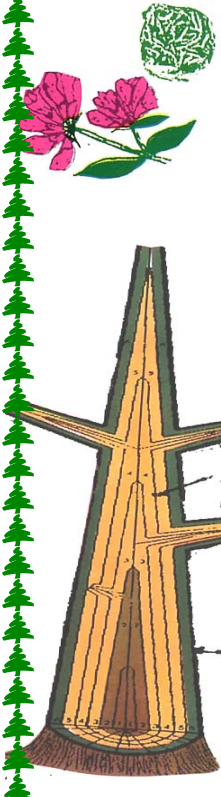
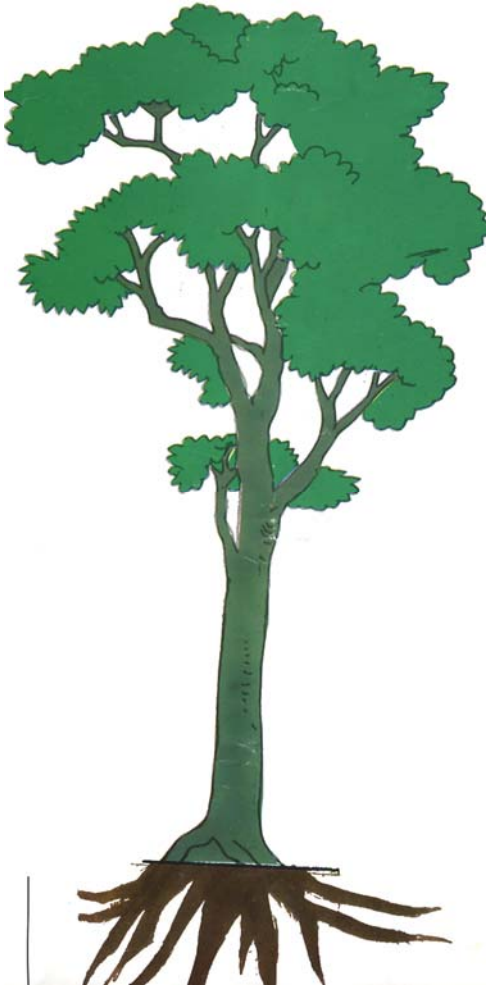
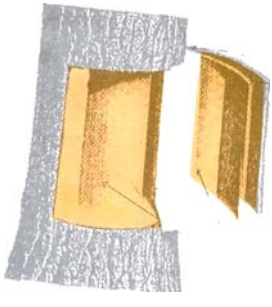
A
Compendium of
Tree Species of Nepal







R.B.Thakur

A
Compendium of
Tree Species of Nepal

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A
Compendium of
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Foreword

A Compendium of Tree Species of Nepal is intended to serve an important need of the students of forestry, forestry professionals and natural resource managers. Based on a careful study of the syllabuses that have come into use at the I. Sc. and B. Sc. levels, this book is an attempt to use the findings of recent works pertaining to tree species. The book provides information about tree species on their morphology, natural occurrence, natural regeneration, artificial regeneration, diseases, pests, and parasites, wood properties and rate of growth, uses, agro-forestry application, silvicultural system, conservation status, and royalty rate and marketing price.

There is no dearth of books on tree species, but each of these books available emphasizes a definite aspect of the tree species, not all the important aspects. So, these books lack in some important aspects and do not give the holistic picture of a tree. This compendium, unlike other books, gives nearly a complete picture of tree species. Furthermore, it is formatted in such a way that readers can easily understand and benefit from its concise form. It is a comprehensive summary of tree species, so this is unique and of its own kind.

"**Tree morphology**" is the specialty of the book. It has been explained in detail with the help of diagrams of different parts like leaf, flower, fruits, etc. of tree species. This will help readers particularly in identification of tree species. In addition, it presents chemical characteristics such as crude protein content, i.e., nutritional value of fodder species, gum and resin, tannin content, pulp and paper, etc. which makes this compendium different from other books. Readers can save their valuable time by using this document instead of searching for many books.

I hope therefore that students as well as professionals will find this compendium very useful. It is worth their money that they will spend buying it and worth their time they will invest reading it.

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Firstly, this compilation is dedicated to my respected teachers Mr. C.L. Das, late V.P. Jayaswal and Mr. P.N. Pradhan; my lovely son Ashutosh and all my friends.

I express my deep sense of gratitude and respect to Prof. Dr. A. K. Das, Prof. Dr. I.C. Dutta, Mr. D.N. Thakur, and Mr. J.N. Shah for their help, encouragement, guidance and practical suggestions extended to complete this compilation.

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This book is very much a product of the institute of forestry. A number of teachers have shared and nourished my enthusiasm. They read several drafts of manuscripts and suggested numerous improvements in aspects related to their specialized fields, specifically Dr. B.K. Paudel, Dr. Julie Huddle, Mr. J.N. Yadav and Mr. R. A. Khan in silviculture & silvicultural system; Mr. J.N. Shah, Mr. A.R. Gyawali, and Mr. S. Choudhary in timber utilization; Mr. K.R. Tiwari and Mr. K.M. Shrestha in soil suitability and agro-forestry application; Mrs. Sunita Singh in taxonomy and tree morphology; Dr. B.R. Bhatta and Mr. J. N. Pandey in forest pathology and forest entomology respectively. I hereby express my sincere and profound gratitude to all of them.

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A very special appreciation goes to my parents, relatives and colleagues who always encourage and inspire me. A deep appreciation is extended to my wife, Nirmala for her inspiration, patience and understanding shown during the preparation of the manuscript as well as final preparation.

I request all the readers of this book to give their faithful comments or suggestions for improvements. Any kind of suggestions and comments for improvement and betterment of the book by any readers will be highly welcomed and appreciated.

R.B. Thakur
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TABLE OF CONTENT

4	*Brassaiopsis hainla*		19	*Lannea coromandelica*	
5	*Brassaiopsis glomerulata*		20	*Leucosceptrum canum*	
6	*Bridelia retusa*		21	*Michelia champaca*	
7	*Buddleja asiatica*		22	*Pinus roxburghii*	
8	*Castanopsis hystrix*		23	*Pinus wallichiana*	
9	*Castanopsis indica*		24	*Prunus cerasoides*	
10	*Castanopsis tribuloides*		25	*Quercus lamellose*	
11	*Cordia dichotoma*		26	*Quercus leucotricophora*	
12	*Daphniphyllum himalense*		27	*Quercus semicarpifolia*	
13	*Erythrina arborescence*		28	*Salix babylonica*	
14	*Eurya acuminate*		29	*Saurauria napaulensis*	
15	*Exbucklandia populnea*		30	*Schima wallichii*	

CHAPTER: IV TREE SPECIES OF HIGH-HILLS					
S.N.	**Botanical Name**	**P.N.**	**S.N.**	**Botanical Name**	**P.N.**
1	*Abies pindrow*		6	*Juniperus indica*	
2	*Abies spectabilis*		7	*Picea smithiana*	
3	*Betula utilis*		8	*Rhododendron arboretum*	
4	*Cedrus deodara*		9	*Taxus baccata*	
5	*Cupressus torulosa*		10	*Tsuga dumosa*	

CHAPTER: V IMPORTANT FODDER TREE SPECIES OF NEPAL					
S.N.	**Botanical Name**	**P.N.**	**S.N.**	**Botanical Name**	**P.N.**
1	*Acacia nilotica*		9	*Garuga pinnata*	
2	*Aesandra butyracea*		10	*Litsea cubeba*	
3	*Artocarpus lakoocha*		11	*Litsea monopetala*	
4	*Bauhinia purpurea*		12	*Morus alba*	
5	*Bauhinia variegata*		13	*Myrica esculanta*	
6	*Choerospondias axillaris*		14	*Pyrus pashia*	
7	*Ficus cunia*		15	*Sesbania grandiflora*	
8	*Ficus nerifolia*				

CHAPTER: VI SILVICULTURE OF BAMBOOS AND RATTANS					
S.N.	**Common Name**	**P.N.**	**S.N.**	**Common Name**	**P.N.**
1	Silviculture of bamboos		2	Silviculture of rattans	

CHAPTER: VII IMPORTANT EXOTIC TREE SPECIES OF NEPAL					
S.N.	**Botanical Name**	**P.N.**	**S.N.**	**Botanical Name**	**P.N.**
1	*Acacia auriculiformis*		10	*Grevillea robusta*	
2	*Callistemon citrinus*		11	*Jacaranda mimosifolia*	
3	*Cassia siamea*		12	*Leucaena leucocephala*	
4	*Casuarina equisetifolia*		13	*Pinus patula*	
5	*Ceiba pontandra*		14	*Populus ciliata*	
6	*Cinnamomum camphora*		15	*Populus deltoids*	
7	*Cryptomeria japonica*		16	*Prosopis juliflora*	
8	*Delonix regia*		17	*Saraca indica*	
9	*Eucalyptus camaldulensis*		18	*Tectona grandis*	

CHAPTER	CONTENT	P.N.
VIII	GLOSSARY OF MEDICINAL TERMS	

CHAPTER	CONTENT	P.N.
IX	REFERENCES	

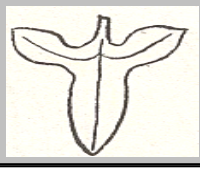
ABBREVIATIONS USED IN THIS COMPILATION:

Bet^{n} : Between
Collect^{n} : Collection
Condt^{n} : Condition
Cu.ft. : Cubic feet
Durat^{n} : Duration
Eco.value: Ecological value
Extract^{n} : Extraction
Germ^{n} : Germination
KJkg^{-1} : Kilo per gram
Meteo. Condition : Meteorological condition
No. : Number
NTFP : Non timber forest product
Preserv. treat : Preservative treatment
Product^{n} : Production
Sp. gr. : Specific gravity
Wt. : Weight

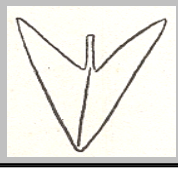
TREE MORPHOLOGY

Shape of the simple leaf

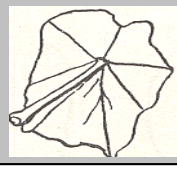
Sagittate: Leaf with an arrow shaped leaf blade.



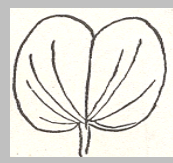
Hastate: Sagittate leaf with its two lobes directed outside.



Auriculate: Having a flat lateral expansion like the lobe of the ear.



Peltate: Flat body of a leaf, a bract or a stigma, attached to the stalk by lower surface.



Bilobed: Having two lobes.

Trilobed: Having three lobes.

5 Lobed or palmate: With mid ribs of lobes or leaflets all radiating from apex of petiole.

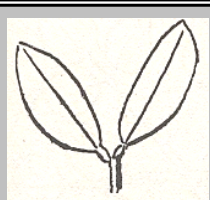
Palmatifid: Leaves divid into lobes to about middle, at acute angles to each other.

Pedatisect:

Lyrate: Large terminal lobe and some smaller basal lobes. *e.g.,* radish, mustard.

Runcinate: Terminal large pointed lobe and the smaller lobes pointed towards the base.

Pectinate: Pinnatified like a comb with narrow close-set segments.



Bifoliate: Palmate compound leaf with two leaflets growing for same point.

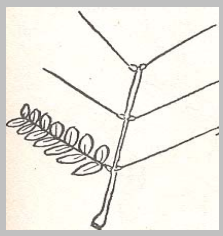
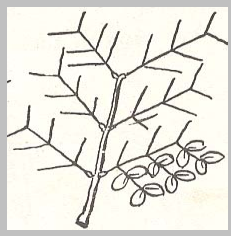
Trifoliate: Palmate compound leaf having three leaflets growing for same point

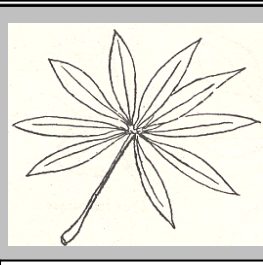
Quadrifoliate: Compound palmate leaf, with four leaflets arising at a common point

Palmately compound leaves

Pinnately compound leaf

Other compound leaf



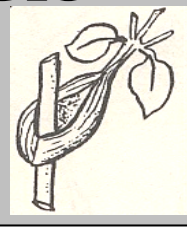
Bipinnate: Primary rachis gives a no. of secondary rachii which bears a row of leaflets in pairs.	**Tripinnate:** Primary rachis gives a no. of secondary rachii that in turn give tertiary rachii which bears leaflets in both sides.	**Decompound:** More than thrice pinnae.	**Digitate**: Leaves with several finger-like leaflets radiating from a central point & joined only at base.

Other compound leaf

Petiole







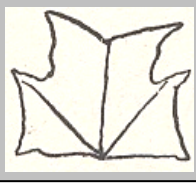
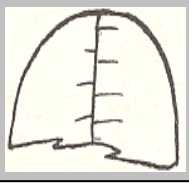
Ternate: Divided into 3 equal parts, these may be further divided into 3 parts, thus 2 – ternate.	**Foliate or digitate**	**Lyretely pinnate**	**Winged**	**Amplexicaul:** Clasping or surrounding the stem, as base of leaf.

Leaf apex

Acute: Ending in a sharp point forming an acute angle, *e.g.*, mango.	**Obtuse:** With blunt or rounded end *e.g.*, Banyan.	**Notched**	**Apiculate:** Forming abruptly to a small tip, *e.g.*, *Dalbergia.*	**Acuminate:** Drawn out into long point; tapering; pointed, *e.g.*, *Ficus religiosa.*

Leaf apex

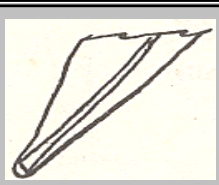
Leaf base

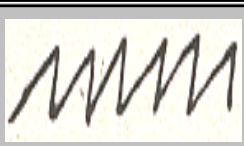




Caudate: Pointed and drawn out like a tail. *e.g.*, Peepal.	**Truncate:** Almost flat.	**Rounded**	**Cuniate:** Wedge shaped, *e.g. pistia.*	**Rounded**

Leaf base

Leaf margin

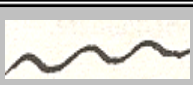
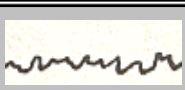





Cordate: *heart-shaped, i.e.,* with the base shaped like the figure of a heart on cards.	**Decurrent:***running down* into; said of a sessile leaf when blade is prolonged below insertion & so runs down stem.	**Sagittate**	**Serrate:** Toothed, the teeth directed upwardly. *e.g.*, rose.

Leaf margin

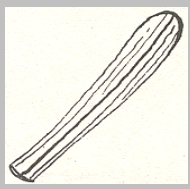



Crenate: With scalloped margin.	**Sinuous**	**Undulate**	**Erose**	**Spinous:** With spines or prickles.

Venation

Position of leaf



Parallel: All the veinlets run parallel to each other.

Reticulate: Vein lets irregularly distribute & fuse to each other to form a network of veins

Opposite: On different sides of the axis with the bases at the same level.

Alternate: A single leaf arising at each node.

Whorled: More than two leaves arranged in a circle round an axis.

above

Shape of flower

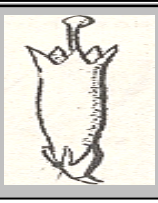
Stellate: *Star-shaped*; with radiating rays like the points of a star.

Campanulate Bell-shaped, the petals are fused to each other.

Funnel-shaped: Called as infundibuliform.

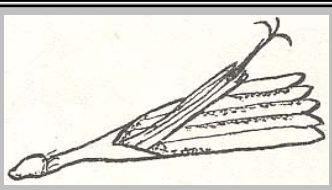
Labiate: *Two-lipped.*

Personate: Zygomorphic, gamopetalous corolla with two lips.



Tubular: Tube like, gamopetalou s corolla

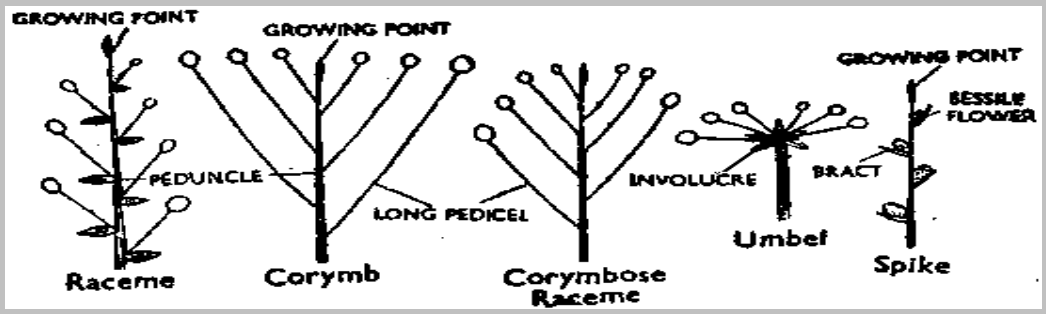
Digitaliform



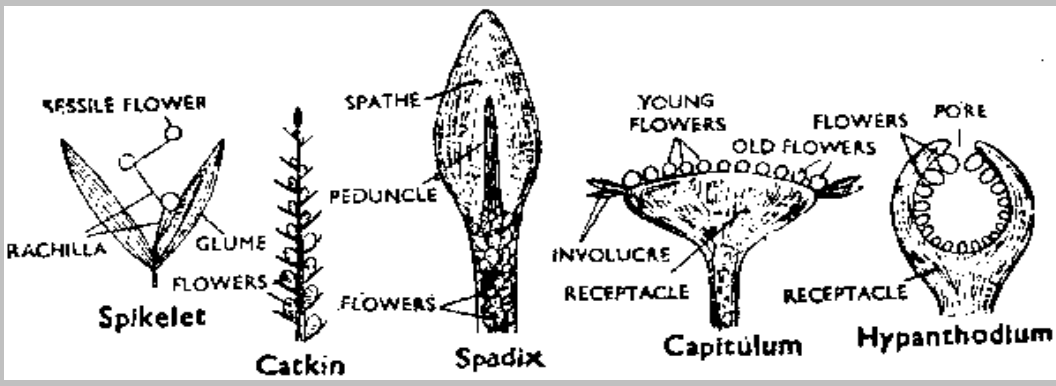
Ligulate: Corolla forming a short, narrow tube below and ligule like flat structure above.

Spurred corolla: Drawn out into a beak or spur.

Inflorescence

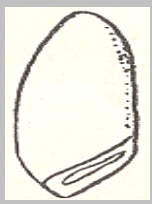
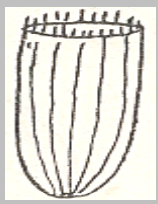
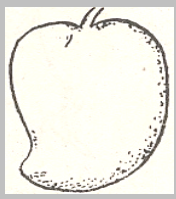


Raceme: Inflorescence having a common axis & stalked flowers in acropetal succession.	**Corymb:** A raceme with lower pedicels elongated so that the top is nearly flat.	**Corymbose raceme:** It is an intermediate between corymb and typical raceme.	**Umbel:** A cluster of flowers whose spreading stalks or rays arise form apex of stem, resembling spokes of an umbrella.	**Spikes:** Inflorescence with sessile flowers along a simple, undivided axis.



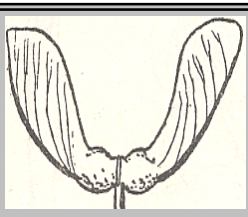
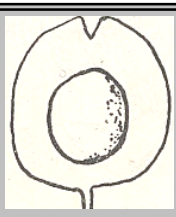
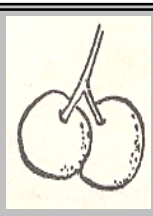
Spikes: Inflorescence with sessile flowers along a simple, undivided axis.	**Catkin:** A spike with unisexual flowers and pendulous rachis, *e. g., Morus*.	**Spadix:** A racemose inflorescence with elongated axis, sessile flowers & an enveloping spathe, *e.g., Musa*	**Capitulum:** An inflorescence of sessile flower crowded together on a receptacle & surrounded by involucre.	**Hypanthodium :** Inflorescence with concave capitulum on whose walls, flowers are arranged, *e.g., Ficus.*

Fruits


Caryopsis: Very small one-seeded fruit with pericarp fused with seed coat: *e.g.*, maize.	**Achene:** Small one-seeded fruits with pericarp (membranous or leathery), separated from seed coat.	**Drupe:** A fleshy fruit with an inner hard stone enclosing the seed.	**Stone:** Having a stony endocarp around the seeds.	**Glans or nut:** A one seeded fruit with a hard outer covering.



Acorn: A nut partly enclosed within a cup which is made up of a circle of hardened, bract leaves. e.g Oak	**Carcerule:** Ripened fruits break up into indehiscent, *e.g.*, tulsi.	**Samara:** A dry winged fruit that does not split open. *e.g.*, *fraxinus*	**Compound samara**: It splits at maturity into one seeded winged mericarps *e.g. Acer.*	**Berry:** A simple juicy fruit, usually small, with seeds in the middle of a pulp.





Regma: Fruits split up at maturity into three cocci or dehiscent single seeded parts.	**Capsule:** A dry fruit formed of two or more fused carpels that splits open when ripe.	**Siliqua:** A long narrow two chambered fruit. e.g. Mustard.	**Sorosis:** Multiple fruit developing from a spike or spadix or female catkin, *e.g.*, mulberry.	**Cone:** Female organ of Conifers formed of woody scales on that seeds are borne

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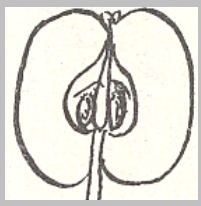
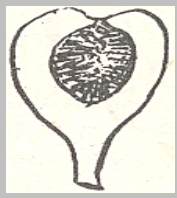
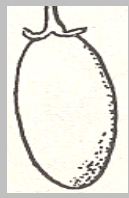
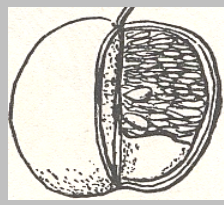
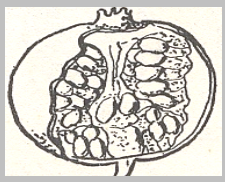
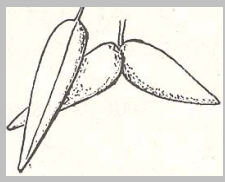
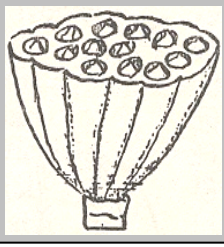




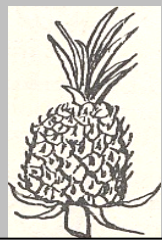
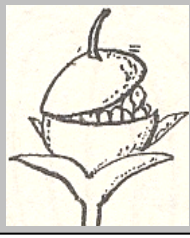


Pome: apple, Succulent fruit with seeds in many cartilaginous dry cells.	**Syconus (Fig):** Develop from hypanthodium type of inflorescence, *e.g.*, banyan.	**Amphi sarca:**	**Pepo:** Many seeded fruit with parietal placentation, *e.g.*, cucumber.	**Hesperidium:** Special type of berry in which endocarp is membranous, partitioned & bears juicy hairs, *e.g.*, citrus fruits, orange.

Balausta: Fruit contains two irregular rows of seeds, one above the other.	**Folllicles:** A dry pod-like fruit splitting down one side only.	**Pod or legume:** A long cylindrical or somewhat flattened fruit, usually splitting into 2 valves, as in *Leguminosae*.	**Lomentum or legume:** Fruit is constricted bet^{n} seeds into a no. of one seeded compartments, *e.g.*, gum tree.	**Spiral legumes**




Thalamus	**Ectaerio**	**Sorosis**	**Capsule or pyxis**	**Berry**

CHAPTER: II

TREE SPECIES OF TERAI

(1)

Local name: Khair	Sub–family: Mimosaceae
Acacia catechu	Family: leguminosae

1. Natural occurrence:

It occurs between Terai -1400m elevations, widespread in Terai, it is quite common in peninsular region, particularly in drier parts; it occurs in tropical dry mixed deciduous forests.

2. Morphological Characteristics:

Leaf	Leaves are pinnate. Leaves shedding during February; new leaves appear during April-May.
Flower	Flowering commences in June and continues till July to August; flowers are pale yellow in cylindrical spike.
Fruit	Pods are glabrous, flat and oblong.
Seed	Seed ripens between November-March.
Bark	Bark is dark greyish brown; exfoliating in long, narrow strips.

3. Silvicultural characteristics:

Light	It is a strong light demander; does not tolerate any kind of suppression.
Frost	Frost hardy.
Drought	Very drought resistant.
Fire	Fire resistant.
Soil	Prefers well-drained coarse, gravelly and alluvial soil: can grow on black cotton soil.
Coppice	Coppices well; produces root sucker.
Associates	It makes a good association with *Dalbergia sissoo*; common associates are *Anogeissus latifolia, Diospyrous melanoxylon, and Lagerstoemea parviflora, Terminalias.*
Tree Nature	A moderate sized deciduous tree.
Met.condition.	**Max.Temp**. 40 to 48^0 C, **Min. Tamp** (-1 to 12.8^0C); rainfall: (50cm to 200cm)
Root system	Develop a strong tap root system; can withstand flooding**.**

4. Natural regeneration:

Seed product^n	Good seed year occurs every year.
Seed dispersal	Seeds can be disseminated by river, water and wind.
Seed germinat^n	Seeds can germinate on alluvial deposits.
Other	It can be regenerated by coppices.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, stump planting
Seed collect^{n} time	January to February.
No. of seed kg^{-}1	30,000 to 40, 000seeds kg^{-1}, individual tree yields 0.5 to 2 kg seed.
Seed extraction	Seed should be dried in sun, until they open, and then beaten with stick to separate the seeds. Seeds cleaned by winnowing.
Seed storage	Orthodox seed. Dry thoroughly in the sun.
Viability of seed	Seeds retain their viability 6-8 months.
Seed Treatment	Seeds soak and scarify before plantings.
Seed sowing time	Seed should be sown during March to April for July planting.
Duration of germ^{n}	30 days.
Germination (%)	60-80%, germination is epigeal.
Nursery period	**Seedling: 12**-14 in Terai; 14-16 weeks at higher altitude.
Best planting size	20-30cm tall with root collar diameter 3mm or larger.

6. Forest pathogens:

The fungus *Ganoderma lucidum*, is a root parasite causes high mortality in khair plantation. The *Angiosperm Parasites, Loranthus languorous and Dendrophthoe falcata* are often found on khair.The tree is attacked by *Buprestid Beetle* and *Cerambycide Beetle*, which usually attack teak. *Porcupines hystrix* are seriously damaged to plantation or killed by eating their bark partly or wholly.

7. Wood properties:

Weight	Wood is very heavy-to-heavy; it weighs about 1008-1040kgm^{-3} at 12 % moisture content (m.c.), specific gravity is 0.98.
Hardness	Timber is very hard.
Working quality	It is difficult to saw and work, it is also difficult to chip with machines.
Strength	Timber is extremely strong.
Calorific value	c.v is about 25,600 KJkg^{-1}.
Durability	Timber is very durable not attacked by white ants.
Preserva. Treat.	It is not required.
Seasoning	It seasons slowly but well.
Wood color	**Sapwood:** yellowish white; **heartwood:** light or dark red, turning brownish with age; wood is straight grained to interlocked grain; heartwood is pinkish to reddish brown and medium to coarse textured.
Porous	Wood is diffuse porous.

8. Uses:

Timber	Fairly good source of timber, it is used for making rice pestles, oil and sugar cane crushers, ploughs, boats, furniture carts, sword handles etc.
Fuel wood	It is an excellent fuelwood. It makes a good and high quality charcoal.
Fodder	It is a good fodder tree in India, but least used in Nepal.
Edible food	Seed of khair gives 44.2% crude protein.
Tannin	Cutch is used for tanning and dyeing purposes; cutch is used for dyeing pulp & paper, at present cutch is being used to a larger extent in printing than in dyeing.

Gum and resin	The gum resin from tree is used in mastectomies. Gum has sweetening taste and forms strong mucilage with cold water.
Ecological Value	Trees are planted to check erosion and help water conservation. It has a symbiotic association with *Rhyzobium bacteria*, which forms nodules in the root and fix N_2.
Medicinal Value	An extent from the plant proved toxic to other growth of fungi, *Periculari Orizae, Clletotrichum falcatum*. Katha has been long used in ayurvedic medicine, it is regarded as astringent, cooling and digestive, used to relax condition of throat, mouth and gum; also used in cough and diarrnoea.
Other	Lac can be successfully grown on khair trees; Katha is an indispensable ingredients of *Pan* preparation.

9. Agroforestry application:

This tree light, deciduous crown and nitrogenuous bacterial nodules in the roots, so it is suitable for planting along field bunds at a distance of 4.5m from agricultural crops (Hocking, 1998) **.**

10. Silviculture systems:

In mixed dry deciduous forests, it is frequently worked under coppice, coppice with stand-ards or coppice- with reserves system on a rotation of 30 years for coppice. (Parkash,1991)

11. Royalty: NRs. 10/kg for air-dry wood. (Forests rules, 1995).
12. Market price: NRs. 60-70/kg for air-dry wood at Sirha district (Parajuli *et al*, 1997).

(2)

Local name: Haldu, karma	**Trade name:Haldu**
Adina cordifolia	**Family: Rubiaceae**

1. Natural occurance:

It is commonly found up to 800m altitudes. It occurs in Terai, Bhabar and Duns, often extending to outer Himalayas .

2. Morphological character:

Leaf	Leaves are simple, opposite and heart shaped; leafless for short time in May.
Flowering	Flower is yellow in globes; flowering occurs between June–July.
Fruiting	Capsules split into two dehiscent cocci.
Seed	Seeds are minute; ripen in cold season.
Bark	Bark is light grey; exfoliating in patches, blaze light red inside with white streaks.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost tender.
Fire	Fire tender
Soil	It grows best on freely drained soil.It often establishes on landslips, alluvial soil near river. It attanis a good growth on clayey loam and sandy loam soils.
Coppice	It coppices readily.

Associates	Sal is the major constituents. Some associates are: *Acacia catechu, Albizzia pocera, Dillenia pentagyna, Gmelina arborea,Holoptelia integrifolia, Mallotus philippinensis.*
Graze& browse	Browsing sensitive, it causes considerable damage to seedling.
Tree nature	It occurs scattered in deciduous forests.
Soil pH	It tolerates high pH value up to 8.3.

4. Natural regeneration:

Seed product^{n}	Seeds are shed between April and June.
Seed dispersal	Seeds are dispersed by wind.
Seed germination	Germination takes place early in the rain. It establishes well on bare ground such as landslips, alluvial soils near rivers and abandoned cultivation land.
Coppice/ root sucker	Natural regeneration may occur from coppice shoots.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting.
Seed collect^{n} time		April-June
No. of Seed Kg^{-1}		Seed is very light about 11 million kg^{-1}, 1 kg of fruit yield about 60,0000 seeds.
Seed extraction		The flesh should be removed from the seed before storage.
Seed storage		Orthodox seed; fruit should dry in sun and store in sealed plastic bag.
Viability of seed		Viability of seed should retain for 12 month; germination is better at 9 months than fresh, viability lost after 2nd season.
Seed Treatment		Not required
Seed sowing time		March. Seed should be sown on trays, as seeds are tiny.
Durat^{n} of germinat^{n}		Germination can obtain in 30 days.
Germination (%)		30-40%.
Nursery period	**Seedling**	Nursery seedling requires three to five month for July planting.
	Stump	Stump is prepared from 12-15 month old seedling.

6. Forest pathogens:

- The borers *Batocera Rufomaculata* and *Xylotrechus Smei* attack the timber.
- The wood is highly susceptible to drywood termites.
- It is comparatively susceptible to brown rot than white rot.

7. Wood properties:

Weight	Wood weighs about 695 kgm^{-3} at 12% m.c; light to moderately heavy.
Hardness	Wood is hard.
Working quality	It saws well, takes good polish, easily fissile.
Strength	Moderately strong.
Calorific value	About 27000 KJkg^{-1}.
Durability	Wood is moderately durable in exposed situations & durable under cover.
Seasoning	It is moderately refractory wood, seasons well.
Porous	Pores are small to very small, not visible to naked eye. Diffuse porous; growth ring is usually indistinct

8. Uses:

Timber	Timber is used for carving; bobbins, furniture, paneling etc.
Fuel wood	A good fuelwood species, charcoal 32.1%.
Fodder	Leaves are considered as a medium quality fodder.
Tannin	Bark gives tannin 7-10%.
Medicinal value	Roots are used as astringent in dysentery. Bark is acrid and bitter used in biliousness. It is also regarded as febrifuge and antiseptic.
Pulp & paper	Wrapping, writing and printing paper is also made from the wood pulp of this species.

9. Rate of growth:

Haldu growth is very slow in the first year seedlings being only 10-15cm in the nursery. Following year, growth is faster and seedlings are 50-60cm fairly fast and annual height increment of saplings is about 60cm. (Parkash, 19991).

10. Silvicultural system: In mixed forest, it is worked under selection system with an exploitable diameter of about 60cm. In areas of poor growth, it is worked under simple coppice. In sal forest, Haldu is a principal associates, clear felling system followed by artificial regeneration, or shelter wood or selection system should be adapted. (Parkash, 1991).

11. Royalty: NRs. 100/kg for air-dry wood. (Forest rules, 1995)

12. Marketing price: NRs. 200/cu.ft for round timber and NRs. 350/cu.ft for sawn timber at Sirha district, Nepal. (Parajuli *et al*, 1997)

(3)

Local name: Bel	**English name: Bengal Quince**
Aegle marmelos	**Family: Rutacaeae**

1. Natural occurrence: It occurs scaterred in the Terai, lower Hills and the Duns.

2. Morphological characteristics:

Leaf	Leaves are alternate, trifoliate, occasionally, digitately five folilate, leaflets ovate lanceolate.
Flower	Flowers are large, greenish white, sweet scented, in short axillary panicles.
Fruit	Fruits are globose, grey or yellowish, ring woody.
Seed	Seeds are numerous, oblong, compressed, embedded in pulp.
Bark	Bark is soft, corky, light grey, exfoliating in irregular flakes.

3. Silvicultural characteristics:

Light	Light demander.
Frost	It is a fairly frost resistant.
Drought	Drought hardy and found in dry localities unfavorable to the majority of the species.
Soil	It can withstand various types of soils and a pH range of 5 to10.
Coppice	It coppices well.
Associates	It is generally associated with *Acacia cathechu*, *Anogeisus latifolia*, *Bauhinia purpurea* and *Butea monosperma* etc.

Graze & browse	Grazing and browsing animals cause severe damage to the seedlings.
Tree Nature	It is a moderate sized, spinous, slender, aromatic tree, with a somewhat fluted bole, growing wild throughout the deciduous forest of Terai, Duns and lower Hills. It is often cultivated in farm.
Meteorological condition	In its natural habitat, absolute **Max. Temp.(**40-46)^{0}c, absolute **Min.Temp**.(0-7)^{0}c, annual rainfall (570 to 2000)mm.

4. Artificial regeneration:

Preferred propag^n	Nursery raised seedlings, root cuttings, by layering, root suckers.
Seed collectn time	Fruits are collected between March and May.
No. of seed kg^{-1}	5300 seeds kg^{-1}.
Seed extraction	Seed should be washed to remove the pulp.
Seed storage	Orthodox seed. It should be dried and stored in air-tight container.
Viability of seed	Seeds have short viability from 1 to 6 months.
Seed treatment	It is not required.
Seed sowing time	Seeds are sown in June or July.
Duratn of germ^n	Germination completes within 21 days.
Germination (%)	Germination may obtain up to 56%.
Nursery period	**Seedling**: Seedlings require at least one year to fit for transplanting.
Best planting size	20-30cm tall seedlings with 3-5mm root collar diameter.

5. Diseases, pests and parasites of Bel: (i) Leaves, twigs, fruits and thorns are sometimes infected by *Xenthomonas bilvae* which causes a short hole and fruit canker**. (ii)** Young leaves and shoots are eaten by the caterpillars of *Paplio demoleus*. **(iii)**The beetles of *Amblirrhynus poricollis* etc. feed on the plant sap and defoliate the trees.**(iv)** Fruits are attacked by white ants when they fall to the ground.

6. Wood properties:

Wood color	Wood is light yellow and strong aromatic when first exposed, later fading to yellowish grey or greyish white.
Hardness	Wood is hard.
Weight	Wood is heavy, specific gravity is 0.89 and weight is 912 kgm^{-3}.
Working quality	It is fairly easy to saw and fairly make smooth surface.
Durability	Timber is fairly durable if not contact with ground or in exposed situations.
Seasoning	It is difficult to season and has a marked tendency towards surface cracking, cupping, and twisting.
Others	Heartwood is lacking.

7 Uses:

Timber	Timber is used for tool-handles, agricultural implements, furniture, carving etc.
Fodder	The young leaves and shoots are used as fodder for cattle, sheep & goats.
Edible food	Ripe fruit is eaten fresh.
Tannin	Bark contains 5.52% tannin.
Gum and resin	Fruits yield 2% dried, water soluble gums, which serves as a good adhesive.
Ecological value	Due to its ability to grow in poor, stony and alkaline soils, it is

	recommended for reclamation of wastelands and also for windbreaks.
Medicinal value	Roots as well as the bark are used in the form of decoction as a remedy in *Melancholia*, intermittent fevers and palpitation of the heart. Fruit is used in chronic diarrhoea and dysentry.
Paper and pulp	It is also used for making pulp for manufacture of wrapping paper.

