

Concept and Actual State of Developing Environmental Conservation Forests at Oita Works

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Abstract:

The Oita Works of Nippon Steel has been revegetating its site by ecological techniques since the beginning of its construction. Old forests in Oita were investigated and species suited for the local climate were planted to produce "native woods" at Oita Works. Twenty-five years after the start of planting, these native woods cover 1.05 million square meters and total about 800,000 trees along and within the boundaries of Oita Works. These woods play an important role as a symbol of environmental conservation and coexistence with the local community. The green tracts of land at Oita Works are the result of companywide ecological efforts and will continued to be developed and cared for as local woods.

1. Introduction

The need for industrial revegetation became earnestly advocated after the 1960s. Today, trees, shrubs, and grasses are required not only for their functional benefits as buffer greenbelts and disaster prevention measures but also for their aesthetic benefits as greenery that enrich daily lives and enable factories to be built in intimate harmony with local communities.

The Oita Works of Nippon Steel started to develop green tracts of land at its site just as these ideas began to gain popularity. Oita Works completed the planting of trees by traditional landscape garden methods in 1970. In June 1971, its vegetation program was totally revised by introducing ecological techniques under the guidance of Professor Akira Miyawaki of Yokohama National University.

The Factory Site Location Law established in 1973 clearly

states the importance of industrial revegetation. The pollution prevention agreements Oita Works concluded with Oita Prefecture and Oita City in 1973 obligate Oita Works to develop green plots within its premises.

After 25 years of vegetation activities in accordance with the law and agreement, native woods cover 1.05 million square meters and comprise 100 species and 800,000 trees. The industrial revegetation activities of Oita Works are introduced below. (See **Photo 1** and **Tables 1** and **2**)

2. Vegetation at Oita Works

2.1 Initial industrial revegetation after construction

Oita Works is located on sandy land reclaimed from the sea. The initial tree planting plan in 1970 was made when parks and gardens were gaining popularity and was aimed at becoming a model for the worldwide steel industry. The plan proposed to scatter trees on grassy plots and plant low flowering shrubs along the boundary of the site. The plan started in December 1969 and ended with the completion of a 50-m wide and 3-km log green-

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Table 1 Outline of vegetation at Oita Works

Type of green plot	Vegetation scale	
	Area (1,000 m ²)	Number of trees (×1,000)
Boundary environmental protection forest	258	152
Intrawork environmental protection forest	116	393
Intrawork street trees	131	148
Intrawork workplace vegetation	92	99
Intrawork grassy plot	454	
Total	1,051	792

Tree species	Breakdown of tree species	
	Main tree species	Proportion (%)
Trees	<i>Kusunoki, tabunoki, horuto, kashi, yamamomo, shii</i>	26
Subtrees	<i>Matebashii, sangoju, mochinoki, isumok, tsubaki, sazanka</i>	23
Shrubs	<i>Nezumimochi, tobera, masaki, tsutsuji, sharinbai, aberia, aoki, tounezumimochi, yukiyangagi</i>	51

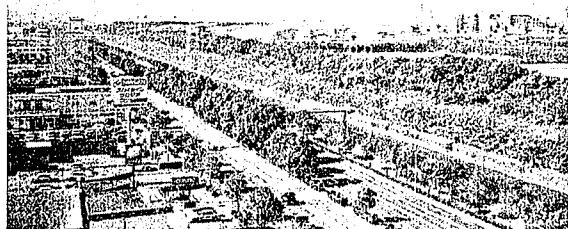


Photo 1 Environmental protection forest along the boundary of Oita Works

belt in July 1970. The species included the *kusunoki*, *kuroganemochi*, *sangoju*, *matebashii*, *kyochikuto*, *nezumimochi*, *shishigashira*, *satsuki*, *hirado-tsutsuji*, *hamahisakaki*, and *aberia*. The tall *kusunoki* was planted at the center of the greenbelt, the medium *kuroganemochi*, *matebashii* and *sangoju* were arranged at the inside of the green belt, and the low *nezumimochi* formed a hedge at the outside of the greenbelt. The flowering trees *kyochikuto*, *shishigashira*, *hirado-tsutsuji*, *satsuki*, and *aberia* were planted in groups from the center to the inside of the green belt, and grasses were grown on vacant lots.

