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## Relation between Forest Management System and Forestry Technique

By

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森林施業と林業技術

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### Abstract

The Development of forestry is accomplished by the integration of both logging and regeneration techniques. However, the history of the forest management shows an emphasis was often layed on only the logging technique. Especially, in national forests a large-scaled clear cutting and production of timber had been promoted under so-called " a productivity increase plan " since 1950s. As the results, the two techniques were separated, and the logging technique was remarkably progressed, while the serious problems were induced for the forest and environmental preservations, as well as an infertility of forest. Accordingly, in reconsideration of the large-scaled clear cutting, a new forest management system has been practiced in the national forests since 1973. The management system includes the decreases of annual cutting amount and clear cutting area as well as the introduction of natural forest management system by selection cutting, etc. However, since the conversion of the forest policy has not been fully carried out, some problems to be solved are left.

In this study the problems are made clear and the improving direction is shown through discussing the relation between the forest management and forestry technique. According to the conclusion, it is necessary for the Japanese forestry to firmly establish a management system which integrates the logging and regeneration techniques, i. e. establishment of a forest management such as an intensive selection cutting which is capable of bringing out the natural genetic characteristics of forest, or preregeneration system etc. It is also important to develop the productive technipue, secure the skilled laborers, and increase related (social) investment, so as to support such management systems.

**Key words:** Forest management system, Logging technique, Regeneration technique.

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## 1. Introduction

The development of forestry can be accomplished only by the unification of the both techniques: the logging technique and the regeneration technique. However, the history of forest management system in Japan indicates that an emphasis has been placed primarily on the logging technique. Especially, since the late 1950s, the National Forestry Agency had pushed forward a large-scaled clear cutting method and a build-up of logging productivity under "a productivity increase plan." As the results, the logging productivity increased remarkably, but the logging technique was separated from the regeneration technique. For that reason, it has brought about not only the decrease of forest fertility but also the destruction of the environment<sup>14,19)</sup>. In 1973, having reflected on the mistaken management in the past, the National Forestry Agency adopted a new policy called "new forest management system." The new policy meant to carry out a fundamental forest management system: a natural forest management has been introduced including the selection cutting system, while the cutting area for the clear cutting system and annual felling amount have been decreased. However, the new system of forest management has not been basically changed, and the suitable technique system has not been yet applied for the forest management. Therefore, at present, the problems of management system is not solved essentially.

In this report, the author would like to clarify the problems of nowadays management system and to propose the method of improvement on management system in future by examining the relation between forest management system and forestry technique.

## 2. Forest management system and productive technique

### 1) System of forest management

A forest is always moving toward a stable genetic condition, in the course of enhancing its fertility, through a struggle for existence amongst species, and forest stories, i. e. overstories and understories, as well as through mutual protective effect. Regenerative power in forests consists of production capability and resistance capability. As the improvement of forest composition becomes more advantageous, the regenerative power is improved<sup>1,5,17)</sup>. Forest management system lies in harmony with the forces of nature. Forest management should be carried out to prepare a condition by artificial selection, and to make use of nature's processes of forest, where useful trees can grow rapidly<sup>15)</sup>.

The forest management system is generally classified into two categories: natural-forest management and planted-forest management. If classified in terms of forest formation, or in other words, methods of cutting and regeneration, there are three categories: selection cutting, preregeneration and clear cutting systems. In selection cutting system of forests, in which various kinds of trees may grow harmoniously and form multi-stories, the natural genetic characteristics are utilized most naturally<sup>9,17)</sup>. Forests under this system are similar to the forests formed in purely natural condition. Natural forest management system often employs this working system. The clear cutting system is entirely opposite to the selection cutting system. In the former, only profitable trees such as larches or firs are planted exclusively and artificial selection and fosterage are provided. This system generally forms a stand of single layer. Most planted forest comes under this system. Preregeneration system is a halfway point between the other two systems.

Under planted-forest management system, a large amount of good timber can be obtained in a short period. But a planted forest has some weak points. It is less resistant to bad weather conditions or damage by insect, etc. In a natural forest, young trees and understories are protected by overstories, and there are also broad-leaf trees in the forest which are strong to winds and insect attack. But in the case of a planted-forest of single species/single layer, those qualities are often lacking. Therefore, when a planted forest is created, countermeasures are necessary to overcome severe natural conditions in the mountain. As concrete measures, culturing operations after planting are important along with careful selection of species suitable to the location, suitable framing of felling area, making mixed forest composed of various species and setting of protective belts. Culturing operations including weeding, clean-cutting and thinning are indispensable. And then, to build forests resistant to bad weather conditions and insect damage, etc., thinning is especially important. Appropriate thinning assures a good harvest of the forest. On the other words, extensive or uniform thinning makes generally single layer forest, however, intensive management system which aims production of large diametral and superior trees can get return from thinning, at the same time, make also the forest of a good stand which has a function of growth and protection<sup>18)</sup>.

