Historical Aspect of Selective Cutting Work in Japan and an Experiment on Selective Cutting of Sugi Forest

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Historical aspect of selective cutting work

1) Selective cutting work in national forests

(1) In the feudal era

Sugi forests* of Akita, Hiba forests of Aomori, Hinoki forests of Kiso, and Sugi forests of Yanase are representative stands to which selective cutting work was adopted during the era of the feudal clan governments.

Since about 1600, the Akita clan adopted a selective cutting work with a cutting cycle of 30 years for broad-leaf trees in Sugi forests. By cutting the broad-leaf trees of diameter less than the middle class, the layered Sugi saplings were exposed to sunshine to promote their growth. On the other hand, cutting of the Sugi trees was severely restricted.

The Nanbu clan in the Shimokita peninsula and the Hirosaki clan in the Tsugaru peninsula adopted a selective cutting work with the cutting cycle of 10 years to Hiba forests located in both peninsula since about 1790. In the prescribed plots, a light cutting was practiced only to the trees which had reached the stage of utilization diameter class.

In the Kiso district, cutting without a principle had been practiced until 1672, but later the sites convenient for rafting were selected and clear cutting was made around there. The Bishu clan noticed a decreasing number of big trees, i.e., the tendency of forest land deterioration, from a survey on tree species and diameter class conducted in 1791, so that it adopted a selective cutting work with the cutting cycle of 50 years. However, as it was not enough to sustain yield the cutting cycle was revised to 66 years.

On the other hand, the Tosa clan designed a forest management plan for Yanase Sugi forest in a period from 1617 to 1871. In this plan, 6 tree species such as Sugi, Hinoki, etc. were designated as "Tomegi" (tree species prohibited from cutting). By taking the "Tomegi system" as the basis for sustaining yield, an extreme curtailment of cutting was practiced. Besides, a work similar to the present selective cutting system was practiced for natural forests in the period from 1681 to 1684. It was the selective cutting at the number ratio of 70% and the cutting cycle of 50 years.

(2) Since 1868 (after the Meiji restoration)

The forests under the feudal clan governments were transferred to the national government after the abolishment of clans and institution of prefectures by the Meiji restoration. The forests were devastated for the time being by destructive cuttings. In about 1920, a selective cutting work was adopted, reaching the peak in about 1933. However the anticipated effectiveness of regeneration by natural seed-shedding after the selective cutting work was not fully manifested. Furthermore,

* Sugi = *Cryptomeria japonica*
Hiba = *Thujopsis dolabrata*
Hinoki = *Chamaecyparis obtusa*
Momi = *Abies firma*
Tsuga = *Tsuga sieboldii*
Shikimi = *Illicium anisatum*

after 1941, treatment of forests was disturbed and became predatory due to effects of the World War II. Thus, without realizing the full effectiveness the selective cutting work disappeared in national forests by about 1950, except in some special tree stands.

2) Selective cutting work in private forests

In some areas of private forests, selective cutting work has also been practiced since the feudal clan era. Planted forest of Sugi and Hinoki at Imasu of Gifu Prefecture, that of Sugi at Tane of Shiga Prefecture, and Sugi natural forest at Iwakawa of Akita Prefecture are representative areas where selective cutting work is still practiced at present.

In other areas, too, examples of selective cutting work for different tree species were observed. The selective cutting work in these examples, though its details are not mentioned here, consists of cutting trees of utilization diameter class, and reserving small-diameter trees not reaching the utilization diameter.

3) Appraisal of selective cutting works

Selective cutting work in private forests has continued on the basis of accumulation of fairly good results. However, that in national forests turned out to disappear without getting an appreciable conclusion. Therefore, at the time when selective cutting work was introduced into national forests before the War, many experimental forests were set there, and the effectiveness of the selective cutting has been investigated. Outline of the results of an experiment will be presented below.