8. Royalty Rate: NRs. 2/kg for dry fruit. (Forest rule, 1995)
9. Marketing price: NRs. 20/kg at major market in Nepal dealing with NTFP (1997).

(4)

Local name: Maharukh	
Ailanthus excelsa	**Family name: Simarubaceae**

1. Natural occurrence: It generally occurs between Terai to 800m.

2. Morphological characteristics:

Leaf	Leaves are pinnately compound up to 90cm long with 8-14 pairs of leaflets.
Flower	Flowers are small, yellowish in panicles.
Fruit	Fruits are one seeded samara.
Bark	Bark is a light grey and smooth in young trees with large leaf scars, rough granular and greyish brown in older trees.

3. Silvicultural characteristics:

Light	It is a strong light demander.
Frost	Frost tender.
Drought	Seedlings are sensitive to drought.
Soil	It is capable of growing on poor soils under relatively low rainfall. It does not grow well on clays and waterlogged areas. It thrives best on porous loamy soils.
Coppice	It coppices well and produces root suckers.
Tree nature	It is a large, deciduous tree with a straight cylindrical bole.
Browsing	It has a high immune to protect from browsing.
Rate of growth	It is a fast growing tree.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, cuttings, stump planting.
Seed collect^{n} time	Seeds ripen in April.
No. of seed kg^{-1}	10,000 seeds kg^{-1}.
Seed extraction	Seeds are separated from the wings by beating and winnowing.
Seed storage	Orthodox seed. The dried seed should be stored in sealed plastic bags.
Viability of seed	Viability of seed remains for less than one year.
Seed treatment	Not required.
Seed sowing time	Seeds are sown soon after collection.
Duration of germ^{n}	Germination completes within 45 days.
Germination (%)	Germination may obtain upto 70-90%.

Nursery Period	**Seedling**	Seedlings should require 6 month in the nursery.
	Stump	Seedlings should require 1year in the nursery for stump.
Best planting size		15-25 cm tall seedling with 3-5mm root collar diameter.

5. Diseases, pests and parasites of Maharukh: It is attacked by a defoliator *Atteva fabriciella* almost round the year.

6.Wood properties:

Wood Color	Wood is white.
Hardness	Wood is soft.
Weight	Wood is light (Specific gravity is 0.45 and weight 335-480 kgm^{-3})
Working quality	It is a easy to saw and work well.
Strength	It is fairly strong wood.
Durability	It is perishable in the open but not so in water. It is susceptible to damage by white ant and insect attack.
Preserv. treat.	Timber is treatable with preservative.

7. Uses:

Timber	It is used for veneers, plywood, packing cases, and poor quality matchwood.
Fuel wood	It makes a good fuel wood.
Fodder	Leaves along with the twigs are found to be a suitable fodder for cattle, sheep, and goats.
Gum and resin	Tree yields an inferior quality of gum.
Ecological value	It serves as one of the hosts for 'Eri'silkworm and as a bee pasturage.
Medicinal value	Bark is bitter, astringent, febrifuge and anthelmintic. It has anti-spasmodic and expectorant properties and is used for asthma, bronchitis, and dysentry. It is also used for dyspepsia and earache, antiseptic properties.
Paper &Pulp	Chemical pulps can be prepared from the wood by sulphate process, which is suitable for writing and printing papers.

(5)

Local name: Rato siris	**Eng name: Kokko**
Albizzia chinensis	**Family: Mimosaceae, Leguminosae**

1. Natural occurrence: : It occurs between Terai to 1500m.According to Champion and Seth (1968) it occurs in northern tropical moist deciduous forest.

2. Morphological characteristics:

Leaf	Leaves are with 8-15 pairs of pinnae, leaflets 50-80, lanceolate.
Flower	Flowers are white with pinkish filaments, in terminal and axillary panicles.
Fruit	Pods are thin & brown.
Seed	Pod contains 8-12 seeds.
Bark	Bark is grey with short vertical wrinkles crossed by deeper horizontal furrows.

3. Silvicultural characteristics:

Light	Moderate light demander
Frost	Frost sensitive.
Drought	Drought sensitive.
Fire	Fire resistant.
Soil	It prefers moist sites.
Coppice	It coppices well.
Associates	In lower altitudes, it often associates with sal and other *Albizzias* and at higher altitude, it associates with sal.
Graze & browse	Leaves are palatable, so seedlings are severely damaged by browsing.
Tree nature	A large deciduous with a broad, spreading and flat-topped crown.
Other	It is sensitive to grass competition. It is also liable to damage the branches by wind-storms.

4. Natural regeneration:

Seed production	The pod begins to ripen in Nov –Dec & continue to hang on the branches throughout the dry season.
Seed dispersal	Seeds are dispersed by wind.
Seed germination	Germination & establishment is best on loose soil with a fair degree of moisture. Seeds begin to germinate with rainfall during monsoon.

5. Artificial regeneration:

Preferred propag^{n}		Direct showing (found to be the best), stump planting, entire plating.
Seed collection time		December – March.
No. of seed kg^{-1}		About 3000 pods & 20,000–70,000 seeds k.g^{-1}.
Seed extraction		Pods are dried in the sun for a few days until they open. Seeds are extracted by hand.
Seed storage		Seeds should be dried & stored in sealed polythene bags with insecticide.
Viability of seed		Seed can be stored for a year.
Seed treatment		Seed should be manually scarified or treated with hot water by immersing it for two to three minutes in water that has been boiled, then soaking in cold water for 24 hours.
Seed sowing time		August to September.
Duration of germination		**For unscarified seed:** seed germinates well in 3 to 4 days, **Seeds treated with hot water:** Germinates in 6-12 days.
Germination (%)		Seed germination is about 50%.
Nursery Period	**Seedling**	**<1000m:** it requires 4 months, **>1000m:** it requires for 10-11 month after sowing in August to September.
	Stump	Stumps are prepared from one-year-old seedling.
Best Planting Size		20-30cm tall seedlings with 3-5mm root collar diameter.
Other		It can be raised only in moist localities.

6. Diseases, Pests and Parasites of Rato Siris:

Diseases affecting *Albizzias* are: **i). Root-rot:** caused by *Armillaria mellea & Ganoderma lucidum,* **ii) Heart rot:** caused by *Ganoderma applanatum* and *Polyoprous gilvus*. **iii) Leaf rusts:** caused

by Ravenellia and Uredo iv) leaf spots: caused by: *Serospora albiziae.*

7. Wood properties:

Weight	Wood weighs about 300-500kgm^{-3} .Timber is light to moderately heavy, specific gravity is 0.72.
Hardness	Timber is soft.
Working quality	Timber is easy to saw and work. It takes an excellent polish
Strength	It is less strong timber.
Calorific value	**Sapwood:** 4358 calories, **Heartwood:** 4845 calories.
Durability	Timber is not very durable in exposed situations, or in contact with ground.
Preserva. treat.	Heartwood is very refractory to treatment. Sapwood is easily treatable.
Seasoning	Highly refractory wood to seasoning, i.e, and timber is liable to severe splitting and surface cracking.
Wood color	**Sapwood** is large & white while **heartwood** is brown. Growth rings distinct to the eye.

8. Uses:

Timber	Use for box making, especially tea-boxes, packing cases & for matches. Use for decorative veneers, cabinet making, paneling and picture-frame.
Fuel wood	It is a good fuel wood.
Fodder	A good fodder with high crude protein content about 15% and total digestible nutrients about 38%.
Tannin	Bark contains 22% tannin.
Gum and resin	Gum is used for sizing Daphne paper.
Ecological value	It belongs to leguminosae family, so it fixes atmoshpheric N2.
Medicinal value	Barks infusion is used as a lotion for cuts, scabies and other skin diseases. The seeds and leaflets are fairly toxic to melon-worm larvae and cotton stainer adults.
Paper and pulp	The wood yields 47.8-49% pulp by sulphate process. It is suitable for writing and printing paper after it is mixed with suitable long fibred pulp.
Others	The wood yields 47.8-49% pulp by sulphate process. It is suitable for writing and printing paper after it is mixed with suitable long fibred pulp.

(6)

Local name: Kalo siris	**Eng name: Kokko**
Albizzia lebbek	**Family: Mimosaceae**

1. Natural occurrence:

It occurs between Terai to about 1200m but common in lower altitudes. It is a constituent of riverain forest with *Dalbergia sissoo* forest and *Acacia catechu*, and *Shorea-Terminalia tomentosa* forest. According to Champion and Seth (1968) it is characteristic of northern tropical moist mixed deciduous forest.

2. Morphological characteristics:

Leaf	Leaves are bipinnate with 8-18 leaflets. New leaves appear in March-April.
Flowering	Flowers are greenish yellow in color. Flowering in April to May.
Fruit	Pods are dark red-brown when ripe. Fruiting in Oct.-Nov, remain long in tree.

Seed	When pods are dry, they open to release seeds.
Bark	Bark is dark brown to greenish black, rough with longitudinal and transverse fissures on outer surface.

3. Silvicultural characteristics:

Light	Light demander
Frost	Frost hardy.
Drought	Fairly drought resistant.
Soil	It prefers a good wel-drained loamy soil, can grow fairly well on clayey, laterite or black cotton soil.
Coppice	It coppices well and produces root suckers.
Associates	It is often associated with *Dalbergia sissoo, Acacia catechu, Shorea robusta, Terminalia tomentosa,* and *other Abizzias.*
Browsing	Grazing and browsing sensitive, it suffers greatly from browsing.
Tree nature	It is a deciduous tree with wide spreading crown.
Root system	It has a superficial root system, it is apt to blow down by wind.Due to heavy crown, it suppresses the weeds.

4. Natural regeneration:

Seed production	It produces seed annually and abundantly; seeds remain viability for long period of time.
Seed dispersal	Seeds are dispersed by wind.
Germination	Seeds are extensively damaged by insects, so natural regeneration may be poor.
Establishment	Establishment of seedling is high on well-drained, loamy and moist soils.
Coppice/root suckers	Natural regeneration also takes place from coppice or root suckers.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump planting, ball of earth, cutting.
Seed collection time		Seeds are collected between Nov.-January.
No. of seed kg^{-1}		5000-10000 seeds kg^{-1}, 880 pods kg-1which give about 300gm of seed.
Seed extraction		Pods are dried in the sun for a few days until they open; seed extraction is done by hand.
Seed storage method		Orthodox seed, put thoroughly dried seed in the polythene bags, seal tightly and keep in a cool place; germination improves after storage of 2-4 years.
Viability of seed		Viability of stored seed is about 30 years.
Seed treatment		Seed is scarified or treated with hot water before sowing.
Seed sowing time		**Above 1000m:** Aug.-Sep, **below 1000m:** February.
Duration of germination		For unscarified seed: seed germinates well in 3-4 days; seed treated with hot water germinates in 6-12 days.
Germination (%)		50-60% from the fresh seed, germination is epigeous.
Nursery Period	**Seedling**	**<1000m:** seedling obtain after 4-5 months,>**1000m:**9-12 months
	Stump	For stump, plants should be raised in beds for 12-15 months.
Best planting size		**Stump:** 8-13mm thick at root collar, 4cm shoot length and 20-25cm root.

6. Diseases, pests and parasites of Kalo Siris:

Several insects of the order *Coleoptera*,*Lepidoptera*, and *Hemiptera attack the Albizzia lebbeck.Ravenelia sessilis* attacks leaves and pods of this tree.

7. Wood properties:

Wood color	Sapwood is white or yellowish white, heartwood is dark brown with black streaks, and is very decorative
Weight	Wood weighs about 680 kgm-3at 12% moisture content, and sp.gr.is 0.61, wood is light.
Hardness	Sapwood is soft while heartwood is hard.
Working quality	It difficult to saw & machine because of broadly interlocked nature of grain. It takes a good polish.
Strength	It is strong wood.
Calorific value	Calorific value is about 27000 $KJkg^{-1}$.
Durability	Sap wood is perishable so it should be removed as soon as possible; but heart wood is durable even in exposed situation.
Seasoning	Timber is moderately refractory to seasoning with tendency to end spitting & surface cracking.
Porous	Diffuse porous growth ring is distinct to indistinct, pores are large to very large, clearly visible to eye.
Texture & grain	Coarse and even texture with straight to somewhat wavy or slightly interlocked grain.
Other	The wood is resistant to termites.

8. Uses:

Timber	It is used for building, furniture, paraquet flooring & decorative articles, carts, agricultural implements and rice pounders.
Fuel wood	It is not a good fuel wood; burns slowly; smoke irritates the eyes.
Fodder	Leaves are a good fodder with 17% to 26% crude protein content, are nutritious and palatable.
Edible food	Seed leaves give 39.5% crude protein.
Tannin	The bark yields (7 to 11%) tannin.
Gum and resin	The tree also produces gum.
Ecological value	It is frequently planted on the poor sites and for erosion control. It is used for afforestation and is grown as a shade tree in tea gardens. It is planted along roadsides and in gardens as an avenue.
Medicinal value	The root bark and root gum are used as dental powder for strengthening the gums. The plants have antiseptic, anti-dysenteric and anti-tubercular properties.
Paper & Pulp	The wood gives 50.3% yield of bleached pulp by sulphate method. Pulp is suitable for writing and printing paper..

9. Agroforestry application: Due to its high quality fodder, it is widely used in Silvipasture systems. Due to its shallow and lateral rooting habit, it is not suggested to grow in cultivated fields. (Hocking, 1993)

10. Silvicultural systems: Since it is generally found in mixed crop, it is worked under simple coppice, coppice with reserves or selection system. (Parkash,1991)
11. Royalty rate: NRs. 100/cu.ft. for round timber at stump site.(Forest rules,1995)
12. Marketing price: NRs.120/cu.ft. Round timber and NRs. 220/cu.ft. for sawn timber at Sirha district.(1997)

(7)

Local name: Seto siris	
Albizzia procera	**Family: Mimosaceae**

1. Natural occurrence:

It occurs between Terai-1350m. According to Champion and Seth (1968), it is found in northern tropical moist mixed deciduous forest.

2.Morphological characteristics:

Leaf	Leaf-rachis is glabrascent, pinnae 4-12, bipinnately compound leaf.
Flower	Flowers are yellowish white; sessile; flowers appear in June -August.
Fruit	Pods are thin, strap-shaped and glabrous. A dry pod contains several seeds. Fruiting is in cold season.
Seed	6-12 seeds in each pod, which are flat, hard, smooth typical of legumes.
Bark	Bark is smooth and yellowish or greenish-white.

3. Silvicultural characteristics:

Light	Light demander, it can not tolerate suppression; it can withstand moderate shade in early stage but not later.
Frost	Frost tender.
Drought	Fairly drought resistant.
Soil	Well-drained alluvial and sandy loam soils are the best for its growth. It prefers moist alluvial sites and swampy places, often near watercourses.
Coppice	Coppice is exceedingly well. It produces root suckers.
Associates	It is often associated with *Albizzia lebbeck.*
Grazing &browsing	Leaves are palatable, so seedlings are seriously damaged by grazing and browsing animals.
Tree nature	It is a large deciduous tree, 18-24m in height and 1.8m and over in girth. Tree is particularly common in low lying moist savannahs.
Other	It is a very sensitive to grass competition. Branches are liable to be broken by strong winds. Plants often die back after planting. It is a multipurpose tree providing better timber, fuel wood and fodder.

4. Natural regeneration:

Seed production	Seed production takes place annually.
Seed dispersal	Seeds are dispersed by wind, partly by water.
Seed germinat^{n}	Germination takes place readily if sufficient moisture is available.
Establishment	Establishment of seedling is high on alluvial soil near river.
Coppice	Natural regeneration also takes place by coppice.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump planting.
Seed collection time		Seed ripens between December-January.
No. of seed kg^{-1}		18,000-24,000 seeds kg^{-1}.
Seed extraction		Pods are dried in the sun for few days until they open; seed extraction is done by hand.
Seed storage method		Orthodox seed; put thoroughly dried seed in a polythene bag, seal tightly and keep in a cool place.
Viability of seed		It retains viability about 15 months.
pre-sowing seed treatment		Seed is manually scarified or treated with hot water and allowed to cool for 24 hours or soaking in cold water for 12 hours.
Seed sowing time		**Above 1000m:** August-September, **below 1000m:** March.
Duration of germination		**For unscarified seed:** seed germinates well in 3-4 days, **seed treated with hot water:** germinates in 6-12 days.
Germination (%)		80-90%, germination is epigeal.
Nursery period	**Seedling**	**<1000m:** it requires 4 months and >**1000m:** it requires 10-11 month after sowing August-September.
	Stump	Stumps are prepared from one-year-old seedlings.
Best planting size		Seedling should be 20-30cm tall for planting out at the beginning of the monsoon.
Others		Roots of Albizias are symbiotic with *Rhizobium* bacteria, which form nodules and fix atmospheric N_2.

6. Diseases, pests and parasites of Seto Siris:

i)Young trees are seriously affected by *Fusarium solani*.**ii)** *Ganoderma applanatum* causes heart rot and white sap. **iii)** Several insects of the orders *Coleoptera, Lepidoptera* and *Hemiptera* attack the tree.

7. Wood properties:

Weight	**Sapwood** weighs about 460kgm^{-3} & **heartwood** weighs about 640kgm^{-3} at 12% moisture content. Specific gravity is about 0.6.
Wood color	Sapwood is white color and heartwood is light or dark brown.
Working quality	Due to interlocked fibres, siris timbers are not always easy to saw and machine, they take an excellent polish.
Strength	It is a strong wood.
Calorific value	It has a calorific value of 26,800 KJkg^{-1}.
Durability	Sapwood is perishable so it should be removed as soon as possible. Heartwood is durable even in exposed situations.
Preservative treat.	Timber is good for preservative treatment.
Seasoning	Albizzias are moderately refractory wood to season; they have tendency to end splitting and some surface cracks. If properly stacked and well protected against rapid drying, they season well.
Texture & grain	Lustrous, coarse and even textured with straight to somewhat wavy or interlocked grain.
Porous	Diffuse porous wood.
Other	The wood is resistant to termites.

8. Uses:

Timber	It is largely used for sugarcane crushers, rice-pounders, wheels, agricultural implements, bridges and house posts. It is well known for parquet, strip flooring, paneling, and railway carriage work.
Fuel wood	Fuel wood produces irritant smoke and makes good charcoal.
Fodder	Leaves are a fairly good cattle fodder, containing about 17% crude protein.
Edible food	Analysis of seed gives 30.5% protein.
Tannin	Bark contains 12-17% tannin & leaf contains 3.2% tannin.
Gum and resin	The tree also produces gum.
Ecological value	It is a leguminous plant, so it fixes atmospheric N_2. It is used for afforestation and also grown as a shade tree in tea–gardens.
Medicinal value	The plant is used for stomach and intestinal diseases and during pregnancy. All parts of plant show anti-cancer activity. The decoction of bark is given in rheumatism and haemorrhage. Bark is used as fish poison.
Paper & Pulp	The wood gives 50.3% yield of bleached pulp by sulphate method. Pulp is suitable for writing and printing paper.

9. Agroforestry application: Same as Kalo siris.

10. Silvicultural system: It is worked on coppice system, with a rotation of 20-40 years. In some states of India, it is worked on clear felling system on a 60-year rotation. (Parkash, 1991)

(8)

Local name: Kaju	**Eng name: Cashew nut**
Anacardium occidentale	**Anacarciaceae**

1. Natural occurrence:

It is native to tropical America and naturalized in warmer parts of Terai and India. It can be grown under a wide range of climatic and soil conditions; altitudes from sea level to 1000m, and annual rainfall varies from 500 to 3500mm.(Hocking, 1993)

2. Morphological characteristics:

Leaf	Leaves are ovate or obovate oblong, hard, and glabrous.
Flower	Flowers are small, yellow with pink strips, terminal panicles, with both staminate and hermaphrodite flowers.
Fruit	Fruits are kidney-shaped nuts, fleshy receptacle.

3. Silvicultural characteristics:

Frost	Frost tender.
Light	Light demander.
Soil	It grows best on deep loam. It is not very tolerant of saline and clayey soil. It grows well in shallow and impervious soil. It can grow satisfactorily even on relatively infertile acidic soil with little rainfall, unsuitable for most other crops, but it bears no fruit in these harsh conditions. (Hocking, 1993)
Graze & browse	It is not browsed by cattle.
Drought	Drought resistant.

Tree nature	It is a small, spreading, evergreen tree, sometimes reaching a height of 12m.
Wind firmness	It is highly resistant to strong winds since Roots system is strong and penetrating, both top and lateral roots. (Von Maydel, 1986).

4. Artificial regeneration:

Preferred propagation	Entire planting, direct sowing, air layering, grafting, budding, inarching.
Seed collection time	Seeds are collected between March and June.
No. of seed kg^{-1}	145-165 seeds kg^{-1}.
Viability of seed	Seeds remain viable for 8 months after collection.
Seed sowing time	May and June.
Durat^{n} of germination	Germination is completed in about 20 days.
Germination (%)	Germination can obtain 80-100%, if seeds are stored in tin receptacles. Seeds store in airtight containers give 90-95% germination.

5. Wood properties:

Colour	Wood is reddish brown.
Hardness	Wood is fairly hard.
Elasticity	Wood is heavy wt. 608kgm^{-3}.

6. Uses:

Timber	It is termite resistant and is used for very good timber for local constructions, packing cases, country boats and tea chests.
Fuel wood	It is also used as fuel wood.
Edible food	Cashew kernel is eaten as a dessert and is an important item of confectionery. It is used raw, roasted or fried.
Tannin	Testa is a good source of condensed type of tannins (24-26%) & bark contains 9% tannins.
Ecological value	Cashew trees are used for afforestation purposes. Site selection for afforestation is the barren, denuded areas, which are usually unsuitable for raising any other timber species.

Other uses of *Anacardium occidenatalae*:

Kernels: Kernels yield an oil (40-53%), which is said to have a nutritive value equal to almond oil and superior to olive oil. It is a good medicinal and chemical antidote for irritant poisons.
Cashew apple: It looks like an over-ripe apple, has a fibrous flesh and nutritious and juicy. It is edible and yields delicious beverages. The fresh fruit is also used in the vinegar industry. Its juice is used as diuretic and is useful for kidney troubles and in advanced cases of cholera.
Cashewnut shell: It yields a gum, which is acidic in nature, are useful in cosmetic, pharmaceutical, textile, paper and ink- industries.
Cashewnut shell liquid: Cashewnut shell yields a vesicant juice, known in trade as cashew nut shell liquid (CNSL), which is a rich source of naturally occurring phenols and raw materials for the manufacture of numerous industrial products like plywood adhesive, thermoplastic and thermosetting resins, plastics, lubricants etc.

Cashewnut husk: It contains 24-26% condensed type of tannins.
Cashewnut bark: The bark exudes a pale yellow to reddish gum, which possesses insecticidal properties, is useful in bookbinding and other pharmaceuticals.
Cashewnut buds and young leaves: are used as vegetables. They are also a source of green manuring.
Cashewnut leaves: Leaves contain 23% tannin.

7. Agroforestry applications: In homestead garden tree, it is grown in combination with a no. of tother trees and shrubs. In regular plantations, intercropping with arable crop (taungya) is practiced for 7-8 years, till the tree canopies close up. (Hocking, 1993)
8. Silvicultural system: Trees are rarely felled except when they become too old (over 40 years). Since it occurs in mixed forest, it is carried out under selection system. . (Hocking, 1993)

(9)

Local name: Banjhi	**English name: Axlewood**
Anogeissus latifolia	**Combretaceae**

1. Natural occurrence: It occurs in Nepal from the Terai to about 1700m.

2. Morphological characteristics:

Leaf	Leaves are elliptic-obtuse, entire, rounded at both ends, reddish when they first appear, again turning red before falling off.
Flower	Flowers are minute, greenish, and yellow in globose heads on short axillary penducles.
Fruit	Fruits are small, two winged, yellowish brown or reddish brown.
Seed	Fruit contains single seed.
Bark	Bark is pale yellowish, or pinkish brown, spotted all over with pale greenish or yellow depressions, exfoliating in thin rounded flakes.

3. Silvicultural characteristics:

Light	It is a strong light demander.
Frost	It is somewhat frost resistant.
Drought	Fruits are small, two-winged yellowish brown or reddish brown.
Fire	Fruits contain single seed.
Soil	The tree grows on a variety of geological formations including sandstone, limestone, and metamorphic rocks. It grows best on alluvial soils. It avoids swampy and badly drained soils and requires good drainage.
Coppice	The tree coppices and pollards well in most localities. Coppicing in the rainy seasons is unsuccessful. The best season for pollarding is not later than March. It produces root suckers.
Associates	It is commonly associated with sal forests.
Graze & browse	It is rather unpalatable and not greatly damaged by browsing.
Tree nature	It is a large, deciduous tree, with a drooping branches
Meteor.cond^{n}	In its natural habitat, **Max.shade Temp**. is (38-47^{0}C), **Min**. (0-15^{0}C), annual rain fall varies from (625-2250 mm).

4. Artificial regeneration:

Preferred propagat^{n}		Direct sowing, entire planting, stump planting.
Seed collection time		Seeds ripen between Dec. to March.
No. of seed kg^{-1}		100,000 to 120,000 seeds kg^{-1}.
Seed storage method		Orthodox seed. The dried seed should be stored in sealed plastic bags.
Viability of seed		Viability of seed is about 15 months.
Seed treatment		Seed should be soaked in water.
Seed sowing time		Seed should be sown in June.
Duration of germ^{n}		Germination may take up to six weeks.
Germination percent		25% from the fresh seed.
Nursery period	**Seedling**	Seedlings need about 12 months in the nursery.
	Stump	For stumps, seedlings need more than12 months.

5. Wood properties:

Wood Color	**Sapwood:** is wide and yellowish grey in young trees and of a uniform yellowish olive grey color in mature trees. **Heartwood:** is purplish brown.
Hardness	Wood is very tough and hard.
Working Quality	Wood is heavy to very heavy (Sp.gr. is 0.944 kgm^{-3})
Strength	Timber is strong and elastic.
Calorific value	**Sapwood:** 4986 calories: **Heartwood:** 4909 calories.
Durability	The timber is fairly durable if not exposed to wet conditions. It is attacked by white ants.
Preservative treatment	The heartwood is very refractory to treatment, penetration of preservative being practically nil from side or end.
Seasoning	Timber is difficult to season. In kiln-seasonings and even in mild air-drying, it has a tendency to develop surface cracks.

6. Uses:

Timber	Timber is used for building, houses, for furniture, agricultural implements and veneers.
Fuel wood	The timber makes an excellent charcoal and fuel.
Fodder	Its leaves are used as fodder.
Tannin	Bark contains 12-18% tannins. Young red leaves and shoots contain up to 50% tannins where as mature leaves contain 32% tannin.
Gum and resin	The tree is the main source of gum. The exudation of gum is more in dry years. Gum is used in calico printing and in confectionery. It is used as an emulsifier, stabilizer and thickener in ceramics, foods and pharmaceuticals. It can be used in hair setting agent. It is an efficient binder.
Ecological value	Bark is bitter and astringent. It is practically useful in chronic diarrhoea.
Medicinal value	Bark is bitter and astringent. It is practically useful in chronic diarrhoea.
Paper and pulp	Wood is suitable for making paper.

Local name: Kadam

Anthocephalus chinensis	**Family: Rubiacae**

1. Natural occurrence: Terai to 1000m.

2. Morphological characteristics:

Leaf	Leaves are coriaceous, broadly ovate and elliptic-oblong.
Flower	Flowers are yellow in color.
Fruit	Fruit is fleshy & orange in color, ripening yellow with a single kernel.
Seed	Seeds are small, muriculate.
Bark	Bark is grey and fissured.

3. Silvicultural characteristics:

Light	Light demander but tolerate some shade in early life.
Frost	Frost tender
Drought	Drought sensitive, i.e, young seedlings are sensitive to drought, but liable to damping-off with an excess of moisture in the soil.
Soil	It grows best on deep alluvial soil with a good water supply. The growth is poor on stiff, badly drained soil.
Coppice	It coppices well.
Associates	It is an associate of Sal forest.
Browsing	Grazing and browsing sensitive, very liable to damage by browsing.
Tree nature	A large deciduous tree, occasionally buttressed, up to 37.5m in height and 2.4m in girth, with a clear bole and horizontal branches. Tree is frequently found in moist, warm type of deciduous and evergreen forests. It is a shade tree plantation throughout the country
Meteor. Condition	In its natural habitat, absolute **Max.Temp** is (32-43.3)0C and absolute **Min.Temp** (3-15.5)^{0}C, the normal rainfall varies from 150-500cm.

4. Natural regeneration:

Seed production	Seeds are produced annually and abundantly.
Seed dispersal	Seeds are dispersed by animals, birds, and also by water.
Seed germination	The seedlings appear in dense masses in the rainy season.
Establishment	If seedlings protected from grazing, they establish themselves.

5. Artificial regeneration:

Preferred propagation	Entire planting, stump planting.
Seed collection time	Fruits ripen from Nov-Feb.
No. of seed kg^{-1}	Very small seed, 900,000 to 2700,000 seeds kg^{-1}.
Seed extraction	Seeds extracted by macerating the fruit in water, then they are dried in the sun.
Seed storage method	Seed can be stored for a year in a container.
Viability of seed	Viability of stored seed is about 1 year.
Seed treatment	Does not require.
Seed sowing time	Seed should be sown in Feb-Mar. for July planting.
Duration of germ^n	Germination takes place in three weeks.
Germination percent	Germination is 80% from fresh seed.

Nursery period	**Seedling**	4 -5 months.
	Stump	1-year-old seedling is made into stumps.
Best planting size		**Stump:** 8-13mm thick at root collar, 4cm shoot length & 20-25 cm root.
Other		Seedlings are sensitive to the drought and excessive moisture.

6. Diseases, pests and parasites of Kadam:

Dendrophthoe falcata attack on this tree. The larvae and beetles of several insects and pests bore the wood. Some larvae defoliate the tree.

7. Wood properties:

Wood color	Wood is light colored, white or yellowish white. The sapwood and heartwood are not distinguishable.
Weight	Wood is light or moderately heavy ($600kgm^{-3}$) and sp.gr. is 0.35.
Hardness	Wood is lustrous, soft or moderately hard.
Working quality	It is easy to work to a smooth finish.
Strength	It is moderately strong.
Calorific value	Its fuel wood yields about 23,000 $KJkg^{-1}$ when burnt.
Durability	It is not durable. Graveyard test have shown that natural durability of timber is 23 months but treated timber is durable.
Preservative treat.	Timber can be easily treated.
Seasoning	Timber is non-refractory to seasoning.
Rate of tree growth	The tree shows 2-8 rings per 2.5cm, the annual growth increment varying between 1.96 and 7.98cm. It is one of the fast growing tree species.

8. Uses:

Timber	The timber is used for excellent veneers, matchboxes, match splinters, packing cases, tea-boxes, and light constructional work.
Fuel wood	It is a good fuel wood, burns slowly, and produces occasionally crackling sound.
Fodder	Leaves are fed to cattle. Young leaves are slightly aromatic with unpleasant taste while older ones are odourless and sour.
Edible food	Fruits are edible and flowers are used as vegetable.
Tannin	The bark also contains tannin (4.61%).
Medicinal value	The stem bark is reported to possess tonic, astringent, febrifugal and anti-diuretic properties and is given in coughs. The juice of bark is treated for the inflammation of the eye.
Paper & pulp	The bark fibre is useful for the cordage. The wood can be pulped, gives a pulp of better color for writing, printing and wrapping paper. The cold Caustic soda process yields pulp (70-89%) suitable for newsprint. It is suitable for making Pencils of high & medium qualities.

9. Tending operation: Being a fast-growing species, establishes itself soon. Hence, it does not need much of weeding and cleaning both in natural forests and in plantations.

10. Silvicultural system: It is found in mixed forests, worked under selection system, on a felling cycle with a prescribed exploitable diameter/ girth. (Parkash, 1991).

11. Royalty rate: NRs. 40/cu.ft. for round logs at the stump sites. (Forest rules, 1995).

12. Marketing price: NRs. 120/cu.ft. for round logs and NRs. 225/cu.ft. for sawn timber at Kapilbastu District, Nepal (1997).

(11)

Local name: Neem	**Eng name: Nim**
Azadirachta indica	**Family: Meliacae**

1. Natural occurrence:

It occurs between Terai to about 900m. According to Champion and Seth (1968) it is characteristics of Northern tropical wet evergreen forest.

2. Morphological characteristics:

Leaf	Leaves are imparipinnate, alternate and leaflets 8-19.
Flower	Flowers are white or pale-yellow, small, scented, numerous & slender.
Fruit	Fruits are globose with few seeds.
Bark	Bark is grey or dark grey, rough, reddish brown inside.

3. Silvicultural characteristics:

Light	Light demander but tolerate heavy shade during the early years.
Frost	Very sensitive to frost esp. In seedlings and sapling stage.
Drought	Drought hardy.
Fire	Fire tender species.
Soil	It grows on almost all kinds of soils including clayey, saline & alkaline soils, but does not well on black cotton soil.It thrives better than most other trees on dry, stony, shallow soil with a waterless sub-soil or in places where there is a hard, calcareous , or clay pan near the soil. It does not tolerate inudation. Dislike excessive moisture and can't stand water logging
Coppice	It coppices and produces root suckers and withstands pollarding well.
Browsing	Damage by browsing animals.
Tree nature	A large evergreen and multipurpose tree, with a straight bole, and long spreading branches forming a broad crown.
Meteo. condition	In its natural habitat; absolute **Max.Temp:** 49^0 C, the normal rainfall varies from 45-112cm

4. Artificial Regeneration:

Preferred propag^n	Direct sowing, stump planting, entire planting.
seed collect^n time	Seed ripens in June to July.
No. of seed kg^{-1}	3000-6500 depulped seeds kg^{-1}.
Seed extraction	The pulp should be removed from the fruit before sowing.

Viability of seed		Viability of seed is very short.
Seed treatment		Does not require.
Seed sowing time		Seed should be sown immediately after collection.
Duration of germinat^{n}		Germination occurs within a week or two.
Germination percent		80%, germination is hypogeal.
Nursery period	**Seedling**	4 -5 months
	Stump	1-year-old seedlings are made into stumps.
Best planting size		**Stump:** 8-13mm thick at root collar, 4cm shoot length and 20-25cm root

5. Main diseases of neem are:

A. Nursery diseases :(i.) Damping off-caused by *fusarium oxysporum*.

B.Foliage Diseases :(i) *Rhizoctonia* leaf web blight: caused by *Rhizoctonia solani* **ii. *Colletotrichum* leaf spot and blight:** caused by *Callecotrichum gloeosporioides.* **Iii.Alternaria leaf spot and blight:** caused by *Alternaria alternata*.

C.Root rots: caused by *Ganoderma lucidum*

D.Pink diseases: caused by *Corticium salmonicolor*.

6. Wood properties:

Wood color	Its timber is decorative. Sapwood is greyish white, and heartwood is red.
Weight	The wood weighs between 560-850kgm^{-3}. It is moderately heavy wood.
Hardness	Heartwood is very hard.
Working quality	It is easy to saw and work by hand or machines, does not take polish well.
Calorific value	Wood has high calorific value of about 29,000kJkg^{-1}.
Durability	Its timber is durable, even in open situations.
Seasoning	Timber is moderately refractory and seasons well.
Rate of tree growth	The rate of growth is fairly good, showing five rings per 2.5cm, giving a mean annual girth increment of 3.2cm.

7. Uses:

Timber	The timber is used for furniture, carts, packing-cases, ship and boat building, agricultural implements etc.
Fuel wood	It is a good fuel wood except for producing acrid and irritating smoke.
Fodder	A good fodder tree; crude protein content is 12-18%, leaves are placed in cloths, book and paper to repel insects.
Edible food	Pulp of the fruit is eaten.
Tannin	Heartwood contains tannin, stem bark contains 12-16% tannin, and bark also yields red dye.
Gum & resin	The bark exudes gum, which is stimulant, demulcent and tonic and is useful in catarrhal and other affections. The gum possesses adhesive properties; gum is used by silk-dyers in the preparation of colors.
Ecological value	The trees increase the soil fertility and water holding capacity. It has unique properties of calcium-mining which changes the acidic soil into the neutral. The trees has been used for the afforestation of dry localities, ravine and for checking for soil erosion as wind breaks. It is very useful roadside avenue tree in dry and moderately dry climate and an excellent shade tree during the hot season.

Medicinal value	Neem extracts possesses anti-diabetic, anti-bacterial and anti-viral properties, have been successfully used in case of stomach worms and ulcers. Bark is useful in malarial fever and cutaneous diseases. Seeds contain the azadirachtin which inhibits the feeding of locust. Kernel oil are used in cosmetic preparation such as creams, hair -lotions, medicated-soaps, washing-soaps and tooth-pastes and antimicrobial activity. Twigs are traditionally used as tooth brushes. The seed produces an oil used for soap manufacture and in pharmaceuticals.
Others	The oil cake obtained from the seeds and the fallen leaves make good manure.