## 2) Productive technique of forestry

The author has mentioned the forest management system. The ultimate purpose of forestry is the production of lumber. Forestry can be classified into two categories in terms of production process: harvesting and culturing. Production generally involves laboring process and natural process (forces of nature). Laboring input determines the way of a productive technique carried out with machines and tools. Now the author would

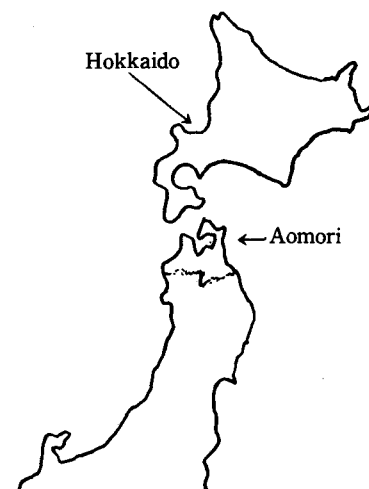


Fig. 1. Location of Hokkaido & Aomori region.

like to touch upon the productive technique in forestry.

The harvesting process is usually divided into three stages: felling and cross-cutting, skidding, and timber transportation. For felling and cross-cutting, previously axes and saws had been used, and skidding to the forest depot had been done by human or livestock force. But nowadays the formers have been practiced with chain saws, and the latter has been mainly done with skidders or tractors. Timber transportation had been carried out by using rivers or forest railways, but it has been done with trucks now. Figure 2 shows the development.

Meanwhile, the productive technique in culturing process has lagged behind. For example, even though some soil preparation work is done with tractors or other machines, man-power-needed tools such as chain saws, brush cutters and the others still play main roles. Anyway, this productive technique should be utilized through the genetic characteristics of forest in order to develop the forestry or forest management system, and the unified development of logging and regeneration techniques is needed for the suitable management system<sup>16,17</sup>. On the other words, adoption of natural-forest or planted forest management system, either in selection cutting, preregeneration or clear cutting system must be based on the state of the forest and the climatic conditions of the location together with the economic conditions. For the elevation of productivity, the technique corresponding to each management system also becomes necessary. For example, in the selection cutting system which is considered to be the most suitable for the characteristics of forest, the logging operation must be naturally done among the standing trees. And then, this system is a working one for the forest where logging technique is essentially and directly related to the regeneration technique<sup>5,17</sup>, therefore, the selection of cutting trees is very important. For that reason, the productive technique is demanded to be suitable for the inside-operation of forest. In most cases, it is pointed out that "the instrument of labor such as natural process" is adopted<sup>19</sup>. On the contrary, clear cutting system is different from selection cutting one, that is, the logging is fundamentally separated from the regeneration system. On other words, the each technique has the possibility of respective development.

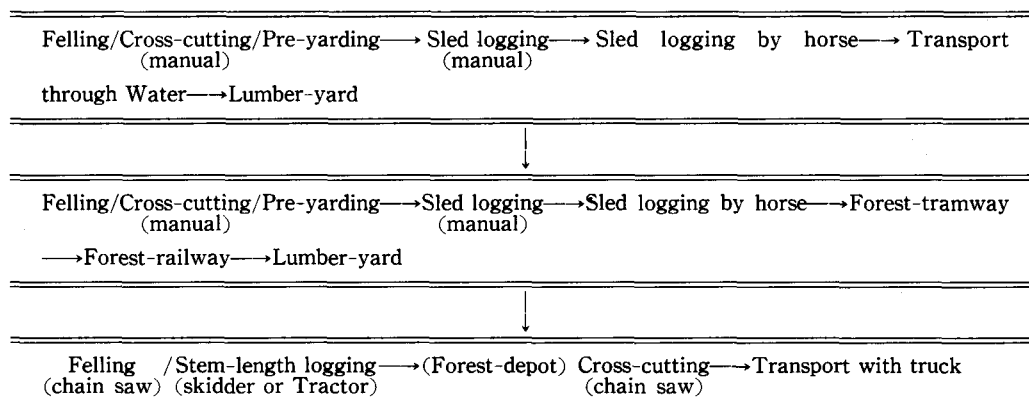


Fig. 2. Development of logging method.