Selective cutting and regeneration experiment in Sugi natural forest

1) Experimental object and outline of experimental forest

To make clear the effect of selective cutting adopted to Sugi natural forest in Yanase on structure of tree stand, tree growth, number of fallen seeds, seed germination, and sapling emergence, an experimental forest for selective cutting and regeneration by natural seed shedding was newly set up on Mt. Koyashiki under the jurisdiction of the Yanase District Forestry Office, located in east of Kochi Prefecture, in 1925. The experimental forest has an area of 3.93 ha. at an elevation of 450–500 m above sea level, and is divided into southern aspect and northern aspect at about the center of the area by a small valley. Age of the tree stand is 180 years on an average, with the maximum of 270 years. The area belongs geologically to Jurassic Akigawa layer, and its soil is clayey loam originated from sandstone and shale, as parent materials. The vegetation belongs to the plant association of Momi-Tsuga-Sugi-Shikimi.

In 1925, the first selective cutting was done to promote natural seed-shedding. Data on changes in tree stand structure or those required for leading the forest to an ideal selective cutting tree stand type have been collected by periodical surveys. In 1967, the second selective cutting was made, and its effect on tree stand structure, number of fallen seeds, germination and sapling emergence was examined.

2) Changes in tree stand structure

At the start of the experiment, the forest was an evenly aged old stand with plenty of Momi and Tsuga. The first selective cutting was done with the purpose of increasing Sugi by natural regeneration. Momi and Tsuga were heavily cut. Cutting ratio in number by tree species was 7–56%, and cutting ratio in volume was 8–59% (Table 1). After the cutting, number of trees per ha was 13–56, and the volume per ha 12–169 m^3.

The tree stand structure immediately before the second selective cutting which was done in 1967, after 42 years from the first one, showed that each tree species increased its number and volume per ha as compared to those after the first cutting in 1925, except somewhat decreased number of Tsuga.

The second selective cutting gave 22–95% cutting ratio in number by tree species, and 9–99% cutting ratio in volume. Tsuga was mostly cut away (Table 1).

Changes in the number of trees as classified

Table 1. Number and volume (m^3) of trees per ha before and after selective cutting

Trees	Item	1925				1967			
		Before cutting	Cutting volume	Cutting rate, %	After cutting	Before cutting	Cutting volume	Cutting rate, %	After cutting
Sugi	Number	66	10	15	56	81	18	22	63
	Volume	208	39	19	169	312	28	9	284
Hinoki	Number	14	1	7	13	29	3	10	26
	Volume	13	1	8	12	27	1	4	26
Momi	Number	19	6	32	13	16	12	75	4
	Volume	90	25	28	65	71	70	99	1
Tsuga	Number	110	62	56	48	43	41	95	2
	Volume	285	169	59	116	153	139	91	14
Total	Number	209	79	38	130	169	74	44	95
	Volume	596	234	39	362	563	238	42	325

by diameter class during the period from the first selective cutting in 1925 to the second cutting in 1967 showed that number of trees of small diameter class (15–24 cm), middle diameter class (25–36 cm) and large diameter class (37–50 cm) decreased, but that of fine diameter class (8–14 cm), super large diameter class (51–70 cm) and extremely large diameter class (>71 cm) increased.

Furthermore, annual diameter increment in successive years showed the maximum in 1935–1940 for Sugi and Hinoki, and then it continued with a slightly decreasing tendency until the second cutting. After the second selective cutting, an increase in diameter growth was again observed. The larger the diameter class, it was noted, the greater was the diameter increment.

Mean volume increment for a definite period between periodical surveys was 2.98–4.59 m^3 for Sugi, 0.12–0.51 m^3 for Hinoki, 0.09–0.86 m^3 for Momi, and 0.01–1.77 m^3 for Tsuga.

3) Sapling emergence and number of fallen seeds

(1) Experimental plan

To trace the emergence and growth of saplings, the raked ground plot, cleaned ground plot, and the control plot (each 20 m in width) were laid out in that order on both aspects of Mt. Koyashiki from the central valley toward the both ridges. The experimental plots totalled 27. In addition, seed traps, each 1 m^2, for measuring the number of fallen seeds were set up at random at 35 places. Moreover, 1 m^2 plots for observation of saplings were laid out in each of the experimental plots, as a rule 3 of the former to one of the latter, totalling 78.

(2) Number of fallen seeds and seed germination rate

Seed collection was made for 5 years from 1967 to 1971. The number of fallen seeds was the greatest in November to December, throughout the whole survey period (Fig. 1). The seed germination rate was higher in the month which showed a greater number of fallen seeds than in the months with a less number of fallen seeds. Seeds obtained in the year of bumper seed crop were better in quality and quantity than those of the year of poor seed crop.