(12)

Local name: Simal	**Eng name: Silk cotton**
Bombax ceiba	**Family: Bombacacae**

1. Natural occurrence:

Terai to 1500m, the trees is very common in the dry as well as moist mixed deciduous forests. It is found in the mixed evergreen forest as well.

2. Morphological character:

Leaf	Alternate, digitate with 5 or 7 leaflets.
Flowering	Flowers appear when tree is leafless. Flowering is January–March.
Fruiting	A hard woody capsule, 10cm long. Fruiting in April–May
Seed	Seeds are embedded in dense wools.
Bark	Bark is pale ash to silver grey, smooth in early years, later became rough with cracks.

3. Silvicultural character:

Light	Strong light demander.
Frost	Frost tender.
Drought	drought resistant
Fire	Seedling severely affected but pole thick bark resists to damage by fire.
Soil	Grow well on deep, sandy, alluvial soils. Poor growth on stiff clays & badly drained soils.
Coppice	Coppices well in early stage but not later. Also produce root suckers abundant.
Associates	Sal is the major constituents. Some other associates are: *Acacia catechu, Adina corndifolia, Albizzia procera, Dillenia pentagyna, Gmelina arborea, Holoptelia integrifolia Mallotus philippinensis.*
Browsing	Sensitive, it causes considerable damage to seedling.
Tree nature	The tree grows sporadically in the mixed deciduous forest & alluvial – Savannah type forest, tending to be gregarious nears the riverbanks.
Meteorological condition	Absolute **Max. Temp** (37.5–50)^{0}C, Absolute **Min. Temp** (-2.5 to 17.5)^{0}C, Average annual rainfall (50 -460 cm or more.)
Other	Shows die–back phenomenon as sal; it is a fast growing tree; buttress formation; deciduous tree; branches horizontal.

4. Natural regeneration:

Seed production	Good seed year comes annually.
Seed dispersal	The seed is dispersed by wind
Seed germinat^{n}	Seedlings come up in clumps of dense thorny shrubs, and grasses where they get protection against grazing . They colonize abandoned cultivation.
Coppice/ root suckers	Natural regeneration may occur from coppice or root sucker.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump planting, branch cutting but survival rate is poor.
Seed collection time		April to may.
No. of seed kg^{-1}		100 dry pods= 2kg equivalent to 600gm seed= 21,000-45,000 seed kg^{-1}.
Seed extraction		Pods should be dried thoroughly in the sun.
Seed storage		Orthodox seed, store in sealed container, plastic bag.
Viability of seed		1 year.
Seed treatment		Not necessary
Seed sowing time		March.
Duration of germination		Germination commences within a week and is completed within about 25 days.
Germination (%)		20-80 %.
Nursery Period	**Seedling**	2-3 month
	Stump	One year old seedling.
Best planting size		Stump shoot: 3.8 cm, root 30cm extra shoot as well as root are are cut off and the side roots are pruned.
Other		The tree has thin foliage and its power of suppressing weeds is very poor, so weeding requires after the first one or two year.

6. Forest diseases, pests, parasites and damages by animals:

- ***Ganoderma lucidum,***a root rot fungal diseases cause severe damage in plantations.
- Standing trees may be infested by a no. of pests such as long horn beetles, defoliators **,** and shoot borer .
- ***Tonica niviferana*** **,** a shoot borer bores through the young shoots, often killing the tree.
- Several beetles and larvae bore the dead wood.
- **Injuries by animals**, Porcupines, rats and mice gnaw the fleshy roots of young seedlings. Bison and deer browse and trample young plants. Squirrels are very fond of flower buds.

7. Wood properties:

Weight	It is light in weight between 250-500kgm^{-3}, 385kg/m^{3} at 12%mc.
Wood color	Timber is creamy white or pale pink in color.
Hardness	Extremely soft wood.
Working quality	Moderate fissile. It is easy to saw and work. It peels well without any preliminary treatment. Due to coarse texture and prominent vessels lines , it absorbs too much paint and varnish. It glues well.
Strength	Its timber has very weak strength

Calorific value	It has a fairly high calorific value: 20,500KJkg^{-1}.
Durability	Its wood is slightly durable.
Preservative treatment	It is very easily treatable with preservatives, penetration being complete. Treated timber is moderately durable in open but lasts longer under cover.
Seasoning	It is non refractory wood i.e **:** capable of withstand rapid seasoning . The timber may be air seasoned but kiln seasoning is preferable.
Others	The tree has very short rotations.
Growth rate	Under favorable condition, growth is rapid. It can reach a diameter of 38cm in ten year. It is a fast growing tree species.
Porous	Diffuse porous, growth ring is indistinct to distinct.

8. Uses:

Timber	Sapwood and heartwood are not distinguishable. The wood is extremely perishable in open condition. The timber may be used for plywood , match industry , pulp and paper etc.
Fuel wood	It is not a good fuel wood species.
Fodder	Young twigs and leaves are lopped for fodder. The seed cake is richer in protein, is an excellent cattle feed. Leaves are medium quality fodder.
Edible food	The tender leaves are eaten; the flower buds and fleshy calyces are eaten. The young roots are eaten either raw or roasted as sweet potato in India.
Tannin	Gum contains tannin; root contains 0.5% tannin; bark contains 3.01% tannin.
Gum and resin	The bark exudes a gum from natural wounds caused probably by decay or insects. Gum is astringent, tonic and demulcent properties and used for dysentery, influenza and menorrhagia. Gum also contains tannic acid.
Ecological value	It is a good habitat for vulture and hawks, bees etc. Due to high rate of depletion of Simal trees, it would be possible to extinct the vulture, hawks and so many species DOF has banned to cut this tree.
Medicinal value	The young fruits are used as expectorant, stimulant, and diuretic and considered in beneficial calculous affection, chronic inflammation and ulceration of bladder and kidneys.
Other	The floss from this tree is known as Indian kapok. The capsule of this tree is silky cotton, not very long but short or strong. A tree is full bearing produces 4.0-7.2kg clean floss, free from seeds. The floss is suitable for stuffing lifebelts and other life saving appliances besides mattresses, cushions and pillows.

9. Tending operation:

Simal being a fast-growing species requires little weeding after the first 1 or 2 years.

10. Silvicultural system:

For plantation crops, the best silvicultural system is clear felling followed by artificial regeneration on a rotation of 25-40 years, according to site factors and the size of timber most in demand. (Parkash, 1991)

11. Royalty rate: NRs. 80/cu.ft. for round timber at the stump sites. (Forest rules, 1995).

12. Market price: NRs. 125/cu.ft. for round timber and NRs. 200/cu.ft for sawn timber at Sirha district, Nepal. (1997).

Local name: Raj briksha	English name: Indian Laburnum
Cassia fistula	Caesalpinaceae

1. Natural occurrence: It is an indigenous species of Nepal, commonly occurring between Terai and 1400m elevations.

2. Morphological characteristics:

Leaf	Leaves have rachis and glandless petiole, leaflets 4-8 pairs, distinctly stalked, oblong or ovate, clothed with young, caducous, silvery & pubescence.
Flower	Flowers are bright yellow, in axillary, pendulous, lax racemes.
Fruit	Pods are cylindrical; pendulous; smooth; hard; dark brown or black.
Seed	Seeds are light brown, hard, smooth, shiny bi-concave, 40-100 seeds embedded in sweetish pulp.
Bark	Bark is grey; smooth; exfoliating in small woody scales.

3. Silvicultural characteristics:

Light	It is light demander but withstands moderate shade.
Frost	Frost tender.
Drought	Drought resistant.
Soil	It grows under a very wide range of climatic and edaphic variations; and it can grow on poor; shallow soil.
Coppice	It coppices well.
Associates	It occurs frequently in Sal forests.
Graze & browse	Browsing sensitive.
Tree nature	It is a deciduous, medium sized and scattered tree.
Meteorological Condition	In its natural habitat, **absolute Max. Temp: (**35-47.5)^0 C, absolute **Min.Temp:** (0-17.5)^0 C, annual rainfall 450-3000mm or even more.

4. Natural regeneration:

Seed product^n	Pods commence falling on the ground from April until September or even later.
Seed dispersal	Seed are dispersed by animals which eat the pulp and reject the seeds or swallow or pass them out.
Seed germination	Seeds germinate during the rains, a few lying dormant until the second or even the third rains.
Establishment	Seedling will establish if it protected from frost, weed growth, damping-off diseases.
Root sucker	Much of the natural regeneration of the forest is from root suckers esp. in hills where surface roots are liable to be exposed.

5. Artificial regeneration:

Preferred propag^n	Direct sowing, nursery raised seedlings, stump planting.
Seed collect^n time	Seeds are collected from Dec-April.
No. of seed kg^{-1}	6300 seeds kg^{-1}.
Seed storage	Orthodox seed. Seeds are being collected and separated from the pods

method		and stored in calico bags for at least one year to after-ripen..
Viability of seed		Seed can retain its viability for more than ten years. One year old seed germinates better than fresh seed.
Seed treatment		Seed should be treated with hot water.
Seed sowing time		Seed sown in March or April.
Germination (%)		65% for two-year-old seed, down to 40% after 13 years.
Nursery Period	**Seedling**	3-5 month, seedlings are ready for monsoon planting.
	Stump	Stump should be prepared from one-year-old seedlings.
Best planting size		15-30cm tall seedlings are necessary.

6. Diseases, pests and parasites of Rajbriksha:

i). Brown spongy heart-rot: Caused by *Trametes incerta*.

ii). **Angiospermic parasites:** *Dendrophthoe falcata* is also attacked on this plant.

7. Wood properties:

Wood color	Sapwood is wide, white or pale, dirty white in colour. Heartwood is greyish or yellowish red to brick red or light reddish brown.
Weight	Wood is very heavy. It weighs about 970 kgm^{-3}. Average wt. 700kg/cu.ft.
Working quality	It is difficult to work, but seasoned wood presents no difficulty. It finishes to a smooth surface and polishes well.
Strength	Timber is very strong.
Durability	Timber is durable even in contact with water. The heartwood is very durable in the open and under cover; is considered more durable than Sal. Sap wood is not liable to fungal attacks,but liable to attack by borers.
Preserva. treat.	Sapwood can be protected from borer attack by antiseptic treatment.
Seasoning	Highly refractory wood for seasoning i.e, very difficult to season. Air seasoning of wood may result severe surface cracking, cupping and splitting. By girdling of trees, surface cracking and end-splitting may reduce.
Growth rate	It is a slow growing species for the first 2 to 3 years, after which the growth is more rapid.

8. Uses:

Timber	Timber is suitable for house-posts, bridge posts, electric poles, agricultural implements, excellent tool handles, high class furniture, boat building etc.
Fuel wood	It is an excellent fuel and yields first class charcoal.
Fodder	Leaves are used as fodder for livestock.
Edible food	Leaves are eaten.
Tannin	Bark yields (3-8) % tannin. Twig bark gives a much better colour than the bole bark, it is used for tanning heavy leather.
Gum and resin	Seed yields a dark coloured gum which have possibility as a source of industrial gum. Seeds also yield oil (3%).
Ecological value	Tree is planted for ornament in gardens.
Paper and pulp	Wood may be suitable for soft paper.
Others	Leaves are also a source of green manure.

Medicinal value of Rajbriksha:

- **Bark:** Possesses tonic and anti-dysentric properties. Powder or decoction of bark is used in leprosy, jaundice syphilis and heart diseases.
- **Pods:** The ethanolic (50%) extract of the pods showed anti-fertility activity in the female. It is given in disorders of liver and in biliousness, acts as a tonic.
- **Fruit pulp and stem bark:** are used in ayurvedic preparations for the treatment of blood impurities.
- **Crushed seeds and leaves:** are employed for making a *Sherbet*, which are useful in jaundice, biliousness, skin diseases and swollen throat.
- **The whole seed powder:** cures intestinal amoebiasis.
- **Root and its bark:** Possess astringent, tonic, febrifugal and purgative properties. The aqueous extract of the root bark exhibits anti-inflammatory activity.
- **A decoction of flower:** is giving in stomach troubles.

9. Tending operarion: Nursery-raised seedlings are more sensitive to weeds than drought; therefore weeding is more important than watering.

10. Silviculture systems: In fuel forests, mixed with other species, it is usually worked under simple coppice system on a rotation of 30-40 years. (Parkash, 1991)

11. Roylty rate: NRs. 2/kg for dry seed (Forests rules, 1995)

12. Market price: NRs. 30/kg for seed at major road heads of Nepal. (1997).

Local name:Tooni	
Cedrella toona	**Family: Meliaceae**

1. Natural occurrence: It grows from Terai to 1700m. According to Champion and Seth (1968), it is found in tropical moist mixed deciduous forest. It also occurs in the lower valleys of Himalayas.

2. Morphological characteristics:

Leaf	Leaves are paripinnate, leaflets opposite: 5-10 pairs and leafless during Jan-Feb.
Flower	Flowers small, white, honey-scented, in much branched. Flowering: Mar-April.
Fruit	Fruits are elongated. Fruiting during June-July.
Seed	Seeds with membranous wings at both ends.
Bark	Thin dark-grey bark which is smooth up to middle age.

3. Silvicultural characteristics:

Light	Moderately light demander.
Frost	Frost hardy species.
Drought	Drought sensitive.
Fire	Fire sensitive.
Soil	It grows best on well-drained, deep, rich, loamy soil. On dry soil, growth is stunted.
Coppice	It coppices well.
Associates	At lower altitude, it is a common associate of Sal forest and *Schima – Castanopsis forest* at higher altitude.
Browsing	Seedlings are liable to damage by browsing.
Tree nature	It is a large deciduous tree with a dense spreading crown.

4. Natural regeneration:

Seed product^{n}	Seeds ripen just before monsoon.
Seed dispersal	Seed dispersal takes place by wind and water.
Seed germint^{n}	Germination better after pre-monsoon rain or during the early monsoon.
Seed Establis.	Germination are established good on deep, sandy, loam soil, near river and abandoned cultivated land.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, Entire planting, Stump planting.
Seed collection time		Seeds ripen between April and June. Capsule collected from the tree before they open.
No. of seed kg^{-1}		125,000-589,000 seeds kg^{-1}. Average being about 350,000 seeds kg^{-1}.
Seed extraction		After collection, the capsules are dried in the sun until they open, then beaten with stick to separate the seeds. Seeds are cleaned by winnowing.
Viability of seed		Viability of seed remains for 3-12 months.
Seed treatement		Seeds should be soaked in water for 48 hours before sowing.
Seed sowing time		Seeds should be sown within 3 months after collection. Seeds should be sown in beds or trays under shade.
Durat^{n} of germinat^{n}		Germination is completed within 10 to 15 days.
Germination (%)		Germination is 60-80%.
Nursery Period	**Seedling**	Seedlings are planted at the break of monsoon. When the seedlings are about 5cm tall, pricked out in polytubes.
	stump	Two year old seedlings are used for making stumps.

6. Diseases, pests and parasites of Tooni:

1.Pests: The stem borer *Hypsipyla robusta* is a serious pest

2.Diseases: i) Root diseases: caused by *Ganoderma lucidum*.**ii) Heart rot diseases:** Caused by *fomes senex*. **iii) Leaf diseases:** caused by *Discella cedrelae.*

3. Two phanerogamic parasites: Affect the tree i.e., *Cuscutta reflexa* and *Loranthus spp*.

7. Wood properties:

Weight	Heartwood is light brick red to reddish brown.
Hardness	Wood is moderately hard.
Working quality	Tooni is one of the easiest woods to saw and work. If properly finished and filled, it takes a very good polish.
Strength	Timber is moderately strong.
Calorific value	**Sap wood:** 21,700KJkg^{-1}, **heartwood:** 21,400KJkg^{-1}.
Durability	Timber is moderately durable.
Preserv. Treat.	The wood needs thorough preservative treatment.
Seasoning	Tooni is a fairly easy wood to air season, if care is taken with the stacking.
Growth rate	It is a fast growing species.

8. Uses:

Timber	Heartwood is used for furniture, interior boards, planks, carvings and cigar boxes. It is an excellent light building wood.
Fuel wood	It gives a good fuel wood.
Fodder	Leaves are lopped for fodder. Leaves contain about 15% crude protein.

Tannin	Sulfur colored dye is extracted from the flowers.
Ecological value	Popular avenue tree is planted along roadsides, canals and in gardens.
Medicinal value	Bark is astringent and anti-periodic.
Paper and pulp	Stem bark yields a cordage fibre.

(15)

Local name: Satisal	**Eng. Name: Indian Rosewood**
Dalbergia latifolia	**Family: papilionaceae**

1. Natural occurrence:

It is common from Terai to 1000m. It occurs in Terai, Bhabar and Duns. According to Champion and Seth (1968) it occurs in northern tropical moist mixed deciduous forests**.**

2. Morphological Characteristics:

Leaf	Leaves are imparipinnate and leaflets are 5-7.
Flowering	Flowers appear in April and are whitish in color.
Fruiting	Fruiting takes place in June
Seed	1-3 seeds per pod.

3. Silvicultural characteristics:

Light	It is a moderate light demander
Frost	It is more frost tender than *Dalbergia sissoo*, it should not be planted where regular frost occur.
Drought	It is drought resistant.
Fire	Once established it can withstand annual ground fire, but killed by crown fire.
Soil	It grows best on well- drained, deep, moist, loamy soil. It does not tolerate bad drainage.
Coppice	It coppices well and produces root suckers.
Associates	It is commonly found in *Dalbergia sissoo* forest.
Tree nature	It is a large deciduous tree. In moist location, it is almost evergreen. It has spreading crown.
Graze&Browse	Leaves are palatable so seedlings are severely damaged by browsing animals.

4. Natural regeneration:

Seed product^{n}	Seeds ripe in June- July .Ripen pods fall down just before the monsoon.
Seed dispersal	Seed dispersal takes place by wind and water.
Seed germinat^{n}	Seeds germinate during rainy season. Seedlings are liable to damage by browsing animals, fire and frost.
Root suckers	It also takes place from root suckers as it produces root suckers abundantly.

5. Artificial regeneration

Preferred propag^{n}	Direct sowing, entire planting, stump planting.
Seed collection time	December to April.
No. of seed kg^{-1}	18,000 - 37,000seeds kg^{-1}.
Seed extraction	Seed should be dried in the sun until they open, then beaten with stick

		to separate the seed. Clean the seed by winnowing.
Seed storage		Orthodox seed. Dry the seeds thoroughly in the sun.
Viability of seed		6 month.
Seed treatment		Not necessary.
Seed sowing time		February to March.
Durat^{n} of germinat^{n}		21 days.
Germination (%)		20-80%.
Nursery period	**Seedling**	3 months; plantation is best before the monsoon season.
	Stump	From one year old seedling, the stump can be prepared.
Best planting size		20 -30 cm tall seedling.

6. Diseases, pests and parasites of Satisal

Heartwood is rarely attacked by borers and white ants. The sapwood is easily attacked by borers belonging *to Bostrichydae, Cerambycidae, Curculionidae and Lyctidae. Polyporus gilvus* has been recorded on the timber causing white rot.

7. Wood Prpperties

Weight	Moderately heavy-to-heavy wood, wood weighs about 820kgm^{-3}.
Hardness	Wood is hard.
Elasticity	Timber is elastic.
Working quality	It is easy to saw and work, takes a very good polish.
Strength	Strong wood.
Calorific value	C.v is about 21360 KJkg^{-1}.
Durability	Heartwood is very durable but sapwood is less durable. Often attack by borers.
Preser. treat.	Sapwood is easily treatable. Heartwood does not require treatment.
Seasoning	Moderately refractory wood to seasoning.
Wood color	Heartwood and sap wood are easily differentiated, sap wood is yellowish white heartwood light purple brown to deep purple brown.
Porous	A diffuse porous wood. Growth ring is indistinct to fairly distinct.

8. Uses:

Timber	Rosewood is highly prized for high class furniture and cabinet making, it is famous as a decorative timber, very suitable for marine and aircraft grade plywood, popular for carving and engraving. Excellent for high class bent furniture and used for superior walking sticks, umbrella handles and other wood articles
Fuel wood	It is an excellent fuel wood.
Fodder	Trees are lopped for fodder.
Ecological value	It is a leguminous plant so fix atmospheric N_2 and makes soil fertile. It helps in soil conservation.

9. Agroforestry application:

Being light-crowned and deep- rooted, it appears quite feasible to raise this species as individual trees on field margins, and boundaries or within crop fields. (Hocking, 1993)

10. Royalty rate: NRs. 250/cu.ft. for round logs at the stumps sites. (Forest rules, 1995).
11. Market price: NRs. 800 to 1000/cu.ft. for sawn timber at Kapilbastu district , Nepal. (1997)

(16)

Local name: Sissoo	**Sub –Family: Papilionaceae**
Dalbergia sissoo	**Family: Leguminosae**

1.Natural occurrence: In Nepal it grows up to 1500m. Its general distribution is in the Indus, Ganges and Brahamputra river systems, including their tributaries from Afghanistan to Assam.

2. Morphological characteristics:

Leaf	**Leaf shedding:** Mid- Jan to Mid-March (Paush- Falgun); **leaves appear:** March and April).
Flower	Flowering (March- May).
Fruit	Yellow brown pods that turn dark brown as they ripen in Dec-Jan.
Seed	Kidney-shaped seed. Do not naturally split from the pods which drop off the tree intact.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost hardy.
Drought	Drought hardy.
Fire	It is not very fire resistant (moderately fire resistant).
Soil	It grows well on alluvial soil, but poor growth on saline soil, heavy clay soil, and less than 60cm soil depth. It does not grow in waterlogged areas.
Coppice	It coppices and pollards freely and produces abundant root suckers, especially when the roots have been damaged.
Associates	It makes a good association with *Acacia catechu* on freshly deposited soil.
Graze & Browsing	Grazing and browsing sensitive. i.e, youngs are very liable to damage by grazing and browsing animals.
Tree nature	It is a large deciduous tree with clear bole. It is often gregarious on new alluvial lands or river banks.
Other	Roots are nodulated. Seedlings are sensitive to weed and grass competition.

4. Natural regeneration:

Seed product^{n}	Seed production abundantly almost every year. Pods fall between Dec–Mar.
Seed dispersal	Seed dispersal by wind and flood water, so in nature, it is found near rivers.
Seed germination	Germination begins when ground is moistened by river and rain water. For establishment, it requires full overhead light, permeable soil and freedom from weeds.
Root suckers	Naturally it may grow from root sucker.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, stump planting, branch cutting and root cutting.

Seed collection time		December to March.
No. of seed kg^{-1}		33,000 seeds kg^{-1}
Seed extraction		Seed should be dried in sun, until they open and then beaten with stick to separate the seeds. Clean the seeds by winnowing.
Seed storage		Orthodox seed; dry thoroughly in the sun.
Viability of seed		6 to 12 months.
Seed treatment		Soak the segments of pod containing the seed in cold.
Seed sowing time		March to June.
Durat^{n} of germ.		Germination takes place in 8 -10 days. It completes within 15 days.
Germination (%)		90-100 %; germination is epigeal.
Nursery period	**seedling**	**For Terai:** 4 months, above Terai 8 -12 months
	Stump	**For Terai:** 12 months, above Terai 15 -16 months.
Best planting size		**For stump:** Root collar dia.7–15mm, stem 3-5cm & tap root 20-25cm tall.

6. Diseases, pests and parasites of Sissoo:

i). Sissoo wilt (*Fusarium solani*) can cause a serious incidence of deaths on sites liable to water-logging. **ii).** *Ganoderma lucidum*:a bracket fungi cause root rot. **iii).** *Polyporus gilvus* also causes root & butt rot. **iv).** Minor damage is caused by two foliage rusts (*Uredo sissoo* and *Maravalia achroa*), a leaf spot (*phyllachora dalbergiae*) and powdery mildew (*Phyllactinia dalbergiae*). **v).** The larvae of *Plecoptera reflexa* can cause serious defoliation.

7. Wood properties

Wood color	Heart wood and sapwood are easily distinguishable. **Sapwood:** pale brown, **Heartwood:** golden brown to deep brown.
Weight	Moderately heavy-to-heavy wood, wood weighs about 780kgm^{-3}.
Hardness	Wood is hard.
Elasticity	Timber is elastic.
Working quality	It is easy to saw and work, takes a very good polish.
Strength	Very strong wood.
Calorific value	c.v of heartwood is 21,700 KJkg^{-1}.
Durability	Heart wood is very durable and sapwood is less durable which is often attacked by borers.
Preserva. treat.	Sapwood is easily treatable. Heartwood does not require treatment.
Seasoning	Moderately refractory wood to seasoning.
Grain & texture	Lustrous, coarse & even textured with straight to some what wavy or interlocked grain.
Porous	Diffuse porous wood; rays fine to very fine.
Growth rate	It grows rapidly under favorable conditions either naturally grown or planted or coppiced.

8. Uses:

Timber	Heartwood is used for building, furniture, cart wheels and tool handles. Suitable for marine and aircraft grade plywood. Most popular wood for carving and engraving.
Fuel wood	It is an excellent fuel wood, makes an excellent charcoal.

Fodder	It is a valuable fodder tree. Leaves contain15-16% crude protein content and total digestible nutrients about 50%.
Ecological value	It is a leguminous plant so fix atmospheric N_2 and makes soil fertile. It helps in soil conservation.
Other	Tree is an excellent source of honey.

9. Agroforestry application: Sissoo is a friend of the farmer, as well as the forester-a tree which pays rich dividents . (M.D.Chaturvedi). This quote reflects its fast growth and high quality products. In national degraded forestland, sissoo is being raised by leased taungya in some areas. On private land, it is grown as Agro-silviculture system, silvo-pastoral system, aqua-silviculture, agro –silvo- pastoral system, as it has thin crown which offers minimun light competition. Due to its strong lateral roots, it has some limitation to grow in semi arid land. (Anon 1980).

10. Silvicutural systems: For natural riverain forest, it is worked under selection system with thinning. For irrigated plantations, it is worked under coppice- with standards with 22 years rotations and for unirrigated plantations. It is worked under clear felling systems on 50 to 60 years rotations with artificial regenerations. (Parkash, 1991).

11. Royalty rate: NRs.50/cu.ft. for round logs at stump sites. (Forest rules, 1995).

12. Market price: NRs. 200 to 300/cu.ft. for round timber and NRs. 300 to 600/cu.ft. for sawn timber at Sirha district, Nepal. (1997).

(17)

Local name: Tendu	
Diospyros melanoxylon	**Family: Ebenacae**

1. Natural occurrence: It is found bet[n] Terai to 1500m. It is likely to be confined in western Terai of Nepal. According to Champion and Seth (1968) it occurs in northern tropical dry deciduous forests.

2 Morphological characteristics:

Leaf	Leaves: alternate and sub-opposite, broad–ovate, coriaceous and hairy when young.
Flower	**Male flower:** Sub-sessile in short drooping cymes. **Female flowers:** solitary; larger than the male flowers. Flowering during June-Aug.
Fruit	**Fruit:** globose, glabrous, smooth, yellow when ripe. **Pulp:** yellow, sweet, aromatic. **Fruiting:** April-May.
Seed	Seeds are 4-8.
Bark	Bark is greyish black exfoliating in regular rectangular scales.

3. Silvicultural characteristics:

Light	Light demander. Seedling will withstand moderate shade.
Frost	Frost hardy.
Drought	Drought resistant.
Fire	Fire resistant.
Soil	It can grow on a wide range of soil type, poor denuded soil, dry hill slopes, stony soils and moist valleys where it grows best. It is sensitive to water

	logging and dampness.
Coppice	It coppices moderately well and pollards better, produces vigorous root suckers.
Associates	It is associate of sal, *Lagersrtoemia parviflora*, *Anogeissus latifolia.*
Graze & browse	Young plants are immune to browsing.
Tree nature	It is a medium sized, crooked deciduous tree.

4. Natural regeneration:

Seed production	Seeds ripen from April to June.
Seed dispersal	Seed dispersal is by wind; seed falls on the ground before monsoon.
Seed germination	Seeds germinate during monsoon.
Establishment	Seedlings require partial shade in the early stage.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump planting (is not very successful).
Seed collection time		Seed collection between April and June. Seeds are berries type.
No. of seed kg^{-1}		Each fruit contains 3-8 seeds, about 1100 seeds kg^{-1}. 5 kg of fruits produce about 1 kg of seeds.
Seed extraction		Seeds are thoroughly dried in the sun. Seed is extracted by beating.
Seed storage		Seeds can be stored in airtight container in cold places.
Viability of seed		Seeds retain their viability about 6-12 months.
Seed treatment		Alternate wetting and drying the seeds for 48 hours.
Seed sowing time		April or May.
Durat^{n} of germinat^{n}		Germination completes within one month.
Germination (%)		Germinative capacity of fresh seed is 90%. Germination (%) decreases between 10-60% after one year of storage.
Nursery period	**Seedling**	3-5 month.
	Stump	From one year old seedlings.
Other		Entire planting is done earlier because seedling develops long tap- roots.

6. Wood properties:

Wood color	Heartwood is very dark green or greenish black.
Hardness	Extremely hard and tough wood.
Weight	Wood weighs about 960 kgm^{-3}.
Working quality	Difficult to saw and work. Wood can be finished to a fine smooth polished surface.
Strength	Wood is fairly strong.
Durability	Naturally wood is durable. Lighter colored portions are not durable.
Preserva. treat.	Heartwood is non-durable and requires preservative treatment.
Seasoning	Highly refractory wood for seasoning i.e., very difficult to season.
Growth rate	Its rate of growth is slow. Rate of coppice growth is some what more.
Other	It is diffuse porous wood. Growth ring usually distinct.

7. Uses:

Timber	Its timber is an excellent wood for hammer and tool handles, it is used for carving, walking sticks and umbrella handles.
Fuel wood	Fuel wood is poor quality as it gives out sparks.

Fodder	It gives poor quality fodder. Leaves contain about 7% crude protein and digestibility coefficient is very low.
Edible food	Fruits are edible.
Ecological value	Suitable for afforestation in degraded sites like abandoned cultivated land.
Others	Its main use is for wrappers of bidis from leaves.

9. Agroforestry application: Tendu mixed with agricultural crop is not known. Being deep-rooting habit, its cultivation on field boundaries appears to be a feasible. (Hocking, 1993).
10. Silvicultural system: It is found as an associate of Sal forest. In moist mixed deciduous forest, it is worked under uniform or clear-felling or their modifications. In dry mixed deciduous forest, it is worked under coppice or coppice with reserves system on a coppice rotation of about 30 years. Since tendu leaves are a valuable material for *Bidi* industry, forest working plans usually do not permit its felling, unless over mature, dying or in clear felling coupes. (Parkash, 1991).

(18)

Local name: Gamhari	
Gmelina arborea	**Family: Verbenaceae**

1. Natural occurrence:

Terai to 1200m,it occurs in sal forest of Terai,Bhabar and Duns . It is found in moist mixed deciduous forest.

2. Morphological characteristics:

Leaf	Leaf is alternate, broadly ovate. Flower appears with new leaf in Mar-April.
Flowering	Flowers are yellow in color.
Fruiting	A drupe about 2.5cm long and yellow when ripe. Fruiting is bet^{n} May-June.
Seed	Seeds are usually lenticular. No. of seed varies between 1 and 3.

3. Sivicultural characteristics:

Light	Light demander
Frost	Moderately frost hardy species i.e., frequent frost can kill the tree.
Drought	Moderately drought resistant, but intolerant of excessive drought.
Soil	It prefers moist fertile valleys, with good drainage. It can also grow on poor dry sites but the growth is stunted.
Coppice	It coppices well.
Associates	It is the major constituents of sal. Some associates are: *Acacia catechu, Adina cordifolia, Albizzia procera,Dillenia pentagyna,Gmelina arborea, Holoptelia integrifolia Mallotus philippinensis.*
Browsing	Sensitive, it causes considerable damage to seedlings.
Tree nature	It is a deciduous tree, growing to more than 30m high on favorable sites.
Other	It is a fast growing timber species.

4. Natural regeneration:

Seed product^{n}	Fruit ripens in May and June.
Seed dispersal	Fruit pulp is eaten by deer and cattle, thus these animals help to disperse of seed.
Seed	Seeds germinate during monsoon. Alternate heat and moisture are needed to

germination	stimulate germination. Seeds will not germinate under dense shade of grass and weed that also hampers germination of seed.
Coppice	Natural regeneration may occur from coppice shoots.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, and stump planting.
Seed collection time		Fruit ripens between May and June.
No. of seed kg^{-1}		1600 kernels kg^{-1}; 1 kernel may have up to three seeds.
Seed Extraction		Pulp should be removed from kernels.
Seed Storage		Recalcitrant seed.
Viability Of Seed		Properly depulped and dry seeds will retain its viability for six month or may longer and in cold storage (5^{o})c, it may store for 2 or more years.
Seed treatment		Soak seeds in water for 48-72 hours and plant as soon as possible after collection.
Seed sowing time		Seed should be sown immediately after collection.
Durat^{n} of germinat^{n}		Germination commences within 7-14 days after seed sown.
Germination (%)		13-85%.
Nursery Period	**Seedling**	Two months require for seedling.
	Stump	Stumps are made from one year old nursery raised seedling. It is simple to raise *Gmelina* as stump plants.

6. Forest pathogens:

- Damage is caused by defoliators, (*Calopepla* spp) and borers (*Dihamnus* spp.and *Alicide* spp.)
- A fungus, *Poria rhizomorpha* causes stem and root diseases in shady, unfavorable and waterlogged situations and in clayey soils.

7. Wood properties:

Weight	Wood is rather light (420-640) kgm^{-3} and specific gravity is 0.47.
Hardness	It is a hard wood.
Elasticity	This wood is elastic in nature.
Working quality	It is easy to saw and work to a smooth surface. It finishes and polishes well. It peels well on a rotary lathe.
Strength	Wood is strong.
Calorific value	Its c.v. of wood is 20,100KJkg^{-1}
Durability	Timber is durable in contract with water. Natural durability of timber is about 15 years.
Preserva. treat.	It requires no preservative treatment.
Seasoning	It is non refractory wood i.e., seasons well without cracking or warping.
Wood color	Wood is creamy white in color, turning yellowish in exposure.
Rate of growth	Rate of growth is fast. Coppice growth is also very fast.
Porous	Diffuse porous to semi ring porous wood, growth ring is distinct to indistinct.

8. Uses:

Timber	It is the one of the best & most reliable timber of India. Used for furniture, veneer, plywood, pulpwood, planking, match sticks, match boxes etc.
Fuel wood	It is a good fuel wood species. Charcoal burns well.

Fodder	It is a good fodder for cattle.
Edible food	Fruits are eaten by cattle and man.
Ecological value	Its leaves are sometimes used as feed for silkworm.
Medicinal value	It is also planted in garden and avenues, the drupes, leaves, flowers, roots and barks are used as medicine.
Other	**Tender leaves** are demulcent. **Leaf juice** is used for foul ulcers; **root** is bitter used as tonic, stomachic, laxative and glactacgogue. **Bark** is bitter tonic and stomachic and useful for fever and indigestion.

9. Agroforestry application: The tree casts shade and nothing grows under dense stands.

10. Silviculture system: It is carried both to coppice system as well as clearfelling followed by artificial regeneration of the species. (Parkash, 1991).

(19)

Local name: Bot Dhainyaro	
Lagerstroemia parviflora	**Lythraceae**

1. Natural occurrence: It grows in Terai and Bhabar zone up to 1200m altitude.

2. Morphological characteristics:

Leaf	Leaves are elliptic, oblong or ovate and glabrous. New leaves appear in May.
Flower	Flowers are in lax axillary and terminal panicles, white & fragrant. Flowering: May-July.
Fruit	Capsules are ovoid or ellipsoid.
Seed	Seeds are winged.
Bark	Bark is light grey to reddish, smooth, exfoliating in narrow longitudinal flakes.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy species.
Drought	Drought resistant
Fire	It recovers well after fire.
Soil	It grows on a variety of soil; prefer recent alluvium; avoid waterlogged areas; thrives best on deep porous loam, though often found on clay. It also grows on black cotton soil.
Coppice	Tree coppices well and also produces root sucker. It pollards vigorously.
Associates	It is an associate of Sal forests.
Browse	It is not browsed by cattle
Tree nature	It is a medium sized deciduous tree. It is generally found in dry mixed forests; it is not gregarious.
Others	Rotation of 30 year for the production of pole.

4. Natural regeneration:

Seed production	Fertile seeds produce one year out of three.

Seed dispersal	Seed dispersal takes place by wind.
Seed germination	Germination is successful during rainy seasons.
Establishment	Seedling well establish on recent alluvium & abandoned cultivated land.

5. Artificial regeneration:

Preferred propag^{n}		Entire planting, stump planting, hard-wood cuttings (cutting during Feb. and March, when tree is leafless).
Seed collection time		December to May.
No. of seed kg^{-1}		30,000-60,000 seeds kg^{-1}
Seed storage method		Orthodox seed; seeds should dry thoroughly in the sun and store in air tight container.
Viability of seed		Viability of seed is best at 2nd and third year in storage, and then again deteriorates.
Seed treatment		Orthodox seed, seeds should be soaked in water for 48 hours before sowing.
Seed sowing time		Seeds are sown during March on open beds.
Durat^{n} of germinat^{n}		Germination completes within 28 days.
Germination (%)		**Fresh seed:** 10%, **three year old seed:** 40%, **4th year:** nil. Germination is better from two or three years old seed than fresh seed, due to after–ripening.
Nursery Period	**Seedling**	Seedlings are ready after 15 months in the nursery.
	stump	Stump can be prepared from 1 to 2 year seedlings.
Best planting size		Seedling: 30cm tall with 5 to 7mm root collar diameter.

