure 8, the profit curves of soil productivity expressed in terms of timber volume harvested at final age are presented. This figure indicates it reaches a break-even point under the following assumptions ;

Harvested timber volume at final age, 135 m³
Thinned timber volume, 27 m³
Stumpage price per m³, 4,500 wons
Compounded interest rate for both capital and interim return, 6%

Figure 8 shows the relationship between profit rate, land purchasing cost and soil productivity when the stumpage price is 4,500 wons per cubic meter (10 wons per sai) and the thinning income is compounded at the current rate of 23 percents. Reviewing the figure, it should be noted that land purchase costs within these scales does not greatly influence the profit rate. For larch plantations 40 years after planting, if

250 m^3 per hectare is taken as the prevailing yield standard, the rate of interest should be lower than 9 percents, otherwise perhaps rather more than half of the producers will face a loss rather than a gain. If an interest rate of 10 percents is taken, the interim income should accumulate at least at a rate of 15 percents not to show a loss.

Fig. 9 (1-7) shows profit curves when the stumpage prices are increased to 20 wons per sai.

4. Earnings from pine plantation.

Here, pines mean red pine (*Pinus densiflora*), black pine (*P. Thunbergii*) and pitch pine (*P. rigida* or other any hybrid pine), the stumpage prices of which are almost the same regardless the quality of the wood. at present jack pine (*P. banksiana*), scots pine (*P. silvestris*), eastern white pine (*P. strobus*) and loblloly pine (*P. taeda*) are all also promising pine species. However, they are excluded from consideration simply because of the short experiences of their cultivation. Due to the effect of creaming done previously in natural red and black pine forests, many crooked stems and growth-stagnated individuals form the bulk of the remaining population.

In addition to this, the soil fertility of pine stands is generally low. This has resulted mainly from the annual raking of the fallen needles for the purpose of fuel. Pine needles are regarded as one of the best fuel materials for cooking as well as for underfloor heating and for the production of ash for agricultural use. The lack of a humus content in soils where pines grow has become a serious problem. With soil infertility at the present low level forest land owners hesitate to invest in it. Improvement of silvicultural operations is necessary for the promotion of timber yield, for example, the use of good quality seed, healthy planting stock, correct planting, more intensive

Table 11 The content of input in *Pinus densiflora* plantation at the final age of 40 years (3,000 stocks/ha)

Item / Year	Purchasing cost of forest land	Site preparation	Planting stocks	Fertilizer	Planting cost	For planting guide	Brush control	Wage for after-dressing	Transportation and survey cost	Protection and surpervision	Total	Accumulated costs by year
	w	300w×15p	1,265 w ×3000s	w	300 w×15p	500w×2p	300 w×6p	w	w	w	w	w
1	30,000	4,500	3,795	743	7,200	1,000	1,800		665	600	50,303	50,303
2～4							1,800 w ×3y 5,400			600 w×3y 1,800	7,200	57,503
5～19										600w ×15y 9,000	9,000	66,503
20				3,302				300w ×3w 900		600	4,802	71,305
21～40										600 w×20y 12,000	12,000	83,305
Total	30,000	4,500	3,795	4,045	7,200	1,000	7,200	900	665	24,000	83,305	

care following planting and finally promoting the soil fertility. The majority of foresters recognize that the renewal of red and black pines should be promoted by natural regeneration rather than planting. However, currently, the planting of red pine is increasing.

Table 12. The content of input in *Pinus densiflora* plantation at the final age of 40 years (10,000 stocks/ha.; ha unit)

Item / Year	Purchasing cost of forest land	Site preparation	Planting stocks	Fertilizer	Planting	For planting guide	Brush control	Wage for after-dressing	Trasportation and survey cost	Protection and supervision	Total	Accumulated costs by year
	w	300w × 15p	1,265w × 10,000 s	w	30w × 50p	500w × 6p	300w × 6p	w	w	w	w	w
1	30,000	4,500	12,650	2,477	15,000	3,000	1,800		665	600	70,692	70,692
2～4							1,800w × 3y 5,400			600w × 3y 1,800	2,400w × 3y 7,200	77,892
5～19										600w × 15y 9,000	9,000	86,892
20				3,302				300 × w 3p 900		600	4,802	91,694
21～40										600w × 20y 12,000	12,000	103,694
Total	30,000	4,500	12,650	5,779	15,000	3,000	7,200	900	665	24,000	103,694	

(1) Input.

30,000 wons for hectare appears a high price to pay for land on which to plant pines. To the writers knowledge the cost at land free of standing trees at Pyongchang-gun, and Hwaengsung-gun districts of Kwangwondo in 1967-1968 was 3,000 wons per hectare only in general. The silvicultural costs and other inputs and their end-values are presented in table 11 in which a planting density of 3,000 trees per hectare is assumed and in table 12 in which 10,000 trees per hectare is assumed. The actual contents of inputs made by forest

Item	Pine	Larch
planting stock	1.5 × 3,000 stock = 4,500 w	3.4 × 3,000 stock = 10,200 w
site preparation	200w × 7 person = 1,400	200w × 7 person = 1,400
planting	200 × 15 person = 3,000	200 × 15 person = 3,000
fertilizers	5 × 3,000 stock = 15,000	5 × 3,000 stock = 15,000
brush control	200 × 2p × 3time = 3,000	200 × 5p × 3time = 3,000
Total	26,900	32,600

Table 13. The content of input in *Pinus koraiensis* plantation at the final age of 60 years (ha)