(3) Emergence, establishment, and height of saplings

Sugi saplings emerge in about June, but the number of saplings continues to decrease by die back until about April–May in the next year. In the following June, the new emergence of saplings occurs again. In 1969, the year of starting observations on saplings, the number of saplings which emerged was the greatest in the raked ground plot, followed

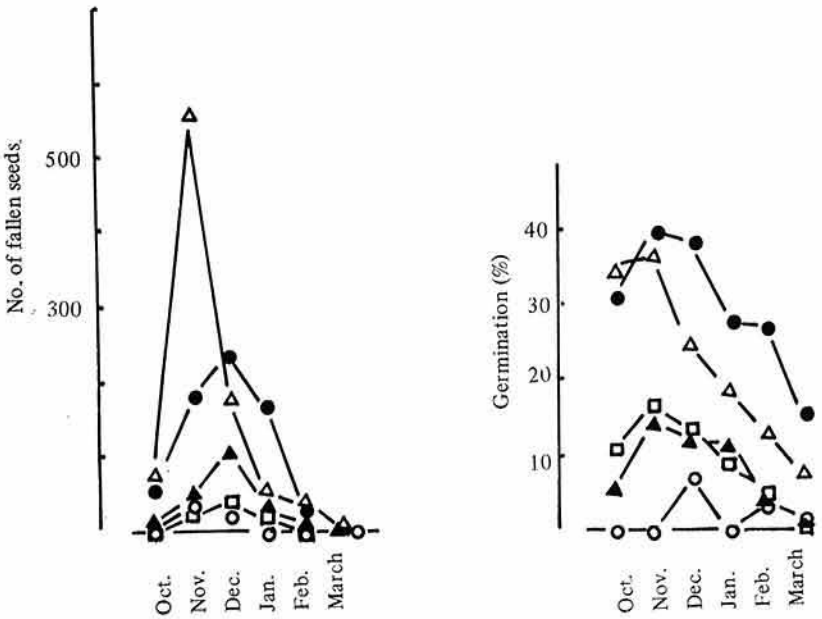

Fig. 1. Number of fallen seeds and germination rate

Note: ● 1967 October~1968 March
○ 1968 October~1969 March
▲ 1969 October~1970 March
△ 1970 October~1971 March
□ 1971 October~1972 March

Table 2. Number of saplings emerged and rate of saplings established

Ground surface treatment and locations*	Southern aspect*		Northern aspect*	
	No. emerged saplings	% established	No. emerged saplings	% established
Raked ground	14	57	16	63
Cleaned ground	12	67	10	60
Untreated control	10	70	7	57
Upper part	12	75	11	55
Middle part	11	53	11	73
Lower part	13	54	12	58

* In Mt. Koyashiki

by the cleaned ground plot and the control plot in that order on both southern and northern aspects, irrespective of the location of each plot, upper, middle or lower part of the mountain. Thus, it was found that the saplings which emerged acn be improved considerably by treating ground surface (Table 2).

As to the survival rate of saplings which emerged in 1969, no definite tendency in survival rate was observed between the two aspects and among the ground treatment plots in 1976 (Table 2).

Comparison of sapling height between 1970, the year of starting measurement, and 1976,

Table 3. Growth of saplings in height (cm)

Aspects	Ground surface treatments	1970	1976
Southern	Raked ground	9.0	66.3
	Cleaned ground	8.0	70.0
	Untreated control	7.3	36.0
Northern	Raked ground	6.6	53.1
	Cleaned ground	6.6	42.0
	Untreated control	5.9	24.8

the final year of the measurement, showed that the sapling height was greater on southern aspect than on northern aspect, but there was no definite tendency between ground treatment plots and height growth.

Closing remarks

This paper described outline of history of selective cutting work in Japan and an experiment on selective cutting and regeneration by natural seed-shedding. In private forests, selective cutting has been practiced in some places since feudal clan era, whereas in national forests it has disappeared since about 1950, except some special tree stands. Recently, in view of the better preservation of forest stands, re-examination of selective cutting work is proposed by some people. In practicing selective cuttings, there is a great problem how to promote growth of upper and lower stories in the forests treated by selective cutting.

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