Accordingly, the technique of clear cutting system is not able to be applied to selection cutting system. But the intensive technique for thinning in clear cutting system is similar to the technique of selection cutting system<sup>17,18)</sup>. Therefore, the intensive technique of thinning becomes applied to the selection cutting system.

As mentioned above, to get the development of forestry it is important to recognize the relation between forest management system and productive technique as well as the characteristics of forest. Then, the author would like to examine the practical development process of forest management system and productive technique mainly in Hokkaido.

### **3. Development of forest management system and productive technique**

#### **1) Forest management system before 1950s**

Deforestation in Hokkaido had got into stride from the beginning of 1900s. However, at the outset, extensive selection cutting system had been carried out in general, and large diametral and superior trees had been concentratively cut down. Besides, almost all cutting-blank had been disposed of for the regeneration under the name of "natural upgrowth." And the logging operation had been nearly done on the fallen snow in winter. It was the reason that such works were practiced depending upon the laborers in the business line mainly with farming and fishing industries, and that it had been done in this season in consideration of services of skidding (utilizing fallen snow) and timber transportation (using river in the spring flooded season) at the time when the traffic means were undeveloped. Felling and cross-cutting were generally made with axes and saws available, and horse-porer was chiefly used for skidding<sup>7,8)</sup>. As mentioned above, though the then management system was not necessarily intensive, because it was the operation on the fallen snow, and felling amount was so small, it had not caused any big devastation of forests.

In 1919, production enterprise under direct management of the National Forestry Agency was commenced together with the operation of forest railways. Thus, felling amount in the national forests had been increased. In addition, the process of transportation restricted in only winter by means of river and horse power was expanded to the summer operation using the railways. And also such a development was seen in the system of logging technique as appearance of transportation through tracks by means of man and horse power to connect to the forest railways. Such a progress in the system of logging technique made plundering felling of forests to be advanced, but on the other hand, expansion of collecting areas caused accomplishment of the selection of felling trees to be easy, and regeneration operation of the forests to be enlarged as well<sup>8)</sup>. In other words, even though it would be partial, afforestation was actively conducted, and auxiliary operation for natural regeneration was also sharply increased. And the planted forests showed favorable results in this period, the majority of the planted forests was ranged from three to six hectares (small area afforestation), and even as to the clear cutting blanks, in most cases, many trees of overstories remain, which were considered to be provided with protective functions<sup>6,9)</sup>. For instance, in Jozankei Working Unit (Imperial forest), through the age of 1930s, small-scaled (0.1 to 1.4 ha) auxiliary cultivations under trees were carried out with intensive natural forest management system, they now remain

with favorable results<sup>2)</sup>. These successes suggest that the forest management system was done conforming to the natural genetic characteristics of forest, and at the same time, there was the productive technique corresponding to the management system.

With the lapse of pell-mell times during and after the War, at the entry to 1950s, tractors and skidders were introduced for logging operations, and the improved natural forests such as the national forests in Kitami region had been partially advanced, which made the forest management system to be developed<sup>17,20)</sup>.

At that time the primitive selection cutting system had been done, on the whole but the productive technique had been developed as being suited to the then forest management system. Particularly the skidding technique had been developed with use of fallen snow as characteristic technique in Hokkaido. This was a means of carrying timbers out using horse power : even though it was sheerly in the stage of a tool, since the operation was to be done on the snow, seedlings and saplings would be rarely damaged, and its mobility was so ample that it would have been a technique to fit in selection cutting system<sup>8,9)</sup>. On the other hand, the regeneration work was also done though so partial, such as small area cultivation under trees, which showed the development of the technique to fit in the characteristics of forest.

## 2) Current state of forest management system and the problems

In Hokkaido, there had been limitless mixed forests composed of needle-leaf trees, such as spruces, firs, etc. and many kinds of broad-leaf trees including oaks, etc. The oaks and other broad-leaf trees were very popular as materials for furniture, the timber was exported to Europe and other countries in quantity. And then, the forest management up to the age of 1950s had been put on mainly the primitive selection cutting system, but the forest management system had taken effect maintaining natural forest resources into constant consideration, and meantime the productive technique had also relatively coped with it.