6. Diseases, pests and parasites of Bot Dhainyaro:

Following fungi attack the tree:

1. **White stump rot:** *Fomes durissimus*. **2**. **Dark brown heart rot:** *Fomes fastuosu* **3**. **Spongy yellow heart rot**. **4. White pocket rot. 5. Grey heart rot** etc.

7. Wood properties:

Wood color	**Sapwood**: greyish white; **heartwood:** brownish grey or sometimes a greyish brown.
Weight	Wood weighs about 850 kgm^{-3}; Wood is heavy; sp.gr. is 0.75.
Hardness	Wood is hard.
Working quality	A fairly easy wood to saw and work; saws with less trouble when green. It takes a good polish after careful filling.
Strength	Wood is strong.
Calorific value	**Sapwood:** 4,951 Calories; **Heartwood:** 4,885 calories.
Durability	Wood is fairly durable. Average life as determined by graveyard test is 4 -5 years.
Preserv. treat.	Heartwood is not much durable & requires thoroughly preservative treatment.
Seasoning	It is refractory wood to seasoning; difficult to air season as it is prone to end-splitting, surface cracking and warping.
Growth rate	Rate of growth is moderately fast. Mean annual girth increment is 0.96 inch.
Porous	Diffuse porous, no annual rings; pores moderate size & irregular wavy grain.

8. Uses:

Timber	It produces valuable timber. It is used for building construction, door and window frames, carts and agricultural implements.
Fuel wood	It is an excellent fuelwood and makes a very good charcoal.
Fodder	It is not a good fodder tree; crude protein content is about 8%; total digestible nutrient: 50%.
Tannin	**Bark:** 7-10% tannin**, leaf:** 16% tannin.Bark is used for dying thread; bark dyes black.
Gum & resin	Yield a sweet edible gum.
Ecological value	Tree is a host of the *Tussar* silk worm. It is used for ornamental plantings.
Paper & pulp	The wood is useful in the manufacture of ryon grade pulp.
Others	It yields an inferior fibre.

9. Silviculture system: It is suitable for working under simple coppice or coppice with reserves system on a rotation of 30 years or more for production of poles. In mixed high forest, it is worked under selection system with an exploitable girth of about 0.9m.(Parkash, 1991).
10. Royalty rate: NRs. 50/cu.ft. for round logs at the stump site. (Forest rules, 1995).
11. Marketing price: NRs. 1450 to 1500/ ton at urban center of Kapilbastu, Nepal. (1997).

(20)

Local name: Mahuwa	**English name: Butter tree**
Madhuca indica	**Family: *Sapotaceae***

1. Natural occurrence: It is commonly found between Terai and 1200m. It is found in mixed deciduous forest of Sal.

2. Morphological characteristics:

Leaf	Leaves are clustered near ends of branches, elliptic, or elliptic oblong, coriaceous.
Flower	**Flowers** are in dense fascicles near ends of branches, **calyx:** coriaceous, **corolla:** tubular, cream-colored, scented and caducous.
Fruit	Berries are ovoid, long, greenish turning reddish yellow or orange when ripe.
Seed	Seeds are 1-4, brown, ovoid & shining.
Bark	Bark is dark coloured and cracked.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost hardy.
Drought	Drought resistant.
Coppice	It coppices fairly well.
Associates	It is often found in sal forest.
Browse	When young, it is browsed by deer and cattle.
Tree Nature	It is a medium–sized deciduous tree , usually with a short bole and large rounded crown.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, nursery raised seedling, stump planting.
Seed collect^{n} time	Seeds are collected between June and August.

No. of seed kg^{-1}	450 seeds kg^{-1}.
Viability of seed	Seeds are viable for 1 to 6 months.
Seed treatment	Not required.
Seed sowing time	Seeds are sown between July and August.
Durat^{n} of germination	Germination completes within 15 days.
Germination (%)	Germination is high.
Nursery period	**Seedling:** 12 months in the nursery.
Best planting size	20-30cm tall seedlings.

5. Diseases, pests and parasites of Mahua:

i) Tree is damaged by *Loranthaceous* parasites.**ii). White spongy rot:** is caused by *Polystictus steinheilianus.* **iii). Heart rot:** caused by *Fomes caryophylii* **iv). Root and butt rot :** caused by *Polyporus gilvus.* **v). Leaves** are eaten by caterpillars of *Achaea janata.*

6. Wood properties:

Wood color	**Sapwood** is reddish white to brownish white. **Heartwood** is light to dark red or reddish brown.
Weight	Wood is heavy, (sp.gr. is 0.95 to 0.97, and wt. is 61-62 lb /cu.ft).
Working quality	It is difficult to saw but takes a fair polish.
Strength	Wood is strong.
Calorific value	**Sapwood:** 4890-4978 calories.
Durability	Wood is durable.
Preserv. treat.	Heartwood is difficult to treat with antiseptic oil but sapwood treats readily.
Seasoning	Mahua wood is refractory and liable to split and crack.

7. Uses of Mahua:

i). Mahua oil: Fresh oil from properly stored seed is yellow in colour with a pleasant taste.Mahua oil is used mainly in the maufacture of soaps, particularly laundry soaps. Mahua's oil is edible and used for cooking purposes in some rural areas. Refined oil is used in the manufacture of lubricating greases and fatty alchohals. Oil is also used for candles. It has emollient properties and is used in skin diseases, rheumatism and headache.

ii). Mahua cake: Mahua cake is used as manure. It possesses insecticidal and pesticidal properties.

iii). Mahua flowers: Corollas are a rich source of sugars and contain appreciable amounts of vitamins and calcium. Mahua flowers are eaten raw or cooked. Mahua flowers are largely used to the preparation of distilled liquors. Flowers are also used for the preparation of vinegars; flowers are also used as feed for livestock. Flowers are regarded as cooling, tonic and demulcent. They are used in coughs, colds and bronchitis; they show anti-bacterial activity against *Escherichia coli*. Honey from the flower is edible and is used for eye diseases.

iv). Mahua timber: Wood is used for building purposes as beams, doors, window frames, especially posts.It is used for carriage, furniture, turnery, sports, good musical instruments, ship building, boats, bridges and other constructions; it is also a good fuelwoood.

v). Mahua berries: Mahua berries are eaten raw or cooked; they are also eaten by cattle, sheep, goats, monkeys, and parrots.

vi) .Leaves: Leaves are eaten by cattle; they are also used as green manure.

8. Agroforestry application: It is not usually planted in agricultural lands since it has wide–spreading dense crowns. (Hocking, 1993).

9. Silviculture system: Since the tree is valuable for its flowers and seeds, which it continues to provide up to more than 200 years age, it is rarely felled. It is generally reserved both in high forests and coppice forests. In some locations, in mixed deciduous forest, it is worked under selection fellings. (Parkash, 1991).

(21)

Local name: Sindure, Rohini	**Trade Name: Kamala Tree**
Mallotus philippinensis	**Family: Euphorbiaceae**

1.Natural occurrence: It often occurs between Terai and 1500m.

2. Morphological characteristics:

Leaves	Leaves are variable; broadly ovate to ovate; oblong ; glabrous above pubescent with numerous red gland beneath.
Flower	Flowers are in spikes, dioecious and small.
Fruit	Capsule globose, 3-lobed, 3-valved, densely covered with reddish brown glandular pubescence.
Seed	Seeds are sub-glosbose, black and smooth.
Bark	Bark is thin, grey, and somewhat rough**.**

3. Silvicultural characteristics:

Light	Shade bearer, tree can stand considerable shade.
Frost	Frost hardy.
Drought	Drought resistant.
Soil	It grows on a wide range of soil types.
Associate	It is commonly found in sal and certain shrub and mixed forests.
Coppice	It coppices well.
Tree nature	It is a shrub or a small, much branched, evergreen tree with a short and often buttressed bole.
Graze &browse.	It is extensively browsed by cattle, goats, and other wild animals.

3. Natural regeneration:

Seed production	Seeds fall in the beginning of the rainy season.
Seed dispersal	Seeds are dispersed by wind.
Germination	Seeds are germinated in the rainy season.
Establishment	Seedlings are susceptible to damage by browsing and by drought and insect attack .These factors hamper the establishment of seedlings.

4. Diseases, pests and parasites of Sindure, Rohini:

i. Tree is attacked by **several rot-causing fungi**; *Fomes caryophylli, Polyporous adjustus etc*. **ii. Heartwood:** is damaged by the borer *Aphrodisium cantori.* **iii. Sapwood of felled and dead timber:** is liable to attack by *Xylotrechus smei.*

5. Wood properties:

Wood color	Wood of kamala tree is whitish to light reddish grey, often with darker streakes and somewhat lustrous.
Weight	Hard wood, moderately tough and heavy (Av.wt. is 48 lb/cu.ft.)
Working quality	It is somewhat difficult to saw, but can be worked to a smooth surface under tools.
Calorific value	**Sapwood:** 4,835 calories.
Seasoning	Kamala wood is refractory. It warps and shrinks badly and is liable to insect attack.

6. Uses:

1). Kamala dye: The red pubescent is separated from ripe fruit by beating and shaking. It may be obtained by stirring the fruits vigorously in the water, when the dye settles down as a sediment, the sediment is collected, dried and pieces of pericarp and other refuse seperated by sifting.

- The yield of powder is 1.4 -3.7 % of the wt. of fresh fruits.Kamala dye is available as a Granular, reddish brown resinous powder, almost without odour and taste.
- Kamala dye is extensively used in dyeing of silk and wool.
- It is used for colouring food stuffs and beverages
- It is used for anti-oxidant for ghee and vegetable oils.

2. Kamala powder: It is used in external applications for parasitic affections of skin, such as scabies, ringworm, and herps.
3. Kamala seed oil: Kamala seed kernels yield oil or semi-solid fat which is used in the formulation of hair fixers and ointments.
4. Kamala seed cake: The seed cake left after the extraction of oil may be used as manure.
5. Kamala wood: It is relatively unimportant timber .It is suitable for rafters, tool handles, match-boxes and small turnery articles.

- It is extensively used as fuelwood.

6. Kamala leaf: are used as fodder.
7. Tannin and dye: Leaves and barks contain tannin. Bark contain 6-10% tannin which is deep reddish colour, useful for leather. Root yields a red dye.
8. Meditional value: All parts of the Kamala tree are used in external applications for skin disease.

Local name: Bakaino	**English name: Persian Lilac**
Melia azedarch	**Family: Meliaceae**

1. Natural occurrence:
It grows between 700-1300m, usually occurs in rather moist forest or in valleys in *Schima-Castanopsis* forest. It is native to Iran (West Asia).

2. Morphological characteristics:

Leaf	Leaves are bi- or occasionally tri–pinnate, leaflets ovate or lanceolate and serrate. Leafless occurs during December to March.
Flower	Flowers are lilac, fragrant, in axillary panicles.
Fruit	Fruits are an ellipsoid-globose, drupe with 4-5 seeds fruiting during cold season.
Seed	Seeds are contained within a hard stone.
Bark	Bark is dark grey with shallow longitudinal furrows.

3. Silvicultural characteristics:

Light	Light demander. It can grow under light shade in youth.
Frost	Frost hardy.
Drought	Drought resistant.
Fire	It is fire tender.
Soil	It can survive on shallow soil, but growth is stunted; rapid growth on deep, well-drained and fertile soil.
Coppice	It coppices well.
Associates	It is associated with *Schima-Castanopsis* forest.
Browsing	Seedlings are liable to damage by browsing.
Tree nature	It is a moderate sized deciduous tree; cylindrical bole; bearing a spreading crown and an ornamental avenue tree.
Other	Tree is liable to blow down by wind. Burrs often produce on the stem esp. near the base.

4. Natural regeneration:

Seed product^{n}	Seed production is abundant and annually.
Seed dispersal	Seed dispersal takes place by birds and mammals.
Seed germ.	Germination will be plenty during rainy season.
Establishment	Seedlings are well established on deep, fertile and well-drained soil.
Root suckers	Natural regeneration may take place from root-suckers.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump planting, cuttings, root suckers.
Seed collection time		Seed ripens between November to March.
No. of seed kg^{-1}		There are about 850 dried fruits, or 1200-1500 cleaned stones kg^{-1}.Single stones have five seeds.
Seed extraction		Stones have to be broken by hammer and the seed picked out carefully.
Seed storage method		Orthodox seed; dry thoroughly in the sun; store in airtight container.
Viability of seed		Viability of seed remains for five years.
Pre-sowing seed treatment		It is not necessary but germination period of untreated seed is long, retaining the flesh.Removing the flesh, soaking and cracking the stones may help the rapid germination of seed.
Seed sowing time		**<1500m:** Seed sown in March to April, **>1500m:** August.
Durat^{n} of germ^{n}		Germination starts in 2-8 weeks and may extend over several months.
Germination (%)		80% when seeds are fresh.
Nursery period	**Seedling**	<**1500m:** 3-4 months take for monsoon planting**, >1500m:** 11 months.
	Stump	Stump can be prepared from 11-month seedling.
Best planting size		15-20cm tall seedlings with 3 to 5mm root collar diameter.

6. Diseases, pests and parasites of Bakaino:

1. Root rots: Mainly caused by *Rosellinia bunodes*. **Brown root rot:** is caused by *Ganoderma lucidum*. **2**.**Stem and twig diseases** caused by *Corticium salmonicolor*. **3**.**Leaf diseases:** caused by *Cercospora spp.* **4**.**Phanerogamic** parasites affect the branches and the whole tree.

7. Wood properties:

Wood color	**Sapwood:** Yellowish white**, Heartwood:** Red, turning reddish brown with age.
Hardness	It is tough and moderately hard.
Working quality	It is easy to work, turn peels and finish.
Weight	Moderately heavy wood, wood weighs about (400-600) kgm^{-3}.
Calorific value	c.v of **heartwood** is 20,900$KJkg^{-1}$; c.v of **sapwood** is 21,300 $kJkg^{-1}$.
Durability	Wood is durable. It is resistant to attack by white ants.
Seasoning	Moderately refractory wood to seasoning.
Growth rate	It is a fast growing tree species.
Other	Rotation year should be for 20 years. It is resistant to attack by white ants.

8. Uses:

Timber	Use for toys, cigars-packing cases; suitable for sportsware; roofing material and agricultural implements; furniture; ornamental plywood.
Fuel wood	It is a medium quality fuel wood.
fodder	Leaves are highly nutritious, crude protein content is about 12%.
Edible food	Its fruits are poisonous to man and animals though sheep, goats and birds eat the fruit without any ill effect.
Gum & resin	Gum exudes which are used in spleen enlargement.
Ecological value	It is grown as a shade tree in coffee and tea plantation; suitable for afforestation in ravine land, grassland, abandoned cultivated and denuded land.
Medicinal value	Leaf juice is considered as an anthelmintic, anti-lithic, diuretic.A decoction of leaves is regarded as astringent and stomachic. Aqueous extracts of the heartwood are useful in asthma.Seeds are used in rheumatism.
Others	It is a fast growing multipurpose tree. The leaves, bark, fruits possess insect repellent properties. Extract of leaves are used in sprays, protect plants against grasshoppers and locusts.

9. Agroforestry application: Due to its long leafless period during winter, it is suitable to grow winter agricultural crop. It is also successfully planted in sugarcane.(Hocking, 1993).

10. Silvicultural system: For plantation, it is worked under 7-8 year rotation for fuel. It is short-lived, tuens hollow and unsound beyond 0.6-0.9m girth so it must have to be removed. (Parkash, 1991).

11. Royalty rate: NRs. 40/cu.ft. for round logs at the stump site. (Forest rules, 1995).

12. Marketing price: NRs. 250/cu.ft. for round logs at the major cities of Nepal. (1997).

Local name: Sandan	**Family: Leguminosae**
Ougenia dalbergoides	**Sub Family: Papilionaceae**

1. Natural occurrence: It grows between Terai to 1200m.

2. Morphological characteristics:

Leaf	**Leaves** are pinnately, trifoliate, **leaflets** coriaceous, **leafless** during Feb-Mar.
Flower	Flowers are in short fascicled racemes, white or pink, somewhat fragrant. Flower appears during March-April.
Fruit	**Fruit:** a pod, linear-oblong, flat, light brown. **Fruiting:** May-June.
Seed	Each pod contains 2-5 seeds.
Bark	Bark is grey or brown, deeply cracked.

3. Silvicultural characteristics:

Light	Light demander. Young seedlings require some shade.
Frost	**Seedling:** Frost tender, **mature trees:** Frost hardy
Drought	**Seedlings:** Drought sensitive; **mature trees:** Drought resistant.
Fire	Fire tender, trees are damaged by fire.
Soil	It can grow on a wide range of soil type; can grow on clayey soils and gravelly deposits and grows best on alluvium soils.
Coppice	It produces coppice and root sucker well. Root suckers quickly establish land slips and eroded sites.
Associates	It is a common associates of sal forests at lower altitudes; and *Pinus roxburghii* at higher altitude.
Browsing	Seedlings and saplings are readily browsed.
Tree nature	A small to medium-sized deciduous tree with fairly straight to crooked trunk.Sandan is common, sometimes almost gregarious, in mixed deciduous forests.
Ecological value	It has superficial root system. It is a characteristics species of landslips, banks, and sites of river and exposed situations on alluvial loam it attains a comparatively large size.

4. Natural regeneration:

Seed product^{n}	Pods ripen during May and June.Pods falls on the ground in June- July.
Seed dispersal	Seed dispersal takes place by wind.
Seed germination	Germination takes place early in the rains, and generally abundant on bare loose ground, landslips along roadsides and on cultivated field.
Establishment	Establishment of seedling will be best, if grass & weed competition is negligible, similarly damage by grazing and browsing animals may be less.
Root sucker	It produces long root sucker, by which natural regeneration may take place.

5. Artificial regeneration:

Preferred propagation	Direct sowing, entire planting, stump planting, shoot cutting, and root cutting.
Seed collect^{n} time	Pods are collected between June and July.
No. of seed kg^{-1}	28,000-33,000 seeds kg^{-1}.
Seed storage	Orthodox seed; dry thoroughly in the sun; store in air-tight container.
Viability of seed	Viability of seed is much low.
Seed treatment	Seeds should be soaked in water for 48 hours before sowing.

Seed sowing time	Seeds are sown immediately after collection.
Durat^{n} of germi^{n}	Seed takes 10-30 days for germination.
Germination (%)	Germination may obtaion 75%.

6. Diseases, pests and parasites of Sandan:

Heart rot diseases: Caused by *Fomes Caryophilli*, **Buff brown pocket rot** caused by *Polystictus nilgheriensis*.The tree is susceptible to damage by a no. of defoliators and borers.

7. Wood properties:

Wood color	**Sapwood:** light grey, **Heartwood:** a greyish brown or light reddish brown.
Weight	Heavy wood; sp.gr is 0.84, av.wt. is 865 kgm^{-3}.
Hardness	Tough and very hard wood.
Working quality	Timber is difficult to saw and work, takes a good polish.
Strength	Timber is strong.
Calorific value	**Sapwood:** Calorific value is 4891 cal., **Heartwood:** c.v. is 5178 calories.
Durability	The wood is durable; less liable to termite attack. Graveyard test indicate a natural durability of timber is 10-15 years.
Seasoning	Wood air seasons slowly without much degrade. Seasoning in the logs are satisfactory.
Porous	Diffuse porous, pores are moderate in sized, enclosed irregular shaped.
Growth rate	Height growth of seedling is slow under natural conditions.

8. Uses:

Timber	It produces valuable timber .It is used for agricultural implements, cart and carriage building, construction work, furniture e.t.c. It is elastic, special timber for marine plywood.
Fuel wood	It gives a good fuel wood.
Fodder	Tree is lopped for fodder.
Tannin	Bark contains 7% tannins.
Ecological value	Sandan is a useful lac host.
Medicinal value	An exudation from the incised bark is used in diarrhoea and dysentery. Bark is used as a febrifuge and also as fish poison.
Paper and pulp	Stem bark yields a cordage fibre.

9. Agroforestry application: Since the tree has plentiful lateral roots which produce root-suckers readily, it is not suitable with agriculture crops as minor tillage operation will encourage root suckers. (Hocking, 1993).

10. Silvicultural system: In mixed forests, it is worked as an accessory species alongwith the principal and more valuable species i.e. sal, teak etc, under coppice, coppice-with reserve, uniform, selection or selection–cum-improvement system.

11. Royalty rate: NRs. 100/cu.ft. for round logs at the stump sites. (Forest rules, 1995).

12 Marketing price: NRs. 1450-1500/ton at the Kapilbastu district, Nepal.(1997).

Local name: Amala	
Phyllanthus emblica	**Family:Euphorbiaceae**

1. Natural occurrence: It is found in most parts of Nepal below 1500m.

2. Silvicultural characteristics:

Light	Strong light demander.
Coppice	It coppices well and pollards moderately well.
Other	Growth of young seeding is considerably retarded by weed competition.

3. Artificial regeneration:

Preferred propagt^{n}	Direct sowing, entire planting.
Seed collect^{n}Time	Fruits are collected between September and December.
No. of seed kg^{-1}	34,000 seeds kg^{-1}. Each fleshy fruit contains a hard stone with 4-6 seeds.
Seed extraction	The seeds can be extracted by exposing the stones to the sun until they crack and allow the seed to escape.
Seed storage	Orthodox seed, which is dried in the sun and stored in airtight container.
Viability of seed	It can be stored for at least 12 months.
Germination (%)	Germination may obtain 20-30%.
Nursery period	**Seedling:** are planted out during monsoon season after 9 months.

4. Wood properties:

Wood color	Wood is red.
Hardness & Weight	Wood is hard. Wood weighs about 840 kgm^{-3}.

5. Uses:

Timber	Timber is used for agricultural implements and inferior building and furniture.
Fuel wood	It is a good fuelwood.
Edible food	Fruits are edible which are highly nutritious, contains all form of vitamins.
Tannin	Fruits, leaves and barks are used in tanning.
Ecological value	It is used in afforestation of degraded sites in the drier parts.

6. Royalty rate: NRs. 2/kg for fruit. (Forest rules, 1995).

7. Marketing price: NRs. 25/kg at major market near its production site. (Parajuli *et at*, 1997).

(25)

Local name: Vijay Sal	English name:Malabar Kino tree
Pterocarpus anacardium	**Family:Leguminosae, Papilionaceae**

1. Natural occurrence: It often occurs between Terai, Duns, and mid-hills of deciduous forest.

2. Morphological characteristics:

Leaf	Leaves are imparipinnate, leaflets usually 5-7 and oblong.
Flowering	Flowers are in large panicles, yellowish and fragrant.

Fruiting	Pods are orbicular, flat and winged.
Seed	Seeds are 1-2, convex and bony.
Bark	Bark is grey, rough, longitudinally fissured and scaly.

3. Silvicultural characteristics:

Light	It is a moderate light demander.
Drought	Young seedlings are frost tender, while mature trees are frost hardy.
Soil	It prefers a soil with a fair proportion of sand, though it is often found on red loam with a certain amount of clay.
Coppice	It coppices fairly well, but is found pollards better. It produces root suckers sparingly
Associates	It is associated with sal forest.
Graze&browse.	It is extensively browsed by cattle, goats, and other wild animals.
Tree nature	It is a moderate to large sized deciduous tree with a straight clean bole. It is found in deciduous forests both on undulating and flat ground.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, nursery raised seedling, stump planting.
Time of seed collec^{n}		Seeds are collected between December and April.
No. of seed/kg		1590-1940 fruits $kg^{-1.}$
Seed storage		Orthodox seed.
Viability of seed		Seeds retain their viability for 6-12 months.
Seed treat.		Seeds are soaked in cold water.
Seed sowing time		Seeds are sown in June.
Germination (%)		40-90%. Germination commences on 10 days onwards.
Nursery period	**Seedling**	Seedling takes 12 months in the nursery.
	Stump	Stump can be prepared from one-year-old seedling.

6. Diseases, Pests and Parasites ot Vijay Sal: The tree is attacked by a no. of insects, mostly defoliator , and some fungi which causes rotting of the wood.

7. Wood properties:

Wood color	**Sapwood:** is pale yellowish white or white, narrow. **Heartwood:** golden yellowish brown with darker streaks.
Weight	Wood is tough and very hard, and moderately heavy (Specific gravity is 0.796, weight is 801 kgm^{-3}).
Working quality	Wood is easy to saw but rather difficult to work to a good finish. It machines well and takes a good surface.
Strength	Wood is strong.
Calorific value	**Sapwood** 4,904 calories, **heartwood** 5,141 calories.
Durability	Timber is fairly durable in exposed situations and very durable under cover.
Seasoning	Wood is medium refractory and air seasons well without splitting, warping or surface cracks to any appreciable extent.

8. Uses:

Timber	Timber is used for house building, ship building, rail–way sleeper electric transmission poles, agricultural implements , tool handles, bridge , etc.

Fuel wood	Timber is used as an excellent fuel wood.
Fodder	Leaves make an excellent fodder.
Tannin	Bark contains a reddish brown colouring matter.
Medicinal value	The tree yields a gum-kino which exudes when an incision is made through the bark up to cambium. The gum-kino is a powerfully astringent, used in the treatment of diarrhoea and dysentry.It is locally applied in leucorrhoea and in positive haemorrhages.It is used for toothache. Bark is used as an astringent and in toothache. Flowers are used in fever. An aqueous infusion of the wood is used in diabetes and water stored in vessels made of wood is reputed to have antidiabitic qualities.
Pulp & paper	Gum kino is used in dyeing, tanning and printing and potential use for paper industry.

9. Silvicultural systems: Since it is a tree of mixed deciduous forests, it is worked under either selection system or simple coppice or coppice with standard system in which coppice rotation is 40-50 years and no. of standards per hectare 25. (Parkash, 1991).
10. Royalty rate: NRs. 100/cu.ft. for round logs at the stump. (Forest rules, 1995).
11. Market price: NRs. 300/cu.ft. for round timber and NRs. 600/cu.ft for sawn timber at the urban center of Kapilbatu district, Nepal. (Parajuli *et. al*, 1997).

(26)

Local name: Shrikhanda, chandan	**English name: Sandal wood**
Santalum album	**Santalaceae**

1. Natural occurrence: The tree flourishes the best between altitudes of 600 and 1050m, though it may ascend up to 1350m and descend as low as 360m.

2. Morphological character:

Leaf	Leaves are glabrous, thin, elliptic-ovate or ovate –lanceolate.
Flowering	Flowers are straw colored, brownish-purple, reddish purple or violet unscented in terminal and axillary paniculate cymes.
Fruit	Drupe globose, purple black, with hard, ribbed endocarp.
Seed	Seeds are globose or obovoid.
Bark	Bark is reddish or dark grey or nearly black, rough, with deep vertical cracks on older trees.

3. Silvicultural character:

Light	Light demander.
Drought	The tree is sometimes killed by prolonged drought and it often suffers from bark–scorching due to insolation.
Fire	Tree is extensively sensitive to fire.
Soil	Sandal tree grows mostly on red, ferruginous loam overlying metamorphic rocks, chiefly gneiss and tolerates shallow, rocky ground and stony or gravely soils, avoids saline and calcareous soils. The growth is luxuriant on rich and fairly moist soils.The tree needs good drainage and does not withstand water logging.

Coppice	Young sandal tree coppices fairly well. But the older trees have little or no coppicing power, except on moist conditions. Root suckers are freely produced,when the roots are exposed or injured or when the tree has been felled.
Associates	**Primary hosts** for Nepal is *Sesbania, Amaranthus,* C*alotropis* **secondary hosts are:** *Acacia catechu, Acacia nilotica, Albbizia spp, Cassia siamea, Dalbergia sissoo and Terminalia arjuna.*
Tree nature	It is a small to medium-sized, evergreen, semi-parasitic tree, with slender branches, commonly found in the comparatively dry regions of peninsular India.
Meteorolog.cond.	It grows the best where rain–fall varies between 60 to 160cm.
Other	Sandal tree is a root parasite which establishes contact with the host through the formation of haustoria. It obtains its requirement of lime and potash directly from the soil through its roots, while for N_2 and P, it partially depends upon its host, absorbing these elements through haustoria.

4. Natural regeneration:

Seed production	Fruits ripen between January and March
Seed dispersal	Seeds are dispersed by birds.
Seed germination & Establishment	Germination is profuse in the forest immediately after the monsoon but mortality is high due to exceesive heat of sun, drought, fire, grazing, trampling, insect and pests attack and excesive weed growth.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, Entire planting cutting.
Seed collect^{n} time	Fruits are collected during January to March.
No. of seed kg^{-1}	7,000 to 10,000 seeds kg^{-1}.
Seed storage method	Orthodox seed.Put thoroughly dried seed in a polythene bag, seal tightly and keep in cool place.
Viability of seed	Seed begins to loose viability after about 2 years.
Seed treatment	Seeds are scarified and soaked in water before it is sown in trays. Seeds are treated with fungicide and nematicide.
Seed sowing time	Seeds are sown during February and March.
Duration of germin^{n}	Seeds germinate in about 8 to 14 days.
Germination (%)	Germination is up to 80%, germiantion is slow and irregular.

6. Diseases, insects, pests and parasites of Shrikhanda:

i. Spike disease: caused by mycoplasma like bodies (MLB'S).

ii. Other diseases: a. Damping-off **b.** Leaf curl disease.

7. Wood properties:

Wood color	Sapwood and heartwood are sharply demarcated. **Sapwood** is white to whitish yellow and unscented.Heartwood is scented, light yellowish brown when freshly cut turning dark brown with exposure and ageing to reddish brown .The scent lasts for many years. **Heartwood** is yellow or brown, dull to somewhat lustrous, with an oily feel.

Weight	Wood is moderately hard to hard, heavy (Sp.gr. is 0.92, av.wt. is 897 to 1,137 kgm^{-3}).
Working quality	Wood saws without difficulty and can be worked to a smooth surface and takes a stain like polish.
Durability	Timber is durable.Heartwood is not attacked by termites but sapwood is often extensively attacked.
Preserv. treat.	It is treatable with an aqueous solution of boric acid by diffusion process.
Seasoning	Timber seasons almost without fault but slowly.

Uses of sandal wood:

(1) Sandal wood :

i). It is one of the finest wood for carving and it possesses smoothness, uniform fibres and straight and closed grains; moreover, it is comparatively free from knots and is freely worked with tools.

ii). Sandal wood is used in walking sticks, combs, picture frames, fan handles, table lamps, trays, chess-boards, chess men etc.

iii) . Saw dust is used for the extraction of the oil.

Medicinal uses: Both the wood and oil have long been used in medicine. They are credited with cooling ,diaphoretic, diuretic and expectorant properties. A paste of wood is applied to burns, fevers and headache. Oil of sandalwood is used for the treatment of gonorrhoea.

(2) Sandal wood oil:

i). The yield of oil varies, being highest in the roots (Up to 10% of the weight) and the lowest in the chips which constitute an admixture of heartwood and sapwood (About 1.5 to 2.5%) . Average yield of oil from good billets and roots ranges between 4.5 and 6.25%. The main constitute of sandal wood oil is santol ($C_{15}H_{24}O$).

ii. Sandal wood oil is very highly prized as raw material in perfumery. It has an important use in soaps,face creams, toilet powders and other cosmetic industries.It is highly used in medicinal purposes.

(3) Sandal wood roots: Yield a high percentage of sandal wood oil (4.4%) of the finest quality.

(4) Sandal wood seed: Seeds yield 50-55% of a dark red viscid fixed oil (60%) yield by hot-pressing), which is thicker than the castor oil.Its oil has vulcanizable properties, so the oil can be used in the rubber industry .The seed oil is used in the skin diseases.The endosperm of the seed is edible.

(5) Sandal-fruits: Fruits contain betulic acid, glucose, fructose and sucrose.

(6) Sandal-leaves: Fresh leaves of sandal wood yield a pale yellow wax.

8. Agroforestry application:

It is planted in homestead gardens mixed with other trees. Because of its very valuable heartwood, this species is very often planted along field bunds and similar locations in the dry and semi-arid rainfed areas. (Hocking, 1993).

9. Royalty rate: NRs. 25/kg for dry wood. (Forest rules, 1995).

10. Marketing price: NRs. 800/kg for dry wood at Kathmandu, Nepal. **(1997).**

Local name: Kusum	English name: Lac tree
Schleichera oleosa	Family: Sapindaceae

1. Natural occurrence: It is commonly found from Terai to 900m elevations, especially in moist localities.

2. Morphological characteristics

Leaf	Leaves are paripinnate, leaflets elliptic or elliptic oblong, coriaceous.
Flower	Flowers are minute, yellowish green, bisexual, in axillary racemes.
Fruit	Berries are smooth or slightly prickly.
Seed	Seeds are brown, irregularly ellipsoidal, oily, enclosed in a succulent aril which dries up on the seed.
Bark	Bark is grey or brown, reddish inside, exfoliating in small, round, and irregular flakes.

3. Silvicultural characteristics:

Light	It is a shade bearer tree.
Frost	Frost hardy.
Drought	Drought hardy.
Soil	It thrives best on light, well-drained, gravelly or loamy soils, although it also occurs on sandy and laterite soils. The tree prefers slightly acidic soils. It is common in Siwalik range on the sides of ravines on sandstone or on boulder beds.
Coppice	Its coppicing power varies. It pollards well. It freely produces root-suckers.
Associates	It is commonly associated with Sal forest.
Graze & browse	Browsing sensitive.
Tree nature	It is a medium to large sized, deciduous or nearly evergreen tree.
Meteor^{n} cond^{n}	In its natural habitat: **Absolute Max. Shade temp**: - (35-47.5)^{0} C. **Absolute Min. Temp**. (-2.5 to 17.5) ^{0}C. **Rainfall** varies from 75 to 250cm.

4. Natural regeneration:

Seed prod ^{n}	Fruits fall towards the end of summer or at the beginning of the rainy seasons.
Seed dispersal	Seeds are dispersed by animals and birds.
Seed germ ^{n}	Germination and establishment of seedling largely depend upon the quickness of the seeds becoming covered by the earth and debris.
Root sucker	Natural regeneration can also be obtained from the root suckers.

5. Artificial regeneration:

Preferred propag^{n}	**Direct sowing** (fresh seeds are sown in thoroughly prepared soil bed), **Stump planting.**
Seed collection time	Seeds are collected between June-July.
No. of seed kg^{-1}	1410-2190 seeds kg^{-1}.
Seed extract ^{n}	Pulp should be removed.
Seed storage method	Seed can be stored for one year in gunny bags and two years in sealed tins.
Viability odf seed	Seeds are viable only for a short period.

Seed treatment		Not required.
Seed sowing time		Seeds are better to sow immediately after collection.
Duration of germ^{n}		10-90 days.
Germinaiton (%)		Germination capacity of the seed is 58%.
Nursery Period	**Seedling**	Next July.
	stump	Stump can be prepared from one year old seedling.
Best planting size		15-20cm tall seedling

6. Diseases, Pests and Parasites of Kusum:

(i).Stem blight: Caused by *Rosellinia bunodes* **(ii) Yellow cork root:** caused by *Polyporous weberianus* **(iii).white spongy rot:**casued by *Hexagonia apiaria* **(iv).** The most important insect attacking the tree is the **lac insect** *Laccifer lacca* **(v).** Several defoliators, borers and sap suckers attack the tree.

7. Wood properties:

Wood color	**Sapwood** is white or pale-brownish white and **heartwood** uniform light–reddish brown.
Hardness	Very hard and tough wood.
Weight	Wood is very heavy (sp.gr is approx. 0.91-1.08, wt. 945-1,185 kgm^{-3}.
Working quality	Timber is very difficult to saw when dry, and fairly well in a green state.
Strength	Timber is very strong.
Calorific value	**Sapwood:** 4950 cal. **Heartwood:** 4928 calories.
Durability	Timber is not durable in exposed situations. It is durable under cover and is not much prone to borer and termite attack.
Preser. treat.	Timber is easily amenable to treat with preservatives.
Seasoning	It is one of the most refractory woods to season.

8. Uses:

Timber	Timber is commonly used for agricultural implements, tool handles, cart-wheels, sleepers, furniture, etc.
Fuel wood	It makes a good fuel and an excellent charcoal.
Fodder	Trees are lopped for fodder.
Edible food	Raw fruits are prickled, the ripe ones possess whitish pulp and pleasant, acidic taste and are often eaten during summer. Seeds are often eaten raw or roasted. Young shoots are also eaten.
Tannin	Flowers yield a dye.
Gum & resin	The tree yields a resin. Bark contains 9.4% tannin.
Ecological value	The tree is an important host for *kusum*i-lac and the finest quality of lac is obtained from this tree. Flowers are a source of nectar for honeybees.
Medicinal value	Bark is astringent and used in external applications for itch, pain in back, inflammations and ulcers.
Paper & pulp	In mixture with other woods such as *Terminalia chebula, Terminalia alata, Ougenia ooieinensis, Tectona grandis*. Kusum wood yields pulp suitable for the manufacture of wrapping and printing papers.

