

A term paper on

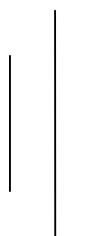
Silviculture of Timber Producing Species

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ABSTRACT

This term paper entitle “Silviculture of timber producing species” includes distribution of timber species, its morphology, silvicultural characteristics, regeneration techniques and management. Although there are more than 25 main timber yielding species listed as a main timber yielding species in Nepal this paper only covered 5 major timber producing. The major timber producing species are selected by considering the literature review from library, internets serving. Shorea robusta, Delbergia sissoo are very popular and aboundly found in Terai as well as lower hills, where as pinus roxburghii, and cedrus deodara are only the source of timber in mid and higher hills .Exotic tree species Tectona grandis is also main timber in plantation forest. Nature and habitat of these species varies with site factor. So we need to focus on their Silviculture before manage it in natural as well as in plantation forest.

Key words: Silviculture, Timber, Natural Regeneration, Management

1. INTRODUCTION

Silviculture is the agriculture of trees how to grow them, how to maximize growth and return, and how to manipulate tree species compositions to meet landowner objectives. it deals with establishment, development ,care and reproduction of stands of timber (Khanna, L.S.,1996).

It is normally directed at the creation and maintenance of the kind of forest as the objectives of the owner. Returns from Silviculture are generally though of in terms of timber production (Smith, D.M., 1962). Silviculture is to produce more useful and valuable forests to meet our multifarious requirements. Where as Timber is define as a commercial wood often in converted form. They are usually more than 2.00 cm in least dimention (Gulaty, M.K., 1981).

Silvicultural methods harvest forest products for human use rather than wait on nature to burn them, eat them, or blow them down. Silviculture looks not only at the timber crop currently available, but also at the effects of present day harvesting on the next timber crop. We foresters are in a unique business in that we commonly make management decisions that will affect crop quality and growth 40 to 80 years into the future. Silviculture can be practiced at any time in the life of a timber stand. It includes; natural habitat of species, its silvicultural characteristics, method of regeneration, tending operations, management and protection.

In timber producing species, objective of owner is producing timber to fulfill the demand of business enterprises of commercial purpose. Object may be for Sawn timber, wood pulp, composite board, furniture.

2. CHARACTERISTICS OF TIMBER PRODUCING SPECIES

Timber producing species are generally in the bigger in size and occupied more basal area, consume more nutrients. They have comparatively slow growth rate than other Non-Timber producing species. Better timber wood is produce from the tree of clear bole which is free from knot and branches. Timber woods have more dense and high calorific value. High durable, more strength and elastic value and easy to work for carpenter are other required characteristics for timber producing species. Generally for the production of timber rotation is long.

3. ROLE OF TIMBER PRODUCING SPECIES IN NEPAL

Timber producing species plays an importance role in the maintenance of ecological and economical balance in Nepal it helps to earn more revenue for government. The pristine tropical forests of Nepal attract the foreign tourists. It also becomes only habitat of wild species of flora and fauna by maintaining it's genetic in natural condition. On the other hand it regularly supply timber for commercial purposes, for composite wood based factory, and the main role of these species is to supply the need of Fuel wood, fodder and timber for the local people as well for whole country.

4. MAIN TIMBER PRODUCING SPECIES OF NEPAL

We can categorize timber species of Nepal accordance with major forest types of Nepal. Major timber species on Nepal with respect of forest type are given below

4.1 Timber producing species of Tropical forest

Topical forest plays important role in timber production. It is situated south of Nepal up to 1000 meter in elevation from east to west. The depletion and degradation of existing forests and woodlands are major causes of concern. Human activities such as logging, agricultural clearing and mining are degrading ecosystems. Tropical forest of Nepal is declining at the rate of 1.3 % from last decade due to increasing population and open border. Major Timber species found here are Shorea robusta, Tectona grandis, Terminalia alata, Dalbergia sissoo, Dalbergia latifolia, Acrocarpus fraxinifolius, Eucalytus camaldulensis, Gmelina arborea, Albizzia lebbeck, Albizzia procera, Lagerstromia parviflora

4.2 Timber Producing Species of Midhills



Fig: Midhill forest of Nepal

Commonly known mahabharat lekh. People self protect the local forest as a community forest. Due to encroachment, population increase, the rate of forest decaling is 2.3% in this zone. Major timber producing species are Exbucklandia populnia Aesculus indica Betula alnoids Castanopsis indica Cedrus deodara Cryptomeria

japonica Pinus roxburghii Quercus lemellosa Toona ciliate etc

4.3 Timber Producing Species of High Mountain



Fig: High mountain timber species

This lies north of the midhills and cover central northen part of Nepal. Major timber species of this zone are Abies pindrow Abies spectibilis Cedrus deodara Cupressus torulosa Juglans regia Pinus wallichiana Quercus floribunda Q. semecarpifolia Aesculus indica.