Year \ Item	Purchasing cost of forest land	Site preparation	Planting stocks	Fertilizer	Planting	For planting guide	Brush control	Wage for after dressing	Collection and treatment of cone	Transportation and survey cost	Protection and supervision	Total	Accumulated costs by year
	w	300w × 15p	2,183w × 3,000s	15g × 3,000s =45kg 16.5kg	300w × 20p	500w × 2p	300w × 6p	w	w	w	w	w	w
1	30,000	4,500	6,549	743	6,000	1,000	1,800			665	600	51,857	51,857
2~4							1,800 w × 3y 5,400				600w × 3y 1,800	2,400w × 3y 7,200	59,057
5~19											600w × 15y 8,000	600w × 15y 8,000	67,057
20				3,302				300w × 3p 900				4,202	71,259
21~30											600w × 10y 6,000	6,000	77,259
31~35									300w × 5p × 5y 7,500		600w × 5y 3,000	2,100w × 5y 10,500	87,759
36~45									300w × 10p × 10y 30,000		600w × 10y 6,000	36,000	123,759
46~60									300w × 15p × 15y 67,500		600w × 15y 9,000	76,500	200,259
Total	30,000	4,500	6,549	4,045	6,000	1,000	7,200	900	105,000	665	34,400	200,259	738,266

owners in Kangwondo district, where more plantings of pine has been done, are as follows: The actual inputs made in pine and larch plantations (ha. won)

In the above all the cost hypotheses are considered resonable. Through dense planting followed by heavy thinning, particularly in red pine, stand improvement and quality might be expected. Alternatively denser planting could give earning analysis.

At the end of a working cycle, no difference in regard to timber quality is made between 3,000 and 10,000 stocks per unit area but the total amounts of timber produced are not equal. The end-values of input are shown in fig. 10 for easier understanding.

(2) Profit

For the profit test, the followings are hypothesized.

1) stumpage value per sai ; 10 wons (3,000 wons/m³)

2) thinning; once at the 21st year, volume is

15 percents of the volume of final harvest.

3) Investment period; 40 years.

4) The range of productivity at final age extends from 75 to 200 m^3 in normal planting and 150 to 400 m^3 in the case of denser planting. The profit rate curves are given in fig. 11 and 12. The means of reaching this figure is the same as for larch.

5. Earning from Korean pine plantation.

On account of its fine quality wood, straightness of stem growth, edible pine nut production and lesser liability to biotic damage. Korean pine (***Pinus koraiensis***) is being increasingly planted by forest owners. This species deep fertile soils with high humus and moderate moisture content in relatively cool regions. Site of this type are usually found along valleys or gentle slopes at the foot of mountains. Natural distribution extends from the northern limit of temperate zone over the extreme cold area at the country.

Quantities of Korean pine seedlings planted by year (unit; 1,000 seedlings)

Year	57	59	85	60	61	62	63	64	65	66	67
Quantity	4,157	7,664	7,867	2,098	6,188	4,050	4,875	6,087	8,429	6,753	15,405

The 1-1 seedlings have generally been planting. This is considered too small in size to be transplanted. At least 1-2 stocks are thought preferrable.

(1) Input.

A primary purpose of planting Korean pine is to boost pine nut production in addition to timber production. The detailed contents of input are given in table 13. Owing to the slow growth of seedlings brush control operations for four successive years has been hypothesized. Though the density greatly influences pine nut production, physiologically cone bearing starts at about 15 years. However, for profit analysis, if the thinning operations are reasonably practiced and soil producticty is moderate, it is assumed problific cone bearing should start on the 31st year after planting. In fact, physically 33～35 years old trees could be a nearer estimate. The investment period of 60 years are hypothesized. As seen from the table 13, about 50,000 wons are invested at the start and about 60,000 wons in total out-right after the completion of brush control.

(2) Material out-puts

The assumptions as to timber and pine-nut yields are as follows:

The range of timber volume at the final age of 60 years, 200～400 m^3
per hectare. Intermediate cuts, at the 20th year, 10 percents of final cut,
at the 30th year, 10 percents of final cut
stumpage price 15 wons per sai.
pine nut yield,

31st to 35th, 50 litter/year per hectare
36th to 45th, 100 litter/year per hectare
46th to 60th, 150 litter/year per hectare

pine nut price, 250 wons/lit.

The correlation between pine and production and soil productivity is ignored for simplicity. The total income at the end of investment period is consist of the end-values of thinnings made twice, pine nut yield made for 30 years and the stumpage price of the final timber harvest. In finding profit rates, increased land value, the original price paid with a compound interest rate of 3 percent for 60 years, was deducted from the end-values of input.

(3) Profit.

The table 14 represents the end-values of pine

Table 14. The end-values of pine nut yields (won).

Year	Interest rate (%)						
	1	3	6	10	15	20	23
31～35	81,775	138,950	302,421	826,838	2,774,400	11,348,738	17,448,587
36～45	303,650	446,508	829,425	1,664,363	4,130,324	9,998,650	16,798,369
46～60	603,638	697,463	872,870	1,191,469	1,784,265	2,701,213	3,475,109

Tab. 15. The end-values of incomes from thinning, pine nuts and final harvesting, and profit rates under input assumptions.

Profit rates in parentheses stand for the case in which the increased land value is deducted from the end-values of input.