2.2 Development of green plots by the introduction of ecological techniques

In 1971, Nippon Steel decided to introduce the ecological techniques being studied by Professor Akira Miyawaki of Yokohama National University to create a comfortable environment more aggressively. At that time Oita Works had almost completed its initial tree planting plan, but it took the initiative in exploiting the ecological techniques before other works at Nippon Steel.

The basic policy was that all trees should be evergreens. Initially, deciduous trees (*niseakashia* and *popura*) were planted for quick vegetation near the evergreens and were to be cut when the evergreens grew tall. Young trees, 0.3 to 0.5-meters tall, were removed after cutting their trunks or roots as little as possible and were replanted close together. Such tree species were selected to suit the climate of the region not the landscape. The trees were closely planted according to the basic ecological idea of natural selection. The conditions were conducive to the formation of natural woods in which weak trees would be driven out by stronger ones. The ultimate aim was to reproduce a native wood suitable for Oita Prefecture. (See Photo 2)

2.3 Utilization of environmental protection forests

The steel industry is generally considered to take a high environmental toll. Oita Works takes all possible measures to protect the environment by devoting about 20% of its total plant and equipment investment to the environment, mainly to reduce pollution at sources. Another pillar of the environmental protection policy was to restore the environment through revegetation and create a new global environment. "Environmental protection forests" have the following benefits and are too important to be

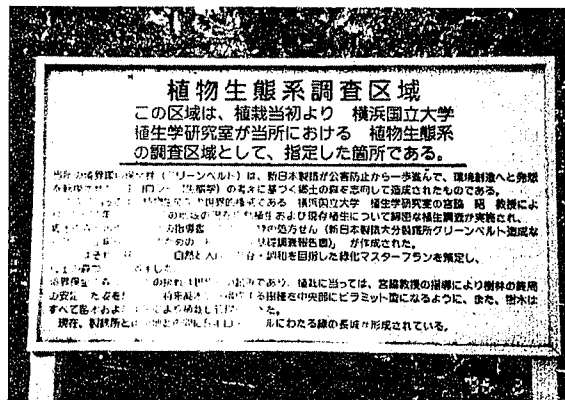


Photo 2 Plant ecosystem survey area in the boundary environmental protection forest

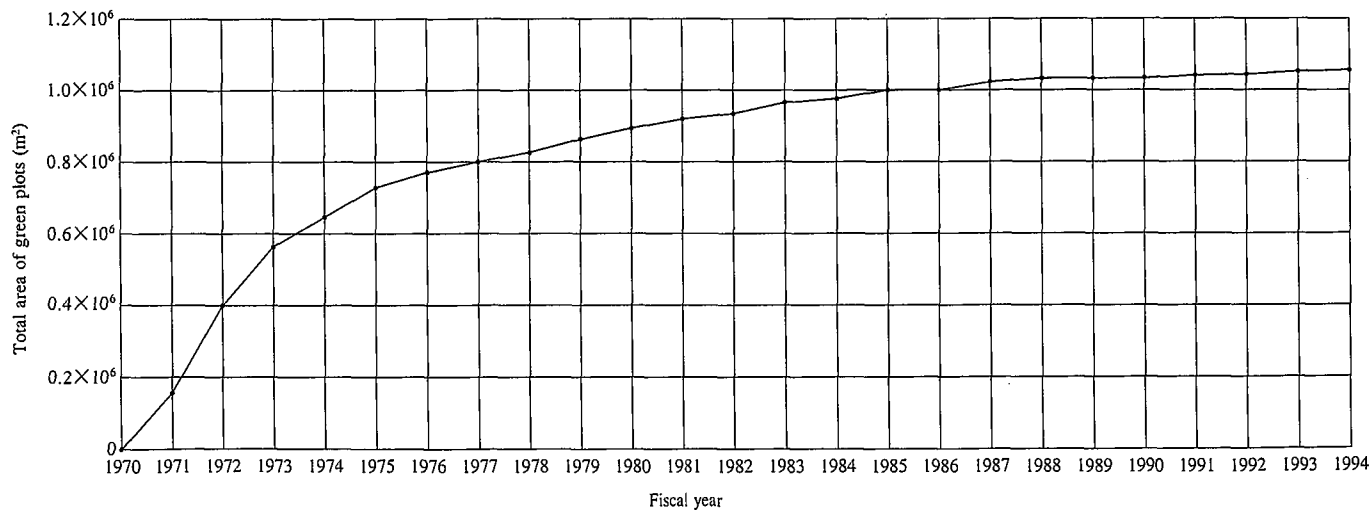
replaced by ordinary plant and equipment investment if the steel industry is coexist with the surrounding communities.