Other uses of Kusum:

i).Kusum kernel oil: The kernels constitute 60-65% of the seeds and the rest being the shell.The fat content of the kernels varies from 59-72%.Kusum oil is a yellowish brown,semi-solid, with a faint

odour of bitter almonds. Its oil has long been used for hairdressing. It is also used for culinary and lighting purposes, as a lubricant for machinary and for cure of itch, ache, burns and other forms of skin troubles. It can be used for soap manufacture and as a textile lubricant.

ii).Kusum oil-cake: It has a good manurial value. The cake is also used for fuel.

(28)

Bhalayo	**Marking nut tree or oriental cashew nut**
Semecarpus anacardium	**Anacardiaceae**

1. Natural occurrence:

It occurs in Sal forest of Terai, Bhabar, Duns and lower hills of mixed deciduous forest.

2. Morphological characteristics:

Leaf	Leaves are large, simple, and ovate-oblong.
Flowering	Flowers are small, dull greenish yellow, dioecious, in terminal panicles.
Fruiting	Drupes, obliquely ovoid, smooth, shining, black when ripe.
Bark	Bark is dark brown, rough.

3. Silvicultural characteristics:

Light	Moderate shade bearer.
Frost	Frost sensitive.
Coppice	It coppices well.
Associates	It is commonly associated with Sal forest.
Tree nature	It is a moderate sized deciduous tree.

4. Wood properties:

Wood color	Wood of the tree is greyish white, often with yellow streaks.
Weight	Wood is moderately heavy (wt. 592 kgm^{-3})
Hardness	Wood is soft.
Working quality	It is easy to saw and work.
Strength	Wood is not strong.
Durability	Wood is not durable.
Seasoning	It is susceptible to sap stain and cracks during seasoning.

5. Uses of *Semecarpus anacardium*:

a. Wood: is suitalbe for cheap and light furniture, packing boxes and carving. It is fairly good for match boxes and splints.Its wood is a medium quality fuel wood.

b. Fruit: fruit is acrid, hot and anthelmintic. It is beneficial in tumours, acute rheumatism, asthma etc. The juice of the pericarp of the fruit and also the tree trunk is a powerful counter-irritant and vesicant. The juice is used for tattooing.

The flesy orange cup (Hypocarp) of the fruit is eaten when quite ripe, it is slightly astringent. Juice of pericarp has anti-bacterial properties.

c. Kerenls: the kernels of the fruit, found inside the hard shell, has an almond like taste and is edible.The kernels yields (20-25%), a reddish brown, semi-drying oil with a pleasant taste,

which is used as the wood presevative against white ants and as a lubricant for wooden axles of carts.

d. Root bark: the juice of the root bark has medicinal value.

e. Gum or gum-resin: the tree exudes a gum or gum-resin which is used in leprous affections and nervous debility.

f. Leaves: contain saponins, is used for soap manufacturing.

g. The tree is a host plant for the lac insect.

(29)

Local Name: Sal	**English Name:Sal**
Shorea robusta	**Family :Dipterocarpaceae**

1. Natural Occurrence:

It is commonly found bet^{n} Terai-1000m and its **Max.altitude:**1500m.Sal forest is dominant in Bhabar, Terai and Duns. It is also covers most of the Siwalik Hills along river valleys. Stainton (1972) distinguishes Sal forest of Nepal into **two types: 1).** Bhabar, Terai and Dun Sal forests. **2).** Hill Sal forest.

2. Morphological characters:

Leaf	New leaf appears in March-April. Leaves are glabrous, ovate-oblong and coriaceous.
Flower	Flowering begins in March-April. Flowers, are yellow in color; which are in lax, axillary or terminal panicles
Fruit	Fruiting in May-July. Fruits are ovoid, with five wings, three longs and two short.
Seed	Seeds are ovoid, with fleshy and unequal cotyledons.
Bark	Bark is reddish brown or grey, smooth or longitudinally fissured.

3. Silvicultural characteristics:

Light	Light–demander.
Frost	Moderately frost hardy.
Drought	Drought -sensitive, show frequently dying back phenomenon.
Fire	One of the most fire- resistant of its region.
Soil	It does not grow in very sandy, gravelly soils, water -logged areas, stiff clays and limestone areas. It prefers old alluvium soil; it may grow on wide range of soil types. Good site indicator of Sal is *Clerodendron infortunatum* and poor site indicator is *Vitex negundo.*
Coppice	It coppices well up to 20-30cm in diameter.
Associates	**Its primary associates are:** Dabdabe, Kutmiro, Koiralo, Tanki, Haldu. Gamhari, Saj, Sandan, Tooni, Tendu etc.
Graze & browse.	It is sensitive to grazing and browsing; very liable to damage by browsing.
Tree nature	It is deciduous for a short time. A large tree exceptionally reaching a height of 45m, in hills it rarely exceeds 15m. It is one of the most gregarious forest tree species. It grows up in more or less even-aged crops, sometimes it may be in uneven- aged crops.
Meteorological condition	**Max. Temp:** (44 - 47)^{o}C, **Min.temp:** (-1 to 7)^{o}C, **normal annual rainfall:** 100 to 450cm

4. Natural regeneration:

Seed production	**Good seed year:** one year in three years, **fruit ripens:** at the beginning of

	the rainy season, June. **Seed production:** abundant, fertile, and wing-shaped.
Seed dispersal	Seed dispersal is by wind since the seeds are winged. Seeds are carried away by wind up to 100m from the mother tree.
Seed germination & Establishment	If there is rain soon after the seed fall, the germination will begin immediately. If there is bare and fertile soil, germination and establishment will be satisfactory.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, stump planting.
Seed collect^{n} time	April to June.
No. of seed kg^{-1}	450-1000 seeds kg^{-1}.
Seed extraction	It is not needed.
Seed storage	Recalcitrant seeds.
Viability of seed	Within one week, seeds loose their viability very rapidly.
Seed treatment	It is not required.
Seed sowing time	Seeds should be shown immediately after collection.
Duration of germ^{n}	Germination completes within 10-28 days.
Germination (%)	40-60% germination is hypogeal.
Nursery period	**Stump:** The stump can be prepared from one-year-old seedlings.

6. Wood properties:

Weight	It is heavy to very heavy wood. Wood weighs about 800 to 960kgm^{-3}. Specific gravity is 0.68-0.82.
Hardness	Wood is very hard.
Elasticity	Wood is elastic.
Working qua.	Its timber is difficult to saw and work due to interlocking fibers and grains.
Strength	It is a very strong wood.
Calorific value	c.v of **heartwood** is 22,700, KJkg^{-1}; c.v of **sapwood** is 21,300 KJkg^{-1}.
Durability	Natural durability of heartwood is very high. It has a long life in exposed situation above the ground, and in the ground as well as under water but sap wood is less durable.
Preservative Treatment	Sap wood is easy to treat with all preservatives but heartwood is very refractory to treatment, side and end penetration is almost nil.
Seasoning	Highly refractory wood to seasoning. (It is very difficult wood to seasoning.)
Grain&texture	Wood has interlocked grain and medium to coarse texture. Diffuse porous.

7. (Diseases, Pests and Parasites in Sal forests)

- Over 150 species of fungi have been reported to cause damage to Sal trees in India.
- Many types of rots particularly by *Fomes, Ganoderma, polyporus, Trametes,* etc. have been recorded.
- *Fomes caryophylli* and *Hymenochaete rubiginosa* cause unsoundness of Sal.
- The insect pests of Sal include a large no. of defoliators and borers.
- Major damage of sapwood and heartwood is done by the members of the family cerambycidae.
- Sal plantations in various localities are attacked by loranthaceous parasites.

8. Uses:

Timber: Sal is the main construction material in Nepal. It is used for construction, door, window frame, planking, carts and carving Sal is available in the market in the form of logs, sleepers, planks, poles and scantlings. After preservative treatment, Sal poles are suitable for overhead, electric, telegraph and telephone lines. It is used for sleepers, beams, scantling and agricultural implements.

Firewood and charcoal: It is an excellent fuel wood. It also makes a good charcoal.

Fodder: Leaves are lopped for fodder, though they are of only medium quality.

Edible food: Sal seeds are sometimes eaten after roasting especially in times of food scarcity. Seed yields 19-20% of fatty oil (Sal butter); Oil is also suitable for soap.

Tannin: Sal bark, along with leaves and twigs, gives tannin material; Bark: 7-12% & young leaves: 20%, twigs and leaves: 22% of tannin.

Gum and resin: On tapping, the Sal tree yields an oleo-resin known as Sal dammar which is widely used as incense. Sal dammar has been used as plastering medium for walls and roofs and as cementing material for plywood.

Ecological value:

Sal is one of the primary hosts of tasar silkworm (*Antheracia mylitta*). It is also recorded as the host of the *kusumi* strain of lac of insect (*Laccifer lacca*).

Medicinal value: The oleo-resin of the Sal is used in the indigenous systems of medicine as an astringent and detergent and is given in diarrhoea and dysentry.It is also used as an ingredient of ointments for skin diseases and in ear troubles.

Paper and pulp: Sal wood is reported to yield a pulp suitable for the manufacture of paper in admixture with bamboo pulp.

Others: Sal oil cake contains10-12% protein and about 50% starch and can be used as cattle and poultry feed.

8. Royalty rate: NRs. 200/cu.ft. for air dry round timber. (Forest rules, 1995).

9. Marketing price: NRs. 300 to 500/cu.ft. for round logs and 600 to 800 for sawn timber at urban areas of Nepal. (1997).

Local name: Jamun	
Syzygium cumini	**Family: Myrtaceae**

1. Natural occurrence: It is widespread in Nepal from the Terai to about 1600m.

2. Morphological characteristics:.

Leaf	Leaves are simple, lanceolate, elliptic-oblong or broadly ovate-elliptic, coriaceous and shiny.
Flower	Flowers are greenish white, fragrant in trichotomous panicles.
Fruit	Fruits are ellipsoid or oblong, black with pinkish juicy pulp.
Seed	Seeds are single.
Bark	Bark is brown or greyish, fairly smooth, with shallow depressions exfoliating in woody scales.

3. Silvicultural characteristics:

Light	Shade bearer, especially when young.
Frost	Frost tender when young but hardy in old.
Drought	It is drought resistant even if it requires high amount of moisture.
Soil	It prefers clay loam soils, but will grow on sandy alluvial soils near rivers. It is not suitable for dry sandy or gravelly soils or stiff clays.A fair amount of soil moisture needs for satisfactory growth.
Coppice	It coppices vigorously.
Associates	In **lower altitudes:**often associate with sal forest, in **higher altitude:**often associates with *Schima-Castanopsis* forest.
Tree nature	It is a large evergreen tree which is often gregarious along streams and swampy places in the Terai.

4. Natural regeneration:

Seed product^{n}	Fruits ripen between June and Auguest.
Seed dispersal	Seeds are dispersed by animals and birds, which eat the fruits.
Seed germinat^{n}	Seeds germinate during the rainy season.
Establishment	Seedling slowly develops during the first year and rapid after second and third year if conditions are favourable.

5. Artificial regeneration:

Preferred Propagation		Direct sowing, stump planting, entire planting, grafting, cutting, and budding.
Seed collection time		Seeds are collected between June and August.
No. of seed kg^{-1}		There are about 1000-1300 seeds kg^{-1}.
Seed extraction		Fleshy part of fruit must be removed.
Seed storage		Recalcitrant seed.
Viability of seed		Seed looses its viability within 2-3 months.
Seed treatment		It is not required.
Seed sowing time		Seed should be sown immediately after collection.
Duration of germination		Germinating power of fresh seed is high. Germination should be completed within 2-3 weeks.
Germination (%)		Germination obtains 50% when fresh, nil after 3 months.
Nursery Period	**Seedling**	Seedlings should be planted after 12 months.
	stump	Stump can be prepared from one year old seedling.
Best planting size		15-20cm old seedling with 3 to 5mm root collar diameter.
Other		Seedlings are sensitive to root disturbance.

6. Wood properties:

Wood color	The wood is reddish grey to brownish grey,dull or some what lustrous.
Texture & grain	It is more or less irregular grained and medium coarse textured.
Hardness	Timber is moderately hard.
Weight	Wood is moderately heavy-to-heavy and specific gravity is 0.67 to 0.78.
Working quality	It saws and machines well.
Strength	It is strong timber.
Calorific value	c.v of sapwood is 4834 calories.

Durability	It is moderately durable in the open and very durable under water.
Preservative treat.	It is very resistant to penetration by antiseptic fluids.
Seasoning	Timber is highy refractory to air seasoning and is liable to surface cracking and spiliting. Grdling has given the best results. Conversion could not be done in dry and hot season.

7. Uses:

Timber	Timber is used for construction, boat-building and for commercial and tea chest plywood. It is also used for agricultural implements, tool handles, cart-wheels, sleepers, furniture, etc.
Fuel wood	Wood is moderately good fuel wood.
Fodder	Leaves are palatable & widely used as fodder for cattle, sheep and goats.
Edible food	The ripe fruit is eaten. A wine can be prepared from the ripe fruit. Fruits are used for making preserves, squashes and jellies. The juice of unripe fruits is used for preparation of vinegar.
Tannin	Seeds contain 19% tannin. Stem bark contains 10-12% tannin. Bark is used for dyeing and tanning.
Ecological value	The blossoms are an important source of honey. The *tasar* silkworms feed on the foliage of this tree.
Medicinal value	Extracts of the barks, stems, leaves, buds, and flowers possess moderate antibiotic activity against *Micrococcus pyrogenes.* A decoction of the bark and also powdered seeds are useful in diarrhoea and dysentry. Extracts of the bark and seed and also leaves are used in the treatment of diabetes.

8. Agroforesty application: It is unsuitable for growing in agronomical crop field except for shade loving crops as it has large, dense and evergreen canopy. It is mostly planted in roadside avenues, canal-side strips, wind-break, water-logged areas etc. mixed with other crops. (Hocking, 1993).

9. Silviculture system: Pure Jamun strips/belts along the stream banks are worked under coppice-with-standards for poles and timbers, generally the coppice rotation is 30 years and for standards, it is 60 years. If Jamun forms an accessory species and is worked along with other species-under selection, shelterwood, clearfelling or coppice systems. (Parkash, 1991).

10. Royalty rate: NRs. 100/cu.ft. for air dry round wood. (Forest rules, 1995).

11. Market price: NRs. 150-200/cu.ft. for round timber and NRs. 350/cu.ft. for sawn timber at Sirha district, Nepal. (Parajuli et al. 1997).

12. Conservation status: Its population is heavily depleted due to loss of its habitat for agriculture, over use, poor regeneration, low frequency; and lack of scientific mgt. of this species.

(31)

Local name:Imli	**English Name: Tamarind tree**
Tamarindus indica	**Family: Leguminosae**

1. Natural occurrence: It is found sparsely in the Terai, lower hill, and the Duns.

2. Morphological characteristics:

Leaf	Leaves are paripinnate; leaflets are 10-20 pairs; sub-sessile and oblong.
Flower	Flowers are small, yellowish with pink strips, in lax, few flowered racemes at the ends of the branchlets.
Fruit	Pods are 7.5 to 20cm long, more or less constricted between the seeds, slightly curved, brownish-ash coloured.
Seed	Seeds are 3-12, smooth, dark brown and shining.
Bark	Bark is brownish or dark grey, longitudinally and horizontally fissured.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost sensitive.
Drought	Drought hardy.
Soil	It thrives best on the deep alluvium and porous soils, sheltered from sun.
Coppice	It coppices well.
Associates	It is often associated with sal forest.
Graze & browse	Browsing sensitive. Goats browse the young leaves.
Tree nature	It is a moderate to large-sized evergreen tree, cultivated or found naturalized throughout the Terai.
Meteor. condit^{n}	This tree generally prefers warm climate.
Other	The tree has usually a short and thick trunk, which is seldom straight. It has a handsome, dense and spreading crown of feathery foliage and is prized for ornament and for planting on the road–sides for shade.

4. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, cutting, and budding.
Seed collect^{n} time		Fruits are collected between March and April.
No. of seed kg^{-1}		1800 seeds kg^{-1}.
Seed storage method		Orthodox seed. Seed should be stored in sealed container.
Viability of seed		Viability of seed remains for 1 to 2 years.
Seed treatment		Seeds are soaked in hot water.
Seed sowing time		Seed should be sown in April.
Durat^{n} of germinat^{n}		Germination generally commences in 5-10 days.
Germination (%)		Germination may obtain 66%.
Nursery period	**Seedling**	Seedling will be ready for the monsoon planting if seeds sown in April.
	Stump	Seedling should remain next monsoon for stump preparation.
Best planting size		20-30cm tall seedlings with 5-7mm root collar diameter.
Other		Regular weeding and watering should be done for the best growth.

6. Diseases, pests and parasites of Imli:

i). The tree is affected by a no. of rots such as: **a) Sap rot:** caused by *Xylaria euglossa.* **b). Brownish sap rot**: caused by *Polyporus calcuttensis*. **c) White rot:** caused by *Trametes floccosa.* **ii).** Several insects attack the fruits and seeds of the *tamarind*, both on the tree and when stored for marketing.

7. Wood properties:

Wood color	**Sapwood** is yellowish, often with brownish red streaks. **Heartwood** is dark brown, usually streaked and mottled with black, particularly in old trees.

Hardness	It is very hard wood.
Weight	Wood is heavy (weight 913-1282 kgm^{-3}).
Working qual.	The wood is very difficult to work, though it takes a good polish and bends well.
Strength	Wood is strong.
Calorific value	**Sapwood**: 4,909 calories and **Heartwood**: 4,969 calories.
Durability	It is durable under cover, and is somewhat resistant to insect attack.
Preserv. treat.	It is very refractory to preservative treatment.
Seasoning	It is moderately refractory and shows cracking and spiliting during air seasons.
Growth rate	Tamarind is a slow growing species.

8. Uses:

Timber	Timber is mostly used for agricultural implements, tool- handles, turnery and constructional works. It yields decorative planks for panelling and furniture.
Fuel wood	Wood is very good fuel, and is preferred for making gunpowder charcoal.
Fodder	Leaves are eaten by goats and cattle.
Edible food	Tender leaves, flowers and young seedlings are eaten as a vegetable. Seeds and kernels are eaten during food scarcity periods.
Tannin	Pulp is also used as an axillary in dyeing and tanning and for polishing and cleaning metal-ware.
Gum & resin	Tree exudes a dark-colored gum of poor solubility, which swells up considerably in water and has not been found of any value.
Ecological value	Tree is a host of the lac insect and of silkworm of the genus *Anaphe* in Nigeria. Flowers are considered to be a good source of honey, which is rich golden colour. It is recommended for planting along the fire-lines and in shelter–belts and wind-breaks to prevent soil erosion. It is also grown for afforestation of the degraded lands on drier areas. It is widely planted in avenues.
Medicinal value	Seeds are astringent and are used in the diarrhoea and dysentry.

Other uses of *Tamarindus indica:*

- **Pulp and pulp products:** The fruit-pulp is the chief agent for souring-curries, sauces, chutnys and certain beverages throughout the greater parts of Nepal and India.
- **Seed:**Seed is used as a valuable raw material for the preparations of sizing powder textiles.
- **Tamarind kernel powder(TKP):** When TKP is boiled with water containing boric acid and phenol, gives a very good paper adhesive .
- **Tamarind kernel oil (TKO):** TKO are useful in the preparation of paints, varnishes and for burning in lamps.
- **Leaves** are used as green manuring of soils.
- **Fibre** is obtained from the young stems and bark**.**

9. Agroforestry applications: because of its dense shade and broad spreading crown, it reduces the growth of agriculture crops under it. It is mostly planted along field margins, roadside avenues, canal side strips, wind break etc. (Hocking 1993).

10. Silvicultural systems: It is worked under coppice for fuel. It is retained till its death in avenues and field boundaries. (Parkash, 1991).

(32)

Local name: Barro	
Terminalia belerica	**Family: Combretaceae**

1. Natural occurrence: Terai to1100m. According to Champion and Seth (1968), it is found in tropical moist mixed deciduous forest.

2. Morphological characteristics:

Leaf	Leaves are broadly elliptic and clustured towards the end of branches.
Flower	Flowers are in solitary, simple, axillary spikes. Flowering during, April-June, after new leaves are appeared.
Fruit	Fruits are globular and grey vulvety.
Seed	Nut has thick walled and hard.
Bark	Bluish or ashy grey bark and longitudinal furrows.

3. Silvicultural characteristics:

Light	It is light demander. Young seedlings tolerate heavy shades during first or second year, but afterwards kills them.
Frost	It is frost tender.
Drought	It is a drought resistant to a considerable extent.
Fire	Fire tolerant and recovers well after burning.
Soil	It requires a good moisture supply or deep sand soil with good sub- soil drainage.
Coppice	It coppices fairly well, but pollards badly, does not produce root suckers.
Associates	It is associated with *Shorea robusta* forest or with other species of *Terminalias.*
Graze &browse	Sensitive. Seedlings are severely damaged by browsing animals.
Tree nature	A large handsome, deciduous tree.It often occurs more or less scattered and not gregariously. Stems straight, frequently buttressed when large.
Meteorological Cond.	In its natural habitat absolute **Max.temp** (36-47.5)^0 C, **absolute Min. temp.** (0-15.5)^0 C, **normal Annual rainfall** (75-330 cm).

4. Natural regeneration:

Seed production	Fruits ripen between November-March.
Seed dispersal	Seeds are dispersed by wind partly by water.
Seed germination	Seeds need moist alluvial ground for germination, if seeds fall thick cover of dead leaves or dense weed growth, germination is hampered. Loose alluvial soil is good for its germination.

5. Artificial regeneration:

Preferred propag^n	Direct sowing, stump planting, entire planting.
Seed collect^n time	Fruits ripen between November-February. Fruits are collected from the ground as soon as they fall, not from the trees.

No. of seed kg^{-1}	60 fruits kg^{-1}, (400-520) seeds kg^{-1} after pulp removing.
Seed extraction	Pulp should be removed.
Seed storage	Orthodox seed dry thoroughly in the sun.
Viability of seed	One year.
Seed treatment	Soak the seed in water for 48 hours.
Seed sowing time	February-March for monsoon planting.
Germination (%)	86-100%, germination is hypogeal.
Best planting size	20-30cm tall seedlings with 5-7mm roor collar diameter.

6. Diseases, Pests and Parasites of Barro:

- **Leaf disease:** Caused by *Puccinia terminaliae, Phyllachora terminaliae.*
- **Heart rot:** Caused by *Fomes fastuosus, Ganoderma applanatum.*

7. Wood properties:

Weight	The wood weighs about 770 kgm^{-3}.Wood is moderately heavy to heavy, specific gravity is (0.60-0.77).
Hardness	Wood is hard and tough.
Working quality	Timber is easy to saw and work; easy to peel and make up into good veneers; absorbs much polish and soon looses its texture.
Strength	It is moderately strong wood.
Durability	Timber is not durable in exposed situations as it is non-resistant against wood -rotting fungi, but it is more durable under cover.
Preservativetreat.	Timber is treatable but complete penetration of preservative is not always obtained.
Seasoning	It is moderately refractory wood to seasoning.
Wood color	The wood is light grey or yellowish; sapwood and heartwood has no clear separation and hard and coarse-grained.
Porous	Wood is diffuse porous; pores are few, large and mostly solitary.

8. Uses:

Timber	Timber is used in house building, packing cases, ploughs etc.
Fuel wood	Wood is used for fuel and charcoal.
Fodder	Leaves are used for fodder; contain (8.6-17.2) % crude protein.
Tannin	Leaves have fairly high tannin content (6.4)%, fruits are also source of tannin, the bark contains (1.4-7)% tannin.
Ecological value	Leaves can be fed to the *tasar* silkworm.
Medicinal value	Fruits are used in ayurvedic medicine, especially to cure coughs. Pulp of fruit is used in the leprosy, piles, diarrhoea and dropsy.
Paper & pulp	The wood is in the mixture of other hardwood is suitable for the manufacture of chemical pulps for writing, printing and wrapping papers.
Others	The non edible from the kernels can be used in the manufacture of soaps. Seeds contain protein, from which adhesive can be developed. Fruits can be used in the preparation of oxalic acid and ink-making.

9. Agroforestry application and silvicultural system is same as Harro.

10. Royalty rate: NRs. 100.00 per cft. for air dry wood (Forest Rules, 1995).

11. Market price: NRs. 120.00 per cft for round timber and NRs. 220.00 per cft for sawn timber at Siraha district, Nepal (Parajuli et al., 1997).

12. Conservation status: Same as Harro.

(33)

Local name: Harro	
Terminalia chebula	**Family: Combretaceae**

1. Natural occurrence:

It occurs between tropical and subtropical forest up to 1100m. It occurs in deciduous and semi deciduous forests of Terai, Bhabar and Duns. According to Champion and Seth (1968), it is found in tropical moist mixed deciduous forests.

2. Morphological characteristics:

Leaf	Leaves are ovate or elliptical with a pair of large glands at the top of petiole. New leaf appears in April.
Flower	Flowers are yellowish white in terminal spikes. Flowers appear during April-June.
Fruit	Fruits are 1" long, ovoid ellipsoidal or globose, grey vulvety. Fruiting: Jan-March.
Seed	Nut has thick walled and hard.
Bark	Bark is dark brown.

3. Silvicultural characteristics

Light	It is a light demander but seedlings can withstand shade in the beginning**.**
Frost	It is fairly frost hardy.
Drought	It is a drought resistant to a considerable extent.
Fire	Fire tolerant and recovers well after burning.
Soil	It is found on a variety of geological formations and grows on clayey as well as sandy soils. It requires a good moisture supply, or deep sandy soils with good sub-soil drainage.
Coppice	It coppices fairly well, but pollards badly, does not produce root suckers.
Associates	It is associated with *Shorea robusta* forest or with other species of *Terminalias.*
Browsing	Sensitive. Seedlings are heavily damaged by browsing.
Tree nature	A medium to large sized handsome & deciduous tree.
Meteor. Cond^{n}	In its natural habitat absolute **Max.temp** (36-47.5)^{0} C, Absolute **Min- temp**. (0-15.5)^{0} C, **normal Annual Rainfall** (75-330cm).

4. Natural regeneration:

Seed prod^{n}	Fruit ripens between November and March.
Seed dispersal	Seeds are dispersed by wind, partly by water.
Seed germ^{n}	Seeds need moist alluvial ground for germination. If seeds fall on thick cover of dead leaves or dense weed growth, germination is hampered. Loose alluvial soil is good for its germination.

5. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump planting.
Seed collect^{n} time		Fruits ripen between November and February. Seeds are collected from the tree not from the ground.
No. of seed kg^{-1}		140-220 fruits kg^{-1}. 540 clean dry seeds kg-^{1} after pulp removing.
Seed extraction		Pulp should be removed.
Seed storage		Orthodox seed dry thoroughly in the sun.
Viability of seed		Seeds stored for 1-2 years, germinates better than fresh seeds.
Seed treatment		Soak the seed in water for 48 hours.
Seed sowing time		February- March for monsoon planting.
Germination (%)		86-100%, germination is hypogeal.
Nursery Period	**Seedling**	Three to five months for monsoon planting
	Stump	One-year-old seedling is required for stump.
Best planting size		20-30 cm tall seedlings with 5-10mm root collar diameter.

6. Diseases, Pests and Parasites of Harro:

Terminalia chebula does not suffer from any serious pests. Few pests have been recorded on the species, but none of them cause any appreciable damage. Among them *Ascortis infixaria, Hyblaea puera , Asura dharma* are important pests.

7. Wood properties:

Weight	It weighs about 920 kgm^{-3}.
Hardness	It is moderately hard to hard wood.
Working Quality	The wood is difficult to saw especially when dry. It is also difficult to work and finishes to hard.Timber polishes well, fibres are slightly twisted.
Strength	Timber is strong and moderately tough.
Calorific value	The calorific value of wood is 3967 calories.
Durability	The timber is moderately durable under cover.
Preservative Treatment	The timber is treatable but complete penetration of preservative is not always obtained. If the timber is treated with a preservative, it will be an extremely useful wood for many purposes.
Seasoning	Timber is highly refractory, difficult to season so should be dried slowly & evenly.
Porous	Wood is diffuse porous, growth ring is indistinct, porous small & moderate size.

8. Uses:

Timber	Timber is not much value and is chiefly used in construction, agricultural implements, furnitures, carts, good quality tool handles etc.
Fuel wood	The tree possesses a poor fuel wood.
Fodder	The leaves are a medium quality fodder, with 10.8-14.3 % crude protein.
Edible food	Fruit is a favourate food for monkeys, deer, sheeps, goat and cattle and kernel is edible and gives an oil which is used for the hair.
Tannin	The dry fruit surrounding the seed is rich in tannin (Average, 30-32%).
Gum & resin	Tree yields a gum which is used for either medicinal purposes or to dyers for mixing with other colors.

Medicinal value	The friuits are credited with laxative, stomachic, tonic and alterative properties. In combination with *Emblica officinalis,Terminalia chebula, and Terminalia belerica*, the *Triphala churna* is prepared which is an ayurvedic medicine, uses in almost all diseases. When coarsely powdered and smoked in a pipe, the fruit affords relief in asthma.
Other	Both myrobalans and the purified tannic acid prepared from them are widely used in ink -making.

9. Agroforestry applications:

The tree can be grown in taungya plantation with agricultural crops. (Hocking, 1999)

10. Silvicultural systems: In mixed Sal forests, it is worked under selection system.

11. Royalty rate: NRs 100.00 per cft for air dry wood (Forest Rules, 1995).

12. Market price: NRs. 120.00 per cft for round timber and NRs. 220.00 per cft for sawn timber at Siraha district, Nepal (Parajuli et al. 1997)

13. Conservation status: It is a scarce but HMG/N is not regarded as rare, endangered or threatened species though its population is severely depleted by continuous habitat loss, poor regeneration, over use and lack of scientific mgt. of this species. (Parajuli et al. 1997)

(34)

Local name: Saj	**Eng. name: Indian Laurel**
Terminalia tomentosa	**Family: Combretaceae**

1. Natural occurrence:

It occurs between tropical and subtropical forest up to 1400m. It is found in tropical moist deciduous and tropical dry deciduous forests and several types of forests.

2. Morphological characteristics:

Leaf	Leaves are elliptic or ovate. New leaves appear during May-June.
Flower	Flowers are dull yellow in terminal and axillary panicles. Flowers: May -June.
Fruit	Fruits are up to 5cm long with 5 broad, coriaceous. Fruiting during Feb.- April.
Bark	Bark is grey to black, with deep longitudinal fissures and transverse cracks.

3. Silvicultural characteristics:

Light	Light demander but it is rapidly suppressed under shade.
Frost	Frost hardy.
Drought	Drought hardy.
Fire	It is fairly tolerant to fire damage.
Soil	It grows best on deep rich alluvial soil, and avoids sandy soils. It tolerate stiff clayey soil, and is found on the edges of swamp, where it can withstand of good deal of water logging.It is fond naturally on soils of pH ranging up to 8.4.
Coppice	It coppices well up to 40cm in diameter, but above this size coppicing ability reduces. It pollards well and produces root suckers.
Associates	It is a common associate of sal.

Browsing	It is palatable spp & considerable damage to seedling by cattle, deer and pigs.
Tree nature	It is a large deciduous, straight stemed tree, with spreading branches and heavy crown, attaining a height of 32m or more.
Meteor. cond^{n}	**Absolute max. Temp.** (35-48.8) ^{0}C, **absolute min.temp**: (0-15.5) ^{0}C, annual **rainfall** (75 to 380)cm.
Other	It has deep tap root system. A good nurse for young Sal in forestry localities.

4. Natural regeneration:

Seed prod^{n}	Fruits ripen between February- April
Seed dispersal	Seed dispersal takes place by wind partly by water.
Seed germ^{n}	Germination and establishment of seed need full overhead light.
Coppice	Natural regeneration may occur from coppice shoots.

5. Artificial regeneration:

Preferred Propag^{n}		Direct sowing, entire planting, stump planting.
Seed collect^{n} time		Fruits ripen between February-April.
No. of Seed Kg^{-1}		400-700 fruits kg^{-1}.
Seed Storage		Orthodox seed dry thoroughly in the sun.
Viability of Seed		1 year.
Seed treatment		It is not required.
Seed Sowing Time		March-April.
Duration of Germ^{n}		Germination completes within 25 days.
Germination (%)		40-70%, germination is epigeal.
Nursery Period	**Seedlings**	3-4 month for polypot seedlings.
	Stump	12-15 month for stump.

6. Diseases, Pests and Parasites of Saj:

The species suffer from the fungi such as **i). White spongy rot**, **ii). White butt rot:** caused by *Fomes melanoporus* **iii). Spongy root and butt rot:** *Ganoderma lucidum*, and **iv). White stub rot**. Saj also suffers from the attack of some defoliators but the damage is rarely serious for ex. *Dasychira mendosa*.

7. Wood properties:

Weight	Wood is heavy from 800-1100 kgm^{-3} and specific gravity is 0.707-0.94
Hardness	It is very hard wood.
Working quality	The working quality of laurel vary considerable due to variation in weight and structure. Normal straight grained wood is easy to saw and can be worked to a good finish.
Strength	It is a good strong tough wood suitable for most constructional purposes.
Calorific value	21,000 KJkg^{-1}.
Durability	Timber is fairly durable under cover and moderately in exposed conditions.
Seasoning	Wood is highly refractory i.e., season well, but liable to split.
Wood color	**Sapwood** creamy white and **heartwood** dull light brown or reddish or dark brown.

8. Uses:

Timber	It is very widely used for buildings, beams, joints, doors and windows frame.

	Use for construction of carts, agricultural implements, suitable for plywood, furniture paraquet, match splints, railway slippers. Timber is used as suitable for telegraphic or electric poles after treatments. It is suitable for fire proof buildings as it is considerable natural resistance to fire.
Fuel wood	It is an excellent fuel wood and makes a good charcoal.
Fodder	It is a good fodder tree, **crude protein content:** 4 to 14% digestibility coefficient of protein is nil, so leaves are equivalent to straw or hay.
Edible food	The exhausted bark can be used to obtaining oxailc acid in a high yield(14%).
Tannin	Bark is much used for tanning and also used for dyeing. Bark contains tannin as high as 18.7% its extract can also be used as cheap dye for dyeing cotton, wool, silk and jute fabrics, also dyeing pulp and paper.
Gum & resin	The tree exudes a gel like fluid which dries up to light yellow to amber-colored gum, used as purgative and as an adhesive.
Ecological Value	Leaves are much used for feeding for tasar silkworm so, the trees are extensively pollarded.
Medicinal Value	The bark is bitter and styptic and has diuretic and cardiotonic properties. The decoction of bark is taken internally in atonic diarrhoea.
Other	Laurel can be uitilized for making unbleached sulphate pulps for production of wrapping paper and for bleached sulphate pulps for production of writing and printing papers.

9. Agroforestry application: The tree has a deep root system so it is suitable to grow with agricultural crop. (Hocking,1993).

10. Silvicultural system: It is worked as accessory species to the more valuable species, sometimes it is raised in pure plantations. It is worked under some form of selection, or shelterwood or coppice system, at some places under clearfelling system.

11. Royalty rate: NRs. 100/cu.ft. for round logs at the stump site. (Forest rules, 1995).

12. Market price: NRs. 175-200/cu.ft. for round timber and NRs. 350-390/cu.ft. for sawn timber at the major urban centers in the Terai of Nepal. (Parajuli *et. al*., 1997).

13. Conservation status: It is endangered plant species in many parts of Nepal due to continuous habitat degradation and other deforestation activities. (Parajuli *et. al*., 1997).

(35)

Local name: Bayer	
Zizyphus jujuba	**Family: Rhemnaceae**

1. Natural occurrence: It is found in the Terai, the lower hills, and Duns and near pokhara up to about 1200m.

2. Morphological characteristics:

Leaf	Leaves are ovate to oblong-oval or nearly lanceolate, spines are usually two, one of them mostly recurved.
Flower	Flowers are small, yellow or green, usually in the short clusters in the leaf axils.
Fruit	Fruits drupe, oblong to ovoid or sub-globose & fleshy, yellow or red when ripen.

Seed	Stones.

3. Silvicultural characteristics:

Light	Strong Light demander.
Frost	Frost hardy.
Drought	Drought resistant.
Fire	It recovers well after fire.
Soil	It grows on a wide range of soils, and will tolerate moderately saline soils.
Coppice	It coppices and pollards well and produces-root sucker.
Associates	It is often associated with sal forest.
Browsing	Browsing sensitive. Goats browse the young leaves.
Tree nature	It is a medium sized or even large bush, deciduous tree, found in both cultivated and naturalized forest land.