About 25 timber yield tree have been considered as main tree species in Nepal (DFRS, 1999), their stem volume are important specially for industrial and economic planning. Total stem volume of the main tree species is in table 1.

Table: 1 Total stem volumes of the main tree species of Nepal

S. N.	Species	Total stem volume, million m ³ NFI (1998)	S.N.	Species	Total stem volume, million m ³ NFI (1998)
1	<i>Shorea robusta</i>	109.4	14	<i>Laerstrimia parviflora</i>	4.9
2	<i>Quercus spp.</i>	35.9	15	<i>Pinus wallichina</i>	4.1
3	<i>Terminalia alata</i>	29.4	16	<i>Castenopsis spp.</i>	3.9
4	<i>Pinus roxburghii</i>	24.4	17	<i>Symplocos spp.</i>	3.7
5	<i>Abies spectabilis</i>	17.2	18	<i>Persea spp</i>	3.5
6	<i>Rhododendron spp.</i>	16.4	19	<i>Terminalia bellerica</i>	3.2
7	<i>Alnus nepalensis</i>	11.2	20	<i>Garuga pinnata</i>	2.7
8	<i>Schima wallichii</i>	7.9	21	<i>Schleichera oleosa</i>	2.4
9	<i>Tsuga dumosa</i>	7.3	22	<i>Lannea coromandelica</i>	2.4
10	<i>Adina cordifolia</i>	6.9	23	<i>Syzygium cumini</i>	2.2
11	<i>Anogeisus latifolia</i>	6.3	24	<i>Acacia catechu</i>	2.2
12	<i>Lyonia obalifolia</i>	6.1	25	<i>Abies pindrow</i>	1.8
13	<i>Syzygium jambos</i>	5.1	26	<i>Other tree species</i>	67.1
Other tree species cover 67.1 million m ³ or 17.3% of total stem volume. Altogether 229 tree species were identified during the inventory fieldwork. Other tree species cover 67.1 million m ³ or 17.3% of total stem volume. Altogether 229 tree species were identified during the inventory fieldwork.					

A Parts from These 25 major species 229 other tree species is identified in Nepal, as well as different type of exotic species are planted. The exotic species planted in Nepal are Tectona grandis, Populus deltoids, Pinus petula, eucalyptue camaldulensis, cinnamomum camphora etc for the timber purpose (Amatya and Shrestha, 2002).

Among these major timber producing species of Nepal this term paper had selected major five species for describing their silviculture in detail. The selection criteria based on following

1. Their present Commercial value.
2. Market demand
3. Representing major physiographic zone of country
4. Uses in local area

5. SILVICULTURE OF FIVE MAJOR TIMBER PRODUCING SPECIES

5.1 Shorea robusta

Local Name: Sakhuwa	Botanical Name: <i>shorea robusta</i>	only a species of the this family found in Nepal
English Name: Sal	Family: Dipterocarpaceae	

Natural Occurrence: - shorea robusta is commonly found in between terai -1000m and its max altitude is 1500m. sal forest dominant in bhabar, terai and duns. It occupied most of the siwalik hills along river valleys. It is replaced by mixed forest in the area of very high rainfall and along streams. A number of different shorea robusta forest have been distinguished different researcher in Nepal. Dobermez (1976) list nine, where as Stainton (1972) classified sal forest in to 1. Bhabar, Terai and Dun Sal forest and 2. Hill sal forest.



Fig: stem of shorea robusta

Shorea robusta of terai are much larger and richer in species composition than the hill (cited in Jackson, J.K., 1994).