(1)Men and women are only some of many living organisms on the Earth. We coexist with other animals and plants in a delicate ecobalance and cannot live at peace in an environment bounded by steel and concrete. The environmental protection forest not only affords us beautiful greenery but is also a necessary condition for us to live. In Europe, the protection of green plots is a national policy. Protection of forests upstream on rivers and the maintenance of water holding capacity are pursued to such a degree that the rivers' water levels vary little between the rainy and dry seasons.

(2)The global ecosystem depends on the balance among production, consumption, and reduction. The environmental protection forest is a producer that releases oxygen by photosynthesis, a consumer that grows on various nutrients, and a very efficient decomposer-reducer. From the viewpoint of global environmental problems, increasing greenery is an important measure against global warming, reduction in tropical rainforests, desertification, and decrease in wildlife. It is positioned as an important part of each company's effort to create a rich environment. Green forests

Table 2 Chronology of vegetation and change in total area of green plots at Oita Works

	Item
1970	Construction of greenbelt was completed (work started in December 1969).
1971	Green plots were designated under City Planning Law. Ecology was introduced under the guidance of Professor Akira Miyawaki of Yokohama National University.
1972	Construction of 6-meter tall mound was started. Acorns were collected at Usa Shrine. First long-term vegetation plan was made.
1973	Cherry trees were planted along the greenbelt.
1974	Participants of Japan Conference of International Vegetation Society visited Oita Works.
1975	Additional trees were planted to attract wild birds.
1976	Woods of commemorative trees were completed along a main gate. Second long-term revegetation plan was made.
1977	Construction of 6-meter tall mound was completed. Crown Prince and Princess visited Oita Works to see vegetation activities.
1978	
1979	Construction of 13-meter tall mound was started.
1980	Third long-term revegetation plan was made.
1981	Rosellinia necatrix disease occurred and necessitated disinfection of more than 10,000 square meters of land.
1982	Construction of 13-meter tall mound was completed. Oita Works received Japan Greenery Research and Development Center Chairman Award as a factory with excellent greenery.
1983	
1984	Guidance in vegetation was received from Professor Akira Miyawaki of Yokohama National University.
1985	
1986	Cultivation of ornamental foliage plants in greenhouse was started.
1987	Populus planted for rapid vegetation in green belt were felled.
1988	Trees hindering overhead power lines were pruned.
1989	
1990	New medium-term vegetation plan was made. Some trees obstructing visibility at intersections were felled and various of trees were planted at intersections.
1991	Typhoon No. 19 felled 1,000 trees. As camphor tree grown to a height of 20 meters was replanted in front of the control center. Guidance was received from Assistant Professor Kazue Fujiwara of Yokohama National University.
1992	
1993	
1994	Unusual drought in summer withered 2,000 trees. Guidance was received from Professor Emeritus Akira Miyawaki and Professor Kazue Fujiwara of Yokohama National University.



are estimated to absorb and assimilate 70-100 tons of airborne dust per hectare. Besides this filter effect, a 30-meter wide forest is believed to reduce noise by 5 dB. Tall trees have very efficient sound barrier properties. As with lawns ground homes and in parks, grassy plots are greatly effective in preventing the secondary dispersion of sand.

3. Development, Construction, and Maintenance of Green Plots

3.1 Basic policy of revegetation

The basic purpose of revegetation at Oita Works is the creation of a comfortable environment as the embodiment of ecology. In other words, the first consideration is to form native woods using ecological techniques to build a steelworks rich in greenery that improves the environment of Oita Works and the surrounding community. These activities instill in employees an awareness of revegetation and ecology. They cooperate with people in the local community to create a green environment. To accomplish this policy, the following activities have been implemented:

(1) All employees participate in and promote the revegetation plan for constructing a green steelworks.