Timber volume of final harvest		Interest rate						
		1	3	6	10	15	20	23
m³ 200	end value	2,146,921	2,710,319	4,433,906	10,790,825	44,165,774	209,321,081	530,610,935
	profit rate	5.6(5.9)	6.1(6.3)	7.1(7.3)	8.7(8.9)	11.8	14.6	16.4
250	end value	2,436,385	3,067,169	5,041,203	12,567,560	53,034,971	255,639,176	653,833,153
	profit rate	5.9(6.1)	6.3(6.5)	7.4(7.6)	9.2	12.0	14.9	16.7
300	end value	2,725,849	3,424,019	5,648,502	14,344,903	61,904,167	301,907,271	777,055,370
	profit rate	6.1(6.3)	6.5(6.7)	7.6(7.8)	9.4	12.2	15.2	17.1
350	end value	3,015,313	3,780,868	6,255,789	16,121,941	70,773,362	348,275,366	900,277,588
	profit rate	6.3(6.5)	6.7(6.9)	7.8(8.0)	9.7	12.5	15.6	17.4
400	end value	3,304,777	4,137,717	6,863,096	17,898,980	79,660,559	394,594 461	1,023,499,80
	profit rate	6.4(6.6)	7.0(7.1)	8.0(8.1)	9.9	12.7	15.9	17.7

nut yield by interest percent.

In table 15, the total income including interest and profit rates under the assumed inputs are shown. The figures in parentheses are the profit rates calculated on the assumption that the raised land value is considered as the earning. We can read the fact from the table that the lower the interest rate and soil productivity is the wider the profit rates are in relation to the raised land value. The profit curves are given in fig. 14.

3. General conclusions as to the test of profit ability

In the profit test of forestry, some problems arise. To begin with it may be considered unreasonable to use the present marketing prices of timber for an estimation of long term returns, particularly in countries such as Korea where economic instability still persists. Profit rates will naturally be changed with the increase of stumpage price, however, price variations of other materials will also be accompanied with variations in timber value. For this reason, the relative price ratio becomes uniform. Presently in forest management, the material yields in timber, resin and other minor products are assuming greater importance and particularly so in private forestry.

The writer expounds the bases of profit test on the theory of yield expectation value of the soil, in terms of productivity. In Korea, where the forest management usually from bareland, this is reasonable. However, in large scale management in which sustained production does not begin on bare land this may not be quite so important. In addition, the purpose of forest management does not always aim at finding only the direct value of forests but also in the indirect influence of forests may have on the peoples's welfare. In attempting to solve the silvicultural needs by commercial mathmatics, seemingly many unresonable and complex variables are involved. The necessary reliance on the natural forces in developing productivity, is always a weak point in the capital investment. Even though the above mentioned logic is emphasized, the results obtained from the test of profit using alternative assumptions may give some latitude to producers.

The problem is which alternative is the better To invest in growing stock or to use the capital for some other purpose? If the owner's aim is, as assumed, to earn the highest net revenue from his resources, the answer is simple. To put the money where its net efficiency will be highest. Invested as growing stock, the cash should increase the annual timber yield through a certain interest rate. If the owner can do better than this elsewhere, then presumably he will put his money elsewhere. But if the owner cannot do better than a certain percent return elsewhere, then surely his aim should be to make the extra investment in growing stock, even on a long term rotation. Thus, the forest owner's decision regarding timber production in this case must be dependant upon the efficiency of his alternative use of funds. That is to say, his alternative rate of return. It is not easy to compare profits expected between species because of the variabilities of site-factors, and the risks involved in business, etc. However, regardless of the choice of species, the findings through this study are that unless the interest rates are lower than 6-7 percent sound forestry enterprise can hardly be expected. Stumpage values and interest rates become the key factors in making a decision on forestry investment. It is, however, hoped that the results of this study will be useful for those contemplating investment in forestry.

摘　　要

본연구에 있어서 낙엽송, 소나무, 잣나무, 밤나무 그리고 포풀러를 주요 조림수종으로 취급해서 이들 樹種을 用材林生産 또는 採實林의 目的으로 經營한다하는 合理的이라고 생각되는 몇 前提條件을 세워서 投資에대한 收入率을 分析해 보았다.

收入에 關與하는 因子에는 특히 土地條件 (肥沃度 水分, 傾斜, 表土條件 등), 經營方法등에 따라 變化할 可能性이 多分히 많은 것이지만 일단 一般水準을 생각해서 分析을 했다.

時代의 變遷에 따라 投資分析에 쓰여지는 因子의 값은 따라서 달라질것이나 現時에 있어서의 어떤 水準이 란것을 考察해 본 것이다.

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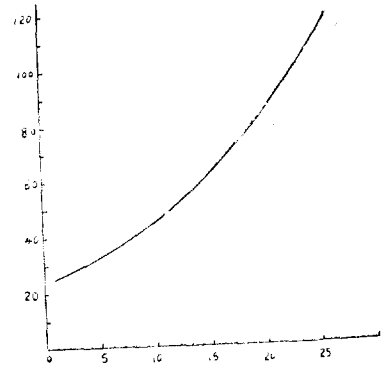

Fig. 1. End value curve of input at final age of 10 years in poplar plantation established by Yung-Young Ind. Co. by annual compound interest. (unit; ten thousands won)