Nevertheless, due to a considerable damage caused by No. 15 typhoon in 1954 and based on a large conversion of the forest management system laying "a productivity increase plan," the national forests occupying 55% of the forests in Hokkaido had responded to the requirements of increased felling amounts during "high economical growth period" since 1955, had rapidly denuded the forest resources in Hokkaido<sup>9)</sup>. In other words, under the name of natural forest management, felling had been done largely beyond retrieving force of forest, and under the name of improving the natural forests and increasing forest productive force, a vast clear cutting had been driven away, conjointly enlarging all-round simple planting operation in wide areas up high lands where the natural conditions were so severe. Table 1 shows the transition of felling amounts. On the one hand, the pursuance of operational efficiency for increasing the felling amount promoted the introduction of gigantic mechanical labor instruments in the lopsided technical systems, such as jumbo tractors and skidders along with extensive clear cutting system. In this process, forest road networks had been remarkably expanded (see Table 2), timber transportation was converted from the forest railways to trucks, and the priority had been transferred from the operation in winter to in summer. Figure 3 shows the changes of logging method in Kitami Regional Forest office. And this meant a rapid development of

**Table 1.** Felling amount of forests in Hokkaido\*(1,000 m<sup>3</sup>)

	Total in Hokkaido				National forest				Others
	Total	Timber		Fire wood	Total	Timber		Fire wood	Total
		Needle -leaf	Broad -leaf			Needle -leaf	Broad -leaf		
1950	7,995	3,451	1,826	2,718	4,414	2,328	1,046	1,145	3,581
1955	10,134	4,927	2,519	2,688	7,582	4,174	1,714	1,856	2,552
1960	11,269	5,077	3,848	2,344	8,185	4,073	2,684	1,427	3,084
1965	12,467	5,704	5,663	1,100	8,256	4,215	3,649	422	4,211
1970	11,849	4,584	6,990	275	7,411	3,449	3,865	106	4,438
1975	9,102	4,112	4,909	81	5,831	3,002	2,835	23	3,271
1980	8,810	4,273	4,537	—	5,070	2,612	2,459	—	3,740
1985	8,141	4,518	3,623	—	4,609	2,575	2,034	—	3,532

\* Calculated according to Hokkaido forestry statistics.

**Table 2.** Extension of forest-road in Hokkaido\*

(km)

	Total			National Forest		
	Truck way	Rail way	Others	Truck way	Rail way	Others
1950	1,775	905	1,238	809	827	781
1955	2,867	937	2,002	1,639	894	1,172
1960	5,687	413	1,499	4,401	413	803
1965	8,741	63	1,139	6,938	63	505
1970	12,734	—	936	9,283	—	237
1975	16,251	—	1,020	11,470	—	56
1980	18,582	—	1,350	12,846	—	39
1985	20,444	—	1,646	13,984	—	34

\* Calculated according to Hokkaido forestry statistics.

the productivity of logging, but on the other hand, it had come to think light of the establishment and deployment of the technical systematization of fundamental natural forest management system. Above all, that had impeded the development of the technique of selection cutting system which would be a working system most adaptive to the natural genetic characteristics of forest, and the thinning system which would be similar to the former. In other words, the selection cutting system consists in a working system to make the logging technique to be promptly combined with the regeneration technique, while the clear cutting system in the extensively large area in which the logging operation is separated from the regeneration operation, expansion of the technique learnt to the efficiency of the former operation (stem length skidding etc.) makes the practice of the fundamental selection cutting and intensive thinning difficult<sup>9)</sup>. Furthermore, the planted forests in the large area in negligence of natural law and in the type of single dendrological planting make plenty of resultless plantations appear. For example, the resultless plantations have been given birth: 1000 hectares in the jurisdiction of Sapporo Regional Forest