(2) The following have been pursued as concrete targets:

(i) Plant a 50-meter wide, five-kilometer long environmental protection forest at the boundary between the steelworks and the surrounding community.

(ii) Plant a 4-meter wide native wood as street trees along both sides of main roads in the steelworks.

(iii) Plant grass and trees in vacant lots in the steelworks to prevent the dispersion of sand and dust.

(iv) Plant trees around each workplace and mill.

(v) Conduct a revegetation campaign to contribute to the local community.

3.2 Development, construction, and maintenance of green plots

3.2.1 Securement of trees

Oita Works made it a rule to nurture trees by itself.

3.2.2 Selection of tree species

The tree species selection process started with an investigation of trees traditionally grown in Kyushu from Seki in Saga Prefecture in the south to the Kunisaki Peninsula in the north. It is also important that tree species should be suitable for the sandy land reclaimed on the seacoast.

3.2.3 Development of tree planting soil

Oita Works' land was reclaimed from the sea. A gravel layer was spread more than 20-meter deep, and the surface layer was soil not suited for the cultivation of trees. Because the quality of soil is an important factor for the growth of trees, the soil had to be substantially improved before planting trees. This improvement involved two methods to meet specific purposes of green plots. One method was strip soil dressing, which was mainly used in the boundary environmental protection forest. The other method was soil filling, which was mainly used in the mound development section. After the initial large-scale soil improvement, tree planting soil from Oita County has been used to expand green areas. (See Photo 3)

3.2.4 Tree planting methods

(1) Tree planting for boundary environmental protection forest

Oita Works developed a 50-meter wide, five-kilometer long environmental protection forest, at the boundary with the adjacent land. In the two-kilometer long west section, a 13-meter high

mound was built and planted with trees. About 160,000 trees are planted in both the flat and mound areas of the boundary environmental protection forest. Some young trees were purchased initially in 1970. Since then, all young trees have been grown in the nursery of Oita Works. Acorns collected in the compound of the Usa Shrine were directly sown and are now large trees.

The trees grown in the western three-kilometer flat region are shown in Fig. 1. The sleeve and mantle communities contain shrubs, and the center has tree and subtree layers. The overall cross section is pyramidal. Popura and niseakashia were planted for early growth at the adjacent land side of the boundary environmental protection forest. When the central trees grew to an almost pyramidal pattern 20 years later, the popura and niseakashia achieved their original purpose and were felled. Native trees were selected and planted to create a natural environment of various trees. Kusunoki, *tabunoki*, and *horuto* are major trees arranged in decreasing order. Among subtrees are *tounezumimochi*, *masaki*, and *sangoju*, and the shrubs include *hirado-tsutsuji*, *sharinbai* and *tobera*. Tree species number few hundred.

The two-kilometer long western region was developed as a mound to reinforce the environmental protection function of native woods. A six-kilometer high mound was built in 1977. Then the north slope of the mound was raised. In 1982, a 13-meter tall and two-kilometer long environmental protection forest was completed. The trees planted on the mound are shown in Fig. 2. The low-lying skirt is a tree layer, and the top of the six-kilometer high mound is level as road for work vehicles. The 13-meter high mound is planted with six rows of trees from the slope

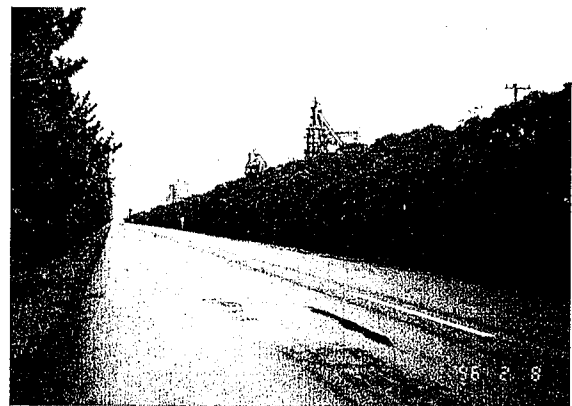


Photo 3 Intra-work street trees

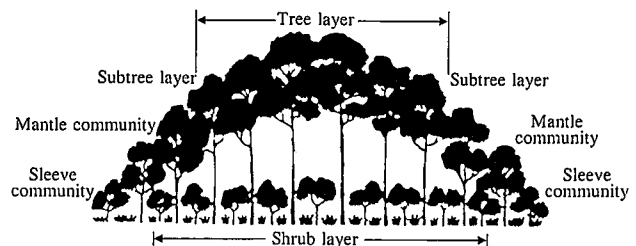


Fig. 1 Trees planted in environmental protection forest (flat area)

to the top. Kusunoki and tabunoki are the main trees, tounezumochi, masaki, and matebashii are the principal subtrees, and hirado-tsutsuji and sharinbai are representative shrubs.