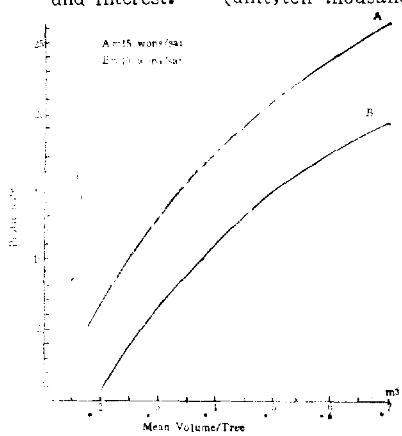

Fig. 2. Profit rate curve at final age of 10 years in poplar plantation established by Yung-Young Industrial Co. by mean volume growth of 15 wons/sai

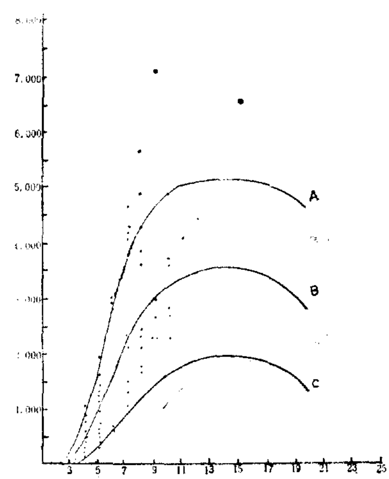

Fig. 3. Chestnut yields by ages per ha. (unit; kg)
A ; very successful case
B ; successful case C ; fairly successful case

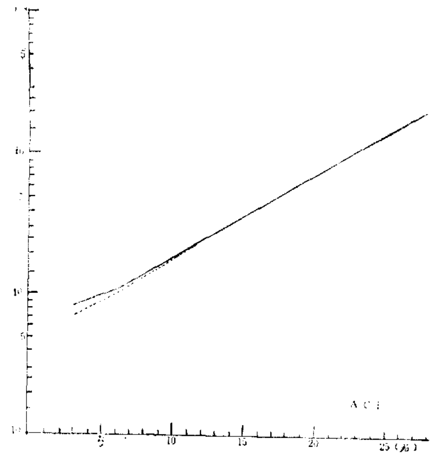

Fig. 4. Chestnut plantation at age of 20 years. Brocken line: when increased land-value is deducted from end-value(ha).

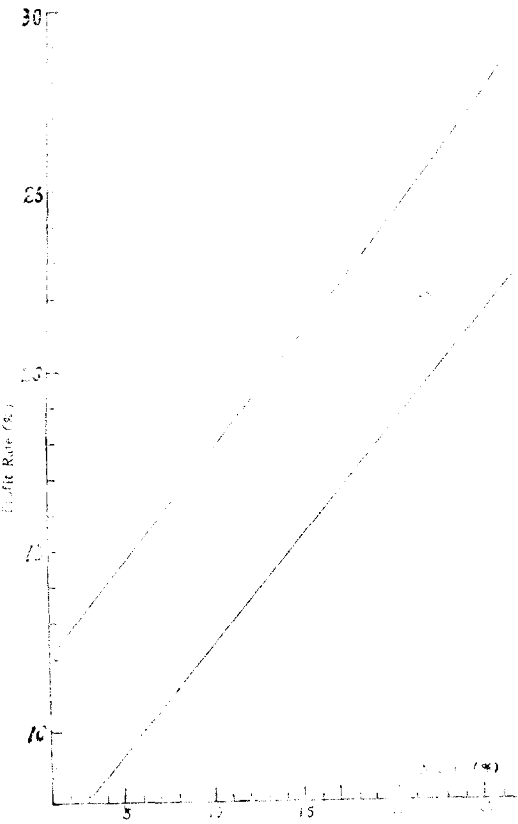

Fig. 5. Chestnut plantation for 20 years by A.C.I. applied to fruit income per ha.
H ; successful case.
L ; fairly successful case.

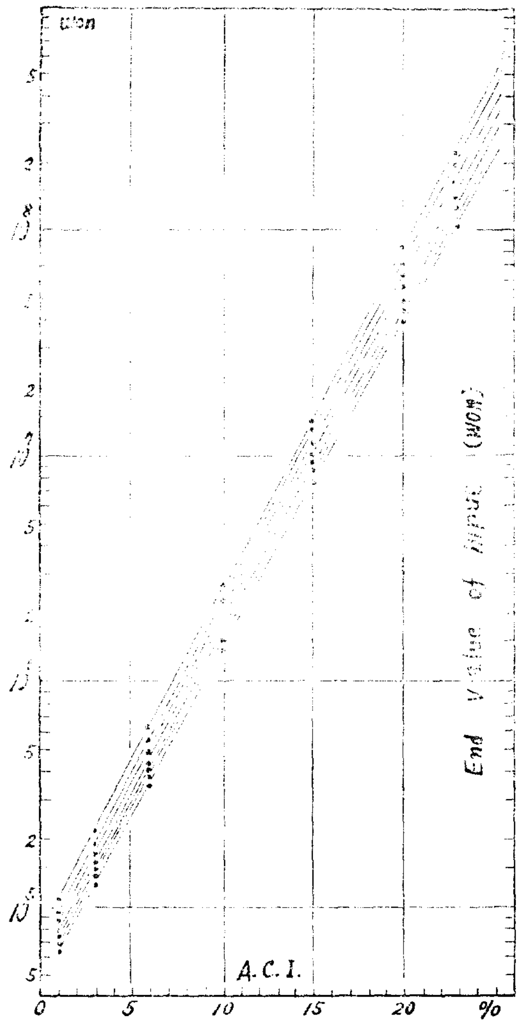

Fig. 6—1. End value curve of input at final age of 40 years in larch plantation by purchasing cost of forest land.