Morphological characters

Leaves are glabrous, ovate- oblong and coriaceous. New leaf appears in March- April. **Flower** yellow, lax axillary of terminal panicles, about 2cm across in large showy branched clusters. Flower time is March- April. Fruit are ovoid, about 8 mm in diameter with five wings, three long and two short. **Bark** is longitudinal fissured or smooth and reddish brown or gray in colour. **Seeds** are ovoid, with fleshy and unequal cotyledons.

silvicultural characteristics

Tree nature: large tree, height up to 45 m. in Terai and rarely exceeds 15m in hills. It is deciduous for short time. This is gregarious forest tree species, grow up in more or less even-aged crop, some times it may be in uneven-aged crops. **Light** demander, **Frost** Moderately frost hardy, **Drought** sensitive, **Fire** resistant **Root system** is Tap root of deep length and lateral roots spread in all directions. **Coppice** well up to 20-30 cm in diameter it prefer **Soil** old alluvium soil it may grow on wide range of soil types. **Good site** indicators are Clerodendron infortunatum. It avoided very sandy, gravelly soils, water-logged area, stiff

clays and lime stone area. Vitex megundo is poor site indicator. **Meteorological condition:** maxi tem. 44-47 °c, min temp. -1 to 7 °c, normal annual rainfall: 100 to 450 cm. its **Associates** with terminalia spp., largerstromia parviflora in Terai; taki, pinus in hills. sal is sensitive to **grazing and browsing** and vary liable to damage by browsing. It shows **dying back phenomenon** due to the fire, drought and other pressure.

Natural regeneration.

It produce **Good seed** in every 3 years **Fruit** are ripens at the beginning of the rainy season (June). **Seed dispersal** by wind. Seedd are carriedaway wind up to 100m from the mother trees. **Germination** will begin almost immediately if they got rain soon after the seed falls other wise it will die. For **seedling development** it required full over days light and little side shade.

Artificial regeneration

Method of plant propagation are direct showing, entire planting, stump planting. **Seed collection time** is April to June. **No of seed per Kg:** 450- 1000. **Seed extraction** is not required. **Seed type** is recalcitrant and its **Viability** is about to 7 days. On need of **Seed treatment**. And **Seed sowing time** is immediately after collections **Germination** required 10-28 days and **Germination percentage:**40-60%. **Germination type** is hypogeal.

Wood properties

Air dry wood weight is 800-960 kg per cubic meter. Specific gravity in between 0.68-.082. Difficulty to saw and high durability. This is high seasoning refractory and interlock grain and medium to coarse texture.

Insects and diseases

In sal **root rot** is due to the polyporus shoreae and heart rot it due to the hymenochaete rubiginosa, fomes caryophylli, F. fastuosus, and **wood borer** of sal is hoplocerambyx spinicornis, where as dasychira spp. are **defoliator** (Bakshi, B.K., 1982)

Management

In Nepal we only removed dry and dead tree from the forest. Selection cum improvement system first time in Nepal was established in 2020/22 for the Terai Sal forest. Most of all

silvicultural system can be apply in the as according to the species, site and the objective. Different Trial has been established in Nepal to compare its growth performance.

5.2 Dalbergia sissoo

Local Name: Sisoo	Botanical Name: Dalbergia sissoo	Sub family: papilinaceae
English Name: rose wood	Family: leguminosae	

Dalbergia sissoo is best known internationally as a premier timber species of the rosewood genus (FACT Net, 1989).

Natural Occurrence

Sissoo is native to the foothills of the Himalayas of India, Pakistan and Nepal. It is primarily found growing along river banks below 900 m elevation, but can ranges naturally up to 1500 m with common associate with acacia catechu

Morphological characters



Fig: leaf of Dalbergia sissoo

Leaves are alternate, pinnately compound. leaflets rounded or notched at tip, 2.2-8 cm by 2-6.3 cm, leaf shedding in mid jan to mid march. New leaf appears in March- April.

Flower yellowish –white, flowering time is march- may

Fruit are in yellow brown pods, usually 1-2 seeded, ripen in Dec- jan.

Bark is longitudinal fissured or smooth and reddish brown or gray in colour. **Seeds** are kidney shaped and do not naturally split from the pods.

