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MANAGEMENT OPTIONS FOR SAL FORESTS (*SHOREA ROBUSTA* GAERTN.) IN THE NEPAL TERAI

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ABSTRACT. This paper reviews problems and issues related to management options for the lowland (terai) forests of Nepal. Two types of sal forest (*Shorea robusta*) are found in the country: terai forests and hill forests. Sal is the dominant tree species of the terai forests, where it constitutes about 45% of total wood volume. In the hills, however, sal is only a minor species by volume. Significant loss of this species throughout southern Nepal is having a profound social and economic impact on the area. Natural regeneration of sal in Nepal has been observed but only under undisturbed conditions. Since local people are exploiting most sal forests, it is unlikely that the species will be able to withstand the current pressure being exerted by increasing populations. Consequently some means of production forest management needs to be employed. This paper discusses the current situation and offers suggestions for managing and conserving the terai forests.

Key words: sal forest, *Shorea robusta,* forest management, natural regeneration, soil

INTRODUCTION

Sal (*Shorea robusta* Gaertn.) is the most valuable tree species in the plain regions (terai) of Nepal. Sal is also found in the lower hills (up to 1200 m). Although a deciduous tree species, sal never completely sheds all of its leaves. The tree occurs in deciduous dry forest with low rainfall (1000 mm/year), deciduous moist forest with moderate rainfall (1500–2000 mm/year), and evergreen moist forest (2000–6600 mm/year). The species most closely associated with sal are *Terminalia tomentosa* and *T. bellerica.* Sal is a moderate light-demanding species and grows in a range of soil types, except for very sandy, gravely, or waterlogged soils.

In Nepal, two types of sal forests are found: terai sal forest and hill sal forest (Stainton 1972). Even though sal is economically and ecologically the most valuable tree species of Nepal, very little research has been conducted on the proper management practices for growing sal. The species, however, has been studied for a century in adjacent India, where natural regeneration and sal establishment have been difficult (Joshi & Troup 1980). Although no significant, large-scale sal research has been undertaken in Nepal, several recent research projects in terai sal forest have indicated that the species has potential for natural regeneration and establishment (Gautam 1990, Mathema 1991, Rautiainen 1994).

The natural forests of the terai have deteriorated severely as a result of continued human population growth and unsustainable agricultural practices. Illicit tree cutting, uncontrolled and heavy cattle grazing, fodder collection, and forest fires have had an adverse effect on the forests in the terai. Sal, the dominant species and with high commercial value, has been the emphasis of sal forest management. Degradation of sal forests in Nepal has reached the point where the species is considered endangered. The goal of this paper is to review the current status of sal forests and the potential of forest management to preserve the species.

SAL FORESTS IN THE TERAI

Sal is the tree species with the best timber quality in Nepal; and in the past, the sal forests of the terai were the source of the country's wealth. These forests, however, were exploited and wood products exported to India. During the last two decades, remaining forestland has been placed under full protection as a result of the loss of sal forests. With high demand for timber, rising wood prices have led to widespread illegal logging and timber smuggling. In the 1940s, because of malaria in the terai, people began migrating to the hills. Following eradication of the disease in the 1960s, hill people began migrating to the terai for an easier life. The eradication of malaria from the terai-boosted settlement (legal and illegal) has led to further encroachment on sal forests.

The Water and Energy Commission of Nepal placed the annual deforestation rate for 1964/65–1978/79 at 1.8% and predicted increased deforestation rates from then on. The current study, however, has not found an increased deforestation rate; instead total forest area in the terai in 1978–1991 has decreased only 1.3% per year (Land Resources Mapping Project 1986). In FIGURE 1, the Rupandehi is shown as fourth in ha lost, but it actually has the highest deforestation

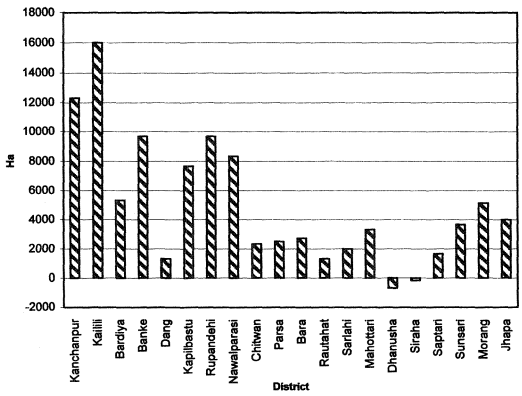

FIGURE 1. Changes in forest area by district in the terai region of Nepal, 1978–1991.

rate (ha lost/total ha) at 37%, mainly caused by forestland conversion to arable land, both authorized and illegal. The largest absolute loss of forestland has taken place in the far west of Nepal, with a decrease in forest area of 12,400 ha in Kanchanpur and 16,000 ha in Kailali.