From upper line ; 30,000, 21,000, 15,000, 9,000, 6,000, 3,000 wons per ha.

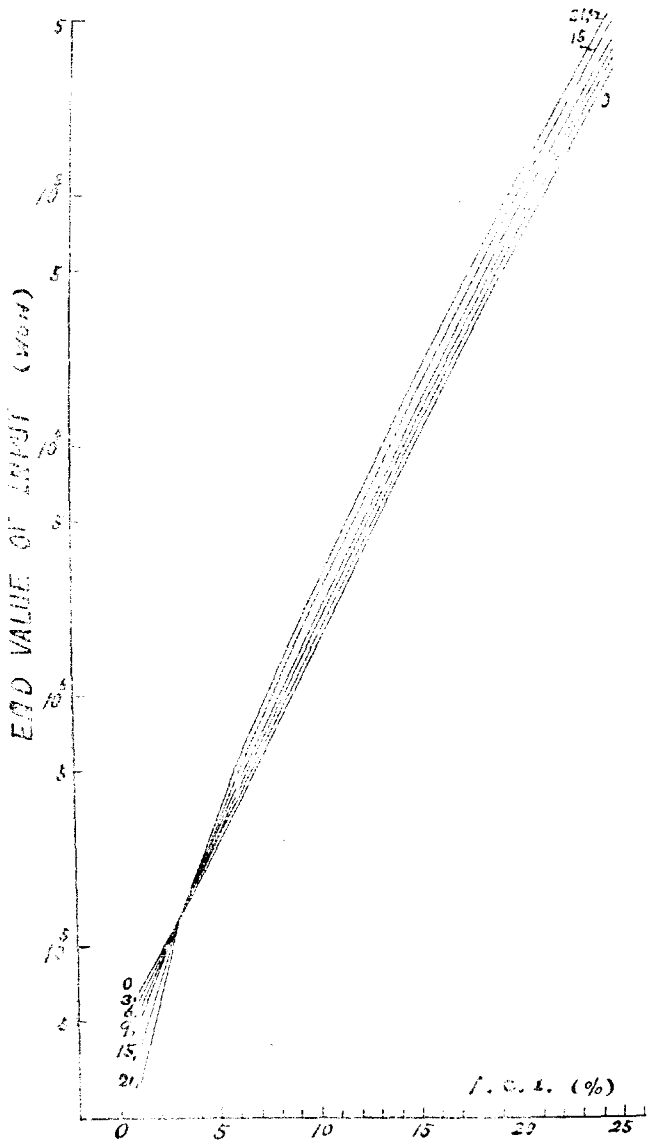

Fig. 6 2. Larch plantation at final age of 40 years (ha).