4. Artificial regeneration:

Preferred Propagation		Direct sowing, entire palnting, stump planting, root-cutting, budding, ring-grafting.
Seed collection		Fruits ripen between December and March.
No. of seed kg^{-1}		1000-2500 cleaned dry stones kg^{-1}.Each stone contains two seeds.
Seed extraction		Seed shoud be extracted from the stone.
Seed storage		Orthodox seed. Seed should be stored in sealed container.
Viability of seed		The cleaned stone can be stored for up to five years in sealed container, though during this period viability drops from 95- 30%.
Seed treatment		Either stratification of seed in sand for 60-90 days at 5^0C or scarification of seed from the stone and treatment with sulphuric acid.
Seed sowing time		Seeds are sown during April or May.
Germination (%)		To store the seed for four months to let it after-ripen improves the germination. 95% when fresh seed down to 30% at 5 years when stored in tins.
Nursery Period	**Seedling**	Seedling requires 15 months in the nursery.
	Stump	Stump can be prepared from 15-months seedling.
Best planting size		20-30 cm tall seedling.

5. Wood properties:

Hardness	Wood is hard.
Weight	It weighs about 930 kgm^{-3}.Wood is heavy.
Elasticity	Wood is elastic.

6. Uses:

Timber	Heartwood of old trees are used for the manufacture of combs and turnery.
Fuel wood	It is a good fuel wood and makes excellent charcoal.
Fodder	Leaves are used as fodder. Leaves contain 12.6 to 16.9% crude protein.
Edible food	Fruit is edible and has a high content of vitamins C.
Tannin	Fruit contains 10% tannin. Bark contains 7% tannin.
Medicinal value	Leaves are laxative and prescribed in scabies and throat troubles.Seeds are edible and frequent eating of kernels increase the flesh and strength.
Others	It is grown as a hedge for fencing.

CHAPTER: III

TREE SPECIES OF MID - HILLS

(1)

L.N: Phirphire	E.N: Himalayan maples
Acer oblongum	Family: Aceraceae

1. Natural occurrence: It is found in the outer Himalayas in ravines and moist valleys, and along stream banks on well-drained soil. In Nepal, it occurs between 1200 and 2400m.

2. Morphological characteristics:

Leaf	Leaves are simple, oblong or lance shaped and the rounded leaf base has three veins.
Flower	The flowers, which appear with the young leaves in the March-April, are small petals in the whorls of five. Flowers are borne in the bunches at the ends of leaf bearing branchlets.
Seed	The nuts are smooth and angular and very easy to recognize as they have two divergent wings.
Bark	Bark is grey, smooth with vertical wrinkles.

3. Silvicultural characteristics:

Light	Light demander
Frost	Frost hardy.
Soil	Good drainage and porous soil is requiring for the best growth.
Coppice	It coppices well.
Associates	It is often associated with S*chima-Castanopsis* forest.
Browsing	Since leaves are palatable and nutritious, browsing causes severely damaged.
Tree nature	It is a medium-sized evergreen tree.
Others	The trunk is often buttressed at the base.

4. Artificial regeneration:

Preferred propag^{n}	Seedlings.
Seed collect^{n} time	December-April.
No. of seed kg^{-1}	21,000 cleaned seeds kg^{-1}.
Seed extraction	Collected twigs with seed are spread in the sun to dry and separated by beating gently with a stick.
Seed storage	Orthodox seed. Seed should be dried thoroughly in the sun.
Viability of seed	Seeds remain viable for a very short time (up to 6 months). Sow seeds soon after collection.
Seed treatment	None.
Seed sowing time	March-April.
Nursery period	**Seedling:** 15 months.

Best planting size	20-30cm tall with 3-5mm root collar diameter.

5. Diseases of Phiphire:

The tree is susceptible to various diseases: **i). White sap rot:** is caused by *Trametes lactinea* **ii).** Several borers and defoliators also attack the tree.

6. Wood properties:

Wood color	The wood is white, turning pale greyish brown with age.
Hardness	Wood is moderately soft.
Working quality	It is easy to saw and work both by hand and on by machine, finishes well and takes a good polish.
Weight	Wood is moderately heavy. It weighs about 720 kgm^{-3}.
Strength	Wood is not very strong.
Durability	Timber is not durable in open but it is fairly so under cover.
Seasoning	Timber season's well. It can be kiln-seasoned easily.

7. Uses:

Timber	The wood is used for making drinking cups and agricultural implements.
Fuel wood	It is comparatively a good fuel wood.
Fodder	A moderately good fodder tree.

(2)

Local name: Lekh pangre	**English name: Indian horse chest nut**
Aesculus indica	**Family: Hippocastanaceae**

1. Natural occurrence: It is found in the wet temperate forests of the western Himalayas, usually in moist depressions and ravines. It occurs between 1200 and 2700m but commonly found between 1900 and 2400m.

2. Morphological characteristics:

Leaf	Leaves are digitate, leaflets 5-9 oblanceolate or oblong.
Flower	White tinged with yellow and red in large thyroids panicles.
Fruit	Capsules are ovoid, rough outside, and leathery.
Seed	Seeds are 2-3, dark brown, smooth and shining.
Bark	Bark is grey when old, exfoliating upwards, in long and thin bands.

3. Silvicultural characteristics:

Light	Moderate light demander, require moist and shady place for its early development.
Frost	Moderate frost hardy.
Drought	Drought sensitive.
Soil	The tree is very handsome and generally found growing gregarious in rich, moist, deep, cool sites, and shady ravines. In dry and hot places, its growth is stunted.
Coppice	It coppices well up to a considerable size, and also produce root suckers.

Associates	It is characteristic of moist sites near streams in forest of *Pinus roxburghii* and *Quercus leucotricophora*.
Browsing	Since leaves are palatable and nutritious, browsing causes severely damaged.
Tree nature	It is a large deciduous tree with a short cylindrical bole and spreading crown, distributed in the Himalayas from Kashmir to west Nepal.
Meteoro. condition	In its natural habitat: absolute **Max. Temp**. 26-39^0 C, absolute **Min. Temp**. –4 to -12 ^{0}C or perhaps lower. Normal annual rainfall 100- 250cm or more.

4. Natural regeneration:

Seed production	The capsules open & seeds 35-44 kg^{-1} fall to the ground during Oct to Nov.
Seed dispersal	Seeds are dispersed by gravity into depression, as they are smooth & rough.
Seed germination	Seeds lying in moist & protected by leaves & debris germinate successfully in the spring and establish themselves. Seedlings also found in large no. in loose, moist soil among stones boulders, which hold up the seeds.

5. Artificial regeneration:

Preferred propag^n	Seedlings.
Seed collec^n time	**Far west:** January, **elsewhere:** September onwards.
No. of seed kg^{-1}	35-90 seeds kg^{-1}.one fruit contains one seed.
Seed extraction	Capsule segments are peeled off carefully by hand.
Seed storage	Recalcitrant seed. Do not allow the seed to dry out.
Viability of seed	It can be stored for 4-5 months if kept moist, cool and aerated.
Pre-sowing seed treatment	It requires moist cold stratification; this can be done by sowing immediately in autumn & allowing over-wintering or by storing in pits.
Seed sowing time	February -March, if stored over winter.
Durat^n of germin^n	Usually starts 3-4 weeks after sowing.
Nursery period/Seedling	**<2000m:** 4-6 months, **>2000m:** an extra 12 months are needed i.e., 16-18 months.

6. Wood properties:

Wood color	Wood is of a cream color.
Hardness	Wood is soft.
Working quality	It is easy to saw and work well.
Weight	Wood is moderately heavy, it weighs about 500kgm^{-3}.

7. Uses:

Timber	Wood is turned into cups, dishes and plates that are used to hold milk, ghee etc. by local people.
Fuel wood	It is comparatively a good fuel wood.
Fodder	It is not very high quality fodder.
Edible food	The fruit is fed to cattle and goats and local people eat embryo.

(3)

Local name: Utis	**English name: Alder**
Alnus nepalensis	**Family: Betulaceae**

1. Natural occurrence: It occurs between 500-2700m, mostly above 900m.At lower altitudes; it prefers moist sites and shady aspects. According to Champion and Seth (1968) it occurs in Himalayan moist temperate forest.

2. Morphological characteristics:

Leaf	Leaves are alternate, elliptical with prominent parallel veins.
Flower	Flowers are in male and female catkins. **Male catkins:** long and pendulous, **Female catkins:** short and rigid.
Fruit	Fruit is a small woody cone.
Seed	Seed is very small and winged.
Bark	Bark is silvery grey with horizontally pattern of raised swellings.

3. Silvicultural characteristics:

Light	Light demander. It is a pioneer species, which grows well in full sunlight.
Frost	It is a moderate frost hardy, young seedlings are often defoliated by frost and very often killed.
Drought	In its natural habitat, the drought seldom occurs.
Fire	It is a fire resistant species, as it contains large amount of water, and found in moist sites.
Soil	It grows well on soils with high water content, but not in water–logged areas; common near river and stream; does not need high fertility; grow well in landslips, gully and open areas.
Coppice	Coppicing ability is severely affected with provenance and time of cutting.
Associates	Mostly pure forest but sometime it may be found in *Schima-castanopsis* forest.
Grazing & browsing	Seedlings are liable to damage by browsing. It is a relatively immune from browsing above 50cm height.
Tree nature	It is a large deciduous tree of Himalayas; tree having a sparsely branched with a straight cylindrical bole.
Other	It performs symbiotic relationship with *frankia*, an actinomycetes which forms root nodules to fix atmospheric N_2.

4. Natural regeneration: It takes place through seeds. Seeds are dispersed by winds.

5. Artificial regeneration:

Preferred propag^{n}	Direct planting, entire planting and bare-root planting.
Seed collect^{n} time	November-April.
No. of seed kg^{-1}	400,000-23,00,000 seeds kg^{-1}; one tree yields at least 1 kg of fruits; about 8 kg of fruits give 1 kg of seed.
Seed extraction	Catkins are dried in the sun and shaken. The extracted seed is winnowed to clean out dust and chaff.
Seed storage method	Orthodox seed; seeds are thoroughly dried in the sun, and then put in polythene bag with seal- tight.
Viability of seed	Unstored seeds remain viable for only a few months while stored seed can remain viable for more than one year.
Seed treatment	None
Seed sowing time	**<15000m:** March, **15000-2000m:** September, **2000-2500m:** August, **>2500m:** frost is an increasing hazard.

Durat^{n} of germi^{n}	Germination starts 1-2 weeks after sowing, & completes 2 weeks later.
Nursery period/Seedling	Seedlings remain in nursery bed until July. **<1500m:** 4 months, **>1500m:** 11 months.
Best planting size	25-30cm tall, root collar diameter is 3-4 mm.

6. Forest pathogens:

Alder is attacked by defoliators, one of them are *Oreina spp* (Chrysomelidae). The larva of a cossid moth, *Zeuzera spp*, is a stem borer, which attack on this tree.

7. Wood properties:

Wood color	**Sapwood** is white and **heartwood** is reddish brown when fresh; turns to light brownish grey on exposure.
Working quality	It is easy to saw and work.
Weight	Wood is light 320-370 kgm^{-3}.
Calorific value	Relatively low calorific value 18,230 $kJkg^{-1}$.
Durability	Wood is moderately durable.
Seasoning	Non-refractory wood to seasoning, it seasons well.

8. Uses:

Timber	It is a medium quality timber, used for simple construction, furniture etc.
Fuel wood	It is not a good fuel wood species in respect of calorific value but it dries rapidly and burns easily.
Fodder	Mature leaves are eaten by sheep and goats but not by cattle.
Tannin	Bark contains 7% tannin.
Ecological value	It is a shade tree for cardamoms. Direct sowing of seed is done for stabilizing landslips, moist ravines and roadsides. Tree is used for anti-erosion work.
Paper and pulp	Wood yields 39% pulp suitable for newsprint and for ordinary wrapping and writing a paper.

(4)

Local name: Seto Chuletro	
Brassaiopsis hainla	**Family: Araliaceae**

(1). Natural occurence: 800-1800m. **(2). Silvicultural characters: Tree Nature:** A small evergreen tree. **Light:** Light demander. **Frost:** Moderately frost resistant. **(3). Artificial regeneration: Method of propagation:** From seed, hardwood cutting. **No. of seed/kg: 25,000 to 35,000. Time of seed collection:** June to July. **Seed nature:** Recalcitrant seed. **Seed treatment:** Flesh must be removed. **Sowing season:** May or June, immediately after collection. **Germination (%):** 80% from fresh seed **Duration of germination:** 3-4 weeks. **Crude protein content:** 22%. It is a good quality fodder tree.

(5)

Local name: Kalo chuletro	
Brassaiopsis glomerulata	**Family: Araliaceae**

(1). Natural occurence: 1200-2000m grow at higher altitude than B.hanila.**(2). Silvicultural characters: Tree Nature:** A small evergreen tree. **Light:** Light demander. **Frost:** Moderately frost resistant.**(3). Artificial regeneration: Method of propagation:** From seed, hard-wood cutting. **Time of seed collection:** April. **Seed nature:** Recalcitrant seed. **Seed treatment:** Flesh must be removed. **Sowing season:** April-June, immediately after collection. **Germination (%):** 80% from fresh seed **Duration of germination:** Starts 2-3 weeks and continue for 3-4 weeks.

(6)

Local name: Gayo	
Bridelia retusa	**Family: Euphorbiaceae**

1. Natural occurrence: It occurs up to 1200m in Nepal.

2. Morphological characteristics:

Leaf	Leaves are rigidly coriaceous, lanceolate or ovate lanceolate, acute or acuminate.
Flower	Flowers are unisexual, small, and yellow in clusters on long, terminal or axillary paniculate spikes.
Fruit	Drupes which are globose fleshy, purple-black.
Seed	1-2 seeded.
Bark	Bark is grey or brown, exfoliating in irregular flakes.

3. Silvicultural characteristics:

Light	It will withstand moderate shade.
Frost	**Seedlings:** frost tender, **mature trees:** frost hardy.
Drought	Moderately drought resistant
Soil	It is capable of surviving on dry shallow soil.
Coppice	It coppices well and produces root suckers.
Associate	It is common associate of *Shorea robusta* forest.
Graze & browse	Trees are lopped for fodder, since leaves are palatable; it is severely browsed by cattle.
Tree nature	It is a shrub or medium to large deciduous tree. Young stems often with stout blunt thorns.

4. Natural regeneration: It takes place through seeds, which are dispersed by birds.

5. Artificial regeneration:

Preferred propaga^{n}	Seedlings.
Seed collec^{n} time	Fruits ripen between November and March.
No. of seed kg^{-1}	10,000 to 18,000 seeds kg^{-1}. Each fruit contains 1 or 2 bony seeds.
Seed extraction	Pulp should be removed from the seeds before they are sown.
Viability of seed	Viability of seeds is rather short, about six months.
Seed treatment	Seed should be soaked in water for 24 hours.
Germinat^{n} percent	75% from fresh seed.

6. Wood properties:

Wood color	**Sapwood:** greyish white to grey, **heartwood:** grey or olive brown.
Hardness	Wood is moderately hard.

Working quality	It is easy to saw and work well. It takes a good polish.
Weight	Wood is moderately heavy; weight is 830 kgm^{-3}.
Durability	Timber is fairly durable.
Seasoning	Non-refractory wood to seasoning, it seasons without serious defects. The logs require conversion immediately after felling and are stacked open piles under cover. After proper seasoning and preservative treatment; it can be substitute for Sal and teak.

7. Uses:

Timber	It is used for making carts, cart shafts, wheels and agricultural implements, and other tool handles.
Fuel wood	It is comparatively a good fuel wood.
Fodder	Leaves are a good cattle feed. Leaves contain 14-18% crude protein.
Edible food	Fruits are edible.
Tannin	Bark contains 16-40% tannin.
Medicinal value	Bark is a valuable astringent and is used in rheumatism.

(7)

L.N: Bhimsen pati	**E.N: White butterfly bush**
Buddleja asiatica	**Family: *Buddlejaceae***

1. Natural occurrence: It occurs in Nepal between 350 and 2000m. It is mostly distributed in tropical and sub-tropical regions.

2. Morphological characteristics:

Leaf	Leaves are opposite, lanceolate, oblong or acuminate.
Flower	Flowers are white, fragrant, in erect or drooping terminal panicle spikes.
Fruit	Fruits are ellipsoid.

3. Silvicultural characteristics:

Light	Light demander.
Frost	**Seedlings:** frost tender, **Older trees:** frost hardy.
Soil	They are mostly vigorous growers, easily cultivated under suitable conditions in any goods soils and in full sunshine.
Coppice	It coppices well.
Associates	At its lower range, it is an under storey of sal and at higher range, it is an under storey of pine forests.
Grazing & browse	Trees are lopped for fodder, since leaves are palatable; it is severely browsed by cattle.
Tree nature	It is a large sized evergreen tree. It is common on wasteland.

4. Artificial regeneration:

Preferred propag^{n}	Seedlings, stem cuttings.
Sed collect^{n} time	**Fruiting:** April, **fruit ripening:** end of May.
No. of seed kg^{-1}	Seeds are very minute. Twenty million seeds kg^{-1}.
Seed storage	Orthodox seed; seed should be dried thoroughly in the sun.
Viability of seed	Viability of seed retains for at least one year.

Nursery period/Seedling	**At lower altitudes**: about four months. **At higher altitude:** an extra 12 months are needed.
Best planting size	20-30cm tall planting stocks.

5. Wood properties:

Hardness	Wood is tough and moderately hard.
Weight	Wood weighs about 44 lbs per cu.ft.

6. Uses:

Timber	Wood of branches makes good walking sticks.
Fuel wood	It is comparatively a good fuel wood.
Fodder	It is a medium quality fodder. Leaves contain about 20% crude protein.
Edible food	Flowers and seeds are edible.
Ecological value	Plant is grown as an ornamental hedge and also suitable for growing on landslips.
Medicinal value	A concentrated infusion of the roots uses as the treatment of Malaria.
Others	The dried and powdered root is used by local people for the preparation of fermented liquor. Leaves are used as detergent on account of the presence of saponian.

(8)

Local Name: Patle katus	
Castanopsis hystrix	**Family: Fagaceae**

1. Natural occurrence: It grows between 1000-2500m.It is commonly found in east of Sun-koshi river and absent in the Far West. It is common in east and central Nepal. According to Champion and Seth it occurs in east Himalayan sub-tropical hill forest.

2. Morphological characteristics:

Leaf	Leaves are lanceolate or narrowly elliptic.
Flower	**Male spikes:** numerous, **female spikes:** few.
Fruit	A spiny capsule
Seed	A smooth coated nut, nuts are 2-3.
Bark	Bark is grey or cinnamon brown. Young shoots are covered with hairs.

3. Silvicultural characteristics:

Light	Moderately light demander.
Frost	Frost hardy.
Soil	Tree is often found on light soil, on a warm aspect and where the under growth is light.
Coppice	It coppices well.
Associates	It grows together with *Castanopsis tribuloides, Quercus lamellosa* and species of Lauracae family.
Browsing	Browsing sensitive, liable to damage from browsing.
Tree nature	It is a large evergreen tree of mid-hills.

4. Natural regeneration:

Seed production	A good seed year occurs once in three years.
Seed dispersal	Seed is dispersed by wind.
Seed germinat^{n}	Seed germinates well in rich, dark forest soil.

5. Artificial regeneration:

Preferred propagat^{n}		Entire planting (i.e. difficult due to long tap root), direct sowing stump planting, (i.e. are generally preferred).
Time of seed collect^{n}		Seeds are collected between Oct-Nov; fruits are collected immediately after they fall to prevent insect attack.
No. of seed kg^{-1}		600 nuts per kg^{-1}.
Seed extraction		Capsules are opened by hand.
Seed storage		Recalcitrant seed. Seed should not allow drying.
Viability of seed		Seed remains viable for a few months if stored moist, cool and aerated.
Seed treatment		Soak nuts in water for 24 hours before sowing, remove any that float.
Seed sowing time		Seeds are soaked in nursery beds immediately after collection.
Durat^{n} of germinat^{n}		Germination starts about four week after spring sowing and continues for another 3-4 weeks. If sown in autumn, germinates early in spring, 3-5 month later.
Germination (%)		Germination is 70-90%, germination is hypogeal.
Nursery Period	**Seedling**	**<1800m,** 15-16 month requires after spring sowing, **>1800m,** another year will be necessary.
	stump	Stump made from one-year-old seedlings.
Best planting size		Seedlings should be taller than 20cm.

6. Parasites of Patle Katus:

Viscum articulatum, Taxillus vestitus and *Macrosolen psilanthus* are important parasites on this tree.

7. Wood properties:

Wood color	Timber is light greyish-brown.
Hardness	Its wood is hard.
Working quality	It is easy to saw and work, and finish to a good surface.
Weight	Its timber is light to moderately heavy. Its wood weighs about 740kgm^{-3}.
Strength	Timber is moderately strong.
Calorific value	Calorific value of completely dried wood is 4,842 calories.
Durability	Its wood is durable.
Preservative treat.	Heartwood is easy to treat but complete penetration is not always obtained.
Seasoning	Non-refractory wood to seasoning.

8. Uses:

Timber	Timber is suitable for construction work, railway slipper after creosote treatment, cheap furniture.
Fuel wood	It is a good fuel wood species.
Fodder	Leaves are of good fodder.
Edible food	Its nuts are edible.
Tannin	Bark and leaf contain (11-13%) and 12% tannin respectively.

(9)

Local name: Dhale katus	**E. N.: Indian or oak chestnut**
Castanopsis indica	**Family: Fagaceae**

1. Natural occurrence: It grows between 1200-2900m.It prefers high rainfall areas, common from Annapurna to eastern districts, as rainfall decreased it is decreased by *C.tribuloides.* According to Champion and Seth (1968), it occurs in east Himalayan sub-tropical wet hill forest.

2. Morphological characteristics:

Leaf	Leaves are elliptic-oblong or oblong-lanceolate, alternate, leathery.
Flower	Male and female flowers are in different spikes, flower appear in Sep.
Fruit	Nut enclosed in a capsule that is densely covered with prickles, fruit ripens between Oct-Dec.
Seed	A smooth coated nut, (1-3) nut per capsule.
Bark	Bark grey.

3. Silvicultural characteristics:

Light	Moderately light demander.
Frost	Frost hardy species.
Soil	It prefers deep fertile, well-drained, moist soil. It is sensitive to water logging.
Coppice	It coppices well.
Associates	It is a common associate of *Schima wallichii*.
Browsing	Browsing sensitive, liable to damage from browsing by cattle.
Tree nature	It is a moderate to large sized, evergreen tree, native to mid-hills

4. Natural regeneration:

It takes place from the seed**.** Seeds are dispersed by wind. Seed germinates well in rich dark forest soil.

5. Artificial regeneration:

Preferred propagat^{n}		Entire planting, direct sowing, stump planting.
Time of seed collect^{n}		Oct-Nov.
No. of seed kg^{-1}		1300 nutkg^{-1}.
Seed extraction		Capsules are opened by hand.
Seed storage		Recalcitrant seed; seed should not be allowed to dry.
Viability of seed		Seed remains viable for a few months if stored moist, cool and aerated.
Pre-sowing Seed treat.		Moist, cool stratification is needed; pit storage provides good stratification treatment.
Seed sowing time		Seeds are sown in nursery beds immediately after collection.
Durat^{n} of germinat^{n}		Germination starts about four weeks after spring sowing and continues for another 3-4 weeks. If sown in autumn, germinates early in spring, 3-5 month later.
Germinat^{n} percent		70-90%.
Nursery period	**Seedling**	**<1800m,** 15-16 month requires after spring sowing, **>1800m**, another year will be necessary.
	Stump	Stump made from one-year-old seedling.
Best planting size		Seedlings should be taller than 20cm.

6. Wood properties:

Wood color	**Sapwood:** yellowish white. **Heartwood:** greyish brown.
Hardness	Wood is moderately hard and rough.
Working quality	It is easy to saw and very easy to split.
Weight	Wood weighs about $700kg^{-3}$, is moderately heavy.
Seasoning	Moderately refractory wood to seasoning, timber seasons fairly well but liable to end splitting.
Grain &Texture	Wood has more or less irregularly, inter–locked grains and medium coarse textured.

7. Uses:

Timber	Wood is used for constructional work, paneling in railway compartments, handles of axes etc.
Fuel wood	It is a good fuel wood species.
Fodder	A good fodder having 15% crude protein and 29% crude fibre.
Edible food	Fruit is edible.
Tannin	Bark contains 6-12% tannin, leaves contains 10% tannin.
Medicinal value	Bark showed anti-cancer activities in mice. The extract of stem-bark and stem show anti-viral activity against *Ranikhet* disease virus. A paste of leaves is applied for headache.
Others	Leaves are used for wrapping *Bidis.*

(10)

L.N: Musure Katus	
Castanopsis tribuloides	**Family: Fagaceae**

1. Natural occurrence: It occurs throughout Nepal from altitudinal range of 450-2300m.It is only katus found in the far–west region.

2. Morphological characteristics:

Leaf	Leaves lanceolate, oblong or ovate-lanceolate.
Flower	**Male spikes:** paniculate or fascicled, **female spikes**: solitary.
Fruit	A spiny capsule.
Seed	Nuts are 1-3.
Bark	Bark is dark grey, corky outside.

3. Silvicultural characteristics:

Light	Moderately light demander.
Frost	**Young seedlings** are frost tender but **mature trees** are frost hardy
Soil	It grows on a variety of soil types; it needs less rainfall than *Castanopsis indica.*
Coppice	It coppices vigorously.
Associates	It often associates with *Schima wallichii* and *Quercus lamellosa.*
Browsing	Browsing sensitive, liable to damage from browsing by cattle.
Tree Nature	It is a moderate sized evergreen tree.

4. Natural regeneration:

Seed product^{n}	Good seed year occurs once in three year.
Seed dispersal	Seed is dispersed by wind.
Seed germ.	Seed germinates well in rich dark forest soil.

5. Artificial regeneration:

Note: Artificial regeneration of Musure Katus is same as Patle Katus except 400 nuts kg^{-1}.

6. Disease, Pests and Parasites of Musure Katus:

1). Young trees are liable to damage by the larva of a moth, *Zeuzera spp*.

2). The angiospermic parasites *Helixanthera ligustrina, Macrosolen psilanthus and Scurrula pulverulenta* are reported on this tree.

7. Wood properties:

Hardness	Wood is moderately hard.
Weight	Its wood weighs about 600 kgm^{-3}.
Durability	Wood is not much durable.

8. Uses:

Timber	Timber is suitable for construction work, railway sleepers after creosote treatment, cheap furniture etc.
Fuel wood	It is used as fuel wood, makes poor charcoal.
Fodder	Leaves are used as a fodder having (10-12%) crude protein.
Edible food	Nuts are used as food.
Tannin	Wood contains 16% tannin; bark contains 6-14% tannin.
Others	It is a multipurpose tree.

(11)

Local name: Bohori	
Cordia dichotoma	**Family: Cordiaceae**

(1). Natural occurence: 200 to 1500m. **(2). Silvicultural characters: Tree Nature:** Deciduous tree. **Light:** Moderate shade bearer**. Frost:** Frost tender. **Fire:** Fire tender. **Coppices:** Coppices and pollards well. **Soils:** Grows best on deep moist sandy loams. **(3). Artificial regeneration: Method of propagation: i).** Seed **ii).** Cutting. **iii).** Stumps. **No. of seed/kg:** 5000 to 8500 stones kg^{-1}**. Time of seed collection:** August to December. **Seed nature:** Orthodox seed. **Duration of germination:** 4-8 weeks. **Crude protein content:** 12-15%.

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(12)

Local name: Rakchan	
Daphniphyllum himalense	**Family: Cordiaceae**

(1). Natural occurence: 1400 to 2300m. **(2). Silvicultural characters: Light:** shade tolerant species**. Frost:** Frost hardy. **Coppice:** Coppices and pollards well. **Associates:** Associate with Oak and Lauraceae. **(3). Artificial regeneration: Method of propagation: i).** Seed **ii).** Hardwood cutting. **iii).** Layering. **No. of seed/kg:** 600 to 700 drupes kg^{-1}**. Time of seed collection:** August to December. **Seed treatment:** May be **i).** Mechanical scarification ii**).** Stratifying the seed in cold. **Seed nature:** Orthodox seed. **Germination (%):** Variable.

(13)

Local name: Phaledo	
Erythrina arborescence	**Family: Papilionaceae**

(1). Natural occurence: 1500-3000m. **(2). Silvicultural characters: Tree nature** deciduous tree**. Light:** Light demander. **Frost:** Frost hardy**. Coppice:** It coppices well. **Associates:** It is commonly associated with *Schima-Castanopsis* forest. **Soil:** Deep-fertile and well- drained soil. **(3). Artificial regeneration: Method of propagation: i).** Entire planting **ii).** Cuttings. **No. of seed/kg:** 2000 seeds kg^{-1}**. Viability of seed:** 5 years. **Time of seed collection:** April and June **Seed nature:** Orthodox seed. **Sowing season:** Spring season. **Germination (%):** 90%. **Duration of germination:** 3 weeks. **Crude protein content:** 17%.

Local name: Phaledo	
Erythrina stricta	**Family: Papilionaceae**

(1). Natural occurence: 1000-1600m. **(2). Silvicultural characters: Same as *E. Arborscence.***

(3). Artificial regeneration: Same as *E. arborscence* except seed collection time is Nov. to March.

Local name: Phaledo	
Erythrina suberosa	**Family: Papilionaceae**

(1). Natural occurence: 900-1200m. **(2). Silvicultural characters: Same as *E. arborscence.***
(3). Artificial regeneration: Same as *E. aborscence* except seed collection time is Nov. to March.

(14)

Local name: Thulo Jhingane	
Eurya acuminata	**Family: Theaceae**

(1). Natural occurence: 1300-2700m. **(2). Silvicultural characters: Tree nature** deciduous tree**. Light:** Light demander. **Frost:** Frost hardy**. Drought:** Drought hardy. **Associates:** It is commonly associated with *Eurya cerasifolia*.**Soil:** Grow on poor soil . **(3). Artificial regeneration: Method of propagation: i).** Entire planting **ii).** Direct sowing. **Time of seed collection:** Berries are collected between Nov.and Feb. **Viability of seed:** Short viability. **Sowing season:** Immediately after collection. **Crude protein content:** 7%.

Local name: Sano Jhingane	
Eurya cerasifolia	**Family: Theaceae**

(1). Natural occurence: 900 to 2300m. **(2). Silvicultural characters: Same as *E. acuminata*** except it is often associated with *E. acuminata.* **(3). Artificial regeneration: Same as *E. acuminata*** except time of seed (berries) collection is May and June. **Crude protein content:** Poor quality fodder.

(15)

Local name: Pipla

Exbucklandia populnea	**Family: Hamamelidaceae**

(1). Natural occurence: 1300-2100m. **(2). Silvicultural characters: Tree nature** Evergreen**. Light:** Shade bearer. **Frost:** Frost sensitive**. (3). Artificial regeneration: Method of propagation: I).** Entire planting **ii).** Direct sowing. **No. of seed/kg:** 200,000 seeds kg^{-1}**. Viability of seed:** 1 year. **Time of seed collection:** Dec-Jan. or March. **Seed nature:** Orthodox seed. **Sowing season:** April to May**. Germination (%):** 19% (Lab test in Nepal). **Duration of germination:** 2-4 week. **Crude protein content:** 17%.

(16)

Local name: Lankuri	
Fraxinus floribunda	**Family:Oleaceae**

1. Natural occurrence: It occurs throughout Nepal between 1200-2700m.

2. Morphological characteristics:

Leaf	Leaves are oppositely arranged, compound in 3-4 pairs and a terminal leaf. Edges of leaflets are finely toothed
Flower	The small white, scented flowers, which appear between March and April, are bone in bunches at ends of twigs.
Fruit	A samara.
Seed	Winged seed cannot be separated from the fruit.
Bark	**Young tree:** grey and smooth, **older tree:** rough and deeply fissured longitudinally with age.

3. Silviculture characteristics:

Light	It is a light demander species; seedling needs full over sunlight while older trees cannot tolerate some shade.
Frost	Seedlings are frost sensitive but mature trees are frost hardy.
Soil	Its growth is best on deep, moist soils, but it can tolerate difficult sites. In India, it is often associated with calcareous soil but in Nepal it is frequently found on non-calcareous soil.
Coppice	It coppices well.
Associates	It is often found in *Schima-Castanopsis* forests and also sometimes as an under storey to *Pinus roxburghii*.
Browsing	Trees are lopped for fodder. Since leaves are palatable, it is severely browsed by cattle.
Tree Nature	It is a deciduous tree of moderate to large sized with a rounded crown.

4. Natural regeneration:

Seed production	Seeds ripen in September-January.
Seed dispersal	Seeds are dispersed by wind.
Seed germination	Seeds remain dormant throughout the monsoon and germinate in the next monsoon.

5. Artificial regeneration:

Preferred propaga^{n}	Direct sowing, entire planting, cuttings.
Time of seed collection	September-January.
No. of seed kg^{-1}	60,000 samaras per kg.
Seed extraction	Keep green samaras in the shade and does not allow drying out.
Seed storage method	**Brown seed** is orthodox, put thoroughly dried seed in a polythene bag, seal tightly and keep in a cool place. **Green seed:** recalcitrants, do not dry in the sun, sow immediately after collection.
Viability of seed	**Brown seed:** remain for 3 years. **Green seed:** very short.
Seed treatment	**Brown seed**: Require a season of warmth followed by cold to overcome dormancy. **Green seed:** none.
Seed sowing time	**Brown seed:** February -March, **green seed:** September - October.
Duration of germination	**Green seed:** At lower altitude, starts in 2-4 weeks. At higher altitude, in the following March. Germination completes within 2 weeks.
Germination (%)	**Green seed:** Usually 70%.
Nursery period	**Seedling: <1500m:** 9-10 months for green seed**. >1500m**: 21-23 months.
Best planting size	20-30 cm tall with root collar diameter of 3mm or larger.

6. Wood properties:

Wood color	The wood is white with a light red tinge.
Hardness	It is hard and tough wood.
Working quality	It saws and works well; it takes a good polish.
Weight	Wood weighs about 770kgm^{-3}.

7. Uses:

Timber	Timber is used for oars, ploughs, and carrying poles.
Fuel wood	Wood is used as fuel.
Fodder	Leaves contain 7.5% crude protein content. A good quality fodder for cattle.
Medicinal value	Juice can be extracted from the stem, has laxative properties.

(17)

Local name: Puwanle	
Ilex excelsa	**Family: Aquifoliaceae**

(1). Natural occurrence: 600 to 2100m. **(2). Silvicultural characters: Tree nature** Medium sized evergreen tree**. (3). Artificial regeneration: Method of propagation: i).** Entire planting. **No. of seed/kg:** 70,000 seeds kg^{-1}**. Viability of seed:** 3 years. **Time of seed collection:** July and Sept.. **Seed nature:** Orthodox seed. **Seed treatment:** Seed mixes with sand and keep in cold place**. Sowing season:** April to May**. Crude protein content:** 10-11%.

(18)

Local name: Okhar	**English name: Walnut**
Juglans regia	**Family: Juglandaceae**

1. Natural occurrence: It occurs throughout Nepal from 1200-2500m. According to Champion and Seth (1968) it is found in moist temperate forest.

2.

3. Morphological characteristics:

Leaf	Leaves are alternate, imparipinnate, leaflets 5-13, sub-sessile, elliptic to oblong–lanceolate.
Flower	**Male flowers:** in long drooping catkins, **female flower:** single or two to three together at the end of young shoots.
Fruit	Fruit is a green drupe with leathery exocarp, endocarp hard, woody wrinkled.
Seed	A nut.
Bark	Bark is grey, longitudinally fissured.

3. Silvicultural characteristics:

Light	A light demander tree.
Frost	Frost hardy.
Soil	It occurs naturally on especially deep, moist, well-drained, boulders alluvium, near streams. It does not grow well on stiff, badly drained or acid soils.
Coppice	It coppices well.
Associates	Its associates: in **western:** *Quercus leucotricophora, Aesculus indica, Acer spp.*, in **eastern***: Quercus lamellosa.*
Browsing	Young seedlings are liable to damage by browsing.
Tree nature	It is a large deciduous and monoecious tree.
Others	It cannot tolerate strong wind.

4. Natural regeneration:

Seed product^{n}	Natural regeneration takes place on gentle slope with loose but deep, fairly moist soil.
Seed dispersal	Seed dispersal takes place by gravity.
Seed germination	Birds, monkeys and rodents destroy large quantities of seeds. A fair degree of warmth and soil moisture is necessary for germination.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, bare-root seedlings, stump planting.
Seed collection time	Seeds ripen between September and December.
No. of seed kg^{-1}	35-120 nuts kg^{-1}.
Seed extraction	Remove the flesh by hand.
Seed storage method	Recalcitrant seed; seed can be stored for a year or more, if kept moist, cool, and aerated.
Viability of seed	One year or more if properly stored.
Seed treatment	Requires moist cold stratification.
Seed sowing time	Seeds are sown either immediately after collection or in February after pits storage over winter.
Duration of germ^{n}	Spring-sown seed usually takes 1-2 months for germination.
Germination (%)	Germination is 70-80%, hypogeal.
Nursery period	**Seedling: <1500m:** 5-8 months, **>1500m:** another year will be

	required.

