CHAPTER 8

FOREST MANAGEMENT PLAN

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8.1 Basic Issues

8.1.1 Subject Areas and Related Issues

This forest management plan (hereinafter referred to as the Plan) is formulated based on the forest management plan guidelines (hereinafter referred to as the Guidelines).

(1) Plan Period

The plan period is 10 years (1998-2007). However, the contents of the Plan will be reviewed whenever a major change of the socioeconomic situation and/or large-scale forest damage occurs.

(2) Subject Areas of the Plan and Their Size

1) Subject Areas and Their Size

The subject areas of the Plan are the two Model Areas established in the Intensive Area and the size of these areas is given in Table 100. The Model Areas belong to Altanbulag District and Uroo District.

Table 100 Size of Subject Areas of the Plan

(Unit: ha)

Location	Model Area 1	Model Area 2	Total
Altanbulag District	6,934	18,601	25,535
Uroo District	-	4,116	4,116
Total	6,934	22,717	29,651

2) Outline of Subject Areas

a. Natural Conditions

- The elevation is approximately 760 - 1,340 m and forests requiring special management consideration, such as sub-alpine forests and *Pinus sibirica* forests, do not exist locally.
- Topographically, most of the land is flat to moderately sloping land. In Model Area 2, however, Tsegaanengil (south-facing, steep mountain

slopes covered with rocks and herbs) is observed. Torrent cut banks are observed at some river terraces.

- The local soil mainly originates from sandy deposits and weathered base rocks, such as granite and diorite. It is necessary to avoid removal of the surface vegetation from the viewpoints of soil conservation and moisture retention of the top soil.
- The annual climate is characterised by a long, cold and dry winter, a cool, dry and windy spring with low rainfall, a warm summer with thunderstorms and a cool autumn with low rainfall. In short, special care should be paid to the dryness.
- There are many species of wild fauna and flora. Although *Rhododendron dahuricum* is listed as an extremely rare species, this shrub species is commonly found in the Intensive Area.

b. Socioeconomic Conditions

- All forests are owned by the central government.
- Model Area 1 is bordered by farmland and grassland and some farmland which is temporarily fallow is also observed. Grassland surrounded by forests also exists in parts of Model Area 2 and bordering areas. Minor grassland in forests and upper reaches is not used for grazing purposes.
- Trees are cut and general timber is produced mainly at fire damaged sites in both Model Areas but trees are not commonly cut to produce firewood.
- A small number of people engaged in forestry work live in Hond next to Model Area 1.
- Model Area 2 is located in the headwater area of a tributary and both the discharge and water quality of this tributary have important implications for the lives of stock raising people.
- No recreational site exists in either of the Model Areas (some are found at Hond nearby) and, therefore, neither of the Model Areas is deemed to function as a forest recreation area.

c. Legal Restrictions

- No strict zone forests as defined by the Forest Law exist in the Model Areas. Protected zone forests include woods on south-facing slopes, isolated woods, woods on steep slopes and headwater forests in Model Area 2 in addition to green zones.
- Entire Model Area 1 was declared a green zone by the government of Selenge Aimak in 1972 but the Altanbulag District is classified in the category of green zone by the new Forest Law. A green zone for the Uroo District is expected to be established in Model Area 2.

d. Forestry Techniques

- The local forestry techniques vis-a-vis natural forests appear to be inadequate as illustrated by the selection of immature fine trees and much damage to remaining trees by logging. The inadequate forestry techniques regarding the creation of man-made forests are illustrated by the low survival rate of the planted seedlings at reforestation sites.
- Hardly any technical training is provided for the staff members of the aimak Forestry Office or for district-level natural conservation officers.
- No experimental forest (plot) for forestry work exists in the Model Areas or their neighbourhood and studies and research on forestry work (and techniques) are seldom conducted.

(3) Outline of Forest Resources

1) Description of Local Forests

- Both Model Areas have repeatedly experienced damage due to forest fires. In 1996, the entire area, except Compartment Nos. 5 through 10 in Model Area 1, was damaged by fire. Particularly severe damage was sustained by *Pinus sylvestris* stands and huge damage was inflicted on young trees at reforestation sites and natural forests.
- Almost all forests in Model Area 1 are natural *Pinus sylvestris* forests, broad-leaved forests of *Betula platyphylla* and *Populus tremula* and mixed forests of needle-leaved and broad-leaved species. There are few over-mature forests. While there are some small and young *Pinus sylvestris* reforestation sites, the survival rate of the planted seedlings is poor and the growth of the surviving trees is inferior to that of naturally regenerated trees.

- Almost all forests in Model Area 2 are natural forests of *Pinus sylvestris*, such needle-leaved species as *Pinus sylvestris* and *Larix sibirica* (with a mixture of broad-leaved trees in the middle and lower layers), such broad-leaved species as *Betula platyphylla* and *Populus tremula* (with scattered coniferous trees in some) and mixed forests of needle-leaved and broad-leaved trees. Many are over-mature forests. Broad-leaved trees also grow along rivers flowing through grassland.
- In both Model Areas, many large diameter needle-leaved trees are of poor character with a hollow stem, a bark pocket, or damaged by decay. In addition, many fallen trees can be observed (falling in the N-NW and S-SE directions). Many *Betula platyphylla* trees are found to be crooked, forked or decayed.
- Although the natural regeneration of needle-leaved trees is relatively good in Pinus sylvestris forests in both Model Areas, the general picture is not particularly good.

2) Quantity of Forest Resources

The area, growing stock and increment by Model Area are shown in Table 101.

Table 101 Area, Volume and Increment by Model Area

(Units; ha, m^3)

	Area		Growing Stock			Increment		
	Forest	Non-Forest	Needle-Leaved Trees	Broad-Leaved Trees	Total	Needle-Leaved Trees	Broad-Leaved Trees	Total
Model Area 1	6,610	324	504,079	265,201	769,280	8,847	3,148	11,994
Model Area 2	18,002	4,715	1,345,131	1,186,929	2,532,060	7,377	12,535	19,912
Total	24,612	5,039	1,849,210	1,452,130	3,301,340	16,224	15,683	31,906

8.1.2 Forest Categories and Forest Division

(1) Forest Categories

Forests in the Model Areas are categorised as follows in accordance with the Guidelines. Unstocked sites appearing on the forest type map are classified as either hospitable sites or inhospitable sites (non-forest) depending on the perceived difficulty of regeneration. Table 102 shows the area by forest category.

① Forest : natural forest (NF, NP, NL, N, M, L)
planted forest (P)
hospitable site (H)
logged-over land (UL)
new fire-damaged area suffered in 1996 (UN)

② Non-Forest : rocky land (R)
inhospitable site (I)
farm land (F)
grassland (G)
firebreak (FB)

Note: The symbols in brackets are used for the forest management plan map.

Table 102 Area by Forest Category

(Units: ha, %)

Forest Category		Model Area 1	Model Area 2	Total	Composition Rate (%)
Forest	Pine Forest	2,770	1,115	3,885	13.1
	Larch Forest	-	1,101	1,101	3.7
	Pine/Larch Forest	-	1,205	1,205	4.1
	Mixed Forest	923	5,379	6,302	21.3
	Broad-Leaved Forest	1,235	6,563	7,798	26.3
	Planted Forest	97	-	97	0.3
	Hospitable Site	16	143	159	0.5
	Logged-Over Land	269	-	269	0.9
	New Fire Damaged Forest Suffered in 1996	1,300	2,496	3,796	12.8
	Sub-Total	6,610	18,002	24,612	83.0
Non-Forest	Rocky Area	4	914	918	3.1
	Inhospitable Site	2	1,436	1,438	4.9
	Farm Land	24	-	24	0.1
	Grassland	222	2,365	2,587	8.7
	Firebreak	72	-	72	0.2
	Sub-Total	324	4,715	5,039	17.0
Total		6,934	22,717	29,651	100.0

(2) Forest Division

As suggested by the Guidelines, compartments with a unit area of 600 - 800 ha are established based on the watershed and a separate serial number is given for compartments in Model Area 1 and Model Area 2. Similarly, the sub-compartments in each compartment are given a serial number. In the case of those sub-compartments damaged by the forest fire in 1996, these are further divided into sections with a serial number to indicate the intensity of the damage (see forest management plan map and the forest inventory book). The resulting number of compartments and sub-compartments is shown in Table 103.

Table 103 Compartment and Sub-Compartment Numbers

Area	No. of Compartments	No. of Sub-Compartments	No. of Sections	Min./Max . Size of Compartments
Model Area 1	10	113	132	349/1,032 ha
Model Area 2	32	676	587	444/1,168 ha
Total	42	789	719	-

Note: Sections are introduced to divide the sub-compartments to show the extent of the fire damage in the relevant sub-compartments.

8.1.3 Forest Improvement Targets

The following forest improvement targets are adopted as suggested by the Guidelines.

- Nature preservation forest : preservation of the forest ecosystem
- Soil & water conservation forest and public health/culture promotion forest : preservation of the specific function of each forest

  appropriate use of damaged trees and early restoration of site in the case of fire damaged areas in 1996 in Model Area 1
- Timber production forest : systematic improvement of a forest with high increment while maintaining adequate stand density with good quality trees, appropriate use of damaged trees and early restoration of sites in fire damaged areas in 1996

8.1.4 Management Categories

The following management categories are adopted as suggested by the Guidelines.

(1) Functional Categories in Plan Area

1) Preconditions for Management Categorisation

Given the site conditions, etc. of the Model Areas, the following preconditions will apply for the functional categorisation of forests.

- Forests in the Altanbulag District in Model Area 1 (forests located within a 30 km radius of the centre of the Altanbulag District: Compartment Nos. 1 through 10) have already been designated green zones.
- Forests in the Uroo District in Model Area 2 (forests located within a 30 km radius of the centre of the Uroo District: Compartment Nos. 7 through 13, No.22 and Nos.26 through 30) are designated as expected green zones.
- Forests occupying the upper reaches of Bohloon River in Model Area 2 (part of Compartment No. 6 plus Compartment Nos.15 and 17) will be conserved as headwater forests from the viewpoints of the flow rate and water quality preservation (some forests overlap with expected green zones).
- Woods on south-facing slopes, isolated woods and woods on steep slopes located in Model Area 2 will be conserved as soil and water conservation forests.
- Some *Larix sibirica* stands growing in parts of Compartment No. 8 in Model Area 2 show a relatively good state of primeval forest and, therefore, will be conserved as nature reserves for scientific research (some overlapping with headwater forests; see forest management plan map).
- In the case of *Pinus sylvestris* forests (green zones) located along the northern and western boundaries of Model Area 1 and adjoining farmland or grassland, cutting will be strictly prohibited to preserve mantle communities (tending will be conducted at reforestation sites if necessary).
- Cutting in scattered forests on steep slopes and major ridgelines and along rivers running through grassland in timber production forests will be prohibited for soil and water conservation in principle although these forests will not be specifically divided.

- Non-forest sites will be integrated to the functional categories of neighbouring forests. The strict prohibition of cutting will apply to rocky areas even though isolated trees and shrubs are dotted in such areas.

2) Forest Classification Under Management Categories

a. Nature Preservation Forests

① Nature reserves for scientific research: forests in Sub-Compartment Nos.9 through 12 and No.15 in Sub-Compartment No.8 in Model Area 2

b. Soil & Water Conservation Forests

① Woods on south-facing slopes: woods in Sub-Compartment No.5 in Compartment No.4, Sub-Compartment Nos.3 and 4 in Compartment No.5, Sub-Compartment No.1 in Compartment No.6, Sub-Compartment Nos.10, 15, 17 and 20 in Compartment No.12, Sub-Compartment Nos.24 and 25 in Compartment No.17, Sub-Compartment No.5 in Compartment No.18, Sub-Compartment Nos.6 and 8 in Compartment No.19 and Sub-Compartment Nos.11 and 25 in Compartment No.26 in Model Area 2

② Isolated woods: woods in Sub-Compartment Nos.7 and 9 in Compartment No.3, Sub-Compartment Nos.2 and 18 in Compartment No.4, Sub-Compartment No.2 in Compartment No.5, Sub-Compartment Nos.11, 12 and 16 in Compartment No.15 and Sub-Compartment Nos.12 and 13 in Compartment No.23 in Model Area 2

③ Woods on steep slopes: woods in Sub-Compartment Nos.3 and 4 in Compartment No.12, Sub-Compartment No.9 in Compartment No.13, Sub-Compartment No.22 in Compartment No.15, Sub-Compartment No.23 in Compartment No.26, Sub-Compartment No.19 in Compartment No.27 and Sub-Compartment No.2 in Compartment No.29 in Model Area 2

④ Headwater forests: forests in Sub-Compartment No.10 in Compartment No.6 through Compartment No.15, and Compartment No.17 in Model Area 2

c. Public Health/Culture Promotion Forests

① Green zones: all forests in Model Area 1

② Expected green zones: forests in Sub-Compartment Nos. 11 through 17 in Compartment No.7, Sub-Compartment Nos. 1 through 5 and 20 through 22 in Compartment No.8, Compartment No.9, Sub-Compartment Nos. 1 through 9 in Compartment No.10, Sub-Compartment Nos.6 through 9 and 11 in Compartment No. 11, Sub-Compartment Nos.3 through 6 in Compartment No.12, Sub-Compartment Nos.3 through 8, 10 and 11 in Compartment No.13 (all of these forests overlap with headwater forests), Sub-Compartment Nos.17 through 19 in Compartment No.22, Sub-Compartment Nos.15 through 22 in Compartment No.26, Sub-Compartment Nos. 1 through 7 and 15 through 23 in Compartment No.27, Sub-Compartment Nos.2 through 16 in Compartment No.28, Sub-Compartment Nos.4 through 29 in Compartment No.29 and Sub-Compartment Nos.3 through 5, 8 through 16, 20 through 22 and 25 in Compartment No.30.

d. Timber Production Forests: forests other than those listed in a., b. or c. above.