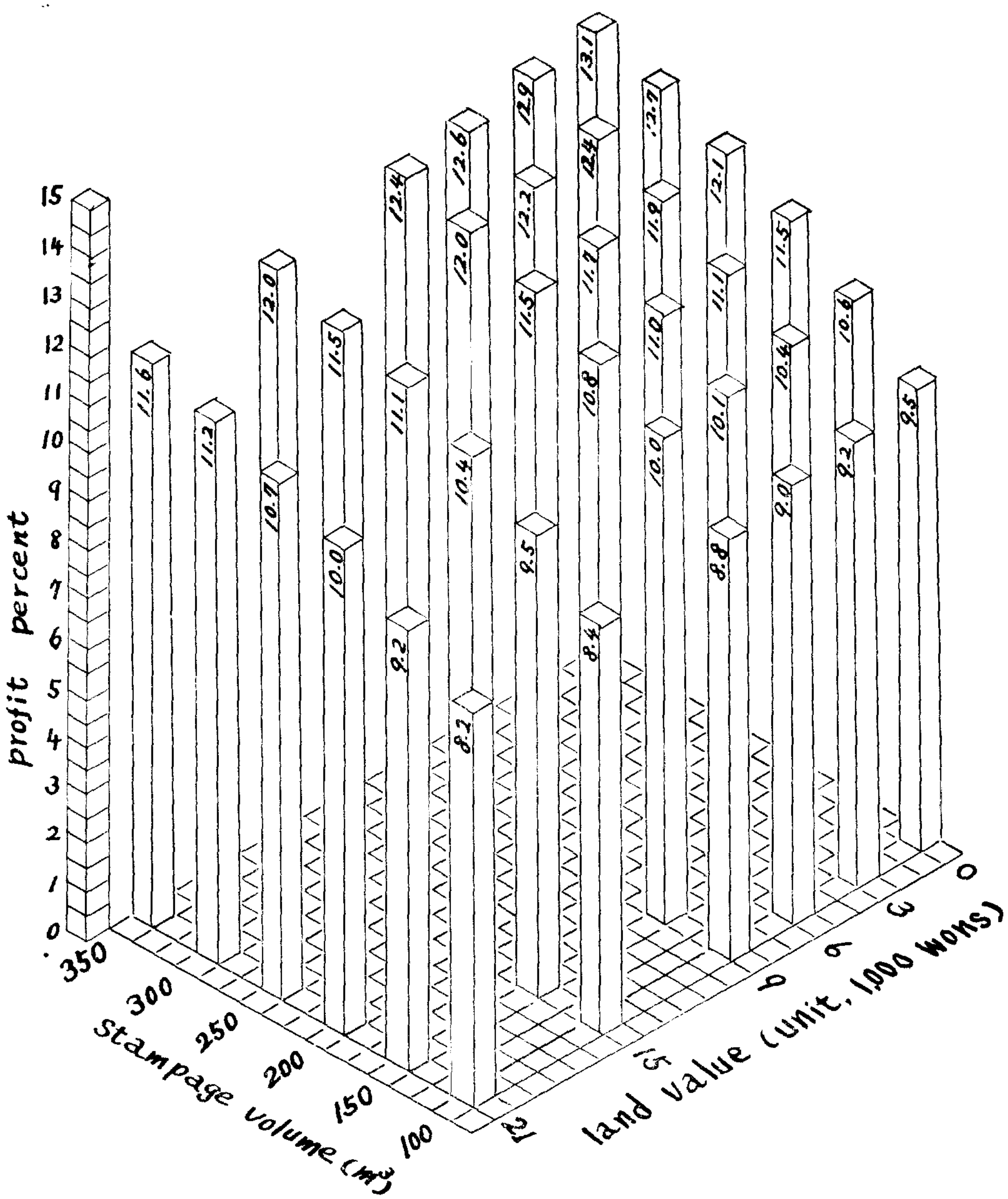

Fig. 8. Relation among profit percent, stumpage volume and land purchasing cost. Possible species; larch, pines. Assumption; stumpage price, 10 wons/sai, final age; 40 years. Thinning incomes were propagated by annual compound interest of 23 percents.

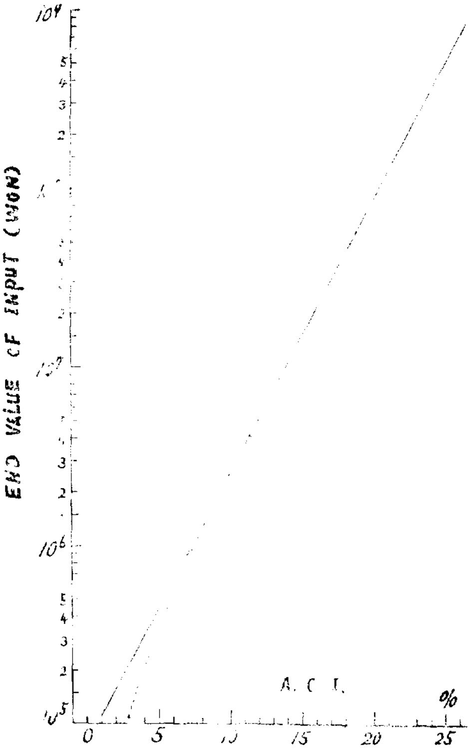

Fig.7. End value curve of input final age of 40 years in larch plantation by annual compound interest (won).

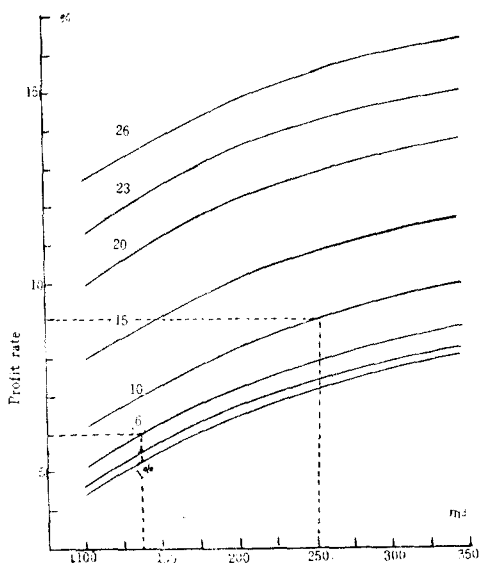

Fig.9—1. Profit rate curve of larch plantation at final age of 40 years by annual compound interest rates applied to thinning income.

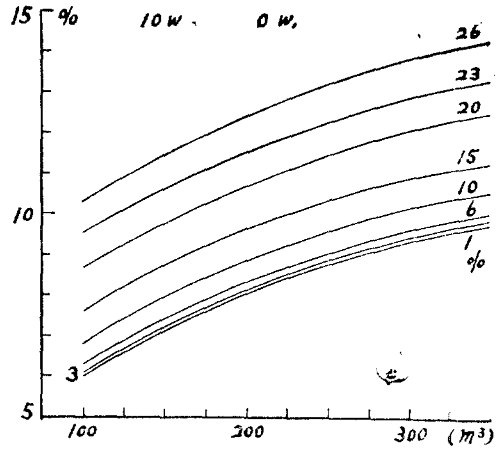

Fig.9—2. Profit rate curve of larch plantation by A. C. I. rate applied to thinning income by stumpage price per sai and land purchasing cost per ha.

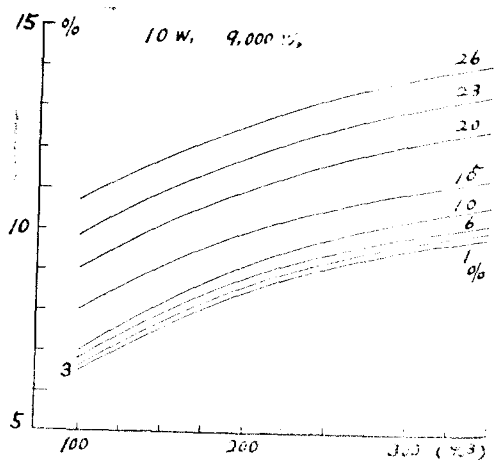

Fig. 9—3.