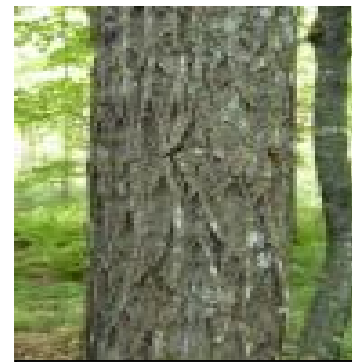


Fig: stem of Dalbergia sissoo

Silvicultural characteristics

Tree nature: large tree, It can grow to 30 m in height and 80 cm in diameter, but is usually smaller. deciduous in nature. It has clear bole, often gregarious on new alluvial lands or river banks

Sissoo are **strong light demander** species. Seedlings are **intolerant of shade, frost hardy** and **Drought hardly**, moderately **fire resistant**, **Root system** is bimorphous, taproot with vigogous lateral root. **Coppice and pollard** freely and produce abundant root suckers. It prefer to grow well on alluvial **soil**. And poor growth on saline soil, heavy clay and less than 60 cm soil depth. It does not growth in waterlogged areas. A permanent water table 7 m below the surface made the site very favorable. As for **Meteorological condition** temperature in its native range averages 12-22°C, but varies from just below freezing to nearly 50°C. An average annual rainfall of 500 to 2000 mm is distributed in a monsoonal pattern with droughts of 3-4 months. it make good **association** with acacia catechu on freshly deposited soil. Sissoo is sensitive **grazing and browsing**, young seedlings vary liable to damage by browsing. roots have nodules.

Natural regeneration

Natural regeneration also possible from the self cut root in the form of root suckers. **Seed Production** abundantly almost every year. **Fruit ripens** in December to March. **Seed dispersal** by wind and flood water. **Seed germination** begins when ground is moistened by river and rain water. it required full over days light, permeable soil and freedom from weeds for **development**.

Artificial regeneration

Plant propagated by direct showing, entire planting, stump planting, branch cutting and root cutting. **Seed collection time** is December to March and **No of seed per Kg** 33,000. **Seed extraction** by dried in sun until they open and beaten to separate the seeds and clean the seeds by winnowing. **Seed type** is orthodox so dry before storage .**Viability of seed** is 6 to 12 month cold water **treatment** is required at the time of **Seed sowing** which is march to June. It takes 8-10 days for **Germination and Prcentage:** 90-100%. **Germination type** is epigeal. **Nursery Period** for seedling is 4-12 month and for stump is 12-16 month. **Panting spacing** are 4 x 4 m, 3 x 3 m and 2 x 2 m. **weeding** is important during the first 2-3 years. In a trial at Adabhar, Nepal, mean height at 18 months was 3.8 m in fully cultivated plots and 1.3 m when weeding was confined to a 50 cm diameter circle around the plants (Jackson 1987).

Wood properties

Air dry **weight** is 780kg per cubic m. and **Specific Gravity** 0.7- 0.8. easy to saw timber for carpenters. Durability is high and high seasoning refractory. Lustrous, coarse and even textured with straight to some what or interlocked grain.

Pests and Diseases

Fungus, *Ganoderma lucidum*, which causes root and butt rot, is common. *Fusarium solani* and *Polyporus gilvus* cause similar diseases. *Plecoptera reflexa*, leaf defoliator, *Dichmeria eridantis*, leaf roller, *Stromartium barbatum*, a wood borer, and *Sinoxylon anale* and *Lyctus africanus*, powder post beetles, have been reported as having caused considerable damage.

Sissoo suffers minor damage from two foliage rusts and a powdery mildew (Jackson 1994).



Fig: dying trees of
Dalbergia sissoo

Management

We generally adopt clearfelling and plantation. Simple coppice, coppice with standard and coppice with two rotation system is also used. Weeding, cleaning, thinning is also required. In plantation forest three times weeding should be done in first year, twice in second year and once in third year. Protection from fire, browsing should be needed.

5.3 Pinus roxburghii

Local Name: Khote salla,	Botanical Name: Pinus roxburghii	Mycorrhiza association presence in root soil.
English Name: chip pine	Family: pinaceae	

Natural Occurrence

It occurs between 400 to 2000m altitudes. It is primarily found growing up to 2700m in western Nepal (Thakur, R.B.,2003).

Morphological characters



Fig: female cone of pinus roxburghii

Leaves are in cluster of three, long, light green like a needle shape. Needles usually persist for about one year. Shedding of needles in May or June. **Flowers** are conelets male flower is about 1.5 cm long and arranged in the form of cones, female cone solitary, woody.