3) Area, etc. by Management Category

The area, growing stock and increment by management category are shown in Table 104. The growing stock and increment by species and age class are shown in Table 105.

Table 104 Area, Growing Stock and Increment by Management Category

Model Area	Management Category	Area (ha)		Growing Stock (m^3)			Increment(m^3)		
		Forest	Non-Forest	N	L	Total	N	L	Total
1	Public Health & Culture Promotion Forest	6,610	324	504,079	265,201	769,280	8,847	3,148	11,994
	Subtotal	6,610	324	504,079	265,201	769,280	8,847	3,148	11,994
2	Nature Preservation Forest	336		73,054	19,856	92,910			
	Soil & Water Conservation Forest[1]	6,027	1,440	504,494	395,436	899,930	3,352	4,474	7,826
	Public Health & Culture Promotion Forest[2]	2,030	150	211,881	117,389	329,270	989	1,257	2,246
	Timber Production Forest	9,609	3,125	555,702	654,248	1,209,950	3,036	6,805	9,841
	Subtotal	18,002	4,715	1,345,131	1,186,929	2,532,060	7,377	12,535	19,912
	Total	24,612	5,039	1,849,210	1,452,130	3,301,340	16,224	15,683	31,907
Double Categories	Nature Preservation Forest/Soil & Water Conservation Forest	336		73,054	19,856	92,910			
	Soil & Water Conservation Forest/Public Health & Culture Promotion Forest	1,889	12	138,151	111,119	249,270	936	1,306	2,242

Note: 1) "Soil & Water Conservation Forest" excludes the ones doubly designated with "Nature Preservation Forest".
2) "Public Health & Culture Promotion Forest" excludes the ones doubly designated by "Soil & Water Conservation Forest".
3) "N": Needle-Leaved Trees "L": Broad-Leaved Trees

Table 105 Growing Stock and Increment by Species and Age Class

(Unit: m^3)

Management Category	Species	21~40 years		41~60 years		61~80 years		81~100 years	
		Growing Stock	Increment	Growing Stock	Increment	Growing Stock	Increment	Growing Stock	Increment
Timber Production Forest	*Pinus sylvestris*	1,260	29	13,806	332	36,914	561	39,698	534
	Larix sibirica			464	4	3,940	99	2,863	40
	Betula platyphylla	17,191	267	280,671	4,627	276,259	942	4,150	
	Populus tremula	11,959	44	49,008	732	15,010	192		
	Subtotal	30,410	339	343,949	5,696	332,123	1,793	46,711	574
Others	*Pinus sylvestris*	2,490	82	29,847	1,258	72,040	2,097	110,978	1,781
	Larix sibirica			5,220		1,742	26	29,658	346
	Betula platyphylla	38,656	587	394,633	4,869	307,405	2,904	10,085	53
	Populus tremula	5,466	148	31,997	303	7,588	15	2,052	
	Subtotal	46,612	817	461,697	6,429	388,775	5,042	152,773	2,180
Total		77,022	1,156	805,646	12,125	720,898	6,835	199,484	2,754

Management Category	Species	101~120 years		121~140 years		141 years or more		Total	
		Volume	Growth	Volume	Growth	Volume	Growth	Volume	Growth
Timber Production Forest	*Pinus sylvestris*	5,355	110	15,922	224	109,896	110	222,851	1,900
	Larix sibirica	8,238	36	31,760	337	285,586	621	332,851	1,137
	Betula platyphylla							578,271	5,836
	Populus tremula							75,977	968
	Subtotal	13,593	146	47,682	561	395,482	731	1,209,950	9,841
Others	*Pinus sylvestris*	267,167	4,420	36,449	217	250,150	622	769,121	10,477
	Larix sibirica	42,796	660	20,767	307	424,204	1,372	524,387	2,710
	Betula platyphylla							750,779	8,413
	Populus tremula							47,103	465
	Subtotal	309,963	5,080	57,216	524	674,354	1,994	2,091,390	22,066
Total		323,556	5,226	104,898	1,085	1,069,836	2,725	3,301,340	31,907

8.2 Forest Management Methods

8.2.1 Forest Management Methods by Management Category

The cutting methods to be used are selective cutting (group and single tree), shelterwood cutting, and thinning as suggested by the Guidelines while the regeneration methods will be reforestation, enrichment, natural seeding and sprouting.

The clearance of damaged trees in the soil & water conservation forests and public health/culture promotion forests damaged by the fire in 1996 will be conducted if necessary. Table 106 outlines the forest management methods by management category based on the cutting and regeneration methods to be used.

Table 106 Forest Management Methods by Management Category

Management Category	Subject Forests	Cutting Method		Regeneration Method				Cutting Age (Cutting Cycle)
		Regeneration Cutting	Thinning	Reforestation	Enrichment	Natural Regeneration: Seeding	Natural Regeneration: Sprouting	
Nature Preservation Forest	- Nature reserve for scientific research	strictly prohibited	—	—	—	—	—	—
Soil & Water Conservation Forest	<Soil Conservation> - Wood on south-facing slope; wood on steep slope; isolated wood	prohibited	—	—	—	—	—	—
	<Water Conservation> - Headwater forest	prohibited in principle	—	—	—	—	—	—
	- No disruption to preservation of forest function - Limited protection of forest, growth and improvement of restoration capability	(selective cutting of firewood) (clearance of damaged trees)	—	—	— (○)	(○)	(○)	
	- Unstocked forest land	—	—	○	—	—	—	
	<Climatic Damage Prevention> - Wood isolated	Prohibited in principle	—	—	—	—	—	
Public Health / Culture Promotion Forest	- Green zone; expected green zone; isolated wood (on gentle slope)	prohibited in principle	—	—	—	—	—	—
	- Limited protection of forest, growth and improvement of restoration capability	(clearance of damaged trees)		(○)	(○)			
	- Unstocked forest land	—	—	○	—	—	—	
	- Forestry experiment forest	(depends on experiment objective)	as left	as left	as left	as left	as left	
Timber Production Forest	Steep slope, riverside or major ridgeline	prohibited in principle	(○)	—	—	—	—	Shelterwood cutting (L: 10 years); selective cutting (N: 130years, L: 65 years) (N: 30 years) (NL: 30 years)
	Good natural regeneration site	shelterwood cutting / single tree selective cutting	○	—	—	○	○	
	Stocked land other than above	group selective cutting	○	(○) (change of species)	○	△	△	
		single tree selective cutting	○	—	—	○	○	
	Unstocked forest land	—	—	○	—	—	—	

Notes 1. ○ and △ indicate the primary and secondary means of cutting/regeneration respectively. ( ) indicates exceptional cases.
2. The clearance of damaged trees will only be conducted by the Forestry Office.

8.2.2 Cutting Plan

(1) Cutting Age

The following cutting ages are adopted as suggested by the Guidelines.

- *Pinus sylvestris*; *Larix sibirica* : 130 years
- *Betula platyphylla*; *Populus tremula* : 65 years

(2) Cutting Cycle, etc.

Some stands in Model Area 2 will be subject to selective cutting. The following cutting cycles are adopted as suggested by the Guidelines while taking the characteristics of the species and the feasibility of work implementation, etc. into proper consideration.

- Cutting cycle : needle-leaved forests/mixed forests : 30 years
- Selective cutting rate : 25% or less

The cutting cycle for the shelterwood cutting of broad-leaved forests for the second time and thereafter is provisionally set at 10 years but will be subject to review depending on the natural regeneration situation at the time of formulating the plan for the next stage.

(3) Allowable Cut Volume

Timber production forests in the Model Areas are located in the Altanbulag District. As it is impossible to calculate the allowable cut volume for timber production for the entire Altanbulag District, the following equation is used to calculate the allowable cut volume for the Model Areas as suggested by the Guidelines.

The calculation results of the allowable cut volumes (live standing trees) for the Altanbulag District in the plan period of 10 years are given in Table 107. Taking the clearance of trees damaged by the fire in 1996 into consideration, the actual allowable cut volumes are set at 50% of the calculated figures.

Table 107 Calculation of Allowable Cut Volume for 10 Year Period in Timber Production Forests

	Area (ha)	Growing Stock (Vρ) (m^3)	Increment (Iρ) (m^3)	Cutting Age (T) (years)	Allowable Cut Volume (in Plan Period) E = (Iρ/2 + Vρ/T) × 10 (m^3)
Needle-Leaved Trees		555,702	3,036	130	(3,036/2 + 555,702/130) × 10 × 0.9 = (57,926) × 0.9≒ 52,133
Broad-Leaved Trees		654,248	6,805	65	(6,805/2 + 654,248/65) × 10 × 0.9 = (134,679) × 0.9≒ 121,211
Total	9,609	1,209,950	9,841	-	173,344 (for 10 years)

Note: The ratio of those stands where cutting is, in principle, prohibited is set at 10% for the above calculation and subtracted from the allowable cut volume.

(4) Cutting Sites and Cutting Volume

The permitted cutting sites and cutting volume are planned in accordance with the Guidelines while taking the early clearance of the trees damaged by the fire in 1996 into consideration. Cutting volume of needle-leaved live standing trees is planned within 50% of the annual allowable cut volume. In addition, the cutting sites for firewood for home use are planned. The permitted cutting sites and cutting volume are given in Table 108 (see Appendix 18 and forest management plan map). Needle-leaved and broad-leaved fire-damaged trees may be cut within the full of annual allowable cut volume when those trees be sizable and possible to be used.

Table 108 Permitted Cutting Sites and Cutting Volume

District	Model Area	Management Category	Cutting Method	Nos of Compartment, Sub-Compartment and Section	Area (ha)	Needle-Leaved Trees (m^3)	Broad-Leaved Trees (m^3)	Total (m^3)
Altanbulag	1	Public Health & Culture Promotion Forest	Clearance of Damaged Trees	1①[2], 2①[3], ②[2], 3③[1,2,3,4], ⑥, ⑧[1-3], ⑩[1-3], 4③[2], ④[1-5], ⑥[1-3]	782	(78,250)		(78,250)
	2	Timber Production Forest	Group Selective Cutting	5⑨,⑪,⑬,⑭,⑯,⑰, 6⑤,⑦,⑧[2], ⑨[3]	520	25,680	13,180	38,860
			Single Tree Selective Cutting	2②[3], 31②[1], ⑮[4]	62		2,000	2,000
			Shelterwood Cutting	5⑮, 6④	130		5,810	5,810
			Single Tree Selective Cutting (for Damaged Trees)	19㉑[1], ㉒[2], 26⑥[1]	42	(2,000)		(2,000)
			Group Selective Cutting (for Damaged Trees)	2②[3], 20②[1-2], ③[1-2], ④[1-2], ⑤[1-2], ⑦[1-2], ⑨[1-4], ㉒[1], 22㉕[1-2], 23⑥[2-5], ⑩[1-2], 24⑦[1-2], ⑧, ⑭[2-], ⑯[2-3], ㉒[1-3], 31②[2], ⑮[2]	461	(20,670)	(2,000)	(22,670)
			Thinning	19㉑, 26⑥[5]	56	2,550		2,550
Subtotal					1,271	(20,670) 28,230	(2,000) 20,990	(22,670) 49,220
Total					2,053	(98,920) 28,230	(2,000) 20,990	(100,920) 49,220

Note: 1) In the case of "Compartment No.1, Sub-compartment No.2, Section No.2", the description is indicated as "1②[2]".