(2) Tree planting for intraworks environmental protection forest

Similar to the boundary environmental protection forest, trees are planted in the native-wood style in intraworks places where relatively wide open areas are available. A 4.5-meter wide greenbelt is provided at each side of main roads at Oita Works as shown in Fig. 3. Shrubs, subtrees, trees, and shrubs are planted in three to four rows from the roadside outward in the same pyramidal canopy as the boundary environmental protection forest.

At Oita Works, the raw material yards are planted with rapidly growing niseakashia to prevent dust from being scattered by wind. For shrubbery, tobera is closely planted to reduce the secondary dispersion of dust from the ground.

The north coast area of Oita Works is subject to sea breezes. Niseakashia and more than 1,000 pines were initially planted as street trees at the north side of all roads. After the pines grew tall, the niseakashia were felled. Tobera, shirodamo, and matebashii, which are evergreens strong against sea breezes, are planted on the south side of the roads. These trees have grown tall without any salt damage, except for damage from direct exposure to typhoon-driven waves.

Evergreen kusunoki, horuto, and tabunoki are planted as other street trees. Flowering shrubs are planted alone roadside so that each road can be distinguished by the name of the shrub planted there.

(3) Grassy plots

The intrawork soil was dredged soil (sandy soil), and clouds

of dust were raised by wind when the construction work started in 1970. When the construction of the No. 1 blast furnace was completed in 1972, leveling the ground around each plant produced large vacant lots. To prevent dust generation, the vacant lots were turned into grassy areas. Lawn grass seeds were purchased and hand sown by employees at each workplace. Seeds of the spring, summer, and winter grasses were mixed and sown in appropriate places.

Lots left vacant for future plant expansions were dugout, and the holes were filled with water and used as ponds to prevent dust generation. The ponds are inhabited by wild birds and migrant birds, are known as good sites for bird-watching clubs, and are pleasing to plant visitors.

(4) Development of woods of commemorative trees

Oita Works has greenery development other than the native woods and environmental protection forests. Trees commemorating commendations received by the works and its employees and letters of thanks from users, for example, are planted near the main gate and managed as part of the works' landscape.

3.3 Maintenance of green plots

Trees planted according to the ecological techniques adopted at Oita Works are expected to grow into natural woods in a few years. During that time, they need meticulous care, such as weeding, fertilization, disease and insect control, pruning, and watering. Because Oita Works is built on the land reclaimed from the sea, the width of tree planting plots is limited to 50 meters, and the trees cannot be left without care. In addition, because Oita Works is situated in an urban district, shrubs lining intrawork roads are landscaped as hedges.

The nursery was built in April 1972. Seeds are now collected from nearby schools, mountains, and other places and are planted in the nursery. Trees for planting within the premises of Oita Works are all supplied from the nursery. Among the seeds sown in the nursery were some *ichiigashi* seeds from Usa Shrine. The seeds grew into large trees. In 1995, Oita Works supplied 60 adult *ichiigashi* trees from the nursery for a festival at Usa Shrine. The cherry trees planted along the boundary of Oita Works are popularly called "one thousand cherry trees" by local residents. Their flowers are appreciated by the local people during a spring festival each year. (See Photos 4 and 5)

The Japan Greenery Research and Development Center highly rated the development and maintenance of greenery at Oita Works and presented its Chairman's Award to the works in 1982.

Generally, trees are mostly cared for by hand. Because greenery at Oita Works covers a huge area, various types of machines have been introduced to save labor in taking care of trees and lawns (See Photo 6). Today, 1.05 million square meters of green plants are maintained by 24 persons. Table 3 shows an annual schedule for the maintenance of green plots at Oita Works. For details of greenery maintenance tasks, refer to page 132 in Number 300 of *Seitetsu Kenkyu*¹⁾.