Fruit are woody cones, wings, membranous. Cone ripening in next. April- may.

Bark is dark gray, often reddish, deeply fissured, rough and exfoliating in longitudinal elongated plates.

Silvicultural characteristics

It is large tree, monoecious, evergreen, resiniferous tree. It is gregarious forming pure forests but sometimes mixed with other species mainly at lower and upper limit with Sal and blue pine respectively. Sisoo is strong light demander, **frost** hardy **Drought** resistance, it is **fire** hardly due to thick insulating bark, but damage from the fire is considerable since highly resinous tree found on dry, hot slopes. it is a non coppicer **Soil:** it prefer well-drained, light-texture, warm and dry southern aspects.



Fig: bark of pinus roxburghii

As for **Meteorological condition** maximum temperature

32-38°C and minimum temperature fall below freezing point, for pure stand, normal annual rainfall is 100-175°C. it make good association with shorea robusta, gmelina, litsea, bahuinia and anogeissus spp in lower limit and pinus wallichiana, quercus incana, rhododendron arboretum, in upper limit. cattle and sheeps do not graze, leaves are unpalatable to livestock. it has massive root system and is more or less wind firm. Its root has a good symbiotic relationship with mycorrhiza.

Natural regeneration

Seed fall mostly from April to June . **Good seed** produces in every 4-5 years. **Seed dispersal** by wind. **Seed germination** best on bare ground such as abandoned cultivation or brunt areas. Germination commences at the beginning of the monsoon. **Establishment** of seedling is greatly influence by light, drought and topography, soil under growth, fire, grazing and grass cutting.

Artificial regeneration

Method of planting: direct showing, entire planting, **Seed collection time:** January and March when cone turn brown, **No of seed per Kg:** 8,000-12,300, **Seed extraction** by dried in sun until cone open them knocked together to dislodge the seeds. **Seed type** is orthodox seeds, dry before storage **Viability of seed** more then one year. **Seed treatment** generally not required but in may treat with cold water, **Seed sowing time** in below 1000m elevation February-march and above 1000m august- September. **Germination time** began in 8-10 days and complete in 70-90 days. **Germination percentage:** 70-90%. **Nursery Period** below 1000m 4-5 months, and above 1000m 10-11 months

Wood properties

Wood is heavy and 650kg per cubic meter. Easy to saw resin tapped tree comparing with non tapped tree, not so durable in expose site but durable indoor uses. It is refractory wood to seasoning

Pests and Diseases

Armillaria mellea, Fomus annosus, Ganoderma lucidum, are common as a root rot. It have also sophisticated by Fomes pini, Ganoderma applanatum, (Heart rot), Cornartium himalayense, coleosporum campanulae are needle rust of pinus. Bark borer Ips longifolia can also attack pine.

Management

Seed tree method, uniform or irregular shelter wood system, Group selection system can be adopted. Thinning may required in after 5 years. Hue amount of resin are collected for these species in Nepal but due to poor management and lack of supervision un technical tapping were done in some place. So we should to discourage such non technical work for its future. Weeding, cleaning should to be done in the plantation work. Generally at age on 4-5 years purnning was done.

5.4 Cedrus deodara

Local Name: Deodar	Botanical Name: Cedrus deodara	
English Name: Deodar	Family: pinaceae	

Natural occurrence: it occurs in Nepal between 1900-2600 m, usually on northwest and northeast facing slopes in western Nepal.

Morphological characteristic

Leaves are needle shape and 2.5-4 cm long in dense clusters at the end of short shoots. Male flower appears in June and female flower appears in August. **Seed** are winged and ripen in October to November. Good seed year occurs once in three years.



Fig: bunch of leaves of cedrus deodara



Fig: Tree of cedrus deodara

Tree nature: it is a very large, evergreen and ornamental tree, branches horizontal or arising irregularly from the stem. **Light** demander but young seedling requires some side shade. it is **frost hardy** and sensitive to drought in seedling stage. young seedling are liable to damage by **browsing**. **Fire** both seedling and mature trees are sensitive to fire. It is a non- **coppicer**.