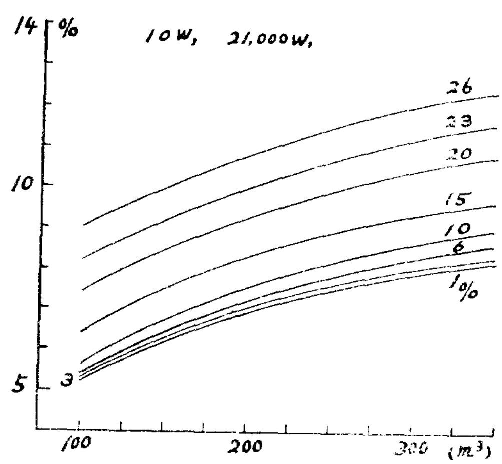

Fig. 9—4.

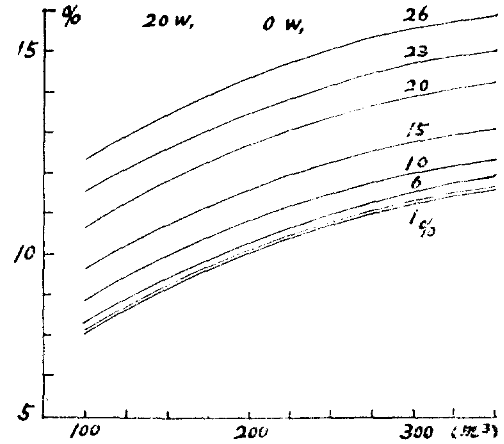

Fig. 9 5.

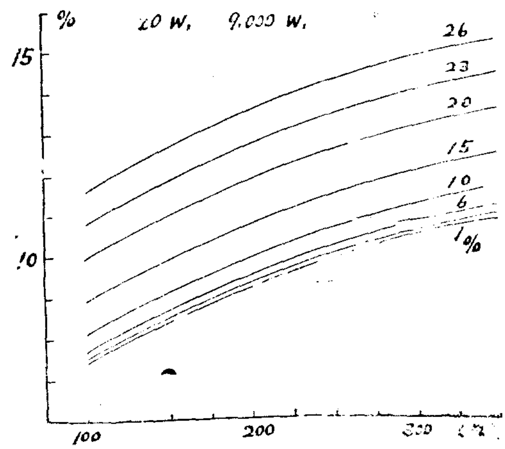

Fig. 9—6.

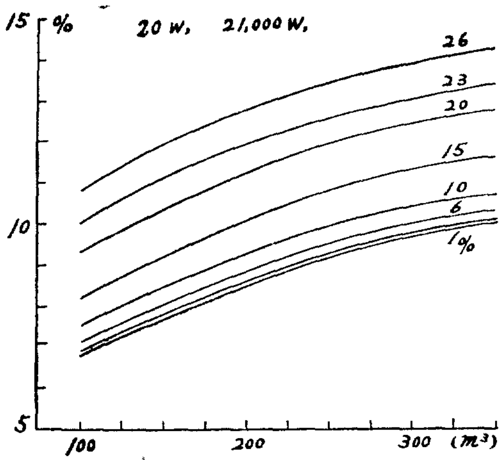

Fig. 9—7.

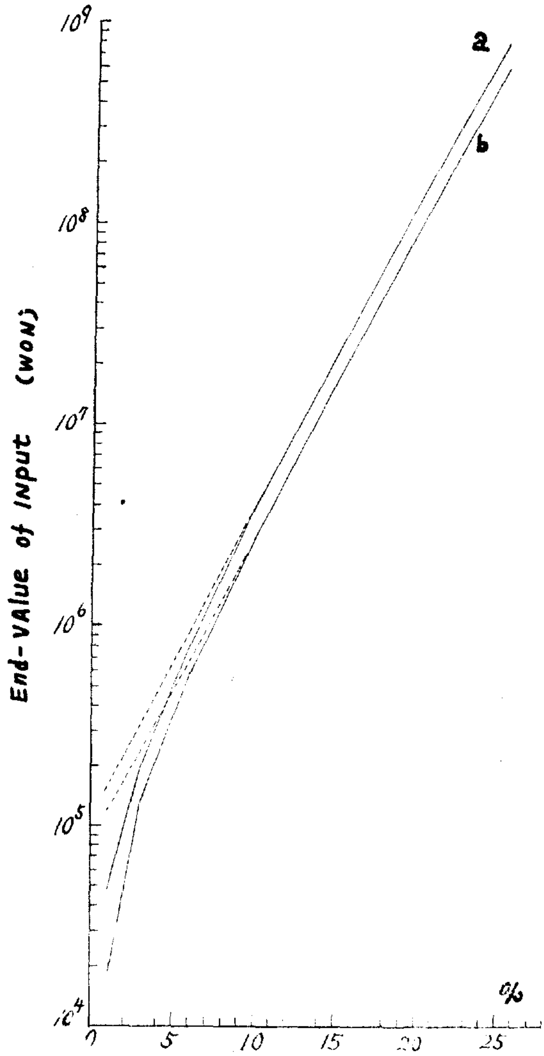

Fig. 10. End value curve of input at final age of 40 years in *Pinus densiflora* plantation by planting density and annual compound interest.
a;10,000 stocks/ha. b;3,000 stocks/ha

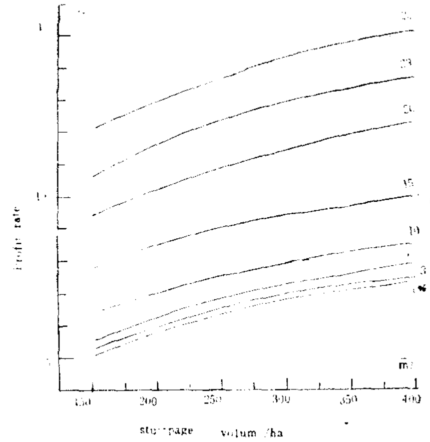

Fig. 11. Profit rate curve of *Pinus densiflora* plantation at final age of 40 years by annual compound interest. 3,000/ha.