4. Present State and Problems

As of the end of fiscal 1994, the area of green plots is 1.05 million square meters and accounts for 16% of the site area of Oita Works. With spectacular native woods formed around and within its site, Oita Works has grown as a green steelworks and is one of the largest green tracts of land in Oita City.

Some of the environmental protection forests are open to local residents as their promenades. Inhabited by many species of

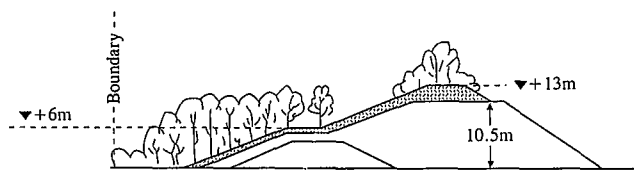


Fig. 2 Trees planted in environmental protection forest (mound)

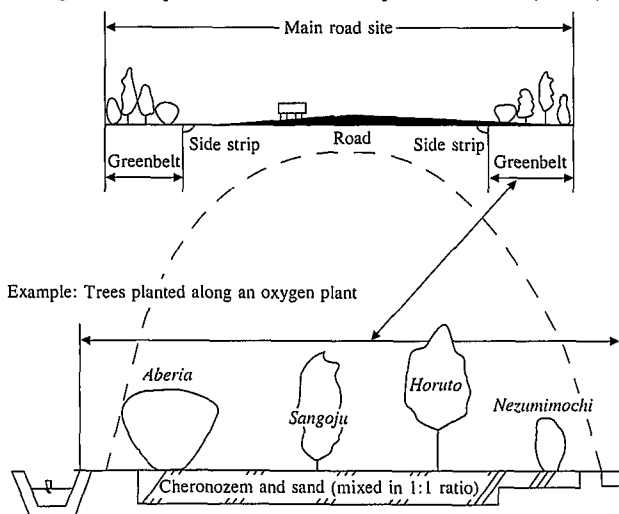


Fig. 3 Trees planted as intrawork street trees

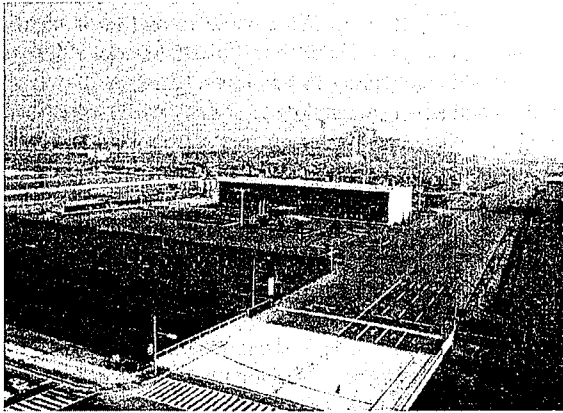


Photo 4 Main gate when trees were planted in 1972

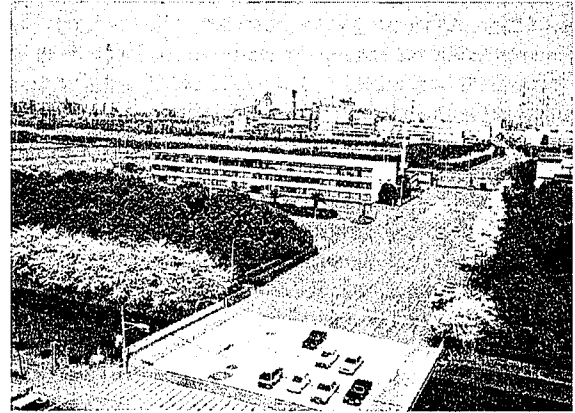


Photo 5 Main gate at present

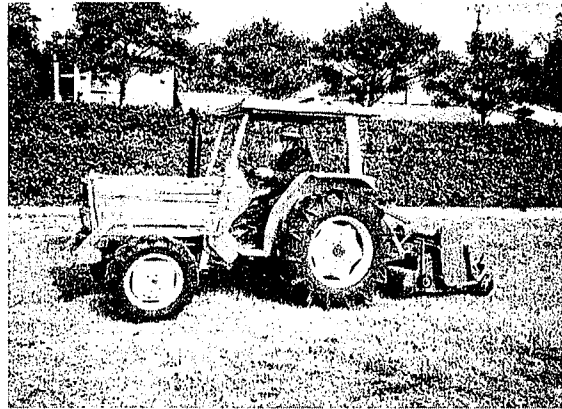


Photo 6 Large mower

Table 3 Annual schedule for maintenance of green plots

Green plot	Month Task	1	2	3	4	5	6	7	8	9	10	11	12	Remarks
		Environmental protection forest	Dressing	Winter dressing (chicken droppings)					Top dressing (synthetic fertilizer)					
Disinfection	Scales					Inspect pest control						Scales		
Watering														
Pruning	Evergreen trees				Pruning of flowering trees and shrub and branch thinning of evergreen trees and deciduous trees						Basic pruning			
Uprooting and replanting	Deciduous trees			Evergreen trees						Deciduous trees				
Grassy plot	Mowing													
	Sowing													
Nursery	Weeding													As required
	Herbicide application													
	Dressing	Winter dressing (chicken droppings)					Top dressing (synthetic fertilizer)					Winter dressing (chicken droppings)		
	Disinfection						Insect pest control							
	Watering													
	Cutting		Deciduous trees		Evergreen trees									
Sowing			Sowing								Seed collection			

wildlife the environmental protection forests are available to scientists for periodic surveys of wild birds and mushrooms.