6. Forest pathogens: Leaf diseases are caused by *Erysiphe polygoni* and *Phyllactinia guttata.*

7. Wood properties:

Wood color	**Sapwood:** Broad, greyish white. **Heartwood:** Greyish brown in color.
Hardness	Wood is moderately hard.
Working quality	The wood is easy to saw and work. It finishes to a smooth shiny surface, takes a fine polish.
Weight	Wood weighs about 28-46 lb/cu ft.
Strength	It is a strong wood.
Durability	Walnut timber is durable under cover, but not so in exposed situations. It is resistant to white ants and fungus attack.
Preserva. treat.	It does not require any antiseptic preservative treatment.
Seasoning	Medium refractory wood to seasoning, wood seasons slowly and requires considerable attention.
Grain & texture	Wood is straight-grained, medium and even-textured.

8. Uses:

Timber	Timber is suitable for rifle parts and gunstocks. One of the best woods for furniture and carving gives extremely beautiful plywood and veneer, use in musical instrument.
Fuel wood	It is a very good fuel wood.
Fodder	The oil cake is rich in protein and is used as cattle feed. Twigs and leaves are lopped for fodder.
Edible food	Fruits are edible; it is also valued in confectionery and in ice creams. The kernel contains vitamin 'A' and ascorbic acid. The kernels yield 60 to 70 % of a drying oil, known as walnut oil, which is used for edible purposes.
Tannin	Green walnut nulls, shells, bark and leaves are used for dyeing and tanning.
Medicinal value	Leaves are rich in ascorbic acid, carotene and an olive brown volatile oil. Leaves and barks are used in eczema, herpes, scrofula and syphilis. Fruits are used as alterative in rheumatism. Aqueous extracts of fresh leaves possess strong bactericidal action against *Bacillus anthracis* and *Coryne-bacterium diphtheria*. Unripe fruit is used as fish poison. Green walnut shells are used as hair dye.

Local name: Jhingat, Hallongre	
Lannea coromandelica	**Family: Anacardiaceae**

(1). Natural occurence: Terai to 1400m. **(2). Silvicultural characters: Tree nature** Evergreen tree**. Light:** Strong light demander. **Frost:** Frost tender**. Fire:** fire resistant. **Coppice:** It coppices well. **Associates:** Associate with sal forest. **Soil:** Grow on sandy soils. **(3). Artificial regeneration: Method of propagation: i).** Hardwood cutting **ii)**.Seed. **No. of seed/kg:** 5500 to 10,000 seeds kg^{-1}**. Viability of seed:** 3 years. **Time of seed collection:** May and June. **Seed**

nature: Recalcitrant seed. **Sowing season:** Immediately after collection**. Germination (%):** 80-90%.

(20)

Local name: Bhusure, Ghurmiso	
Leucosceptrum canum	**Family: Labiatae**

(1). Natural occurence: 1000 to 2800m. **(2). Silvicultural characters: Tree nature:** Evergreen shrub or small tree**. Coppice:** Coppices freely. **Associates:** Under storey of *Schima-Castanopsis* forest. **Soil:** Moist shady ravines. **(3). Artificial regeneration: Method of propagation: i).**Hard wood cutting **ii)**. Seed. **Germination (%):** 80%. It is only used for fodder.

(21)

Local name: Champ	
Michelia champaca	**Family: Magnoliaceae**

1. Natural occurrence: It occurs between 600-1500m.

2. Morphological characteristics:

Leaf	Leaves are ovate to lanceoate, coriaceous.
Flower	Flowers are usually axillary, solitary, yellow or fragrant.
Fruit	Fruit is fleshy capsule that opens.
Seed	Seed is brown, angular, with pink fleshy aril.
Bark	Bark is grey or brownish.

3. Silvicultural characteristics:

Light	Moderately light demander, seedling and sapling will grow under high shade.
Frost	Frost hardy.
Drought	In its natural habitat, the drought seldom occurs.
Fire	Sensitive to fire.
Soil	Grow well in moist; well drained, deep and fertile soil .It does not stand water-logging.
Coppice	Coppice well; does not produce root suckers.
Associates	It is mostly found in *Schima-Castanopsis* forest.
Browsing	Young seedlings are liable to damage by browsing.
Tree nature	It is a very light, evergreen tree with a straight cylindrical bole.
Other	It is a very fast growing species. It produces numerous epicormic branches.

4. Natural regeneration:

Seed product^{n}	Seed production is obtained almost every year.
Seed dispersal	Seed dispersal takes place by wind.
Seed germination	Germination of seed is hampered as birds & rodents destroy much of seed.

5. Artificial regeneration:

Preferred propag^{n}	Entire planting, stump planting, direct sowing.
Seed collection time	Seed is collection between August-September.

No. of seed kg^{-1}	1000 seeds kg^{-1}.
Seed extraction	The collected fruits spread in the shade for 2-3 days until they open. Seeds are removed by gentle threshing.
Seed storage Method	Recalcitrant seed should not be dried in the sun; it should be kept in cool, moist and aerated place. It should be buried underground, putting in a fine wire mesh bag.
Viability of seed	Viability of seed is very short about two weeks.
Seed treatment	Arils must be removed.
Seed sowing time	Seed should be sown from Sep- Dec within a few days of collection.
Germination (%)	85% from fresh seed.
Nursery period	**Seedling: < 1000m**, 9-10 month. **>1000m**, a second year is necessary.
Best planting size	Seedling should be 30-40 cm tall.

6. Wood properties:

Wood color	Wood is yellowish to olive brown.
Hardness	It is a soft wood.
Working quality	The timber is easy to saw, works to a smooth surface and takes a good surface.
Weight	Lightwood, wood weighs about 460-660 kgm^{-3} at 12% moisture content, specific gravity is 0.53.
Calorific value	C.v of heartwood is 21,300 $KJkg^{-1}$.
Durability	Timber is not very durable.
Preservative treatment	Heartwood is refractory to treatment, side and end penetration of preservatives being practically nil, sapwood can be easily treated.

7. Uses:

Timber	Wood is used for posts, boards, veneers, furniture, decorative fitting, carving and shipbuilding.
Fuel wood	It is a good fuel wood.
Fodder	It is a good fodder species.
Edible food	Fruits are edible.
Tannin	Bark yields tannins. The flower yields a yellow dye used for dyeing textiles.
Eco. value	A variety of silkworms are rear on the tree.
Medicinal values	The seed contains 32.2% of fat, a resin and resin acids. The seed fat is used in the medicine. Fruits and seeds are useful for healing cracks in feet. Bark is stimulant, diuretic and febrifuge.
Others	Suitable for making pencils. Flowers are distilled to produce perfumes;

(22)

Local name: Rani salla	**E.N: Chir pine**
Pinus roxburghii	**Family: Pinaceae**

1. Natural occurrence: It occurs between 400-2000m altitudes. It grows up to 2700m in western Nepal.

2. Morphological characteristics:

Leaf	Leaves are in cluster of three, long, light green, needle shaped.
Flower	Flowers are conelets. **Male flower:** about 1.5cm long, arranged in the form of cones, **female flower:** female cone, solitary, woody,
Fruit	Fruits are woody cones, wings, membranous.
Seed	Winged seed.
Bark	Bark is dark grey, often reddish, deeply fissured, rough, and exfoliating in longitudinally elongated plates.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost hardy species**.**
Drought	Drought resistant.
Fire	It is fire hardy due to thick insulating bark, but damage from the fire is considerable since highly resinous tree found on dry, hot slopes/aspects.
Soil	It prefers well-drained, light–textured, warm, and dry southern aspects.
Coppice	It is a non coppicer.
Associates	Associates of **lower limit:** *Shorea robusta ,Gmelina ,Litsea, Bauhinia* and *Anogeissus spp.* Associate of **upper limit** ,*Pinus wallichiana ,Quercus incana ,Rhododendron arboreum ,Lyonia ovalifolia,*
Browsing	Cattle and sheep do not graze, since leaves are unpalatable to livestock.
Tree nature	It is a large, monoecious, evergreen, resiniferous tree .The chir is typically gregarious tree forming pure forests but it often occurs mixed with other species mainly at lower and upper limit.
Meteorological condit^{n}	In pure chirpine forest: absolute **Max. Temp** (32 to 38^{0}C), absolute **Min. Temp.** falls below freezing point, normal annual rainfall: (100-175cm).
Others	It can tolerate a wide range of soil pH. It has a massive root system and is more or less wind firm. Its root has a good symbiotic relationship with *Mycorrhiza.*

4. Natural regeneration:

Seed production	Seeds fall mostly from April to June. Certain amount of seed produces every year but good seed year occurs once in every 4-5 years.
Seed dispersal	Seed is dispersed by wind.
Seed germinat^{n}	Germination is best on bare ground such as abandoned cultivation or burnt areas. Germination commences at the beginning of the monsoon.
Establishment	Establishment of seedling is greatly influenced by light, drought, and topography, soil, under growth, fire, grazing and grass cutting.

5. Artificial regeneration:

Preferred propag^{n}	Seedling: direct sowing, entire planting.
Seed collect^{n} time	Seeds collect between January and March when the cones turn brown.
No. of seed kg^{-1}	8,000-12,300 sees kg^{-1}.100 cones yield about 450 gm of seed.
Seed extraction	The cone should spread on a tarpaulin in the sun until fully open,

	then knocked together to dislodge the seeds.
Seed storage	Orthodox seed. Dry the seeds thoroughly in the sun. Properly dried seed can be stored in sealed plastic bags for more than one year and store in a cool place.
Viability of seed	Viability of seed is more than one year if seed is properly dried.
Pre-sowing seed treatment	Generally it is not required, sometimes seed may soaked in cold water for 2-3 days before sowing.
Seed sowing time	**Nursery: <1000m** February-March, **>1000m:** August –September.
Duration of germina^{n}	Germination begins after 8-10 days, & is completed in another 10-20 days.
Germination (%)	Germination is usually obtained 70-90%.
Nursery period	**Seedling: <1000m:** 4-5 months, **1000-2000m:** 10-11 months.
Best planting size	20-30 cm tall seedling.

6. Forest pathogens: **Important diseases of Chir pine:**

i) Pine swertia felt rust: caused by *Cronartium himalayense*,

ii) Needle rust: caused by *Coleosporium campanulae.*

7. Wood properties:

Wood color	**Sapwood:** White to creamy white, **heartwood:** light red when first exposed, turning reddish brown with age.
Working quality	It is easy to saw and work by hand or by machine, though its resinous nature tends to clog saw teeth.
Weight	Wood is heavy; it weighs about 650 kg m^{-3}.
Strength	Its wood is somewhat weak.
Calorific value	C.v is about 21,200 $kJkg^{-1}$.
Durability	The timber is not very durable in exposed situations, but durable under cover.
Preserva. treat.	Wood requires preservative treatment.
Seasoning	Non- refractory wood to seasoning.

8. Uses:

Timber	It is used for constructional purposes, furniture, packing cases, electric transmission poles, and railway slipper after treatment.
Fuel wood	It burns rapidly and, a good fuel wood.
Edible food	The seeds are eaten by inhabitants of hilly areas.
Tannin	Bark contains 11-14% tannin.
Gum and resin	Turpentine is used in the pharmaceutical preparations, perfumery industry, and insecticide and also as solvent.
Medicinal value	The turpentine oil is valued in medicine, acts as an expectorant and is useful in chronic bronchitis.
Paper and pulp	The chirwood is suitable raw materials for making pulp and paper.
Industrial uses	Turpentine oil is one of the basic raw materials for the synthesis of terpene chemicals which are used in variety of industries such as adhesive, paints, soaps, cosmetics, etc.

Uses of Chirpine Rosin:

1). The rosin is obtained as solid residue in the distillation of the terpentine oil from the oleoresin.**2). The** yield of rosin is about 75% of the quantity of oleoresin distilled.**3).** The rosin is principally used in paper, soap, cosmetics, paint, varnish, and rubber and polish industries.**4).** It is used as an ingredient of printing inks, casein glues.**5).**It is used in the manufacture of fire works, match compositions, shell explosives, insecticides.**6).** Rosin is a source of rosin oil, rosin spirit, rosin pitch and abietic acid.

Uses of Pine needle oil: The young twigs and fresh needles yield a valuable essential oil, is known as pine needle oil which is used in the scenting of soaps, in both preparations, room sprays, deodorants and similar products.

(23)

L.N.: Gobre salla	**E.N: Blue pine**
Pinus wallichiana	**Pinaceae**

1. Natural occurrence: It occurs between 1800-3600m.

2. Morphological characteristics:

Leaf	Leaves are needle like in clusters of five, bluish green, persisting partly for 2-3 years.
Flower	**Male flowers:** catkins like, arranged in clusters, yellow to light brown. **Female flower:** solitary, cylindrical, light brown.
Fruit	Fruit is a long, soft deciduous cone.
Seed	Seeds are ovoid, wings membranous.
Bark	Bark is smooth and resinous in young stems, turning grey and corky with shallow fissures on mature trees.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost hardy, it suffers from snow, the crowns break and young trees develop curvature at the base.
Drought	Seedling may suffer from the drought after the end of monsoon and again in April and May.
Fire	Resistant to fire, blue pine is less fire resistant than chitpine.
Soil	It prefers well-drained, porous soil, and will grow on limestone soil.
Coppice	It is a non-coppicer.
Associates	Blue pine frequently associates with deodar, spruce, silver fir, oaks, *Rhododendron arboreum Lyonia ovalifolia*, *Populus ciliata* etc.
Browsing	It has immune to protect itself from browsing.
Tree nature	It is a tall, evergreen, resinous tree with spreading or drooping branches.
Meteorological condition	In natural sites: **absolute Max Temp:** 37.8^{0}C, **absolute Min. Temp**. -18^{0}C, annual rainfall varies from 100-190cm.Throughout its habitat, heavy snow fall occurs during winter
Others	It can tolerate the competition from shrub and weed growth. Root system is superficial, it is massive and the tree is firm.

4. Natural regeneration:

Seed product^n	Seeds are shed at the end of the monsoon in October and November.

Seed dispersal	Seeds are dispersed by wind.
Seed germi^{n}	Blue pine regenerates profusely because **i).** Fertile seed commences to be produced at an early age of about 10- 15 years. **ii).** Good seed year are frequent. **iii).** There is hardly any year when trees do not bear sufficient amount of seed.
Establishment	Blue pine establishes well if seedlings are protected from fire and grazing, and obtains abundance of light.

5. Artificial regeneration:

Preferred propag^{n}	From seedling only: direct sowing, entire planting.
Seed collection time	Seeds are collected between Oct and Nov. Usually adequate seeds produce each year. Collecting period is short as seed is quickly shed.
No. of seed kg^{-1}	15,000-30,000 seeds kg^{-1}. Seed trees can give 100 or more cones.
Seed extraction	The cones should spread on a tarpaulin in the sun until fully open, then knocked together to dislodge the seeds.
Seed storage method	Orthodox seeds, put thoroughly dried seed in a polythene bag, seal tightly and store in a cool place.
Viability of seed	Seed retains viability for more than a year if stored in an airtight container.
Seed treatment	None.
Seed sowing time	**<2000m:** March-April**, >2000m** August –September.
Duration of germ^{n}	Germination takes place in 2-3 weeks, but it greatly varies.
Germination (%)	Germination achieves 20-90% depending on source and freshness of seed.
Nursery period	**Seedling: <2000m:** 14-15 month**, >2000m:** 22-23 month.
Best planting size	15-20 cm tall seedling require before planting.

6. Disease, pests and parasites of Blue-pine:

i). ***Fomes*** **heartrot:** caused *by Fomes pini*.**ii). Stem blister rust:** caused by *Cronartium ribicola.* **iii). Root and butt rot:** caused by *Armillaria mellea*.**iv). Flowering plant parasites:** The dwarf mistletoe *Arceuthobium minutissimum* is a common parasite of blue pine.

7. Wood properties:

Wood color	**Sapwood:** whitish, **heartwood:** light pink to red with darker striations.
Hardness	Its wood is soft.
Working quality	One of the easiest woods to saw, machine and bring to a good finish.
Weight	Its wood is moderately heavy, wood weighs about 480 kgm^{-3}.
Strength	Its wood is weak.
Calorific value	C.v is about 20,900 KJkg^{-1}.
Durability	Wood is durable under cover but not so durable in exposed situations.
Preserva. treat.	Its wood requires thorough preservative treatment.
Seasoning	It is a non-refractory wood to seasoning. It seasons well and is not so liable to twist and warp as that of *Pinus roxburghii*
Grain & Texture	Straight and fairly even grained, medium fined textured wood
Other	The rotation period is about 120-180 years.

8. Uses:

Timber	The wood of blue pine is considered to the best among indigenous pines. It is used as constructional work, furniture, cheap pencils, musical instrument, match boxes etc.
Fuel wood	It is an excellent fuel wood and makes an excellent charcoal.
Fodder	Leaves are unpalatable to animals & goats but buffaloes will browse buds.
Edible food	Seeds are eaten either raw or roasted.
Tannin	The bark contains a fair amount of coloring matter and is sometimes used for dyeing silk and wool.
Gum and resin	It produces a good resin, but the yield is less than that of *Pinus roxburghii*, so it is not generally tapped for resin.
Ecological value	It is widely used for afforestation in ravine lands, dry and rocky areas, denuded hill slopes, land slips and screes, road side plantation etc.
Medicinal value	The roots yield an oil, which is applied by the workers in the paddy fields to keep off water insects.
Paper and pulp	It is suitable for the manufacture of bleached and unbleached Kraft papers by the sulphate process.
Others	Bark is used for roofing. On distillation, the crude oleoresin gives 27.5% of terpentine oil and 68% rosin.

(24)

Local name: Painyu	
Prunus cerasoides	**Family: Rosaceae**

1. Natural occurrence: It occurs in Nepal between 1200-2400m throughout Nepal.

2. Morphological characteristics:

Leaf	Leaves are deciduous, alternate, apex-long pointed and a double-toothed margin.
Flower	Flowers are often appear before the new leaves, are very attractive, borne in clusters at the end of the branches.
Fruit	Fruit a red fleshy drupe or cherry, each with a single seed.
Seed	Seed contains within a hard stone.
Bark	The bark is grey brown, shiny and patterned with irregular horizontal bands of raised corky patches .The bark of older trees tends to peel of in strips.

3. Silvicultural characteristics:

Light	**Seedling:** tolerate some shade, **older trees:** light demander.
Frost	**Seedling:** frost tender, **older trees:** frost hardy.
Soil	It is more tolerant of poor soil conditions than most species except pines.
Coppice	It coppices as well as produces root suckers well.
Browsing	Trees are lopped for fodder, since leaves are palatable, severely browsed by cattle.
Tree nature	It is a medium to large sized deciduous or evergreen tree.

4. Artificial regeneration:

Preferred propag^{n}	Seedlings, root suckers, cuttings.
Seed collect^{n} time	March- May.
No. of seed kg^{-1}	2500-3200 seeds kg^{-1}.
Seed extraction	Fruit is soaked in water, rubbed together and rinsed well.
Seed storage	Orthodox seed should be dried thoroughly in the sun.
Viability of seed	Viability of seed retains for a year.
Seed treatment	Soak the seed in water for 2-3 days.
Seed sowing time	**<1500m:** March–April when seed is fresh, **>1500m:** late August to early September.
Duration of germ^{n}	Germination completes within 2-3 weeks.
Germination (%)	Up to 85%.
Nursery period	**Seedling: <1500m:** 3-4 month, **>1500m:** 10-11 month.
Best planting size	20-30 cm tall with root collar diameter of 3mm or larger.

5. Wood properties:

Wood color	**Sapwood**: whitish and lustrous, **heartwood**: reddish brown.
Hardness	Moderately hard wood.
Working quality	It saws and works well, it takes a good polish.
Weight	Wood weighs about 720 kgm^{-3}.
Strength	Wood is strong.
Calorific value	19,100 KJkg^{-1}.
Durability	Wood is durable.
Seasoning	It seasons well. It is resistant to fungus and insect attack and works to a good finish.

6. Uses:

Timber	It is used for making building and making ornamental furniture. The wood of saplings, branches and root suckers make excellent walking sticks and umbrella crooks. Its timber is suitable for the manufacture of the gunstocks.
Fuel wood	It is a good quality fuel wood.
Fodder	Leaves contains 6% crude protein, are fed to sheep and goats but not cattle.
Edible food	Fruits are edible.
Tannin	Bark is used for tanning.
Medicinal value	The smaller branches are crushed and soaked in water and taken internally to stop abortion. Kernel is used as a remedy for stone and gravel.
Others	Seeds are used in the necklaces.

L.N: Thulo phalant	English name: Oak
Quercus lamellosa	Fagacae

1. Natural occurrence: It is found in east and central Nepal at altitude between 1600 and 2800m.

2. Morphological characteristics:

Leaf	Leaves are broadly oblong to lanceolate, sharply serrate.
Flower	**Male spikes**: solitary, **female spikes**: solitary or in short spikes.
Fruit	Fruits: acorns that is stackless.
Seed	A corn.
Bark	Bark is grey-brown with rough spots.

3. Silvicultural characteristics:

Light	Seedlings are moderately shade tolerant but sapling stage onwards the tree develops best with full overhead light.
Frost	Frost hardy.
Drought	Drought resistant.
Fire	It is very susceptible to damage by fire.
Soil	It grows well on deep, well- drained, moist soils and on clay loam.
Coppice	It coppices very well. It does not produce root suckers.
Browsing	Seedlings are severely damaged by browsing animals.
Associates	It is frequently associated with Lauraceae (*Litsea, Cinnamomum, Machilus, and Lindera* etc.). In wet areas, it forms very dense forest with abundant epiphytes.
Tree nature	It is a large evergreen tree.
Growth rate	Its mean annual girth increment is about 1.2-2.0 cm.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, stump planting.
Seed collection time	Seeds ripen between Oct & Dec. About one year in three is a good seed year.
No. of seed kg^{-1}	25-30 seeds kg including the cups, 150-250 seeds after removal of cups.
Seed extraction	Remove the cups by hand.

Note: Other information of artificial regeneration is same as *Quercus leucotricophora.*

5. Wood properties:

Wood color	The wood is light russet to greyish brown.
Hardness	Its wood is hard.
Weight	Wood is very heavy-to-heavy. Wood weighs about 940 kgm^{-3}.

6. Uses:

Timber	Wood is used for oars, ploughs and carrying poles.
Fodder	Leaves are used as fodder and contain 10% crude protein.
Fuel wood	Its wood is also used as fuel wood.

L.N.: Sano banjh	E.N.: Fagaceae
Quercus leucotricophora	Syn: *Quercus incana*

1. Natural occurrence: It occurs between 1650 and 2400m. It occurs abundant in central and western parts of Nepal; and scarce, rare or absent towards east.

2. Morphological characteristics:

Leaf	Leaves are oblong or ovate–lanceolate with white or grey tomentum beneath.
Flower	**Male flowers**: male spikes densely hairy and clustered, **female spikes:** usually sessile.
Fruit	Fruits are fleshy, acorns single or in pairs.
Seed	Nut is ovoid, brown with a grey pubescence near the apex.
Bark	Bark is grey to greyish brown, silvery when young, peeling off in rounded flakes.

3. Silvicultural characteristics:

Light	**Seedlings:** shade tolerant for 2-3 years. Older **saplings** & **poles:** strong light demander.
Frost	Frost hardy.
Fire	Sensitive to fire.
Soil	It needs moderately fertile soils, growing well on clays derived from shales and clay loams but does not grow well on dry sites.
Coppice	It coppices well.
Associates	Its common associates are *Rhododendron arboreum, Cedrus deodara, Pinus roxburghii*, and *Pinus wallichiana*.
Browsing	Browsing sensitive. It suffers heavily by browsing and by frequent lopping.
Tree nature	A moderate sized to large evergreen tree. *Q.incana*, is gregarious, and sometimes form pure forests to a considerable extent.
Meteor. condition	In its natural habitat: **Max.Temp**.35^0 C, **Min. Temp:** < 0^{0}C, mean annual rainfall: 100 to 230 cm.

4. Natural regeneration:

Seed product^n	One year in two is good seed year.
Seed dispersal	Seeds are dispersed by wind.
Seed germination	Destroying the seeds due to bears, monkeys, squirrels, rats, birds and insect damage, hampers germination of seed.
Establishment	Drought, grazing, grass cutting, and fires are key factors for establish-ment of seedlings.

5. Artificial regeneration:

Preferred propag^n	From seedlings only: direct sowing, entire planting.
Seed collect^n time	Seeds are collected between November and March.
No. of seed kg^{-1}	500-800 seeds kg^{-1}.

Seed extraction	Remove cups by hand.
Seed storage method	Recalcitrant seed. Khashru cannot be stored and should be sown within 2-3 days after collection.
Viability of seed	Viability remains for very short period.
Seed treatment	Generally it is not required. At higher altitude, moist and cold stratification gives better result.
Seed sowing time	February-March after stratification over winter.
Duration of germ^{n}	It germinates after 4-8 weeks.
Germination (%)	Germination is usually high (60-80%).
Nursery period	**Seedling:** After 15-16 months for spring sowing.
Best planting size	Seedlings should be at least 20cm tall before planting out.

6. Disease, pests and parasites of Sano banjh: i). Heart rot: caused by *Fomes spp* and *Polyporus spp.ii).* **Root rot:**:caused by *Armillaria mellea, Fomes Annosus***iii). Powdery mildew*:** caused by *Sphaerotheca lanestris***.iv).** Many parasites like *Loranthus* and *Viscum spp*. affect the tree.

7. Wood properties:

Wood color	The wood is light russet to light greyish brown.
Hardness	Its timber is very hard.
Working quality	It is easy to saw and works to a smooth surface and takes a bright polish.
Weight	Wood is very heavy, weighing about 1020kgm^{-3}.
Strength	Wood is moderately strong.
Calorific value	**Heartwood:** 19,100KJkg^{-1}, **sapwood:** 19,400KJkg^{-1}.
Durability	It is moderately durable under cover, but liable to attack by large borers.
Preservative treatment	High refractory wood to seasoning. It is liable to split and warp severely and is very difficult to season.
Grain & texture	Straight or somewhat wavy grained, medium fine but uneven–textured wood.

8. Uses:

Timber	It is not a good timber as it warps and splits badly. Use for low- grade construction and agricultural implements.
Fuel wood	It is a good fuel wood, makes extensively good charcoal.
Fodder	Leaves are of a great value as a fodder. It contains average crude protein about 10.6%.
Edible food	Birds, wild animals and cattle greedily eat seeds.
Tannin	Bark contains 6-23% tannin, wood contains of 4-5% of tannin.
Gum and resin	A sweet exudation is collected from the plant, is used in the preparation of confectionary.
Medicinal value	Acorns are used in the indigenous medicine as diuretic and in gonorrhoea and also as an astringent in indigestion and diarrhoea.

L.N: Khasru	**English name: Oak**

Quercus semicarpifolia	**Family: Fagaceae**

1. **Natural occurrence**: It occurs between 1700 and 3800m altitude. It commonly occurs between 2400 and 3000m altitude especially in the west.

2. Morphological characteristics:

Leaf	Leaves ate elliptical or oblong, spinous teethed or entire.
Flower	**Male spikes:** crowded, **female spikes:** short, acorn subglobose, in clusters of 3 or more.
Fruit	Fruits are fleshy acorn.
Seed	A fleshy nut, which can be removed from the cup.
Bark	Bark is dark grey, exfoliating in irregular woody scales.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost hardy.
Fire	Sensitive to fire.
Soil	It tolerates the wide range of soil type. It needs moderately fertile soils, growing well on limestone as well as many other type of soil. It prefers warm, dry southern slopes and absent in high rainfall areas.
Coppice	It coppices well. It pollards fairly well. The growth of coppice shoot is very slow.
Associates	It associates with *Picea smithiana.*
Browsing	It is sensitive to browsing.
Tree nature	It is an evergreen or semi-evergreen tree. It is gregarious and forms a pure forest along the tops and upper slopes within its well-marked zone.
Meteo.cond.	Khasru forests occur in regions of heavy snowfall and moderate rainfall.
Other	It is slow growing species and difficult to raise in the nursery.

4. Natural regeneration:

Seed production	Natural regeneration takes place from seeds. One year in three is good seed year.
Seed dispersal	Seeds are dispersed by wind.
Seed germination	Destroying the seed due to bears, monkeys, squirrels, rats, birds and insect damage, germination of seed gets hampered.
Establishment	Drought, grazing and grass cutting, and fire are key factors for establishment of seedlings.

5. Artificial regeneration:

Preferred propag^{n}	From seedlings only: direct sowing, entire planting.
Seed collection time	Seeds are collected between June and August. Time of seed collection is important because acorns can begin to germinate while still on the tree.
No. of seed kg^{-1}	150-200 acorns kg^{-1} after removal of cups.
Seed extraction	Loose cups should be removed by hand.
Seed storage method	Recalcitrant seed. Khasru cannot be stored and should be sown within 2-3days after collection.

Seed treatment	Generally it is not required. At higher altitude, moist and cold stratification gives better result.
Seed sowing time	Seed should be sown immediately after collection in July- August.
Duration of germ^{n}	Khashru seed starts to germinate 4-5 weeks after sowing.
Germinat^{n} percent	Germination is usually high (60-80%).
Nursery period	**Seedling:** Seedling should require 2-3 year in nursery bed.
Best planting size	Seedling should be at least 20cm tall before planting out.

6. Disease, pests and parasites of Khasru: i). Root rot diseases: caused by *Ganoderma lucidum,* **ii). Heart rot**: caused by *Fomes spp*, *Hymenochate rubiginosa* and *Polyporus spp* .

7. Wood properties:

Wood color	The wood is light pinkish brown to reddish brown.
Hardness	Its timber is hard.
Weight	Wood is heavy to very heavy. Wood weighs about 860 kgm^{-3}.
Strength	Its wood is strong.
Durability	Its wood is durable.
Grain &Texture	The wood is straight to irregular grained, medium fine & uneven textured.

8. Uses:

Timber	It is used for constructional purpose and agricultural implements.
Fuel wood	Wood is an excellent source of fuel wood and charcoal.
Fodder	It is the most abundant fodder species; leaves contain 7.3% crude protein.
Tannin	Leaves and bark contain 8%, 7-11% tannin respectively.
Ecological value	Leaves are suitable for feeding the caterpillar of silkworm, *Antheraca pernyi.*

(28)

L.N: Bains	**E.N: Willow**
Salix babylonica	**Family: Salicaceae**

1. Natural occurrence: It occurs between 1400 and 3650m altitude in Nepal.

2. Morphological characteristics:

Leaf	Leaves are long, narrow pointed tips, and edges are finely toothed.
Flower	The flowers, which appear with the new leaves in February or March, pale yellow male and female catkins.
Seed	Seed capsules are stalkless, greenish in color, small and smooth.
Bark	Bark is fissured, rough and ridged.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	Drought does not generally occur in its natural habitat.
Fire	Fire resistant.

Soil	The tree thrives well in clayey soils in swampy places along the banks of rivers and streams, preferring low elevations and warm climate so it is frequently planted on water logging areas.
Coppice	It coppices and pollards well.
Associates	It is after associated with *populus ciliata*.
Browsing	Trees are lopped for fodder, since leaves are palatable; it is severely browsed by cattle.
Tree nature	It is a small to moderate sized, short lived, ornamental deciduous and dioeciously trees, with spreading branches and drooping branchelets.
Others	Tree can withstand heavy lopping. Rate of growth is fast.

4. Natural regeneration: It often takes place through seeds that are dispersed by wind.
5. Artificial regeneration: It mostly occurs through stem cuttings.

6. Wood properties:

Wood color	Wood is white.
Hardness	Wood is soft.
Working quality	It is easy to saw and work well. Wood is smooth and even grained .It takes a good polish.
Seasoning	It is non-refractory wood to seasoning.

7. Uses:

Timber	It is the best wood for cricket bats. Pliable branches are used for making basket.
Fuel wood	It is also used as fuel.
Fodder	Leaves are used for fodder.
Tannin	Bark and leaves contain 3-9% and 4.9% tannin respectively.
Ecological value	It is a very useful for stabilizing stream banks, landslips, and dam sides and for planting up swampy areas.
Medicinal value	Leaves and barks have astringent and tonic properties. Catkins and twigs are used as an antipyretic, and an infusion of leaves is given in rheumatism.
Paper & pulp	It is a suitable wood for preparing paper and pulp.

(29)

Local name: Gogan	
Saurauria napaulensis	**Family: Saurauiaceae**

1. Natural occurrence: This is a tree of temperate Himalayas, occurring between 750-2100m.

2. Morphological characteristics:

Leaf	Leaves are grouped towards branch tips; leaves are large, on short stalks, finely toothed edges, and rust colored hairs on the underside.
Flower	The attractive pink flower, on short branches arising from leaf axils.
Fruit	The small fleshy fruit, which is green, turning to yellow when it ripens. In fruits, seeds are immersed in Jelly.

Seed	Seeds are tiny and brown.
Bark	Bark is reddish brown, and when old is vertically fissured and cracked into long rectangular scales.

3. Silviculture characteristics:

Light	Shade bearer i.e., fairly tolerant to shade.
Frost	Seedling: frost tender, mature trees: frost hardy.
Soil	It is usually found in moist, shady localities such as the side of the ravines. It is a moderately tolerant to soil of low fertility.
Coppice	It coppices well.
Associates	It is found in *Schima-Castanopsis* forest.
Browsing	Seedlings are severely damaged by browsing.
Tree nature	It is a small to medium sized deciduous tree.

4. Artificial regeneration:

Preferred propag^{n}	Seedlings, cuttings, coppice.
Seed collect^{n} time	March-April.
No. of seed kg^{-1}	4-8 million seeds kg^{-1}.
Seed extraction	The fruit is placed in a cloth bag. The bag is squeezed under water to remove the jelly and rinsed several times in clean water. When all the jelly is removed, the bag containing seed is dried.
Seed storage method	Orthodox seed, put thoroughly dried seed in a polythene bag, seal tightly and keep in a cool place.
Viability of seed	Viability of a seed retains for a year.
Seed treatment	It is not required.
Seed sowing time	March-April.
Duration of germination	If seeds are sown in March-April, germination takes 3-6 weeks. If seeds are sown in between Sept. & Feb., germination takes considerable longer time.
Germination (%)	Germination usually around 22%.
Nursery period	**Seedling:** 14-15 months and can be planted out in July
Best planting size	20-30 cm tall with root color diameter of 3mm or larger.

5. Wood properties:

Wood color	Wood is light pink.
Hardness	Wood is soft.
Weight	Wood is light and spongy. Wood weighs about 400 kgm^{-3}.

6. Uses:

Fodder	Leaves are used as an excellent fodder; leaves contain 12.2% crude protein.
Edible food	Ripe fruit is eaten.
Others	Leaves are used for plates.

(30)

Local name: Chilaune

Schima wallichii	**Family: Theaceae**

1. Natural occurrence: It occurs between 900-2000m, common tree in eastern and central Nepal of mid-hills.

2. Morphological characteristics:

Leaf	Leaves are simple and alternately arranged on branches, leathery, lance like and pointed tip.
Flower	Flowers, which appear in May, are small, fragrant, white and quite showy, borne singly.
Fruit	Fruit is a small, hard and brown woody capsule.
Seed	Seeds are very light and dispersed by wind.
Bark	Bark is grey and marked with vertical and disconnected fissures, and shallow streaks.

3. Silvicultural characteristics:

Light	Moderately light demander.
Frost	Moderately frost hardy.
Soil	It can grow on a wide range of soil type.
Coppices	It coppices very well.
Associates	It is often associated with *Castanopsis spp*., sometimes associated with *Pinus roxburghii* and *Shorea robust.*
Browsing	Browsing sensitive.
Tree nature	It is a large, evergreen tree.
Others	Dieback often caused by *Corticium salmonicolor.*

4. Natural regeneration:

Seed production	Abundant and fertile seed produces annually.
Seed dispersal	Seeds are wing-shaped which are dispersed by wind.
Germination	For germination of seed, enough light is required.

5. Artificial regeneration:

Preferred propag^{n}	Entire planting.
Seed collec^{n} time	Seeds are collected between January and April.
No. of seed kg^{-1}	1,60,000-3,50,000 seeds kg^{-1}.
Seed extraction	Shaking and gentle threshing by placing the fruits in the sun for a few days until the seed open.
Seed storage method	Orthodox seeds, dry thoroughly in the sun then stored in the airtight container, and keep in cool places.
Viability of seed	Viability of seed is short.
Seed treatment	It is not required.
Seed sowing time	Seeds are sown immediately after collection. Generally seeds are sown in March or April for July planting.
Duration of germ^{n}	Germination takes place in 1-3 weeks.
Germination (%)	40%.
Nursery period	**Seedling**: 15 months.
Best planting size	30-45cm.tall seedlings.

6. Wood properties:

Wood color	Wood is light reddish brown.
Hardness	Its wood is moderately hard.
Working quality	It is easy to saw and work with a smooth surface.
Weight	Wood weighs about 690kgm^{-3}.
Strength	In hardness, its wood is 15% below than teak.
Calorific value	Calorific value is about 20,500 KJkg^{-1}.
Durability	It is not very durable wood.
Preservative treat.	Heartwood is very difficult to treat, sapwood is readily treatable.
Seasoning	Highly refractory wood to seasoning, i.e., wood has tendency to warp and twist and also crack while it is seasoning.