Natural forests in the terai cover about 784,000 ha, of which 30% (238,000 ha) are within protected areas and national parks (FIGURE 2). In Nepal, timber production forests are located mainly on the plains. The Forest Resources and Survey Centre (1991) estimated total stem volume of plains forests at 78 million m^3, of which sal constituted 45%, *Terminalia tomentosa* 13%, *Acacia catechu* 3%, *Adina cordifolia* 6%, and *Dalbergia sissoo* 2% (FIGURE 3). The annual growth rate of sal forest in Nepal is 15–20 $m^{-3}/ha^{-1}/yr^{-1}$ under undisturbed conditions, a growth rate threefold higher than in Indian sal forests. The slower growth of the sal species in India may be the result of significant frost. In Nepal no significant frost has been recorded.

TABLE 1 represents the comparative vegetation analysis of sal in both hill and terai forests. This study indicates that in both areas, relative density and relative basal area of sal is 25–87%. Relative frequency varies 12–24%. The Importance Value Index (IVI) reflects a similar trend. Except for the Gorkha district, basal area coverage in terai forests is greater than in hill forests.

SOCIOECONOMICS OF TERAI SAL

Forests in Nepal have value from both cultural and economic points of view. About 60% of household energy, 40% of livestock nutrition, and substantial soil nutrients in the form of organic matter are derived from forests. Local people use

FIGURE 2. Forest areas in the terai region of Nepal, with shaded areas indicating national parks.

more than 100 tree species from the forests in the terai for various purposes. Only a few species, however, are harvested for timber, fuelwood, and fodder. Timber species are *Shorea robusta, Dalbergia sissoo, D. latifolia, Adina cordifolia,* and *Terminalia tomentosa*; species harvested for fuelwood are *S. robusta, A. cordifolia, T. tomentosa, Syzigium cumini,* and *Lagerstroemia parviflora*; and fodder species include *Spathobolus parviflora, Garuga pinnata, Gmelina arborea,* and *A. cordifolia.* Because of high demand, *Shorea* species have been designated as endangered (Joshi et al. 1995). Other endangered species of terai forests are shown in TABLE 2.

NATURAL SAL REGENERATION

FIGURE 4 shows that the terai supports good natural regeneration (Rautiainen 1995, Seppanen

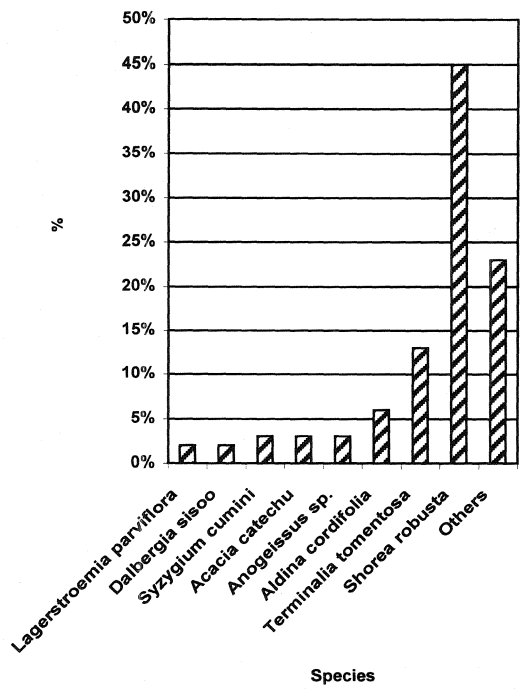

FIGURE 3. Proportional stem value in the terai by species, excluding national parks and reserves.

TABLE 1. Ecological status of *Shorea robusta* (sal) in the terai and hill forests of Nepal.

Parameters	Hill forests			Terai forests	
	Thuli Ban[1]	Lamidanda[1]	Gorkha[2]	Hetauda[3]	Manahari[4]
Ecological parameters					
Frequency (%)	66	100	100	100	—
Relative frequency (%)	12	23	24	14	—
Density (per ha)	420	832	685	456	480[5]
Relative density (%)	68	43	33	56	48
Basal area (m^2/ha)	686	3768	9203	8300	—
Relative basal area (%)	87	25	70	—	—
Importance Value Index	168	91	107	—	—
Seedling regeneration					
Seedlings (per ha)	1872	1564	1016	—	6000–10,000

Note: [1] Dhungana (1997), [2] Pant (1997), [3] Nepali (1998), [4] Rautiainen (1994), [5] Skaerner and Thapa (1993).