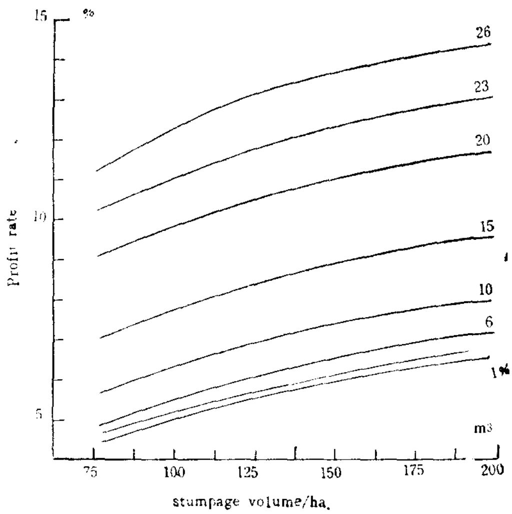

Fig. 12. Profit rate curve of *Pinus densiflora* plantation at final age of 40 years by annual compound interest. 10,000/ha.

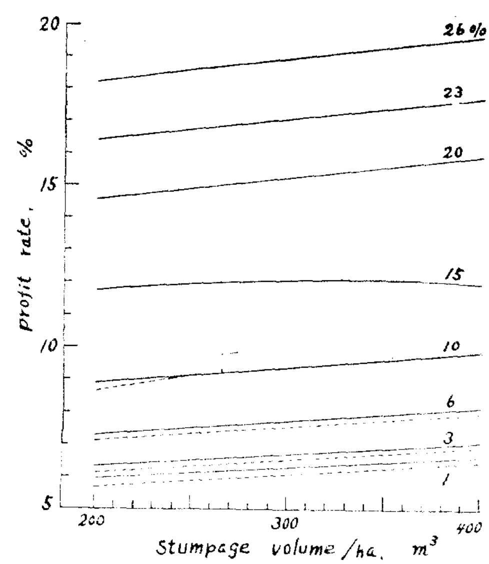

Fig. 13. Profit rate curve of Pinus Koraiensis plantation at final age of 60 years by A.C.I. rates applied to pine nut thinning income.

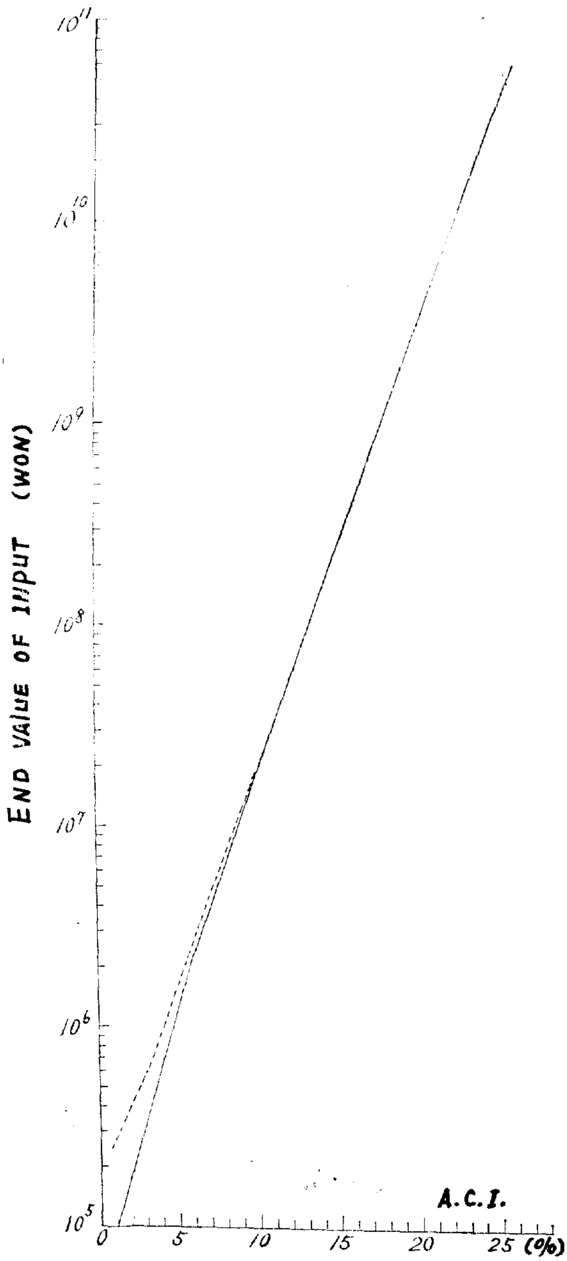

Fig. 13. End value curve of input at final age of 60 years in *Pinus koraiensis* plantation by annual compound interest.