2) The subject amount for fire-damaged trees (or dead trees) is described with brackets.

(5) Cutting Methods

As suggested by the Guidelines, the cutting methods to be employed are group selective cutting, single tree selective cutting, shelter-wood cutting for regeneration cutting, and thinning. The early clearance of damaged trees in 1996 in public health/culture promotion forests will be conducted at stands of which fire damage level is large or medium.

In timber production forests, in order to conduct early clearance of fire-damaged trees group selective cutting or single tree selective cutting will be applied for the sizable stands of which fire damage level is large or medium.

1) Group Selective Cutting

a. Subject Stands

Group selective cutting will be employed for those timber production stands which are mainly composed of mature, large and medium diameter trees with a relatively small number of small diameter needle-leaved trees and succeeding trees requiring enrichment. Those stands with a crown density of less than 50% will not be subject to cutting.

b. Cutting Blocks

• Size Limit for Open Sites

The standard size of an open site made by cutting will be approximately 0.1 ha with due consideration given to the stand composition, level of sunlight received by the planted trees, possible drying of the soil by opening and local weather conditions, etc. The maximum land area for a spot open site created by the cutting of trees, including those standing around an existing open site, is set at 0.3 ha.

• Stands on Steep Slopes, etc.

Stands located on steep slopes, riversides and major ridgelines, etc. will be excluded from the cutting blocks for group selective cutting. No open site should be created at stands bordering a cutting block.

c. Tree Selection Criteria

Taking such issues as the preservation of useful small to medium diameter trees, succeeding needle-leaved trees, characteristics of the planted species and planting method, etc. into consideration, stands will be classified into those subject to cutting and those subject to preservation. Those meeting the criteria given below will be classified as cutting groups (preservation groups will be those which are not cutting groups of which volume growth mainly featuring small to medium diameter trees can be anticipated) and the subject trees to cutting will be selected following the priority order of ① to ③ (those under ① will have the highest cutting priority).

① Tree group mainly consisting of damaged trees (dead or fallen trees which can be used for timber or firewood; the same definition

applies hereinafter), germ-infested trees and/or trees suffering from declined growth (the crown length is less than one-fourth of the tree height and the crown shape is neither round nor oval with a small volume of leaves; the same definition applies hereinafter)

② Tree group mainly consisting of poor quality trees (standing trees which are crooked, forked, hollow and/or bark pocket and of which the timber usage rate is low; the same definition applies hereinafter)

③ Tree group mainly consisting of large diameter trees which have reached the cutting age

d. Cutting Rate

The maximum cutting rate is set at 25% (30% for dead trees damaged by fire, etc.), including trees damaged by cutting, spur road construction and logging.

2) Single Tree Selective Cutting

a. Subject Stands

Single tree selective cutting will be employed for those timber production stands which are composed of large as well as small to medium diameter trees with many succeeding trees or with a good state of natural regeneration, making enrichment unnecessary (the regeneration index is generally less than 0.8), and those sites subject to the cutting of firewood for home use.

b. Tree Selection Criteria

Taking the need to foster succeeding trees and to encourage natural regeneration into consideration, the following types of trees will be selected for cutting (those under ① will be given the highest priority, followed by ② and ③ in that order).

① Damaged trees, germ-infested trees and trees suffering from declined growth

② Poor quality trees preventing the growth of good quality small to medium diameter trees or young trees (including overspread trees)

③ Large diameter trees which have reached the cutting age

c. Cutting Rate

The maximum cutting rate is set at 25%, including trees damaged by cutting, etc.

3) Shelterwood Cutting

The subject forests are broad-leaved forests regenerated with sprouting in timber production forests. The maximum cutting rate is set at 40% and the following cutting will be done 10 years later. Tree selection criteria are same as the case of group selective cutting.

4) Clearance of Damaged Trees

This method will be conducted by the provincial Forestry Office to protect and to facilitate the normal growth and recovery of the remaining stands.

a. Subject Stands

The clearance of damaged trees will be conducted at those stands which are sizable and located at gentle slopes in public health/culture promotion forests which were damaged by the forest fire in 1996. The forests located along farmland and grassland will be excluded.

b. Cutting and Regeneration Methods

In principle, the methods described below will be adopted based on the level of fire damage which is large or medium.

① Damaged Stand Mixed with Live Trees

While only damaged trees are to be cut, group selective cutting with a maximum cutting rate of 30% and enrichment will be employed. The maximum area of an open spot created by cutting will be 0.3 ha.

② Damaged Stands without Live Trees

In the case of a *Pinus sylvestris* hill forest entirely damaged, strip clear cutting will be employed with a maximum cutting rate of 40%. The strip width must be 150% or less of the average tree height in the subject stand and a reserve belt, the width of which is not less than 150% of the strip width, should be created. No trees should be cut in this reserve belt. The maximum strip length should be 200m

in principle. The regeneration method for a strip clear cutting site will be reforestation. Damaged trees left over in areas other than the planting strips should be prevented from being run over by a bulldozer at the time of land preparation.

c. Tree Selection Criteria

The damaged trees subject to cutting will be dead trees or fallen trees which can be used for timber or firewood production. The preservation of some damaged trees must be considered in the process of regenerating a cut-over site to prevent worsening of the weather conditions and also to provide feeding trees for birds.

d. Adjustment of Cut Volume

The cut volume for the clearance of damaged trees will, in principle, be counted as part of the original allowable cut volume for live standing trees.

5) Thinning

Thinning based on the tree form category will be conducted at stands below the cutting age in order to improve the health of these stands, to stimulate diameter growth and to ensure the efficient utilisation of wood resources by means of alleviating the competition between trees.

a. Subject Stands

In the case of existing man-made forests, thinning is not required for many years to come because of the present young age. Thinning will be employed for those stands where thinning is expected to achieve better health and much more rapid diameter growth by means of alleviating excessive competition caused by the presence of too many growing trees, excepting those where cutting is prohibited. The yardstick for the commencement of thinning is when the crown depth of the subject stand becomes approximately one-third of the tree height or when the longest crown branches, i.e. largest spreading branches visible from the ground, of neighbouring trees cross each other at approximately one-quarter of the length.

b. Cutting Blocks

Stands along forest boundaries will be excluded from the subject stands for thinning.

c. Tree Form Categories

Timber producing trees will be classified into four categories based on the tree quality (good or bad) and relative locations vis-a-vis trees to be left uncut (obstructive or non-obstructive) (see Fig. 51).

① Good Tree

Large crown (the crown depth is larger than one-third or one-quarter of the tree height with well-developed large spreading branches) with plenty of leaves and a straight trunk not damaged by rotting fungi

② Bad Tree

Poor-looking tree with a small crown; low quality tree with a crooked or forked trunk; damaged tree

③ Obstructive Tree

Tree of which the location is considered obstructive for the growth of trees to be left over (dominant trees) until the next thinning

④ Non-Obstructive Tree

Tree of which the location is considered not obstructive for the growth of trees to be left over until the next thinning

Pair trees (a pair of trees of which the outer crown is normal with a poor inner crown; once one of these is cut, the other often dies due to growth deterioration) will be treated as a single tree.

d. Tree Selection Criteria

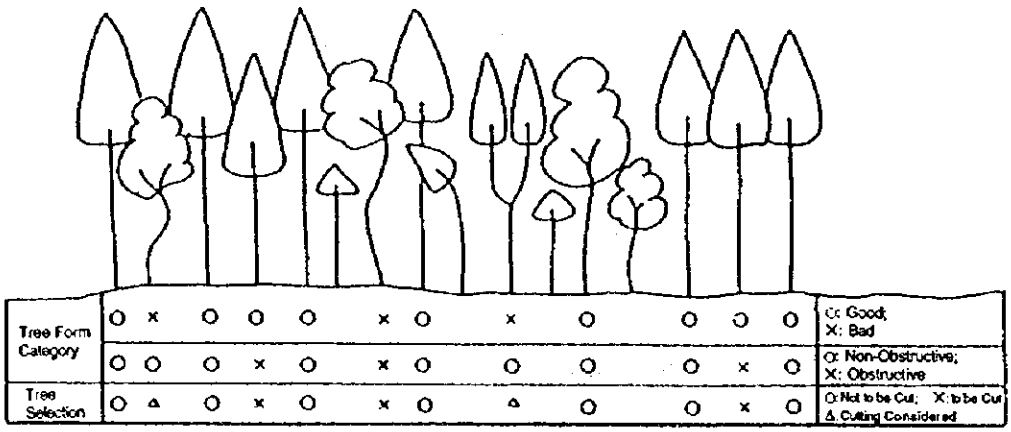
The subject trees for thinning will mainly be selected based on the tree form category in view of an appropriate crown distribution of the entire stand. The subject trees will be mainly those which compete with each

other in the upper crown layer. ① is the highest priority, following by ② and ② in that order (see Fig. 51).

①	Bad and obstructive tree	:	to be cut
②	Good but obstructive tree	:	cutting considered
③	Bad but non-obstructive tree	:	cutting considered
④	Good and non-obstructive tree	:	not to be cut

e. Thinning Rate

The maximum thinning rate is set at 20%, including damaged trees by cutting work, etc.



Notes
1) The cutting of trees classified under Δ is decided based on the tree location.
2) Lower layer trees are not to be cut except for trees damaged by disease or insects, etc.
3) Trees with bird's nests are not to be cut.

Fig. 51 Examples of Tree Selection for Thinning

8.2.3 Regeneration Plan

(1) Regeneration Methods

The regeneration methods to be employed are reforestation, enrichment, natural seeding and sprouting as suggested by the Guidelines.

1) Reforestation

a. Subject Sites

The subject sites for reforestation in timber production forests will be unstocked areas, such as past forest fire damaged areas and cut-over areas, where the progress of reforestation or natural regeneration is poor and those sites where a change from a broad-leaved stand to a needle-leaved stand is required. In the case of public health/culture promotion forests, reforestation will be employed at cleared sites of damaged trees or unstocked areas where planting is required to create a forest.

b. Species for Planting

The main species for planting are *Pinus sylvestris* and *Larix sibirica*. The planting of such broad-leaved species as poplar and elm will also be considered for unstocked areas of soil and water conservation forests and public health/culture promotion forests.

c. Planting Density

For general reforestation purposes, the standard planting density is set at 3,000 trees/ha for *Pinus sylvestris*, *Larix sibirica* and broad-leaved species. When naturally regenerated young trees are growing at a site, the planting density will be adjusted depending on the distribution of such young trees.

d. Land Preparation

In regard to land preparation, the use of a bulldozer to remove the relatively fertile top soil will be avoided as this causes exposure of the soil. Instead of conventional mechanical ploughing, shallow ploughing in strips and the setting aside of the ploughed ground vegetation will be conducted so that such vegetation can be returned to its original place after planting. Alternatively, clearance of the ground vegetation on the planting strips (strip clearance) will be conducted. In the case of sloping land, contour planting in strips will be conducted. In the case of flat land, the planting strips will run in the NE to SW direction at a right angle to the prevailing wind direction and the standard clearance width will be 1 m which may be adjusted depending on the height of the vegetation. The cleared vegetation and slash will be left at the remaining strips (2 m in width) (see Fig. 52).

e. Planting Distance

For general reforestation purposes, the planting distance will be 3 m between the planting lines or 1.1 m between the planted seedlings (see Fig. 52).

f. Planting

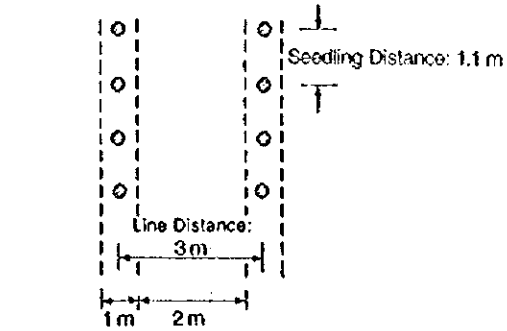
The seedlings will be planted in early or mid-May. Care must be taken to prevent the seedlings from becoming dry during transportation, etc. The inclusion of ground vegetation in planting holes and deep planting must be avoided. After placing a seedling in the planting hole, the ground around the hole must be stamped to ensure good contact between the seedling and the soil. Mulching around the base of the planted seedling must always be conducted using fallen leaves and dead grass, etc. to prevent drying of the ground around the planting seedling. The planting surface should be slightly lower than the surrounding surface.

g. Supplementary Planting

If 20% or more of the planted seedlings die within one year of planting, supplementary planting should be conducted in the following year to improve the number of planted seedlings to the original level.