& Acharya 1994). About 41% of the study plots in both pure Sal (*Shorea robusta*) and mixed sal forests have more than 10,000 seedlings/ha. Unexpectedly, sal seedlings also were found more frequently in forests having no mother sal trees (TH). An average 5-year-old sal seedling has a height of 50 cm. Recent trials have shown that in the Nepal terai, where biotic factors and fires are eliminated, a good establishment of sal seedlings can be attained (Rautiainen 1995). Studies of hill sal forests in Nepal (Dhungana 1997, Pant 1997) found a lower number of sal seedlings (1872–3437/ha) than Rautiainen (1994) found in terai sal forest (6000–10,000/ha, see TABLE 1). Lower regeneration in hill sal forests suggests that sal is a more suitable species for the terai.

TABLE 3 indicates that hill soils generally are more nutrient-rich than in the terai, except for K. Soil texture varies from loamy to sandy-loam at both sites. Studies from India and Nepal indicate that sal grows in various soil types, but loamy soil appears to be the best for regeneration. Hill soils are more acidic than terai soils. Although lower pH and Ca content of hill soil have been associated with better sal regeneration (Dhungana 1997), recent studies in Nepal (Suoheimo 1995) show no significant effect of soil quality on the abundance of sal regeneration. Similar results have been obtained from studies in Indian sal forests (Joshi & Troup 1980, Sharma et al. 1966).

TIMBER PRODUCTION IN THE TERAI

Satellite imagery-based inventory data indicate that at least 480,000 ha of forestland can be classified as production forests (Pesonen 1994). The study indicates that most sal forests can be saved and continuous production secured, if these forests are brought under systematic forest management. Systematic harvesting of sal forests could create employment and produce residues and small-sized wood for domestic use. Parts of cutover forests could be used for pastureland and agroforestry. Protection forests could be used for collecting non-timber forest products (NTFP). Fragmented forests close to villages could be allocated for management as community or leasehold forests.

Terai forests potentially could have a major impact on the national economy of Nepal. Estimated revenues from systematic forest management of 300,000 ha within the terai for 20 years are as much as Rupees 45,000 Lakhs ($66 million US) annually on a sustainable basis (Pesonen 1994).

Production-oriented natural forest management needs to be introduced in the terai, but the problem is how to start. Obstacles to a wide-scale operation throughout the terai include scarcity of detailed silvicultural data, non-existence of an appropriate implementing organization, and uncertainty about environmental impacts. Wesche (1995) found that some sal forests in the terai have a distinct gap in young trees 10–25 cm dbh (diameter at breast height). Most forests are old growth, and this study suggests that they be tested for feasible timber production.

Ongoing debates over whether to manage the sal forests of Nepal for timber production raise both positive and negative aspects.

POSITIVE AND NEGATIVE ASPECTS

The biological and environmental aspects of timber production in the terai include the significant commercial value of sal wood, its prominent regeneration status, its satisfactory growth rate, the adequate establishment of sal seedlings where biotic factors are controlled, a natural regeneration ability that makes it suitable for production forestry, and its tolerance to drought,

TABLE 2. Endangered plant species in the terai forests of Nepal.

Family	Scientific name	English common name	Local name
Apocynaceae	*Alstonia scholaris*	Devil's tree	Chhatium
Aspidiaceae	*Dryopteris* sp.	Fern	Neuro
Combretaceae	*Terminalia belerica*	Bastard myrobalan	Barro
	Terminalia chebula	Yellow myrobalan	Harro
Datiscaceae	*Tetrameles nudiflora*		Mainakat
Fabaceae	*Acacia concinna*	Soap pod	Sikakai
	Bauhinia vahlii	Camel's foot climber	Bhorla
	Dalbergia latifolia	Indian rosewood	Satisal
	Desmodium dalbergioides	Sandan	Panjan
	Pterocarpus marsupium	Indian kino tree	Bijaya sal
Liliaceae	*Asparagus officinalis*	Asparagus	Kurilo
	Curculigo orchioides		Musli
Meliaceae	*Cedrella toona*		Tooni
Myrtaceae	*Syzgium cumini*	Black plum	Jamun
Orchidaceae	*Flickingeria fimbriatum*	Orchid	Jiwanti
Poaceae	*Eulaliopsis binata*	Sabai grass	Babiyo
Rhamnaceae	*Rhamnus nepaulensis*	Buckthorn	Chile kath
Rubiaceae	*Aldina cordifolia*	Yellow teak	Karma
Verbenaceae	*Gmelina arborea*	Malay bush-beech	Khamari

Note: Endangered species are categorized on the basis of over-use, poor regeneration, socioeconomic factors, and low frequency, as designated in the Master Plan for the Forestry Sector, 1988. Source: Joshi et al. 1995.