Twenty-five years after the start of planting, some trees stand 20 meters, some extend branches over intrawork roads. Oita Works now faces the problem of reconciling raising trees with large vehicle traffic and power transmission line maintenance within the premises. Routine maintenance of such trees will become more urgent in the future.

5. Conclusions

Twenty-five years have passed since the cultivation of native woods by ecological techniques. Trees planted in the environmental protection forests initially stood one-two meters tall, but now exceed 20 meters, satisfactorily discharge the functions of buffer and disaster protection greenbelts, and serve as symbols of the coexistence of a manufacturer with a local community.

We will continue to develop the environmental protection forests as proud symbols of the local community and will work to create an industrial park as the embodiment of the ecological techniques Nippon Steel has implemented throughout its organization.

Reference

- 1) Ohta, T. et al.: Seitetsu Kenkyu. (300), 132(1980)

Remarks

<i>Aberia</i>	Abelia
<i>Aoki</i>	Aucuba japonica Thunb.
<i>Hamahisakaki</i>	Eurya emarginata Makino
<i>Hirado-tsutsuji</i>	Rhododendron spp.
<i>Horuto</i>	Elaeocarpus sylvestris var. ellipticus Hara
<i>Ichiiigashi</i>	Quercus gilva Blume
<i>Isunoki</i>	Distylium racemosum Sieb. et Zucc
<i>Kashi</i>	Oak
<i>Kuroganemochi</i>	Ilex rutunda Thunb.
<i>Kusunoki</i>	Cinnamomum camphora Sieb.
<i>Kyochikuto</i>	Nerium indicum Mill.
<i>Masaki</i>	Euonymus japonica Thunb.
<i>Matebashii</i>	Pasania edulis Makino
<i>Mochinoki</i>	Ilex integra Thunb.
<i>Niseakasia</i>	Rhbinia pseudo-acacia
<i>Nezumimochi</i>	Ligustrum japonicum Thunb.
<i>Popura</i>	Populus
<i>Sangoju</i>	Viaburnum awabuki K. Koch
<i>Satsuki</i>	Rhododendron indicum Sweet.
<i>Sazanka</i>	Camellia sasanqua Thunb.
<i>Sharinbai</i>	Rgaoguikeois umbellata var. integerrima Rehd.
<i>Shii</i>	Castanopsis
<i>Shirodamo</i>	Neolitsea sericea Koidz
<i>Shishigashira</i>	Blechnum niponicum Makino
<i>Tabunoki</i>	Machilus thunbergii Sieb. et Zucc.
<i>Tobera</i>	Pittosporum tobira Ait.
<i>Tounezumimochi</i>	L. lucidum Aiton
<i>Tsubaki</i>	Camellia
<i>Tsutsuji</i>	Azalea
<i>Yamamomo</i>	Myrica rubra Sieb. et Zucc.
<i>Yukiyunagi</i>	Spiraea thunbergii Sieb.