① Line Planting

(General Reforestation; Enrichment)



② Nest Planting

(Enrichment)

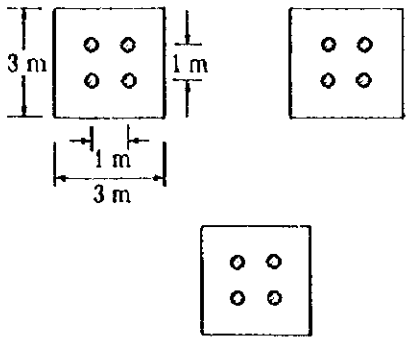


Fig. 52 Land Preparation and Planting Methods

2) Enrichment

a. Subject Sites

The subject sites for enrichment will be group selective cutting sites (including scattered unstocked areas). The similarly cleared sites of damaged trees will be also the subject sites.

b. Species for Planting

The planting species used for enrichment will be *Pinus sylvestris* and *Larix sibirica*.

c. Planting Density

The standard density for enrichment will be 3,000 trees/ha for open sites. The planting density will be adjusted if naturally regenerated young trees are growing depending on their distribution.

d. Land Preparation

Either strip ploughing or spot ploughing will be conducted to prepare the land for enrichment. As broad-leaved trees and shrubs are growing at the subject sites for enrichment, their sufficient cutting and removal is important to prevent the undesirable suppression of the planted trees. The strip ploughing method will be the same as that employed for reforestation. The number of nests created by spot ploughing will be 750 nests/ha with a planting distance of 3.0 m × 3.0 m (see Fig. 52).

e. Planting Distance

The planting distance for line planting is the same as that employed for reforestation. In the case of nest planting, the planting distance will be 1.0 m (square planting of four seedlings in one nest) (see Fig. 52).

f. Planting

Large seedlings are preferable for enrichment planting. The timing of the planting is the same as that for reforestation.

g. Supplementary Planting

The details of the supplementary planting for enrichment are the same as those for reforestation.

3) Natural Seeding Regeneration

a. Subject Sites

Natural seeding regeneration will be selected for those stands subject to single tree selective felling where human assistance is unnecessary because of the presence of many succeeding trees or the excellent state of the regeneration and growth of naturally regenerated young trees and those stands where natural regeneration without human assistance is expected to take place for a long time due to the site conditions and/or legal restrictions. Natural seeding regeneration will also be applied for selectively cut sites of damaged trees if the conditions are similar to those stands described above.

b. Point to Note

If limbs and tops cover young trees after cutting, they should be cleared.

4) Regeneration by Sprouting

a. Subject Sites

Regeneration by sprouting will be selected when a broad-leaved stand is to be created after cutting in a broad-leaved forest or at a broad-leaved forest site in a needle-leaved or mixed forest.

b. Timing of Cutting

Cutting should be avoided during the period when the sap is vigorously flowing or during extremely cold periods and the trees are cut by the root collar. After cutting, the limbs and tops should be removed from the stump.

(2) Tending Methods

The following tending methods will be employed in accordance with the Guidelines.

1) Reforestation

Tending in the form of weeding and improvement cutting, etc. will be conducted if the planted trees are suppressed by the surrounding vegetation or broad-leaved trees. Weeding will, in principle, be spot weeding and the cleared weeds will be laid at the base of the planted trees to prevent drying and to suppress the new growth of weeds. If a planted tree is forked, that of poor growth will be cut to ensure a single stemmed tree.

2) Enrichment

While the tending details are similar to those of reforestation, improvement cutting and brush cutting will be specifically conducted to prevent the suppression of the planted trees by broad-leaved trees and shrubs.

3) Regeneration by Sprouting

ny sprouts, two or three good quality and dominant sprouts will be selected where such difference is apparent and the poorer sprouts will be cut.

(3) Regeneration Period and Completion of Regeneration

Although the forest fire in 1996 increased the land area requiring regeneration (logged-over sites, fire damaged areas and hospitable sites), the regeneration of new cutting sites will be conducted within two years of cutting.

In the case of existing reforestation sites, all of the sites were under the damage by the fire in 1996. Consequently, there are no sites of which the status will be changed from a reforestation site to a man-made forest.

(4) Regeneration Sites and Regeneration Volume

As a result of the forest fire in 1996, the area in need of regeneration has sharply increased, exceeding the present reforestation capacity. Actually the only western Tojiin Nars Area from Herane River where includes the Model Area 1 has 8,700 ha of fire-damaged forests of which damage level were found as large. Accordingly, the regeneration work at fire damaged areas and hospitable sites will be partly postponed. Table 109 shows the expected regeneration sites and regeneration volume in the plan period (see Appendix 18 and forest management plan map).

(5) Nursing

1) Seedling Supply System

The supply of the seedlings required for reforestation and enrichment will mainly rely on the nursery at Hond which is run by the Forestry Office as suggested by the Guidelines. In addition, close liaison will be established with the nursery of Vocant Lumber Company to ensure an adequate supply of the required planting stock.

2) Species for Production

The subject species for nursery production are *Pinus sylvestris* and *Larix sibirica* which are planted in the Intensive Area.

3) Required Quantity of Seedlings

The quantity of seedlings required based on the reforestation and enrichment areas to be planted during the plan period is shown in Table 110.

Table 109 Regeneration Sites and Regeneration Volume

Model Area	Site to Be Regenerated		Regeneration Plan					
	Division	Area (ha)	Nos. of Compartment, Sub-Compartment and Section	Planting (ha)	Enrich-ment (ha)	Natural Seeding (ha)	Sprouting (ha)	Total (ha)
1	Hospitable Site	16						
	Logged-Over Land	269	8①[2,3], ②[1,3], ⑧[3], 9①[2]③[2]④[1]	NP 57				57
	Cleaning of Fire-Damaged Trees (UN)	1,300	2①[5], ②[4], 3②③[1,4], ⑤,⑥,⑦,⑧[1], ⑩[1], ⑪,⑫, 4③[2], ④[2], ⑥[3]	NP 450				450
	Cleaning of Fire-Damaged Trees (NP)	471	1②[2], 2②[2,3,5,8], 3③[2,7], ⑧[2,3], ⑩[2,3], 4④[1,3-5], ⑥[1,2]		NP[144] 471			[144] 471
	Plantation (Fire-Damaged)	97	3①④	NP 29				
	Total	2,153		536	[144] 471			[144] 471
2	Hospitable Site	143	20⑩, 23④, ⑦⑨	NP 59				59
	Fire-Damaged Site (UN)	2,496	19⑭[1], ㉒[3], 20③[2], ④[2], ⑤[3], ⑦[1], ⑨[1,4], ㉒[1], 22㉓[2], 23③[2], ⑥[2,4], ⑩[2], 24⑦[1], ⑧, ⑭[2,4,5,7], ⑯[2]		NP[53] 186	17		[53] 203
	Fire-Damaged Forest Stand (NP, N, M, L)	289	2②[3], 20②[1,2], ③[1], ④[1], ⑤[2], ⑦[2], ⑨[2,3], 22㉕[1], 23⑥[1,5], ⑩[1], 24⑦[2], ⑭[3,6], ⑮[3], 26⑥[1], 31②[2], ⑮[2]		NP[64] 223	25	52	[64] 300
	Cutting Plan	650	2②[5], 5⑨, ⑪, ⑬, ⑭, ⑮, ⑯, ⑰, 6④, ⑤, ⑦, ⑧[2], ⑨[3], 31②[1], ⑮[4]		NP[59] NP[67] 416		154	[126] 570
	Total	3,578		59	[243] 825	42	206	[242] 1,132
	Grand Total	5,731		595	[387] 1,296	42	206	[387] 2,139

Notes 1) The numbers of the enrichment is obtained from the subject area. The numbers with brackets are the substantial areas for the enrichment.

2) The regeneration amount for the cutting plan is 8/10 of the area to be planted.

3) In the columns of Reforestation and Enrichment, NP and NL mean *Pinus sylvestris* and *Larix sibirica* respectively.

4) The site is described as "8①[2]" for Compartment No. 8, Sub-Compartment No. 1 and Section No. 2.

Table 110 Required Quantity of Seedlings and Nursery Size

Species	Planting Area (ha)		Planting Density per ha	Necessary Seedlings by Thousand			Nursed Seedlings per m^2	Corresponding Necessary Area of Nursing Site (ha)
	Reforest-ation	Enrich-ment		Reforest-ation	Enrich-ment	Total		
Pinus sylvestris	595	320	3,000	1,825	982	2,807	34	8.3
Larix sibirica		67	3,000		206	206	34	0.6
Total	595	387		1,825	1,188	3,013		8.9

Notes 1) The planting area for the enrichment is the substantial area to be planted.

2) The number of necessary seedlings is used for the supplementary planting and counted as 25 % of the seedlings covering 10 % of the planting area, which is planted in the duration of 9 years followed by the initial year.

3) The amount of nursed seedlings per m^2 is decided by assuming standardized seedling production rate (some 90 %) and one year of fallow.

4) Points to Note for Nursing

While the present nursing system will principally be adopted, the following points must be noted to ensure the production of high quality seedlings.

a. Seeds

As the Model Areas and their surrounding areas are growing sites of *Pinus sylvestris*, seeds can be obtained locally. Seeds of *Larix sibirica* can be obtained in the upper reaches of Uroo River every year. Efforts must be made, however, to obtain seeds from good quality stands.

b. Nursing

The use of fertiliser, thinning and root cutting should be conducted at appropriate times to ensure the production of good quality seedlings to meet the specifications set by the Guidelines. Organic fertiliser should be used to prepare good soil for the nursing beds while chemical fertiliser should be used to encourage root growth. Care must be taken not to use too much nitrogen fertiliser to avoid producing epinastic seedlings. Root cutting should be conducted in the third year or later. The thinning of seedlings of poor growth or quality and damaged seedlings among densely planted seedlings should be conducted with a view to facilitating the well-balanced growth of the seedlings between the trunk and the root system.

c. Handling of Planting Stock

Planting stock must be carefully handled to avoid drying and damage to the roots.

8.2.4 Forest Roads

(1) Planned Routes

The following routes will be adopted for trunk forest road construction, taking the existing routes of dirt forest roads into consideration, while meeting the relevant requirements specified by the Guidelines.

① Route which runs from Altanbulag through Model Area 1, crosses Iftuck River at the merging point of Mongoin River and Hangai River and runs through the western part of Model Area 2 along Hangai River southward and

the Hangai Pass to a district road by Uroo (total length: 63 km, including 12.9 km in and around Model Area 1 and 15.5 km in Model Area 2, namely Altanbulag-Uroo Route)

② Route which runs from Altanbulag via Hond, crosses Herane River at the merging point of Iftuck River and Bohloon River and runs along Bohloon River in Model Area 2 to Uroo (total length: 83 km, including 27 km in Model Area 2, namely Hond-Uroo Route)

③ Route which runs eastward along the boundary between forests and grassland in the Tojiin Nars area from the state road at southern Sukhbaatar, runs along Altan Namaru Farm and the northwestern boundary of Model Area 1, runs to the south of Lake Gun Nuur to Herane River (total length: 50 km, including 9.1 km along the boundary of Model Area 1 duplicating 6.3 km of Route ① above)

④ Route which runs to the upstream area of Mongoin River along Iftuck River from Route ② above, connecting Route ① ith Route ② above (total length: 19 km)

Spur roads will be selected taking the allowable cutting sites and regeneration sites, etc. into consideration while meeting the relevant requirements specified by the Guidelines (see forest management plan map).

(2) Structural Standards

The structural standards for forests roads and spur roads will be those specified by the Guidelines and the following points will be specially considered in the construction of these roads.

① Minimisation of land feature changes while trying to establish a balance between the cutting volume and banking volume

② Establishment of a longitudinal gradient of 2 - 5% in general and the construction of side ditches as well as cross ditches

(3) Planned Construction Length of Forest Roads

The planned construction length of forest roads and spur roads during the plan period is shown in Table 111.