It grows in moist, well-drained soil, but avoids stiff, drained soil, on shallow rock soil. Its growth is stunted. It is a **gregarious** tree and frequently forms pure forest, but it is also mixed with blue pine, picea, taxus, quercus, juglans, rhododendron etc. **Meteorological condition** its best growth is 100-175cm annual rainfall

Artificial regeneration

Preferred propagation is entire planting, direct sowing, and bare root planting. **Seed collection** time is between October and December **No of seed** per kg is 8000 Seed storage is orthodox. **Seed viability** is with in 4 month. **Seeds are sown** in November and allow passing the winter and germinating in following spring. It takes place about two week for germination and **Germination percentage** is 80-90% **Nursery period**: one year

Wood properties

Wood is heavy 650kg per cubic meter. easy to saw resin tapped tree comparing with non tapped tree. Not so durable in expose site but durable indoor uses. non refractory wood to seasoning.

Pests and diseases

In deodar root and butt rot due to Fomes annosus, Armillaria mellea very common. In case of defoliator Ectropis deodarae attack the leaves.

Management

No any silvicultural system practice in Nepal. It is recommended to apply single tree selection, Irregular shelter wood system and uniform shelter wood system. Tending operation such as cleaning and thinning applied to get maximum benefit.

5.5 Tectona grandis

Local Name: Sagwan	Botanical Name: Tectona grandis	it suppress all the undergrowth leaving the base floor
English Name: teak	Family: verbenaceae.	

Natural occurrence

it is indigenous to India, Burma, java, Indonesia and Thailand. It grows from Terai to 700m elevation in area where the vegetating is open and there is good drainage.

Morphological characters

Leaves are broadly elliptical or obovate. **Flower** are small, white sweet scented and numerous. **Fruit** is hard, bony, irregularly globose, somewhat pointed at the apex. **Seed** are 1-3 rarely 4 in a fruit. **Bark** is fibrous, light brown of grey, exfoliation in long, thin strips.

Silvicultural Characters

It is a large deciduous tree with rounded crown, clean and cylindrical bole, stem is fluted and buttressed at the base. It is strong **light** demander and **frost** tender and drought tender. **Fires** are very sensitive. It best growth on deep, well-drained, loamy to sandy loam **soils**. It does not tolerate water-logging. It is not planted in pure plantations on sloping eroded sites. **Coppice** as well as pollarding very well. Teak normally occurs in the mixed deciduous forest. The common **associates** are *Acacia catechu*, *Adina cardifolia*, *Cassia fistula*, *Dendrocalamus strictus* and *Bambusa atundinacea*. **Browsing** is not readily by animals. It suppress all under growth, leaving a bare floor. It is not sensitive to pH and moderately wind firm in coastal areas. Teak is uprooted during cyclonic storms.

Artificial regenerations

Propagation techniques are direct sowing, entire planting, stump planting, **Seed collection** time between November and January. **No of seed** per kg is 1200-1300 drupes. Seed are **orthodox** so required dried in a polythene bag, seal it and keep in a cool place. Seed **viability** is 1 years generally but may up to 10years in sealed container. Seed treated by hot water mechanical treatment, **Seed sowing** time are generally march and April. **Duration** of germination is from 14 days to 6 weeks. **Germination percentage** is 60-80%. germination is epigeous and best result of 12 month old seed than fresh. **Nursery Period** for seedling is 4-5 months and for stump is 1 years.

Wood properties

Moderately hard, easy to saw and work., weight is 720 Kg per cubic meter and specific gravity is 0.55 to 0.70 it is a very refractory wood to treatment.

Insect and pests

Hapalia machaeralis, skeletonizer and Hablaea puera, defoliator is very common in the teak plants. Bacterial wilt Pseudomonas salanocerum, root rot Armillaria mellea, Fomes lamaensis, also cause damage in plantation of teak. Other diseases are pink diseases due to Corticium salmonicolor and necrotia stem canker.

Management

We generally adopt clearfelling and plantation. Simple coppice, coppice with standard and coppice with two rotation system is also used. Weeding, cleaning, thinning is also required

6. CONCLUSIONS

Timber producing species are main source of income of nation since long history to till now. Shorea robusta, Dalbergia sissoo, Pinus roxburghii, Cedrus deodara, Tectona grandis are the main timber producing species of Nepal. To know the Silviculture of these tree species is main pinaceae for the success in both natural as well as plantation forest. For the sustainable management of these community forestry, management plan should be incorporate the practice of silviculture of locally available timber producing species for its sustainable forest management.

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