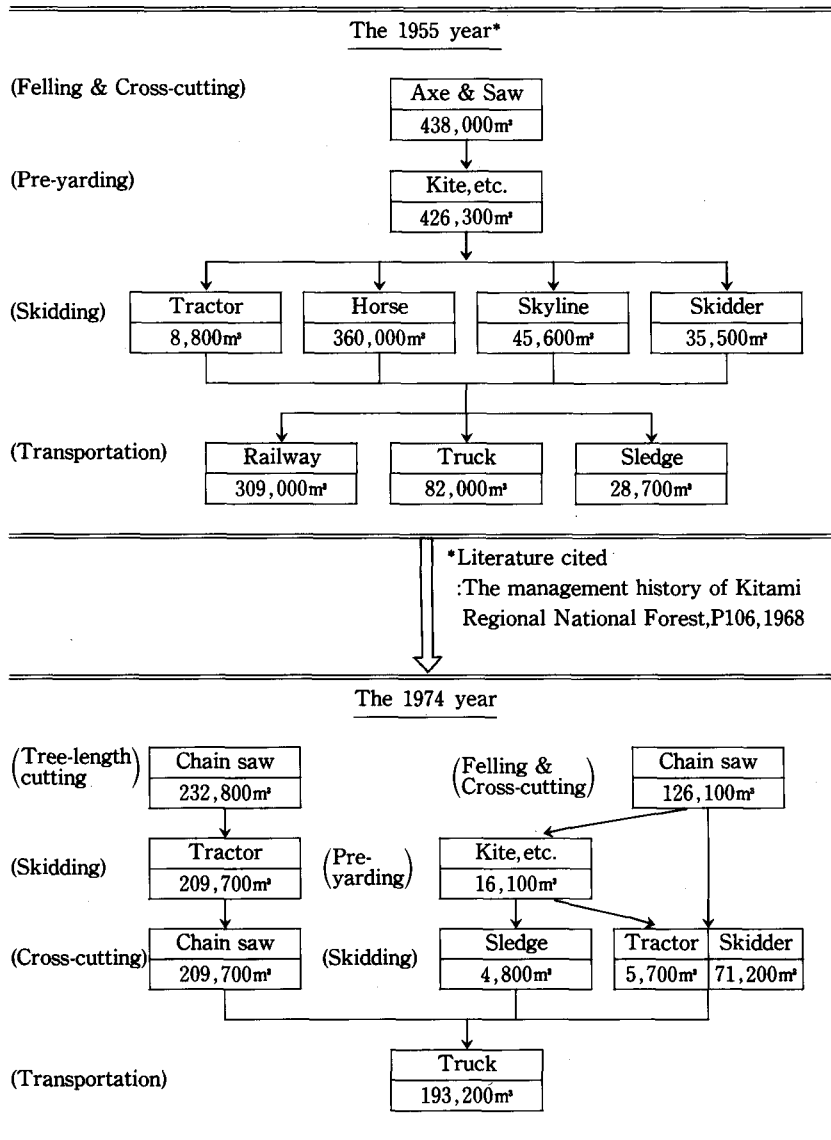


Fig. 3. Changes of logging method in Kitami Regional National Forest.

Office from 1953 to 1967, and 300 hectares in that of Kitami Regional Forest Office since 1960 when the enlarged plantation moved ahead<sup>19)</sup>. As the cause of it, e. g., in the case of Tomakomai Working Unit in the jurisdiction of Sapporo Regional Forest Office, 80% was occupied by natural calamities among which 64% was damaged by cold weather, and 23% was suffered from fungus attack for larch<sup>9)</sup>.

Through the aforementioned progress, in 1973, having reflected on the mistaken management in the past, the National Forestry Agency adopted a new policy called "new forest management system." The new policy meant to carry out a fundamental forest

management system regardless of natural forests or planted forests. Therefore, an emphasis was placed on a natural forest management system including a selection cutting system, while the cutting area for a clear cutting system was restricted within five hectares, and felling amount was also reduced. However, as mentioned above, the forest management and technology mean that the large-scaled clear cutting has continued in practice, and retrieving force of forest resources has remained at an insufficiently low level.

Meanwhile, to promote forestry production, a greater labor force is needed. Forestry production requires heavy workers who work under a severe climatic condition in a mountainous area. And they are required skills and physical strength. Especially, intensive management such as selection cutting system, etc. needs much skillful laborers. But with the advance of the management rationalization in the national forests, the employees have rapidly decreased (see Table 3), and nowadays there are not many young or lower-middle-aged workers. The main disadvantage is the fact that the work in the forests involves some physical danger, such as Raynaud's disease caused with chain saws, and bodily injuries during works. Essentially, technical development accompanies labor saving and improved safety. However, seeking improved working efficiency under the aforementioned large-scaled clear cutting system distorts not only the technology advance of forest management system but also the intensification of labor, and a number of labor accidents are caused. This indicates that the seeking improved working efficiency in neglecting the characteristics of forest would increase the productivity at the time, but decrease it finally.