Table 111 Planned Construction Length of Forest Roads

Model Area	Route Name	Division	Work Type	Length (m)	Width (m)	Remarks
1	Altanbulag-Uroo	Forest Road	Improvement	12,500	10	Gravel Surface, Large Side Ditch
	Firebreak (South-North)	Spur Road	Construction	9,000	5	
	Firebreak (East-West)	Spur Road	Construction	1,700	5	
2	Altanbulag-Uroo	Forest Road	Improvement	4,300	10	Gravel Surface, Wooden Bridge (10 m)
	Hond-Uroo	Forest Road	Improvement	8,500	10	Gravel Surface, Wooden Bridge (10 m, 7 m)
	Compartment No. 5 & 6	Spur Road	Construction	12,000	5	
	Compartment No. 22	Spur Road	Construction	4,200	5	
	Compartment No. 23	Spur Road	Construction	3,000	5	
	Compartment No. 24	Spur Road	Construction	3,500	5	
Total				58,700		

Note: The above amounts are designed for the Model Areas.

(4) Forest Road Maintenance

The proper maintenance of forest roads enables long use and safe travelling. The appointment of a person responsible for the maintenance of each forest road is necessary together with the implementation of the following measures with the assistance of forest patrols and local inhabitants.

① Following the defreezing of a road or strong rain, the road should be swiftly patrolled so that the soil discharged to the road surface and side ditches, etc. can be quickly removed and the dented road surface and damaged drainage facilities can be repaired.

② When there is a risk of roadbed collapse, appropriate measures should be introduced, including the prohibition or restriction of vehicle traffic and/or restriction of the load volume and/or travelling speed.

③ Any measure deemed necessary to protect the road structure or to prevent danger to travelling should be implemented.

8.2.5 Forest Conservation

(1) Forest Land Conservation

No special forest conservation facilities are judged to be required given the present conditions of the forest land. It will, however, be necessary to avoid over-grazing when a forest is used for grazing.

(2) Conservation of Rare Forest Vegetation

One group of *Larix sibirica* forests (consisting of Sub-Compartments Nos. 9 through 12 and No. 15 in Compartment No. 8; total area of 336 ha), of which the primeval state is relatively preserved, will be preserved as a nature reserve for scientific research.

8.2.6 Forest Protection

(1) Prevention of Forest Fires

Awareness of the fact that forest fires, which instantly reduce precious forest resources to ash, are mainly caused by human carelessness, such as the throwing away or burning cigarette ends/matches and the inadequate extinguishing of open fires, etc. is extremely important. Accordingly, as advocated by the Guidelines, the prevention of forest fires will be attempted together with related organizations by means of ① strengthened liaison between the various organizations and people involved in fire prevention and fire-fighting, ② promotion of PR activities using the mass media and ③ improved provision of communication, fire-fighting and other relevant equipment.

On the other hand, the construction, improvement of forest roads and spur roads followed by the regular maintenance and management should be appropriately conducted, also recognizing that those access roads will have a critical role as firebreaks and access for fire fighting.

(2) Damage to Standing Trees Due to Logging and Skidding

In order to prevent unnecessary damage to standing trees due to logging and skidding, full tree length logging will be prohibited and half length logging or specific length logging will be employed as specified by the Guidelines.

(3) Prevention of Damage Due to Diseases, Harmful Insects and Animals

The measures suggested by the Guidelines will be employed to prevent damage due to diseases, harmful insects and animals.

(4) Weather Damage

The measures suggested by the Guidelines will be employed to prevent weather damage.

(5) Damage by Domestic Animals

The measures suggested by the Guidelines will be employed to prevent damage due to domestic animals.

8.2.7 Preparation of Forest Management Plan Maps, etc.

(1) Forest Inventory Book

The forest inventory book was compiled on the basis of the aerial photo interpretation and the findings of the field survey (see the forest inventory book) following the procedure set by the Guidelines.

(2) Forest Type Map and Forest Management Plan Map

Also forest type maps (scale: 1/25,000) and forest management plan maps (scale: 1/25,000) were prepared following the procedure set by the Guidelines (see the forest type map and forest management plan map).

8.3 Forest Management System

(1) Liaison Between Forest Management-Related Organizations

All forests in Mongolia are owned by the state and are under the jurisdiction of the Ministry of Nature and the Environment. While forest management in Selenge Aimak used to be the responsibility of the Forestry Office under the supervision the Division of Agriculture, Stock Raising and Natural Conservation (currently reorganised as the Natural Resources Policy Division), the enforcement of the new Forest Law in June, 1996 transferred the authority relating to the use of forests, etc. to the districts and *bags*. At the same time, the authority to permit the cutting of standing trees was delegated to district chiefs in the case of cutting to produce commercial timber, heads of Bags in the case of cutting to produce timber for home

use and nature protection officers in the case of cutting to produce firewood for home use and the use of byproducts. However, the total cutting volume must be within the limit set by the aimak government. As a specialist forestry organization, the Forestry Office has been newly assigned a series of work, including the advance assessment of applicants for cutting permits approved by the district chiefs, conclusion of cutting agreements with permitted applicants, evaluation of the reforestation progress at cut-over sites and improvement cutting and the clearance of damaged trees, etc. in such protected forests as green zones.

Such administrative work as surveying, patrolling and law enforcement in the field is conducted by nature protection officers posted in the districts. These officers are responsible for the protection and management of natural factors which include not only forests but also land/soil, water and air. One to four officers are assigned to each district in Selenge Aimak, totalling 36 officers as of December, 1994 (in addition to six nature protection officers belonging to the Forestry Office and responsible for the conservation of protected *Pinus sylvestris* forests). However, this manpower level cannot be said to be sufficient to properly conduct the assigned work in such a vast area. Moreover, the present means of communication and patrolling, etc. are also inadequate.

Because of the present complexity of the forest management system involving the Forestry Office, districts and *bags*, etc., whether or not forest management is properly conducted depends on close liaisoning between these players. If such liaisoning is not feasible, it may be necessary to establish a centralised forest management organization and/or to review the forest management system, including the assignment of forestry experts to districts. The prospect of establishing a nature management system whereby a small number of people can properly conduct such vast management in a vast area must be examined in the future based on the progress of the present system.

(2) Strengthening of On-Site Management System

At present, nature protection officers are mainly assigned the following duties.

① Issue of permits to cut trees to obtain firewood for home use and permits to use forest byproducts

② Provision of guidance on fire prevention for people entering forests for cutting, use of byproducts, collection of deer antlers, hiking or other purposes during the forest fire hazard season, patrolling and fire-fighting

③ Supervision of cutting, logging and skidding activities to produce timber for commercial or home use

④ Patrolling to find damage due to weather, diseases, harmful insects or animals and prevention of illegal activities (illegal cutting, illegal harvesting, illegal digging, illegal hunting and illegal grazing in prohibited areas)

The busy work of the nature protection officers is illustrated by the fact that some 300 permits for cutting for firewood for home use are issued every year in the Altanbulag District. It is believed that these officers will be assigned extra duties in the future, including the selection of appropriate reforestation sites, surveying of tree growth at reforestation sites and the management of forest and spur roads.

In view of this prospect, while an increase of the manpower is desirable, it is also necessary to improve the abilities of the officers together with upgrading of the means of communication to strengthen the on-site management system in order to achieve better forest management with limited manpower.

1) Provision of Training

The nature protection officers currently assigned to districts in Selenge Aimak are mainly graduates of agricultural colleges and, therefore, are not specially trained to deal with forests or forestry. It is, therefore, necessary to provide forest and forestry training for these officers to improve their expertise. Possible training items are listed below.

① Understanding and enforcement of forest-related laws, such as the Forest Law, Forest and Grassland Fire Prevention Law on Special Protected Areas, Hunting Law and regulated regulations

② Basic knowledge and practical training related for forest surveys, including forest surveying, tree measurement and aerial photograph interpretation

③ Interpretation of topographical maps and forest type maps

④ Basic knowledge and practical training relating to forest ecology and forest activity-related issues, such as harvesting and regeneration

⑤ Basic knowledge and practical training relating to forest meteorology, forest soil and reforestation-related issues, such as nursing, land preparation, planting and tending

⑥ Prevention and extinguishing of forest fires

⑦ Basic knowledge relating to damage caused by diseases, harmful insects and animals and handling of green zones and headwater forests, etc.

The proper implementation of forest management and appropriate forestry activities based on a forest management plan will be attempted through the above training. The following points must be particularly noted in the light of the enforcement of the new Forest Law.

① Trees other than those specified by a cutting agreement or cutting permit must not be cut to prevent the degradation of forest resources.

② The survival of trees which are not to be harvested by cutting work must be ensured by means of replacing clear cutting with selective cutting and special care must be taken to prevent damage to young trees and remaining trees by logging and skidding.

③ Anyone entering a forest during the forest fire hazard season must strictly abide by the fire prevention measures.

④ Forest roads and spur roads must be appropriately used and maintained by means of regular repair, traffic restrictions when there is a risk of the roadbed being softened and the active use of frozen roads, etc. in view of their importance for the transportation of logs and for fire-fighting activities.

2) Improvement of Means of Communication

Nature protection officers lack access to such means of communication as telephones and radio equipment except at district offices regardless of their posting to a district office or to locations near forests subject to management. Together with the lack of maps, such as forest type maps, they find it difficult to

accurately and swiftly conduct normal administrative communication and emergency communication regarding forest fires, etc. The provision of maps (topographical maps and forest type maps) is particularly important to enable the pinpointing of the sites of forest fires, etc. by latitude and longitude instead of using obscure place names.

It is, therefore, necessary to provide nature protection officers with forest inventory books, forest type maps (scale: 1/50,000) and topographical maps (1/100,000), all of which are essential tools for forest management, so that forest management can be conducted based on clear information on the compartment, sub-compartment, latitude and longitude and the exact location of each forest (stand) can be pinpointed.

While horses are currently used for patrolling purposes (although the cost of feed is supposed to be paid by law, it is not paid due to financial difficulties), motorbikes and four wheel drive vehicles should be provided in the future to improve the mobility of nature protection officers.

(3) Cooperation of Local People

Proper forest management is mainly ensured by the appropriate implementation of the relevant work by natural protection officers, the efficiency of which is only achieved with the active cooperation of local people. It is, therefore, important to cultivate an affection for forests on the part of local people to improve their understanding of the importance of forests and to develop the idea of protecting forests themselves.

To develop this idea of self-reliance on the part of local people, it is essential for the forest management organization to establish a reputation among local people of being highly reliable through the proper implementation of day-to-day work and smooth communication with local people. Moreover, it is important to make those local people living in forest areas conduct fire prevention, fire-fighting and other forest conservation activities in exchange for firewood and timber for home use at a reduced cost for certain quantities. For this purpose, a settlement or group of nomads living in a certain area should constitute a unit. Such arrangements are necessary as the cooperation of local people cannot necessarily be assured by the simple enforcement of the Forest and Grassland Fire Prevention Law, the provisions of which include the imposition of a fine for violation of such compulsory

obligations as the prompt notification of forest fire and involvement in fire-fighting activities.

Moreover, those cutting trees in accordance with a cutting agreement or permit must be reminded of their obligation to strictly abide by the conditions of the agreement or permit and the penal provisions of the Forest Law must be strictly applied to those violating the Forest Law. The strict enforcement of various laws and contractural conditions, including the measure of not granting a cutting agreement or permit for a certain period to those who have bought illegally produced items, should contribute to the implementation of appropriate forest management.

8.4 Forest Fire-Related Measures

8.4.1 Use of Damaged Trees

When trees are damaged by a forest fire, aerial photography on the damaged area and immediate identification of the location of the damaged site and the extent and other details of the fire are important in addition to the establishment and apt implementation of measures to use the damaged trees as soon as possible based on a comprehensive examination of (i) the cutting and regeneration methods, (ii) capability of the prospective operators to conduct felling and logging and of the timber mill to process the damaged trees and (iii) general trends of the timber demand, etc.

(1) Location and Other Details of Damaged Trees

The prospective use of damaged trees varies depending on (i) the distance from a market and road conditions, (ii) topography of the damaged site and (iii) scale and other details of the damaged trees, etc. The use of damaged trees is generally difficult when a fire damaged area is (i) far from a market, making the construction of a new road or the repair of a poor existing road(s) necessary, (ii) located on a slope, making the prospective logging efficiency poor, (iii) a small area with a small volume, (iv) covered by broad-leaved trees with low commercial value and/or (v) subject to special legal restrictions, as the logging and transportation costs of the cut trees are likely to exceed the market value of the damaged trees.

In contrast, the use of damaged trees is feasible when a fire damaged area is (i) near a market with good road access, (ii) located on a gentle slope, allowing logging and skidding by tractor, (iii) a large area with a large volume, (iv)

covered by relatively large diameter and good quality needle-leaved trees and/or (v) not subject to special legal restrictions.