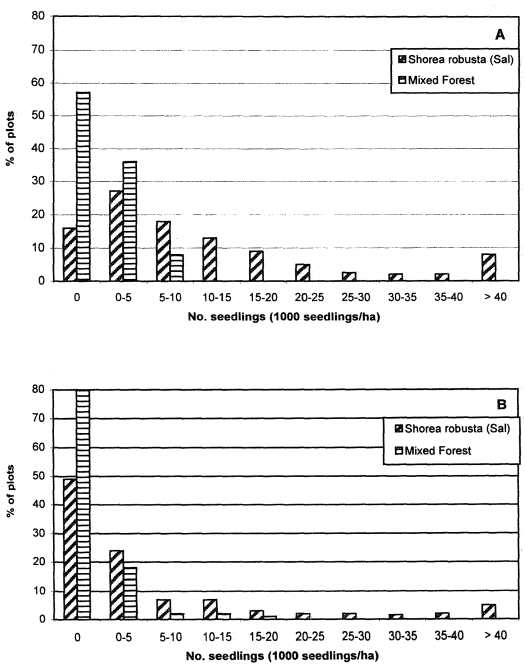

FIGURE 4. Seedling frequency in natural regeneration of sal and mixed forest study sites. Source: Rautiainen 1995.

frost, and fire. An export market exists, because most tropical rain forests are not suitable for timber production, with a few exceptions, such as in Indonesia. From a socio-economic standpoint, timber production forestry needs to be evaluated on a trial-plot basis for its potential to create employment opportunities, its ability to strengthen not only timber production but other parts of the forest products industry, its potential to enhance foreign exchange and meet local needs for fuelwood, fodder, and other forest products through collection of residues left after harvesting. Existing protected areas, such as forest reserves and national parks, already total 220,000 ha or 30% of the total terai forest; and thus timber production need not disturb conservation of biodiversity.

Timber production requires adequate funding, a proper organization, and technical know-how. Free market sales can create problems and socio-cultural restrictions may occur.

Implementation Criteria

The criteria for implementing timber production forestry in Nepal can be summarized as follows:

- Assess biological characters such as regeneration and establishment,
- Identify old-growth sal forests to be logged,
- Test a small trial plot as a model,
- Monitor and evaluate the model test phase (feasibility studies).

TABLE 3. Soil characteristics of *Shorea* (sal) terai forests and hill forests.

Parameters	Hill forests			Terai forests	
	Thuli Ban[1]	Lamidanda[1]	Gorkha[2]	Hetauda[3]	Manahari[4]
Soil texture	Loam—sandy	Sandy loam	Loamy	—	Sandy loam
pH	4.1	4.3	5.1	7.3	6.3
Organic matter (%)	0.9	—	—	—	0.43
N (%)	0.06	0.08	0.09	0.04	—
P (kg/ha)	38.3	87.8	41.0	27.6	—
K (kg/ha)	232	262	221	320	—

Note: [1] Dhungana (1997), [2] Pant (1997), [3] Nepali (1998), [4] Rautiainen (1994), [5] Skaerner and Thapa (1993).

- If the model proves suitable locally, ecologically, and economically; then
- Implement timber production forestry,
- Reforest logged forests, and
- Test and fix the rotation period of logging.

CONCLUSIONS

The present study finds that sal forests in the Nepal terai can be conserved, if natural regeneration of the species is protected from biotic factors and other disturbances. Unlike India, Nepal has abundant natural sal regeneration, and fortunately less seedling dieback occurs. Since natural regeneration is abundant, production-based forest management can be adopted to improve the national economy on a sustainable basis. Hence plantation forests of exotic fast-growing species are not needed, and sal forests can be harvested and secured for the future. The debate continues, though because of the positive and negative aspects of timber-production forestry. On the positive side are the abundant natural regeneration and seedling establishment in sal forests; and on the negative side are the needed funding and technical know-how.

The current study suggests the following management options for managing sal forests in the terai:

- Test the concept of production forestry first and only then begin implementation.
- Begin by logging only old-growth sal forests.
- Develop appropriate silvicultural systems and management practices for Nepal rather than copying systems from other countries.
- Adopt appropriate land-use policies, such as a settlement scheme targeted to areas unsuitable for agriculture and forestry.
- Promote the use of non-timber forest products (NTFP) from protected areas to enhance the economics of local communities.
- Control biotic and other disturbance factors to promote natural regeneration and seedling establishment.

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