According to the author's and other's studies at the national forests in Aomori region since the late 1920s, the intensive selection cutting was developed there<sup>10,11,12</sup>; "The management system of natural Japanese *Thuja* forests on the basis of forest composition group" was established, and practically carried out with excellent works including activities such as a single tree selection cutting, the adoption of a 15-year cutting cycle, the regeneration work, etc. Meanwhile, as the productive technique supporting the practice of these works, it should be described that the logging and transportation with forest railways was remarkably developed under the cooperative system of local laborers skilled through the forest education. Besides, as the condition supporting the intensive management and technique systems, it should be described that the strengthened administration

Table 3. Number of laborers in Hokkaido National Forest Office\*

	Total	Common use	Term use	Extra use
1955	26,091	3,184	2,355	20,552
1960	24,687	2,940	3,872	17,875
1965	21,185	1,526	9,328	10,331
1970	14,146	3,853	6,178	4,115
1975	9,628	5,190	3,050	1,388
1980	7,611	5,208	1,809	594
1985	5,287	4,050	1,182	55

\* Calculated according to enterprise statistics of Hokkaido National Forest.

and increased budget, were assured keeping the secure balance in demand and supply of Japanese *Thuja* lumbers. The other side, in this region the least damage by bad weather conditions and by insects or fungous had broken out<sup>4)</sup>. But such the intensive selection cutting system, since the late 1950s has become gradually extensive under "a productivity increase plan." However, recently the technical development depending on the ground yarding with use of wires and so-called curve yarding by skidder in the selection cutting forests where the intensive management like Experiment Forest, etc. has been designated just as partially seen in the contractor for the national forests, and the operational configuration depending upon the cooperative system, and the assistance for all the workers to obtain the driving qualification of aerial skidder and heavyweight machinery, etc. would be paid attention as recognition of then intensive technical system in Aomori region. This would be something to indicate one technical direction in the future management system by selection cutting method.

Case studies of the selection cutting system used in the Aomori region can be most informative in indicating the changes needed in the forest management system and technological system to meet the present need.

#### 4. Conclusion

The author described above the significance of the forest management system and techniques of forestry, and at the same time the actual points at present to put the managements of selection cutting system being able to intensively and effectively use the natural genetic characteristics of forest, etc. For the practice of "new forest management system," it will be mandatory to establish the systematization of the productive technique to correspond to the system. In that case, it is also important to study the histories of forest management system and embodiments of intensive practical examples.

Concretely, the following conditions will be needed: (1) establishment of the management policy adaptive to the characteristics of forest, (2) productive technique adaptive to the operations in the forest, namely development of "the instrument of labor such as natural process" involved in curve yarding with skidders and high performance with small-sized tractors, etc., (3) establishment of selection guideline of cut trees and auxiliary plantation technique, (4) expansion of forest road networks, and (5) reorganization of labor unions compatible with the operational techniques in the forests, etc.

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## 要 約

林業の発展は、木材を採取するための伐出技術と森林を育成するための更新技術の統一的な追求によってもたらされるが、森林施業の歴史をみれば、しばしば前者に片寄った発展がみられた。とくに1950年代以降の国有林では、生産力増強計画のもとで、大面積の皆伐作業と伐出生産力の高度化を推進した。その結果、伐出生産力は飛躍的に増大したが、一方では伐出技術と更新技術の乖離を拡大して地力の減退をもたらすとともに、環境問題などを顕在化させるにいたった。国有林は、こうした増産計画と大面積の皆伐作業の反省にたつて、1973年、"新た

な森林施業を提唱し、伐採量の低減をはかるとともに、皆伐の伐区面積の縮小と択伐作業などの天然林施業の推進をはかることになったが、従来の施業体系の基本的な転換は行われず、依然として施業に即応した技術体系は確立されていない。したがって、問題を根本的に解決するには至っていないのが現状である。

本研究は、以上の背景をふまえ、森林施業と林業技術の対応関係を検討することにより今日の施業体系の問題点を明らかにし、今後の改善の方向を提示しようとしたものである。

現在、重要なことは、伐出技術と更新技術の統一した施業体系、すなわち森林の自然的属性を有効に利用しうる択伐作業や漸伐作業等の施業体系を確立することである。その場合、森林施業の歴史や集約な施業の実施例に学ぶことが重要である。具体的には、青森地方でみられたような、①森林の自然的属性に適合した施業方針の確立、②林内作業に適合した生産技術、すなわち高性能の小型トラクターや曲線集材などの装置的労働手段の開発、③選木および補助造林技術の確立、④林道網の拡充、⑤林内作業技術に適合した労働組織の再編などが重要であろう。