Therefore, the immediate survey after fire should be conducted in terms of i) location and area of fire-damaged sites, ii) the damage level, and iii) practical condition of damaged trees on species, DBH, quality, etc.

(2) Decision on Forestry Operation Methods

It is important to decide the forestry operation methods in regard to cutting, logging and regeneration using the forest management plan as a reference as soon as the location, scale and other details of the damaged trees is known. The forestry operation methods, taking the species of damaged trees, extent of damage and desirable restoration method for damaged sites, etc. into consideration, are described next.

1) Broad-Leaved Forests

Such tall, broad-leaved trees as *Betula platyphylla* and *Populus tremula* have a special characteristic of commencing regeneration by sprouting immediately after a fire, quickly followed by natural seeding regeneration. Accordingly, if damaged broad-leaved trees can be used as firewood or for other purposes, any cutting method other than clear cutting can be freely selected with natural regeneration being selected for cut-over sites. If the use of damaged broad-leaved trees is found to be difficult, there is no option but to leave the dead trees to decay.

2) Needle-Leaved Forests and Mixed Forests

a. Small Damage

In the case of small fire damage, the trees killed by fire tend to be scattered and composed mainly by small or medium diameter trees. When there is no concentration of damaged trees, it is often difficult to cut and use the damaged trees because of the likely prohibitive costs of cutting and logging, etc. However, the clearance of damaged trees may be profitable if the damaged trees have market value, if a market is available nearby and if the cutting and logging costs, etc. are low. When the use of damaged trees is found to be possible, a combination of selective cutting and natural regeneration should be opted for in principle. Moreover, if tree length logging carries a risk of damaging the

remaining trees, either half length logging or specific length logging should be implemented.

b. Medium Damage

In the case of medium fire damage, the damaged trees tend to be concentrated to a certain extent and include large diameter trees. As it is possible to use the cut trees if a market is relatively nearby and if the diameter class and quality of the damaged trees are reasonably good, a combination of group selective cutting and enrichment should be opted for. The maximum size of an open spot resulting from clear cutting should be limited to approximately 0.3 ha in order to avoid the poor survival and growth of planted trees due to adverse weather conditions.

c. Large Damage

In the case of large fire damage, the damaged trees tend to show a large volume over a large area. However, the damaged trees include carbonised trees and trees of which the outer side has hardened, making their use value as timber very poor. The cutting of only damaged trees with a high commercial value results in vast unstocked forest land, possibly obstructing the favourable growth of planted trees due to worsened weather conditions and burning out of Ao layer of soils. The following methods should, therefore, be employed.

① Needle-Leaved Forests/Mixed Forests at Mountain Sites

Group selective cutting should be opted for. The maximum size of an open spot resulting from clear cutting is 0.3 ha and the cut volume of damaged trees should be kept at 30% or lower of the growing stock. Enrichment should be conducted for regeneration purposes.

② Lowland *Pinus sylvestris* Forests

In principle, strip clear cutting should be opted for with a cutting width of generally upto 150% of the average tree height of the subject stand while creating reserve belts, the width of which should be not less than 150% of the cutting width. The cutting area should not exceed 40% of the subject area. No cutting of damaged trees should be conducted in these reserve belts to facilitate the natural

seeding regeneration of *Pinus sylvestris*. The cutting direction should be at a right angle to the prevailing wind direction. Basically the maximum strip length should be 200m. In principle, the regeneration of former strip clear cutting sites should be reforestation. Uncut damaged trees should be preserved, excepting those which are located in the cutting strips and which have, therefore, been knocked down by a bulldozer during land preparation.

(3) Capabilities of Cutting/Logging Operators and Sawmills and Trends of Timber Demand, etc.

As the cutting and logging of standing trees is dangerous work, technical expertise is required to avoid risks and damage to remaining standing trees during the work. In addition, various rules and agreed conditions on cutting must be followed during cutting. Therefore, it is highly desirable for trustworthy operators with the necessary technical expertise to be entrusted to conduct the cutting and logging of damaged trees.

In regard to sawmills, it is difficult for them to purchase and store logs remarkably beyond their sawing capacity. Moreover, the sawed timber price can substantially drop depending on the demand level or when the timber production volume largely exceeds the demand. Another aspect to be considered is that damaged trees are not the preferred raw materials for sawmills unless the price is significantly lower than the raw tree price. The underlying reasons for this are that fire damaged trees tend to be harder than ordinary raw trees, possibly damaging the saws, and that some damaged trees have already been invaded by borers, etc., resulting in a decline of their market value for timber production.

In general, an up-to-date understanding of the state of operators (technical strength, management ability and credibility, etc.) is the key to the early implementation of cutting and the use of damaged trees and it is necessary to make efforts to foster reliable operators.

In addition, the introduction of band saws which can process any size of logs will contribute to the flex extraction of damaged trees.

When the volume of logs or full length trees to be transported out of forests exceeds the normal sawing capacity, the following measures should be introduced

depending on the actual local conditions. These measures contribute to the removal of feeding trees which constitute a hotbed of the propagation of harmful insects.

① The logs should be stored submerged in a pond or water should be continually sprinkled over them at the timber yard.

② The logs should be piled in parallel crosses in a well ventilated area with a roof (it is essential that the logs are not exposed to rainwater).

③ The logs should be stored after barking (the barked logs may be stored for log houses with the assistance of volunteers).

(4) Early Dealing with Damaged Trees

Standing trees which have been physiologically weakened due to fire damage can be subject to secondary damage by such borers as long-horned beetles and wood borers. In general, it is necessary for those trees which have been either damaged or weakened by forest fire to be cut and logged for use with two years of the damage occurring and can only be used as firewood. It is, therefore, essential to cut and log fire damaged trees as soon as possible for use.

There have been incidents (see 6.2.5) where fire damaged trees have been used as the excuse for illegal cutting. Some argue that the decay of damaged trees without permitting their cutting is an acceptable way of preventing illegal cutting and that the restoration of damaged forest land should be left to nature.

However, as the importance of forest resources in national life is expected to continue to increase, it is essential to try to restore depleted forest resources due to fire as soon as possible so that they can be handed on to subsequent generations. Given the lengthy time required for man-made forests to become usable resources, one opinion favours the early cutting of fire damaged trees with market value and the saving of the sales revenues to create a reforestation fund for the restoration of forests.

If the volume of fire damaged trees is within the allowable cut volume, damaged trees can be cut instead of live trees. If the volume of fire damaged trees exceeds the allowable cut volume, it may be necessary to exceed the allowable cut volume

to cut damaged trees without touching live trees. The coordination of allowable cut volume by aimaks or districts will be also needed.

While strengthening the proper implementation of forest management through holding councils participated by related organizations in terms of early use of damaged trees, another measure to be considered is the withholding of cutting permits for a certain period for those operators which have violated the cutting-related regulations and agreed conditions. It may also be necessary to ban sawmills, etc. which have purchased logs from such operators from cutting.

Based on the above arguments, the following measures for the use of those trees damaged by the fire in the Model Areas in 1996 are put forward.

In Model Area 1 where large and medium damage was caused, a combination of strip clear cutting (group selective cutting for stands with live trees) and reforestation (enrichment for the group selective cutting site) should be opted for. Because the subject forests are classified as green zones, clearance of the damaged trees must be properly conducted by the Forestry Office as stipulated by the Forest Law (the Forestry Office is responsible for such work even if the work is subcontracted.)

In Model Area 2, damaged needle-leaved trees in the fire damaged areas in Compartment Nos.20, 23 and 24 can be used since the damage is large and the area is sizable. However, the use of scattered, damaged needle-leaved and broad-leaved trees on slopes in remote areas will be difficult for the production of general-purpose timber, partly because of the location and partly because of the small concentration in terms of area and volume together with the low commercial value.

The volume of needle-leaved trees damaged by the fire is as large as 575,000 m^3 in the Model Areas alone which is equivalent to between 10 to 20 years of allowable cut volume for the Altanbulag District. The local capacity to conduct the necessary cutting and logging within two years when the use value of the damaged trees is not significantly reduced is limited even if there is sufficient capacity to process them into timber.

8.4.2 Measures to Combat Secondary Damage

Among the measures to prevent secondary damage after a forest fire, those designed to deal with harmful insects which extend the damage by attacking trees weakened by fire are particularly important. In particular, such borers (secondary harmful insects) as long-horned beetles and wood borers invade the stem of physiologically weakened trees because of the death of all or most of the leaves and branches, killing or speeding up the death of such trees and exacerbating the fire damage. These borers also attack freshly cut trees with bark and invade new stumps to constitute hotbeds of propagation.

Meanwhile, such primary harmful insects as *Dendrolimus pini* and *Evetria resinella* repeatedly eat the entire leaves in a single growing season. If they do not eat the leaves continuously for several years, the trees can survive. Nevertheless, declined growth due to the decrease of leaves weakens the vigourousity of the trees which become vulnerable to attack by secondary harmful insects. There are many harmful insects which have various areas of attack (see 6.3.5).

(1) Extermination of Primary Harmful Insects

Such primary harmful insects as *Dendrolimus pini* and *Evetria resinella* can be exterminated by the following methods.

1) Spraying of Insecticide

The larvae (caterpillars) which eat needle-leaves and buds can be exterminated by the spraying of insecticide. Many effective insecticides are currently available and are particularly effective when sprayed on young larvae.

2) Trapping by Light

Light can be used to attract and kill imagoes (adults).

3) Ploughing of Soil

Ploughing of the soil around stumps kills the larvae wintering there by exposing them to air.

4) Use of Natural Enemies

The protection and breeding of predatory birds of *Dendrolimus pini* and others or parasitic insects should be considered to exterminate harmful insects. Such microbes as bacilli and viruses can also be sprayed in forests for the same purpose.

Among the termination methods described above, extensive termination using methods 1) through 3) above in the case of extensive damage is difficult without huge funding to provide the necessary quantities of insecticide, fuel, equipment and labour although these methods may be able to effectively address localised damage after a forest fire. Method 4) requires a long time to achieve its goal and is unsuitable as an emergency measure.

(2) Extermination of Secondary Harmful Insects

Such borers as *Monochamus galloprovincialis* (long-haired beetle) and *Ips sexdentatus* (wood borer) which are regarded as secondary harmful insects can be exterminated in the following manner.

1) Spraying of Insecticide

The spraying of insecticide is not particularly effective against the larvae of borers which eat the stem under the bark. Consequently, toxic gas may be used to kill the eggs laid on the stem or insecticide may be sprayed from the air or in the field when the insects reach the imago stage. The spraying of insecticide on the stem immediately after hatching is fairly effective at the larva stage. However, it is difficult to determine the timing for spraying and spraying is ineffective once the larvae start to discharge chips from the stem. At this stage, cotton immersed with insecticide is filled into the holes created by the larvae and then clay is used to seal the holes. This is not as easy as it sounds and, in short, the extermination of larvae which have bored into the stem using insecticide is difficult.

The use of insecticide to exterminate imagoes is feasible as these fly in the stand. Given the lengthy production period (1 - 2 months) of imagoes, single spraying is insufficient. In practice, aerial spraying over a wide area is difficult as the chemical insecticide could harm grazing stock. While single tree spraying is a viable option, this is both time and labour consuming. The use of toxic gas is also a difficult option.

2) Removal of Feeding Trees

Dead or physiologically weakened trees due to fire and trees damaged by borers should be quickly cut and logged outside the stand to remove feeding trees which are a hotbed for the propagation of harmful insects. The trees damaged by harmful insects can be either cut and incinerated or barked for the spraying of insecticide. As stumps are also hotbeds of insect propagation, they should be barked and sprayed with insecticide. The limbs and tops should also receive the same treatment, i.e. either incineration or sprayed with insecticide. The cut trees must be swiftly removed from the stand to prevent further insect propagation. The same applies to weakened trees which should be cut and removed from the stand. Another effective measure is the provision of a mobile chipping machine in the stand to chip the damaged trees so that the chips can be spread on forest land.

In reality, however, it is often difficult to effectively control secondary harmful insects because of the presence of a huge number of damaged trees, making the early cutting and removal of all of the damaged trees almost impossible, and the prohibitive cost of barking, incineration and/or the spraying of insecticide. It is often the case that fire damaged trees, hollow trees and small diameter trees tend to be left behind in the stand because of the uneconomical logging and transportation costs, creating feeding trees which reduce the effectiveness of extermination measures for borers.

3) Use of Natural Enemies

Birds which eat pine weevils, etc. and such parasitic insects as *Teleomys* spp. should be protected and even bred to destroy harmful insects. However, this process requires a long time to achieve its goal and is unsuitable as an emergency measure.

At present, none of the above-described extermination method are decisive. It can be said that the damage caused by secondary harmful insects cannot be reversed unless the damaged trees and weakened trees which feed such insects are completely cleared.

(3) Post-Fire Insect Damage Control Measures

The measures described above to prevent secondary damage may be feasible when the extent of fire damage is small. In the case of extensive damage, such as

that caused by the fire in 1996, however, it is hardly feasible to promptly cut and remove the damaged or weakened trees which feed harmful insects or to spray the stumps, limbs and tops because of the difficulty of securing sufficient funds to finance the huge insecticide and labour costs, etc. The cutting, barking and storage in water of the damaged trees offer only limited scope even if they can be conducted. In short, it is practically impossible at present to introduce effective secondary damage control measures.

What is important for an insect control measure under these circumstances is to determine the priority order of all forests in the fire damaged areas from the national and local viewpoints, followed by concerted efforts to spray insecticide and to remove feeding trees (damaged trees and weakened trees) in higher ranked forests. This means that an increase of the dead trees is accepted in lower ranked forests. Realistic secondary damage control measures at present are, therefore, to protect live trees with the tactical use of limited insect control funds to prevent the wastage of valuable forest resources and to reduce the number of feeding trees as much as possible through the prompt cutting and removal of dead trees.

The public sector as well as the private sector should be urged to cut and remove at least some of the usable trees damaged by the fire in 1996 in both Model Area 1 and Model Area 2 in order to reduce the number of tree feeding borers as soon as possible.

8.4.3 Restoration Measures for Fire Damaged Areas

The fire damaged areas in 1996 consist of natural forests, *Pinus sylvestris* reforestation sites and naturally regenerated young stands (fire damaged areas prior to the fire in 1996). The restoration of damaged stands is usually conducted by ① natural regeneration, ② reforestation or enrichment or ③ a combination of ① and ②, the selection of which depends on the outcome of a comprehensive review of the forest management type, site conditions, available forestry labour and available restoration funds, etc. of each stand.

In the case of *Pinus sylvestris* reforestation sites and naturally regenerated young *Pinus sylvestris* stands in fire damaged areas existing prior to the fire in 1996, more than half of the planted trees were killed and groups of naturally regenerated trees were also collectively killed. A high density of tall grass has grown at these sites and natural seeding regeneration from the sides cannot be anticipated. Consequently, reforestation will be necessary at some of the reforestation sites and fire damaged

areas to restore needle-leaved forests. The site conditions and other aspects of these sites pose no special problem for reforestation as long as they formed young stands prior to the fire damage. In contrast, further examination of the damaged natural forests will be required as their site conditions, etc. are diverse.

(1) Site Conditions of Damaged Areas

If the site conditions and market value of the damaged trees in the fire damaged areas are unfavourable, the damaged trees should be left standing (see 8.4.1), making it necessary to conduct natural regeneration for their restoration. In this case, while needle-leaved trees will take a long time to regenerate, broad-leaved trees commenced the process of regeneration by sprouting immediately after a fire, making reforestation unnecessary. A broad-leaved stand can easily restore itself through the selection of a reasonable number of fine trees and the cutting of the remainder a few years after sprouting.

When fire damaged trees are cut and used, reforestation or natural regeneration should be selected to restore the cut-over sites. The actual regeneration method to be employed will depend on the preferred species, extent of fire damage, cutting method, land productivity and topographical conditions. While tree death by fire damage tends to occur with small diameter trees first, followed by medium and large diameter trees, cutting to use damaged trees tends to be conducted in the reverse order, i.e. starting with large diameter trees and moving onto medium and small diameter trees. In other words, smaller diameter trees killed by fire damage tend to be left uncut. Therefore, a cautious approach is required as the employment of the conventional land preparation method using a tractor to push all small diameter trees over at sites of major damage results in large unstocked forest land with worsened weather conditions, creating a prospect of difficult growth for the planted trees.

In the case of damaged needle-leaved stands, the following regeneration methods appear suitable.

1) *Pinus sylvestris* Stands

As *Pinus sylvestris* stands mainly grow on sandy soil, enjoying relatively good natural seeding regeneration, it is important to encourage the growth of new buds appearing after a fire together with newly planted trees. At those stands suffering from major damage, either group selective cutting or strip

clear cutting (for hill forests) should be employed with a maximum cutting rate of the damaged trees of not more than 40% of the total growing stock.

Enrichment should be used as the regeneration method for group selective cutting sites and the maximum size of each unstocked open spot created by cutting should be approximately 0.3 ha to avoid the poor survival and growth of the planted trees due to worsened weather conditions. See 8.2.2 for the details of enrichment. During land preparation for enrichment work, the dead trees remaining in uncut areas of open spots should be preserved unless they hinder planting work.

Reforestation should be employed as the regeneration method for strip clear cutting sites to ensure the quick restoration of stands. The cutting width for the strips should be approximately within 150% of the mean tree height while the width of the remaining strips should be not less than 150% of the cutting width. See 8.2.2 for the reforestation method adopted in the cut strips. The damaged trees in the remaining strips should not be cut because of the natural seeding regeneration. The dead trees remaining in the uncut strips within the cutting width should be preserved to prevent worsening of the weather conditions unless they hinder planting work. It will, therefore, be necessary to take extra care not to push these trees down by a bulldozer during land preparation work.

A combination of group selective cutting and enrichment should be employed at sites of medium fire damage as described in 8.2.2

At sites of minor fire damage, single tree cutting should be followed by natural seeding regeneration.

2) *Larix sibirica* Stands

Larix sibirica stands escaped death by the fire in 1996 although the lower stems of some trees were burned. Consequently, the introduction of special restoration measures is unnecessary. If many trees are killed by fire in the future, reforestation or enrichment should be employed to restore the damaged sites because of the poor prospect of the natural regeneration of *Larix sibirica* stands. No artificial regeneration measures should be implemented at those sites where the transition to a broad-leaved stand is inevitable.

(2) Priority Distribution of Reforestation Funds

As the amount of available reforestation funds needed for reforestation and enrichment at damaged sites is limited, priority distribution is essential based on a comprehensive evaluation of the site conditions and other factors of the subject restoration sites so that restoration work can commence at higher priority sites. The factors determining site priority are described below.

① Land Productivity

Priority is given to highly productive gentle mountain foot slopes, gentle hillside slopes and alluvial sites with Haplic Kastanozems with lesser priority given to convex slopes and sites of relatively low productivity originating from sandy deposits with a positive prospect of natural regeneration.

② Weather Conditions

Priority is given to sites with favourable weather conditions, including relatively small damaged sites surrounded by forests or groups of trees and north-facing gentle slopes, etc. with lesser priority given to those sites with unfavourable weather conditions, including large unstocked areas (due to fire damage) adjoining grassland and south-to-west-facing slopes. This order is applied for the cases except for conducting emergent forest conservation measures.

③ Reforestation Labour

Priority is given to sites near the dwellings of workers with reforestation experience, with relatively good transport access and/or near a nursery producing good quality seedlings coupled with good seedling transportation facilities with lesser priority given to remote sites with poor transport access, etc.

(3) Improvement of Reforestation System

In order to restore the fire-damaged area, the improvement of reforestation system is a very crucial issue consisting of 1) training and allocation of silvicultural engineers, 2) consolidation of key nurseries in terms of facilities and machinery, and 3) improvement of silvicultural machinery and materials.

8.4.4 Forest Fire Prevention and Fire-Fighting Measures

Forest fires occur every year in Mongolia under such weather conditions of dry air and little rainfall, turning valuable forest resources into ash. As most forest fires are caused by human carelessness, including the throwing away of burning cigarette ends/matches and the incomplete extinguishing of open fires, etc., basic measures to prevent forest fires are ① improvement of the public awareness of the need to prevent fires and ② extinguishing of fires at an early stage. Needless to say, these measures must be systematically implemented.

As forest fire prevention and fire-fighting activities are not matters to be only dealt with by forest-related organizations and the public, the Forest and Grassland Fire Prevention Law stipulates the authority and obligations of the central government, central administrative organizations, local administrative organizations, individuals, companies and other organizations and the fire committees of the disaster committees established by administrative organizations at all administrative levels are responsible for implementing the necessary measures. While fire control committees have long conducted various activities, the following activities should be stressed in the future in view of their effectiveness for forest fire prevention and fire-fighting.

(1) Publicity Activities for Forest Fire Prevention

As most forest fires are caused by human carelessness, strong awareness of the need to prevent forest fires on the part of individual persons must be promoted through forest fire prevention publicity activities. A national movement with the help of the mass media is required.

1) Active Promotion of Publicity Activities

Forest fire prevention publicity activities can be promoted in a number of ways, including ① radio and TV broadcasting, ② newspaper advertisements, ③ banners, posters and signboards erected in crowded places and along roads, ④ distribution of pamphlets, ⑤ aircraft and vehicles with loud speakers and ⑥ teaching in schools. Special emphasis must be placed on the prohibition of the throwing away of burning cigarette ends/matches (including educating children of the prevention of playing with matches) and the complete extinguishing of open fires.

2) Thorough Conveyance of Fire Warnings to Local People and Related Organizations

Fire warnings issued by the Meteorological Research Center based on its observation results must be conveyed to the related organizations without fail and also to the public through radio or TV broadcasting to remind of extra care in the handling of fire.

3) Preparation of Patrol Plan and Its Implementation

A patrol plan (featuring subject areas, manpower distribution, patrolling hours and communication method, etc.) should be prepared for important forests and those forests which are frequent entered and actual patrolling should be conducted with the cooperation of all related organizations in order to provide proper guidance for people using forests and also to improve their awareness of the need for forest fire prevention. In addition, greater efforts should be made to obtain the cooperation of local people.

(2) Consolidation of Fire-Fighting System

Forest fires can be extinguished relatively easily if proper fire-fighting activities are conducted at an early stage. Once a fire gains force, however, it is fanned by the wind, making it more difficult to extinguish. The main elements of fire-fighting activities are manpower, water and equipment. What is essential is the firm establishment of an early fire-fighting system.

1) Establishment of Fire-Fighting System

Organizations related for forest fire-fighting must establish a fire-fighting system in advance, covering such issues as mobilisation, command, reinforcement, logistic supply and first aid, etc., which can properly respond to the particular location and scale of forest fire. The map exercise will be effective and important for the said system operation.

2) Development of Fire Notification System

Related organizations must be notified of any sighting of a forest fire. To make this possible, it will be necessary to establish a communication channel between related organizations and between these organizations and the nature protection officers/patrolmen (fire-fighting teams during fire-fighting activities) through the provision of mobile telephones and/or radio equipment as a matter of priority.

3) Provision of Topographical Maps, etc.

When the site of a forest fire is notified between related organizations and between related organizations and nature protection officers (or fire-fighting teams during fire-fighting activities), a place name is too vague to pinpoint the actual site and may only be understood by a few people. In order to ensure the exact identification of the site, the provision of topographical maps and forest type maps for district offices, Bags and each nature protection officer is necessary so that the site of a fire can be clearly notified using latitude and longitude data. In addition, training should be provided for all related persons to enable them to read topographical maps and forest maps, etc.

4) Improvement of Fire-Fighting Equipment

Fire-fighting and related equipment should be provided and should be properly maintained to ensure readiness for use. The relevant equipment includes ① direct fire-fighting equipment: fire engines, light weight portable pumps, folding water tanks, aircraft, fire extinguishing agents, backpack water bags, fire beaters and spades, etc., ② indirect fire-fighting equipment: bulldozers, tractors, chainsaws, brush cutters, axes, handsaws, hoes and control fire ignitors, etc. and ③ transportation and communication equipment: buses, trucks, four wheel drive vehicles, portable radio equipment, hand-held loudspeakers, topographical maps and personal fire-fighting outfits, etc.

5) Improvement of Forest Roads, etc.

During the forest fire in 1996, provincial roads and forest roads (earth roads) played the role of firebreaks while the poorly maintained actual firebreaks failed to fulfill their primary function. Forest roads are very important infrastructure to provide transportation routes for swift and effective fire-fighting activities and also to act as firebreaks. Forest roads can be particularly effective as firebreaks if they are located on the leeward side of a ridgeline which crosses the prevailing wind direction (hazardous wind direction). They cannot perform this function, however, if they are impassable due to poor road conditions and failure to clear fallen trees, etc. It is, therefore, essential to improve the condition of forest roads and spur roads as well as to conduct proper maintenance.

CHAPTER 9

TRANSFER OF TECHNOLOGY

CHAPTER 9 TRANSFER OF TECHNOLOGY

During the course of the Study, the Mongolian side strongly requested full technical exchanges and discussions in view of the special importance of the transfer of technology to the Mongolian counterparts.

(1) Characteristics of Technologies in Mongolia

Mongolia is currently in a transitional period and is making efforts to improve the conventional technologies. A comprehensive review of traditionally adopted technologies and systems is in progress to introduce appropriate technologies in all fields and there are high expectations in regard to the positive achievements of the Study.

The counterparts belonging to the Forest Management Center are researchers with a university degree or equivalent who have been involved in the preparation of forest management plans as well as the implementation of stand surveys. They have also published research papers. In short, the local level of technological knowledge is fairly high although there are serious problems of equipment shortage and deterioration.

(2) Outline of Technology Transfer

During the field survey period, six counterparts, headed by the Director of the Forest Management Center, provided comprehensive support for the field survey team and accompanied the field survey team members most of the time. Technology transfer to the counterparts was conducted in the form of OJT and the actual use of the survey equipment through the field survey associated with topographical map preparation and satellite data analysis, the fact-finding survey on the Study Area, the survey on the Intensive Area, the survey to formulate the forest management plan guidelines and the forest resources survey in the Model Areas, etc.

The equipment provided under the Study mainly consists of measuring instruments for forest inventory and transport/communication equipment required for the implementation of the Study. During the field survey for the present year, the counterparts highly evaluated the survey equipment and showed great eagerness to learn how to use it.

In regard to the use of computers, the Forest Management Center has been using software to compile the forest inventory results and a simple spread sheet software based on Quick Basic and, given the compatibility of these softwares with the computer, the computer will be effectively used if provided. The compilation of the forest inventory results for the

Model Areas was conducted using the spread sheet software and technical transfer was conducted on the input of original data, handling of the functions used for compilation work and the use of input data as a database.

The Mongolian side showed strong interest in not only the use of the provided equipment but also in the analytical process employed for the Study in Japan.

CHAPTER 10

RECOMMENDATIONS

CHAPTER 10 RECOMMENDATIONS

Given the current systems regarding forests and forestry, the availability of various data and information and the extensive damage caused by the forest fire in 1996, it is hoped that the forest management plan described in this report will assist the formulation and implementation of appropriate forest management plans in the future to greatly contribute to the conservation and creation of forest resources and also to the vitalisation of forestry and the forest products industry. It is extremely important to try to secure the necessary funding and manpower and to improve the techniques regarding the conservation and creation of forests together with efforts to prevent forest depletion and degradation because of the status of forests in Mongolia which are located in the critical zone for forest growth and which are extremely precious from the global point of view. In view of this importance of forests in Mongolia, the following recommendations are made based on the findings of the Study.

(1) Prevention of Forest Fires

1) Public Relations Activities for Forest Fire Prevention

As forest fires occur every year, both depleting and degrading precious forest resources, their prevention is a prerequisite for the conservation of forest resources. Forest fire prevention is also important for the assured implementation of a forest management plan. In the future, all forest-related organizations must work together to eradicate forest fires, making it a national movement. In particular, the following measures should be introduced.

① Strengthening of Public Awareness

As most forest fires are caused by human carelessness, public relations activities should be conducted with the assistance of the mass media in order to improve the awareness of individuals of the importance of forest fire prevention.

② Issue of Fire Warnings and Patrols

The issue of fire warnings is currently based on the fire hazard index, of which humidity acts as the sole factor. The maximum wind velocity should be added as another factor to improve the index's reliability while the fire warnings issued should be widely conveyed to the public via radio and TV, etc. Moreover, all forest-related organizations should cooperate with each other to patrol forests and to provide relevant guidance and instructions for people entering forests.

2) Development of Fire-Fighting System

A forest fire can be put out if fire-fighting activities are immediately conducted after the outbreak of a fire. It is, therefore, necessary to establish an early fire-fighting system. To achieve this, the following measures should be introduced.

① Development of Fire-Fighting System

All forest-related organizations in the aimak and districts, including those in neighbouring aimaks and districts, should discuss the establishment in advance of the mobilisation, command, reinforcement, logistic supply and relief procedures for fire-fighting activities corresponding to different places and scales of fire. In addition, a quick response system must be established through map exercises and other activities.

② Development of Notification System

Such communication equipment as mobile phones and radio equipment and topographical maps, etc. should be provided for all forest-related organizations, nature protection officers and patrolmen in order to establish communication channels between all organizations and personnel (including between the headquarters and fire-fighting teams during fire-fighting activities) to ensure the immediate notification of a fire sighting to related organizations so that fire-fighting activities can quickly commence.

③ Improvement of Fire-Fighting Equipment

Fire-fighting equipment and related equipment should be provided in key places and should be properly maintained to enable a quick response to forest fires. The range of equipment should include fire engines, aircraft, backpack water bags, spades, fire beaters, bulldozers, chainsaws, brush cutters, trucks, four wheel drive vehicles and portable radio equipment, etc., all of which should be general-purpose equipment.

④ Improvement of Forest Roads

Forest roads are very important infrastructure as they can act as both firebreaks and transportation routes for swift and effective fire-fighting activities. In view of this importance of forest roads, the construction and improvement of trunk forest roads should be conducted.

3) Early Processing of Fire Damaged Trees

Once fire damage unfortunately occurs to a forest, it is essential to swiftly cut the damaged trees and to transport them out of the forest to prevent any expansion of secondary damage due to borers and also to ensure the effective utilisation of forest resources. To achieve these objectives, the following measures should be introduced.

① Urgent Establishment of Extent of Damage

Using an aircraft, aerial photographs of the fire damaged area should be taken to establish the size of the damaged area, extent of the damage, damaged species and damage volume, etc. based on information contained on the aerial photographs and the findings of field investigations.

② Early Processing of Damaged Trees

An urgent damaged trees processing plan should be formulated based on the extent of the fire damage in view of the swift cutting and hauling of the damaged trees, substituting the damaged tree volume for the live tree cutting volume and adjusting the allowable cutting volume for individual aimaks and districts. The storage in water, barking and outdoor piling of the cut and yarded logs should be arranged in roofed, well-ventilated areas to prevent any further damage by harmful insects.

③ Improvement of Sawing Machines

As the existing sawing machines are only capable of sawing upto a log diameter range of between 18 cm and 55 cm (or 65 cm), small and large diameter trees outside this range are left in a forest, becoming feeding trees which assist the outbreak of insect damage. These sawing machines should be replaced by band saws which can process logs of any diameter class. The use of band saws can improve the sawing yield, thereby contributing to the better conservation of forest resources.

(2) Creation of Forest Resources

1) Formulation and Implementation of Reforestation Programme

At present, forest land which has become unstocked due to fire damage occupies a vast area as unregenerated land and requires quick restoration as forest land. Such improvement will not only restore the depleted forest resources but will also contribute to the prevention of global warming by the fixation of carbon dioxide gas (CO_2). As

the creation of forests takes a very long time, the formulation of a reforestation programme is necessary based on a comprehensive examination of the land productivity, meteorological conditions and labour requirement for reforestation, etc., all of which determine the site conditions of the subject regeneration sites, in order to systematically eradicate unregenerated land. To achieve this goal, reforestation funds must be secured together with the establishment of the following reforestation implementation system.

① Training of reforestation and Nursing Engineers/Technicians and Their Assignment to Field Positions

② Establishment of a Central Nursery

In order to strengthen the seedling supply system, there shold be a nursery which can function as a center equipped with a wheel-type tractor (with attachments), greenhouse, cheesecloth, fertiliser, agrochemicals (germicides, pesticides and herbicides) and an equipment warehouse, etc.

③ Provision of Silvicultural Machinery

In order to promote the reforestation activities, the provision of crawler-type tractors (with attachments), chainsaws, brush cutters, planting tools, trucks and four wheel drive vehicles, etc. will be necessary.

2) Development and Improvement of Reforestation Techniques

The seedling survival rate at existing reforestation sites is rather low because of the specific land preparation method involving the removal of the top soil of vast unstocked land with severe weather conditions and also because of the poor character of the seedlings and poor planting methods. Some sites have been damaged by the weather, diseases and/or harmful insects in addition to the death of many young trees due to ground fires, resulting in a low rate of forests reaching maturity.

In order to improve the situation, the introduction of improved reforestation techniques should be attempted, including land preparation without removal of the top soil, the production of good quality seedlings through better soil and root preparation and mulching at the time of planting.

Further technical developments should be attempted to achieve (i) low cost nursing through a combination of mechanical work and herbicides, etc., (ii) mechanical

reforestation through a combination of machinery or pot seedlings and (iii) reforestation by direct seeding with the skillful use of herbicides, etc.

(3) Improvement of Forest Inventory Technology

1) Introduction of New Forest Inventory Technology and Provision of Related Equipment

The latest forest inventory technology, that is remarkably advanced nowadays, should be introduced to afford more efficient and accurate survey method which would be appropriate for such a country of Mongolia having a vast land with small population.

It should be pointed out that such an introduction require the latest survey technologies on analysis of satellite images or airphoto interpretation, training of the subject engineers as well as provision of the related necessary equipment.

The equipment includes land survey equipment as GPS receivers and pocket compasses, and forest inventory equipment such as Spiegel-Relaskop or Blime-Leiss, which are needed for field inspection.

2) Storage, Accumulation and Utilisation of Technical Information

Aerial photographs were taken before and after the forest fire in 1996. While these photographs have their own value as technical information, they are more valuable in science when combined with satellite images and other information/data through forest survey. In view of their importance, the negatives of these aerial photographs must be properly stored and the photographs widely utilised.

Moreover, trial plots should be established for continuous research on the current annual increment of natural forests, the stand productivity of former selective cutting sites of natural forests and the productivity of man-made forests, etc. with a view to accumulating technical data on the ecology of forests located in the critical zone for forest growth.

(4) Consolidation of Forest Management Plan Implementation System

1) Training of Forestry Engineers

At present, only a limited number of forestry engineers for the practical implementation of forest management plans in the field are available at the aimak's Forestry Office and some timber companies while the nature protection officers at the district level lack the necessary skills to conduct forestry activities. To make matters

worse, the specialist forestry college was closed down after the democratisation of the country. It is essential that forestry engineers with sufficient knowledge and experience of forest management be assigned to actual cutting and regeneration sites.

Training on the techniques required for forestry activities and forest management should be provided as soon as possible for nature protection officers at the district level in order to improve their forestry-related expertise. In addition, new training facilities for forests and forestry techniques should be established for the systematic training of forest engineers.

2) Local Forestry Activity Council

The existing selective cutting and natural regeneration work shows some shortcomings, including the cutting of fine trees, damage to remaining trees by logging and skidding work and poor natural regeneration at cut-over sites, etc., resulting in the degradation of many natural forests.

To improve the situation, a local council consisting of representatives of the Forestry Office, nature protection officers at the district level, forestry businesses and academic circles, etc. should be established to discuss various aspects of forestry activities and a forest management plan, including the characteristics of species found in natural forests, selection of cutting sites based on tree age and qualitative composition of stands, cutting methods, including tree selection criteria, preferable logging and skidding methods to avoid damage to remaining trees and appropriate regeneration methods, including enrichment, etc., so that appropriate forestry activities are conducted in accordance with the forest management plan.

3) Preparation and Distribution of Forest Type Maps and Forestry Inventory Books, etc.

At present, the nature protection officers assigned to manage forestry activities lack the relevant maps and other documents, including forest type maps, topographical maps, aerial photographs and forest inventory books, and, therefore, cannot accurately indicate a specific plan or area within a forest using such documents. Moreover, few aerial photographs have been taken in recent years while the forest type maps do not have contour lines.

To improve the situation, new aerial photographs should be taken and forest type maps with contour lines should be prepared to assist proper forestry activities and forest management. The nature protection officers should be provided with forest type maps and aerials photographs as well as topographical maps and forest inventory

books so that they can implement appropriate forest management utilising these documents.

4) Utilisation of Unused Resources

The *Pinus sylvestris* and *Larix sibirica* forests in Mongolia have been declining due to cutting and fire damage, etc. while the number of poor quality trees due to burning of the root collar, hollowing, bark pocket and decay is increasing. Meanwhile, *Betula platyphylla* is hardly used despite the high level of growing stock. As the use of the remaining poor quality trees and hitherto unused broad-leaved trees in forests is essential for the systematic improvement of existing forests to forests with high growth while ensuring a good tree character and appropriate stand density, active efforts must be made in the coming years to develop the appropriate use of poor quality trees as well as broad-leaved trees.