7. Uses:

Timber	It is used for house building, railway sleepers and planks.
Fuel wood	A good fuel wood.
Fodder	Medium quality fodder, it contains 9.6% crude protein, more valued for bedding than as a fodder.
Medicinal value	The young plants, leaves and roots are used medicinally against fevers and the bark is anthelmintic and rubefacient.

CHAPTER: IV

TREE SPECIES OF HIGH HILLS

(1)

L.N.: Chingure, Gobre salla	E.N.: Silver fir
Abies pindrow	**Pinaceae**

1. Natural occurrence: It is found between 2100 and 3000m.

2. Morphological characteristics:

Leaf	The needles persist for three to six years; leaves are distichously.
Flower	Flowers are monoecious. **Male catkins:** long, sessile, and usually clustered. **Female catkins:** solitary or in distant pairs, erect, situated a little below the tips of shoots.
Fruit	An erect cone, which breaks up on the tree.
Seed	Seed is resinous with a large wing and a soft seed coat.
Bark	Bark is smooth on young stems, dark grey or greyish brown, deeply cleft with vertical fissures when old.

3. Silvicultural characteristics:

Light	Shade bearer, it has little or no undergrowth under dense shade.
Frost	It is frost hardy. It suffers little from snow break.
Drought	Seedlings are drought sensitive, as they require a moist fresh soil for their best development.
Fire	Fire does not occur in silver fir forest. If fire occurs, it is more sensitive to injury than any other conifer of that region.
Soil	It prefers cool and moist locality with deep, rich soil, with heavy snowfall. It avoids dry, shallow soil and depressions.
Coppice	It is non-coppicer.
Associates	It is usually dominant but it may mix with others: **broad leaf:** *Juglans, Aesculus, Q.semicarpifoila, and Q. floribunda,* **Conifers:** *Tsuga dumosa, Picea smithiana, Pinus excelsa.*
Tree nature	It is a tall evergreen tree with dense conical crown. It is found on north and west facing slopes, usually in damp gullies but found in all aspects at higher altitudes.
Meteor.cond^{n}	Seasonal snowfall is favorable to its regeneration.
Root system	The root system of silver fir is somewhat superficial, spreading and not very massive. Trees are apt to be thrown by wind on exposed situations.

4. Artificial regeneration:

Preferred propag^{n}	From seedlings: **(i)** Direct sowing **(ii)** Entire planting (**iii**) Bare-root stock planting which has been successful in higher altitude.
Seed collec^{n} time	Seeds are collected bet^{n} Sep.- Oct., with good seed after every 3-4 years.
No. of seed kg^{-1}	27,000 seeds kg^{-1}.

Seed extraction	Seed should be dried in the shade and allow breaking naturally, do not force to open. Remove wings by gently rubbing, seeds in a cloth bag then winnow.
Seed storage method	Orthodox seed. Dry seed for several days in the sun, then put in a polythene bag, seal tightly and keep in a cool place.
Viability of seed	Viability of seeds retain for only six months.
Seed treatment	It may need moist, cold stratification, if collected from high altitude.
Seed sowing time	Seeds sow during Feb-Mar. Mycorrhizal associations are essential.
Durat^{n} of germ^{n}	**At 2000m**, germination of unstratified seed starts about two weeks, and is completed within a month. **At higher altitude**, these periods will be longer.
Germination (%)	75-90%, germination is epigeous.
Nursery period	**Seedling**: At least three years.
Best planting size	More than 20cm in height.

5. Diseases, Pests and Parasites of silver oak:

(**i**) **Needle rust of spruce and fir**: caused by *Ceropsora piceae, Chrysomyxa deformans, Peridermium piceae, Perdermium thomsoni,* (**ii**) **Root rots:** caused by *Armillaria mellea*. (**iii**) **White pocket rot:** caused by *Fomes annosus, Polyporus tomentosus.* (**iv**)**Heart rot:** caused by *Fomes fomentarius, Fomes pini, and Fomes robustus.*

6. Wood properties:

Wood Color	No difference in color between sapwood and heartwood. Wood is creamy white to pale yellow turning light brown on exposure.
Hardness	Its wood is soft to moderately hard.
Fissibility	It is extremely fissile.
Weight	450kg/m^3 (28lbs./cu.ft.) at 12% moisture content.
Strength	Its wood is somewhat weak.
Durability	Its wood is fairly durable.
Preser. Treat.	It requires thoroughly preservative treatment, although it is refractory to treat.
Seasoning	It is non-refractory wood to seasoning.
Porous	A non–porous wood, growth ring distinct on all the three surfaces.
Grain & texture	Medium to fine and even textured with straight grain.
Other	It is very slow growing species. Resin canals absent. Woods are much knotty.

7. Uses:

Timber	It is suitable for all types of packing cases, containers and fruit cases. Wood, which is treated with preservative, is suitable for railway slipper, aircraft work, veneer, match etc.
Fuel wood	It is an important fuel wood tree.
Gum & resin	It gives very little resin.
Paper & pulp	Its wood is suitable for paper and pulp.
Others	Branches are used as litter.

8. Royalty rate: NRs. 40/cu.ft. for round timber (Forest rules, 1995).

9. Marketing price: NRs. 350/cu.ft. for sawn timber at hilly urban center of Nepal (1997).

10. Conservation status: It is threatened species due to heavy felling & other deforestation works.

(2)

L.N. :Talispatra, bunge salla	
Abies spectabilis	**Pinaceae**

1. Natural occurrence: It is found in central and western Nepal between 2400 and 4400m. It is found in higher altitudes than *Abies pindrow.*

2. Silvicultural characteristics:

Light	It is a shade bearer. It has little or no undergrowth with under dense shade.
Frost	It is frost hardy; it suffers little from snow break.
Drought	Seedlings are drought sensitive, as they require moist soil for their best growth.
Fire	Young seedlings are very sensitive to fire.
Soil	It prefers cool and moist locality with deep, rich soil, with heavy snowfall. It avoids dry, shallow soil and depressions.
Coppice	It is a non-coppicer.
Associates	It forms almost pure forests between 3,000and 3,600m. It is often associated with Juniper, various species of rhododendrons, maling bamboo *Arundinaria racemosa*.
Tree nature	A tree resembling *Abies pindrow* but usually more stunted and gnarled. It is an evergreen tree with thick spreading horizontal branches.

3. Artificial regeneration:

Preferred propag^{n}	From direct sowing, entire planting, wilding planting.
Seed collect^{n} time	September-January; good seed years are infrequent.
No. of seed kg^{-1}	There are 8,500-12,000 seeds kg^{-1}.
Seed extraction	Seed should be dried in the shade and allow breaking naturally, do not force to open. Remove wings by gently rubbing, seeds in a cloth bags then winnow.
Seed storage	Orthodox seed, dry seed for several days in the sun, then put in a polythene bag, seal tightly and keep in a cool place.
Seed treatment	It may need moist cold stratification, if collected from high altitude.
Seed sowing time	February-March; mycorrhizal association is essential.
Durat^{n} of germ^{n}	At 2,000m, germination of unstratified seed starts about two weeks, and is completed within a month. At higher altitude: these periods will be longer.
Germ^{n} percent	Germination may obtain 55%.
Nursery period	**Seedling:** Seedling requires at least three years.
Best planting size	More than 20cm in height with 5-7mm root collar diameter.

5. Wood properties:

Wood properties are similar to the *Abies pindrow*.

6. Uses:

Uses are similar to the *Abies pindrow*.

(3)

Local name: Bhojpatra	English name: Birch
Betula utilis	**Betulaceae**

1. Natural occurrence: It occurs in alpine region of Nepal and India between 2700and 4200m.

2. Morphological characteristics:

Leaf	Leaves are stalked, ovate, unequally serrate & slightly hairy along mid ribs.
Flower	**Male catkin** few, perianth 4 –parted. **Female catkin:** solitary or in pair, perianth none.
Fruit	Fruits are erect catkins. **Fruiting seasons:** September to October.
Seed	Seeds are tiny winged and very light.
Bark	Bark is light colored, smooth and papery, peeling off in long thin strips.

3. Silvicultural characteristics:

Light	It is a strong light demander.
Frost	It is a frost hardy species.
Drought	It is a drought resistant.
Soil	Birch forest is occurring in open exposed tracts, which are under snow throughout the greater part of winter. It frequently occurs in gullies.
Coppice	It coppices well.
Associates	It is associated with *Rhododendron campanulatum, R. anthropogon, Abies spectabilis, Pinus wallichiana, Picea smithiana, Quercus spp, Juniperus spp.*
Browsing	Browsing sensitive. Seedlings are heavily damaged by browsing animals.
Tree nature	It is moderate sized, slow growing deciduous tree.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting.
Seed collect^{n} time	Seed ripens between August and October.
No. of seed kg^{-1}	2.5 million Seeds kg^{-1}.
Seed extraction	Catkins are spreaded in the shade for several days, to let them fully yellow. Catkins are broken up by hand and sieve and winnow to clean.
Seed storage	Orthodox seed; should be dried thoroughly in the sun and stored in the sealed container in a cool and safe place.
Viability of seed	Viability of seed remains for about six months.
Seed treatment	It is necessary to stratify seed in cold, moist, sand for four weeks at higher altitudes.
Seed sowing time	Seeds are sown in March.
Durat^{n}of germination	Germinations begin after 2-3 weeks.
Germination (%)	**Fresh seeds:** 32% **stratified stored seed:** 65%.
Nursery period	**Seedling:** It requires at least two years in nursery.
Best planting size	20-30 cm tall, root collar diameter 3mm or bigger.

5. Uses:

Timber	Timber is widely used for furniture, carpentry and construction.
Fuel wood	It is widely used as fuel wood.

Fodder	Leaves are palatable and contain high protein content.
Eco. value	It is planted to stabilize the gully in higher altitude.
Medicinal value	Bark is antiseptic, carminative, used to heal up the wounds; also useful in bronchitis; disease of the blood and the ear, and in leprosy (Ayurveda).
Paper and pulp	Bark is used as a high quality writing paper.
Others	Bark is widely used in water proving, roofs, insulating, cracks in walls and making bottle stoppers.

6. Royalty rate: NRs. 5/kg for dry bark. (Forest rules, 1995).
7. Market Price: NRs. 150/kg at major trading centers of Nepal. (Parajuli *et al.*,1997).
8. Conservation status: Its population is scarce due to heavy felling and other deforestation works.

(4)

Local name: Deodar	**English name: Deodar**
Cedrus deodara	**Pinaceae**

1. **Natural occurrence:** It occurs in Nepal between 1,900 and 2,600m, usually on northwest and northeast facing slopes in Western Nepal.

2. Morphological characteristics:

Leaf	Needles are 2.5-4cm long, in dense clusters at the end of short shoots.
Flower	**Male flowers:** appears June, **Female flowers:** appears August.
Fruit	Female cone ripens in late October to November.
Seed	Seeds are winged. Good seed year occurs once in three years.

3. Silvicultural characteristics:

Light	It is a light demander but young seedlings require some side shade.
Frost & drought	It is frost hardy. It is sensitive to drought in seedling stage.
Graze &browse	Young seedlings are liable to damage by browsing.
Fire	Both seedlings and mature trees are sensitive to fire.
Tree nature	It is a very large, evergreen, an ornamental tree, extensively planted near the temples.
Coppice	It is a non–coppicer.
Soil	It grows on a verity of soils, but avoids stiff, badly drained soils; on shallow rocky soils, its growth is stunted. It occurs naturally on mountainous country with slope varying from moderate to precipitous as well as on level ground on river valleys at suitable elevation. Deodar forests are found on all important geological formations such as granite, gneiss, mica, shale, limestone, quartzite, etc. Its best growth is attained on deep fairly porous fertile soil and cool situations.
Associates	Deodar is a gregarious tree and frequently forms pure forests, but it also mixes other species such as *Pinus wallichiana ,Picea smithiana,Cupressus torulosa,Taxus baccata, Quercus spp,Aesculus spp,Juglans regia, Rhododendron ,Pyrus pashia* etc.
Meteor. cond^{n}	Its best growth is found where annual rainfall varies from 100-175cm. Its

	growth is failed if rainfall exceeds in Eastern Himalayas.

4. Artificial regeneration:

Preferred propag^{n}	Entire planting, direct sowing, bare root planting.
Seed collect^{n} time	The cones are collected between October-December.
No. of seed kg^{-1}	8,000 seeds kg^{-1}.
Seed storage	Orthodox seeds are dried in the sun so as to shed the winged seed.
Viability of seed	The seed loses its viability within about 4 months. So the seeds should be sown immediately after collection.
Seed sowing time	Seeds are sown in November and allow passing the winter and germinating in following spring.
Duration of germ^{n}	Germination takes place about two weeks to start.
Germination (%)	Germination takes place 80-90%.
Nursery peri./seedling	One-year-old seedlings are planted in late autumn or early spring.

5. Diseases, Pests and Parasites of deodar: Various diseases of deodar: (i) Root and but rot: caused by *Fomes annosus*, **ii) Root rot**: caused by *Armillaria mellea* **(iii) Witches broom:** caused by *Peridermium cedri*. **(iv) Butt rot and trunk rot:** caused by *Peniophora luna*.

5. Wood properties:

Wood Color	**Sapwood** is white & **heartwood** is yellowish brown turning brown on exposure.
Working Quality	The wood is easy to saw either by hand or by machine. It finishes to a moderate well. It cannot be efficiently wax-finished and takes varnish only moderately well.
Weight	Wood is light and weighs about 560 kgm^{-3}.
Strength	It is the strongest of coniferous woods and about as strong as teak.
Calorific val.	Its calorific value is 5,294 calories.
Durability	It is the most durable coniferous timber.
Preserv. treat.	Due to the presence of a volatile chemical substance, which acts as a repellent, deodar is resistance to termite. Resistance against fungi can be increased by treating with preservative like creosote.
Seasoning	Timber seasons well without any difficulty under cover. Rapid drying leads to surface cracking and splitting.
Other	The wood is oily and characteristically scented.

6. Uses:

Timber	Deodar is one of the most important and valuable timber. Primary use of deodar is for railway slipper. Timber is used for beams, rafters, frame work, door and furniture. It is an important construction timber.
Fuel wood	Its wood is an excellent fuel wood.
Tannin	Bark contains 8.25% tannin.
Medicinal value	The bark is astringent and useful in fevers, diarrhoea and dysentery. An alcoholic extracts of bark shows significant activity against diphtheria-bacteria and an aqueous extracts of the dried bark shows anti-inflammatory activity against acute and chronic inflammations. The wood possesses diaphoretic, diuretic and carminative properties and is useful in fever and in

	pulmonary and urinary disorders. The wood is one of the ingredients of the well-known ayurvedic preparations *Bhadradarvadi taila*, prescribes for diabetes, leprosy.
Paper & pulp	It can be used as a source of pulpwood.
Other	The timber is suitable for making high and medium quality pencils after suitable treatment.

(5)

Local name: Dhupi	**English name: Cypress**
Cupressus torulosa	**Cupressaceae**

1. Natural occurrence:

In Nepal it is found between 1800and 3500m in the west, its eastern limit being the kali Gandki valley.

2. Morphological characteristics:

Leaf	Leaves are opposite, triangular and closely imbricate.
Flower	Flowers are monoecious; **male flowers:** cylindrical with numerous decussate peltate stamens: **female flowers:** globose cones.
Fruit	Mature cones.
Seed	Seeds are small, compressed and winged.
Bark	Bark is greyish brown, peeling off in long thin strips.

3. Silvicultural characteristics:

Light	It is a moderate light demander.
Frost	Frost hardy.
Drought	It is one of the most drought tolerant tree species in Nepal.
Soil	It is commonly found on limestone but it may grow on dry and poor soil, but the growth is stunted.
Coppice	It is a non–coppicer.
Associates	It is usually associated with *Cedrus deodara* and is often dominant on very steep limestone slopes.
Tree nature	It is a large evergreen tree with a pyramidal crown; branches ascending; horizontal or drooping, curving markedly upwards towards the ends.
Meteo. cond^{n}	It occurs in regions where the rainfall is 300smm or less.

4. Natural regeneration:

Seed product^{n}	Ripe cones shade their seeds between Aug and Dec. while they are still on tree.
Seed dispersal	Seeds are winged and dispersed by wind.
Seed germinat^{n}	Germination takes place in next monsoon.
Establishment	Seedlings establish themselves on bare sites such as landslips and abandoned fields easily.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting.
Seed collection time	Seeds ripen in April; are shed until August; are collected in June.
No. of seed kg^{-1}	There are 1,70,000 to 2,50,000 seeds kg^{-1}.
Seed extraction	Seeds are extracted by drying the cones, and later beating.
Seed storage method	Seeds are stored in sealed container and at cool place.
Viability of seed	Viability of seed remains for 18 months, and then falls off rapidly.
Seed sowing time	August- December.
Germination (%)	Germination is sporadic. (50-60) % germination takes from fresh seed.
Nursery period	**Seedling:** Seedlings need about 15 months in the nursery.

6. Diseases, pests and parasites: Diseases: i). Rusts are caused by *Gymnosporangium distortum* and *G. cunninghamianum* **ii). Branch cankers** are caused by *Monochaetia unicornis.*

7. Wood properties:

Wood Color	Heartwood is light brown, fragrant and an excellent quality wood.
Hardness	Wood is moderately hard.
Working Quality	It is easy to saw and work; finishes to a smooth clean surface. It does not exude any oil so it can be beautifully painted or polished.
Weight	Wood weighs about 600 kgm^{-3}. It is heavy wood.
Strength	It is a strong wood.
Durability	Timber is very durable.
Seasoning	It is a non-refractory wood to seasoning.

8. Uses:

Timber	Timber is used for bridge building, house construction and furniture; also suitable for sleepers and aircraft work.
Fuel wood	It is used for fuel wood.
Ecological value	It is planted as an ornamental tree.
Others	Its timber is used for pencil manufacture. Wood is burnt as incense.

(6)

Local name: Dhupi	**English name: Juniper**
Juniperus indica	**Cupressaceae**

1. Natural occurrence:

It is found in alpine scrub forests between 2,700m and 4,000m. According to Champion and Seth (1968), it is found in East Himalayan dry forest alpine scrub.

2. Morphological characteristics:

Leaf	Leaves are in whorls of 3, linear-subulate, sharply pointed, **Upper surface:** concave glaucous, bluish white. **Lower surface:** bluntly keeled.
Flower	Flowers are usually dioecious, axillary. Flowers appear in March-April.
Fruit	Fruits sub-globose, bluish black when ripe. Fruits ripen in Aug-Sept. of the 2nd year.
Seed	Seeds are usually three, elongated and ovoid.

Bark	Bark is reddish brown.

3. Silvicultural characteristics:

Light	It is a moderate light demander.
Frost	It is a frost hardy.
Drought	It is the most drought resistant species.
Coppice	Unlike other conifers, it coppices.
Associates	It is the only tree in such areas but has an open shrubby under storey.
Meteor. cond^{n}	It occurs in regions having 350 and 500mm rainfall.

4. Natural regeneration:

Seed product^{n}	Fruits ripen in August-September.
Seed dispersal	Seeds are dispersed by birds.
Seed germination	Natural regeneration is often difficult due to heavy grazing pressure in the alpine areas.
Establishment	For establishment of seedling, strict protection from grazing is necessary.

5. Artificial regeneration:

Preferred propag^{n}	**i). Entire planting:** for raising seedlings, the seed should be sown in the trays, and the seedlings pricked out in the polytube when they reach a height of 2-3cm, **ii). Short side cutting:** taken in Oct-Nov.
Seed collection time	Seeds are collected between June and September.
Seed storage method	Seed needs cold stratification over winter before it is sowing.
Viability of seed	Seeds viability can retain for 20 years.
Seed treatment	Seeds soak in hot water for few minutes to increase the germination.
Durat^{n} of germ^{n}	Germination may take up to two years.
Germination (%)	Germination is very irregularly.

6. Wood properties:

Wood Color	Wood is pinkish or reddish brown.
Hardness	Wood is moderately hard.
Working Quality	Wood is extremely fissile, easy to saw and work.
Durability	Wood is very durable.
Seasoning	Wood is non-refractory to seasoning.
Other	Wood is fragrant and highly resinous.

7. Uses:

Timber	Timber is used for fencing, veneering, turnery, and also used for making lead pencils.
Fuel wood	It is an excellent fuel wood; it can be burnt even when green.
Edible food	Juniper fruits are used in the preparation of alcoholic's beverages.
Tannin	Bark is used for tannin; the fruits and roots yield brown and purple dyes respectively.
Ecological value	It is planted as an ornamental tree.
Medicinal value	The fruits and volatile oil possess carminative stimulant and diuretic properties and are useful in dropsy. These are also used in disorders of the urino-genital tract such as gonorrhoea, leucorrhoea. The wood is diuretic

	and blood purifier, used in rheumatism and cutaneous diseases.
Cedar wood oil	The wood on steam-distillation yields 1-3% of a volatile oil, is known as cedar wood oil which is used in insecticides, perfumery, soaps, cleaning and polishing preparations.
Others	Juniper needles are rich in ascorbic acid; they also contain resin, wax and esters. The wood and young twigs are burnt as incense.

(7)

Local name: Jhulle salla	**English name: Spruce**
Picea smithiana	**Family: Conifereae**

1. Natural occurrence:

It is found at elevations of 2,000 to 3,800m, chiefly to the west of Himal Ganesh.

2. Morphological characteristics:

Leaf	Leaves are dark green; spreading all round the shoots; incurved- needle, persisting for a no. of years.
Flower	**Male flowers:** monoecious, axillary, catkin-like, greenish yellow; **Female cones:** solitary, terminal, ripe cones cylindrical ovoid.
Fruit	Cones are terminal, cylindrical & pendulous after fertilization &dark brown when ripe.
Seed	Seeds are obliquely oblong and dark-grey.
Bark	Bark is brownish grey, furrowed, exfoliating in small scales.

3. Silvicultural characteristics:

Light	It requires certain amount of shade in early stage, but once established complete overhead light is necessary for optimum development.
Frost	It is frost hardy.
Fire	Fire does not occur in the spruce forest, if it occurs, spruce is severally affected.
Soil	It occurs on various geological formations; the most common being mica, schist, shale, gneiss, and limestone.
Coppice	It is a non-coppicer.
Associates	It is associated with *Abies pindrow,Cedrus deodara,Pinus wallichiana*, and a no. of broad leaf tree such as *Aesculus indica, Juglans regia, Quercus and Acer*.
Tree nature	It is a very tall evergreen tree. Branches are whorled, spreading or drooping, with slender pendulous branch-lets.
Meteor. cond^{n}	Climatically it belongs to cool temperate regions of the Himalayas with a heavy snowfall and a total annual precipitation of 100-250cm, Max. shade temp. seldom reaches 32^{0}C.
Root system	It has more or less superficial root system and is not wind-firm.

4. Natural regeneration:

Seed prod^{n}	Natural regeneration takes place through seed. Cones ripen between October-November. A good seed year may be after each 3-4 years.
Seed dispersal	Seeds are dispersed by wind.
Seed germ^{n}	Seed begins to germinate during June-July of the following year. Germination

	period continues up to September.
Establishment	Establishment of seedling may be succeeded, if there is **(i)** Recently exposed mineral soil, **(ii)** Protection from fires &**(iii)** Freedom from dense weed growth.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting.
Seed collec^{n} time	Seeds collect during Oct-Nov, before ripening &dispersal of the seed.
No. of seed kg^{-1}	34,000 seeds kg^{-1}.
Seed storage	Orthodox seed. Seeds are dried in the sun so as to shed the winged seed.
Viability of seed	Three years when kept in cold storage, much less in calico bags.
Seed sowing time	Fresh seed should be sown in nursery in October or November.
Duration of germination	Germination commences towards the ends of the following May or June and continues during July and August.
Germination (%)	Germination normally obtains 40%.
Nursery period/ seedling	Seedlings may be pricked out in the nursery when two years old and planted out an age of three or four years.

6. Diseases, Pests and Parasites are same as *Abies pindrow*.

7. Wood properties:

Wood Color	Spruce wood is white; turning brownish with age. There is little differentiation between sapwood and heartwood.
Hardness	It is soft to moderately hard.
Working Quality	The wood is easy to saw and work, but the presence of excessive no. of large knots, the carpentry value is reduced. It is very satisfactory for rotary cut veneer. It takes varnish well. It offers in well glueing.
Weight	Wood is light (Average specific gravity is 0.48; average weight is 481kgm^{-3}).
Strength	Wood is relatively strong for its weight.
Durability	Its wood is not durable in open and moderately so under cover.
Preser. treat.	Its wood is difficult to treat with preservative even under pressure.
Seasoning	The wood is easy to season, but develops fine long splits if exposed to direct sun in green state.
Other	It is a non-porous wood and resin canals present.

8. Uses:

Timber	Wood is used for planking, rough furniture, tea boxes, packing cases, railway slipper after preservative treatment etc.
Fuel wood	It provides good fuel wood and charcoal.
Tannin	Bark contains 4.22% tannin.
Medicinal value	Oil is extracted from the fresh leaves and twigs, and may be used as bath salts, room sprays, and deodorants.
Paper and pulp	The wood yields a long fibred pulp, which is used for the manufacture of news-print and cheap printing and writing papers.
Others	Leaves contain alkaloid, used as manure and as little for cattle feed.

Local name: Lali Gurans	English name: Rhododendron
Rhododendron arboreum	Ericaceae

1. Natural occurrence: It occurs between 1500m and 3300m but is common above 2300m.

2. Morphological characteristics:

Leaf	Leaves are crowded at the ends of branches; narrow; and pointed at both ends; leathery and shiny.
Flower	The large attractive bell-shaped flowers appear in bunches at the ends of branchlets, the flowers are generally a deep crimson color, and when in full bloom the trees are a wonderful sight.
Fruit	The small seed capsules are oblong, slightly curved and ringed length ways.
Seed	Seeds are dark brown, minute, compressed and oblong.

3. Silvicultural characteristics:

Light	It is a light demander tree species.
Frost	It is a frost hardy.
Drought	Young seedlings are very sensitive to drought.
Fire	Overgrazing and fire favors the spread of the species.
Soil	It thrives best on moist loam without lime but can also grow on rocky ground if there is sufficient soil-moisture unlike many species.
Coppice	It coppices well.
Associates	It is a common in western Himalayas and occurs in association with *Quercus incana, Lyonia ovalifolia, Pinus roxburghii.*
Graze& browse	Leaves are unpalatable to browsing animals.
Tree Nature	It is an evergreen, much branched and a small moderate sized tree.

4. Artificial regeneration:

Preferred propag^{n}	Cuttings and seedlings.
Seed collection time	Seed ripens between August and March.
No. of seed kg^{-1}	Seeds are minute, about 12million seeds kg^{-1}.
Seed extraction	Seeds are extracted by drying the capsules on a sheet of paper in the sun.
Seed storage	Orthodox seed; should be dried thoroughly in the sun and stored in the sealed container in a cool and safe place.
Viability of seed	Viability of seeds remains for 2 years.
Seed treatment	Seed should be soaked in water before sowing.
Seed sowing time	Seeds are sown during February and March.
Duration of germination	Growth of seedling is very slow. When plant takes two or three leaves, it should be pricked out in container.
Germination (%)	Germination may obtain more than 80% from the fresh seed.
Nursery period	**Seedling:** Seedlings are planted out during the monsoon.
Best planting size	20-30cm tall seedling with root color diameter 3mm or bigger.

5. Forest pathogens: The tree attacked by several fungi and insects.

6. Wood properties:

Wood Color	**Sapwood:** reddish to brownish white. **Heartwood:** reddish brown to brown.
Hardness	It is moderately hard wood.
Working Quality	It is easy to saw and work, finishes to a smooth surface.
Weight	It is a moderately heavy wood; specific gravity is 0.5; weight 640 kgm^{-3}.
Calorific value	c.v. of sapwood: 4,973 calories. It yields poor quality charcoal.
Durability	Wood is not durable in the open, but moderately durable under cover.
Seasoning	It is highly refractory wood to seasoning. It warps badly and shrinks during seasoning.

7. Uses:

Timber	Wood is suitable for making plates, tool-handles, boxes, packing cases, posts, plywood. etc.
Fuel wood	Wood is used as fuel.
Fodder	It is unpalatable to cattle as well as cause toxic effects.
Edible food	The tender leaves are used as a vegetable. Flowers, sourish-sweet in taste, are eaten.
Ecological value	It is generally planted on newly exposed ground such as road cuttings, landslips, and crevices of bare rocks. It is planted as an ornamental tree in temperate region. It is the national flowers of Nepal.
Medicinal value	Flowers are used in diarrhoea and dysentry .The young leaves are applied to the fore-head to cure headache.

(9)

Local name: Thingure salla	**English name: Himalayan yew**
Taxus baccata	**Taxaceae**

1. Natural occurrence: It occurs in Nepal between 2,300m and 4,400m.

2. Morphological characteristics:

Leaf	Leaves are distichously, linear, with recurved margin, shining above, and pale-yellowish brown or rusty red below.
Flower	Flowers are usually dioecious, **Male strobili** stalked, globose, **Female strobili:** solitary axiliary.
Fruit	Fruit is an ovoid berry.
Seed	Seeds borne in a scarlet, fleshy cup. Seed has two cotyledons.
Bark	Bark is reddish brown, thin and scaly.

3. Silvicultural characteristics:

Light	It is a shade bearer; can grow and reproduce under fairly dense shade.
Frost	It is a frost hardy.
Fire	It is a fire tender because bark is so thin that fire is fatal to the trees.
Soil	The common yew is a conspicuous tree in Himalayan forests, usually in shady

	places under trees. It does not thrive in areas where forests have been cleared.
Coppice	It is a non-coppicer.
Associates	It is associated with *Picea smithiana, Tsuga dumosa, Pinus wallichiana, Quercus semicarpifolia*.
Tree nature	It is an evergreen shrub or tree, usually much branched with spreading branches and dense foliage.
Others	Leaves contain an alkaloid poison which is fatal to man and livestock.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, cutting.
Seed collect^{n} time	Seeds ripen in November.
No. of seed kg^{-1}	8,000 seeds kg^{-1}.
Seed extract^{n}	The pulp should be removed.
Seed storage	Seeds should be stratified in sand over winter in a cool place.
Viability of seed	Seed can be stored for four years in tins in cold storage.
Seed sowing time	Seeds are directly sown into polytubes in the following spring.
Duration of germ^{n}	Germination is very slow.
Germination (%)	Germination may obtain over 95%.
Nursery peri. /Seedling	Seedling takes (2-4) years in the nursery to reach 30cm in height.
Best planting size	30cm tall seedlings with 5-7mm root collar diameter.

5. Diseases, Pests and Parasites of *Taxus baccata*:

A few insects and fungi such as sapwood borer, brown cuboidal rot, white spongy rot etc. cause the decay of felled timber.

6. Wood properties:

Wood Color	The wood is orange brown or dark claret brown, often marked with lighter and darker streaks along the grain.
Hardness	It is the hardest of all coniferous woods.
Working Quality	Its wood saws moderately easily; works very well on machines; finishes to a beautiful and smooth surface and takes an excellent fine polish.
Weight	It is light to heavy wood. Wood weighs about (592-945) kgm^{-3}.
Strength	Wood is valued for its great strength, durability and decorative character.
Calorific value	Calorific value is 4,143 calories.
Durability	Wood is durable.
Seasoning	It is a medium refractory wood to seasoning. It seasons well but slowly and possible to warping and transverse cracks if proper care is not taken.
Elasticity	Its wood is elastic.

7. Uses:

Timber	Timber is used for furniture, veneers, parquet flooring, and paneling, and for gates and fences. It is highly prized for making bows and used for gun and rifle wood.
Fuel wood	It is a good fuel wood species. It burns well.
Fodder	Animals avoid browsing on the tree, due to poisonous containing in leaves.
Edible food	The non- poisonous and fleshy aril is eaten by the tribals.
Tannin	Red juice of the bark is used in Nepal as an inferior dye.
Medicinal	A medical tincture made from the young shoots is used for the treatment of

value	headache ,diarrhoea, coldness of the extremities etc.
Other	Active constituents possess taxol, essential oil, tannic acid and, 11 types of a taxine alkaloid. It is planted as an avenue tree. Extracts of *T.baccata* can be added in cosmetics, such as hair-lotions, beauty-and saving-creams and dentifrices.

Other medicinal uses of *Taxus baccata*:

- Leaves are used in asthma, bronchitis, remedy for indigestion, hysteria, nervous complaints, and as an aphrodisiac.
- A decoction of the wood is a well-known remedy against hydrophobia in Germany.
- Leaves and barks are a good source of taxol, which is used against ovarian, lung, breast and other types of cancer.

(10)

Local name: Thingure salla	**English name: Hemlock**
Tsuga dumosa	**Family: Pinaceae**

1. Natural occurrence:

It occurs in Nepal between 2100m and 3600m.According to Champion and Seth (1968), it occurs in east Himalayan moist temperate forest with mixed coniferous forest.

2. Morphological characteristics:

Leaf	Leaves are distichously, dark green and grooved above, silvery white beneath.
Flower	Flowers are monoecious; **male flowers:** in the axils of previous year's leaves; **Female flowers:** on the previous years lateral shoots.
Fruit	Mature cones.
Seed	Cones are broadly ovoid.
Bark	Bark is thick and rough.

3. Silvicultural characteristics:

Light	It is a shade bearer tree.
Frost	It is a frost hardy tree.
Drought	One of the most droughts tolerant tree species of Nepal.
Fire	It is a fire sensitive.
Soil	It grows on soil with a wide range of pH from 4.3-7.5. It needs mychorrizal soil in the potting mixture.
Coppice	It is a non-coppicer.
Associates	It is associated with Rhododendron, Spruce, and Fir. **Upper limit:** Fir and birch forest, **Lower limit:** *Aesculus-Juglans–Acer* forest.
Tree nature	It is a large evergreen, handsome tree with a pyramidical crown, spreading branches which droop gracefully.

4. Natural regeneration:

Seed product^{n}	Ripe cones shed their seeds between Aug & Dec. while they are still on tree.
Seed dispersal	Seeds are winged and dispersed by wind.
Seed germ^{n}	Germination takes place in next monsoon.

Establishment	Seedlings establish themselves on bare sites such as landslips and abandoned cultivated land easily.

5. Artificial regeneration:

Preferred propagat^{n}	Direct sowing, entire planting.
Time of seed collect^{n}	Seeds are collected between January and March.
No. of seed kg^{-1}	About 400,000 seeds kg^{-1}.
Seed extraction	Seeds are extracted by drying the cones, and later beating.
Seed storage method	Seeds are stored in sealed container and at cool place.
Viability of seed	Seeds retain their viability after six months.
Seed sowing time	Seed should be sown during spring season.
Durat^{n} of germinat^{n}	Germination completes within 45 days.
Germination (%)	Germination may obtain 80-90%.

6. Wood properties:

Wood Color	The wood is white.
Hardness	It is a soft wood.
Working Quality	It can be beautifully painted or polished; easy to saw and work.
Weight	The wood weighs about 450kgm^{-3}, the wood is light.

7. Uses:

Timber	The timber is used for construction purpose; also used for making door and window frames. But it is not a very high quality timber.
Fuel wood	It is used for fuel wood.

CHAPTER: V

IMPORTANT FODDER TREE SPECIES OF NEPAL

(1)

L. N.: Babul	**E. N.: Indian rose wood**
B.N. : ***Acacia nilotica***	**Family: Mimosaceae**

1.Natural Occurrence: It is found scattered in the lower Terai. Usually found in drier parts of Terai, but will not thrive without irrigation if the climate is too arid.

2. Morphological characteristics:

Leaves	Leaves are bipinnate.
Flowers	Flowers are golden yellow and sweet-scented.
Seed	8-12 seed per pod, compressed, ovoid and dark brown.
Bark	Bark is dark-brown or nearly black, with regular deep, longitudinal fissures.

3. Silvicultural characteristics:

Light	It is a strong light demander
Frost	Frost tender
Fire	Babul is not a fire-resistant species.
Drought	Drought-resistant.
Coppice & Root sucker	The babul is usually pollarded well and is freely lopped for thorn fences & fodder. Root suckers are seldom produced.
Browsing	It is susceptible to browsing damage particularly by goats and camels, even by sheep and buffaloes**.**
Lopping	Lopping for fodder and thorn hedges is a source of much injury to the babul.
Tree nature	It is a medium to large sized almost evergreen tree.
Root system	The young plant develops a long taproot from the commencement, and strong lateral roots are also formed early. Under normal conditions on dry ground the taproot reaches a considerable length where water is found.
Soils	It grows best on alluvial silts near rivers, where it is often flooded deeply each year, but is said to tolerate a wide range of soils including heavy clays. Black cotton soil is generally very suitable for babul.
Associates	Babul commonly associates with Sissoo and Khair forests.
Climate	**Absolute Max.** shade temp. $(32\text{-}39)^0$C, **absolute Min.** temp. $(-1 \text{ to } 10)^0$C and rainfall varies from 500 to 2,000mm.

4: Natural regeneration: Natural regeneration is mainly through seed and seedling coppice.

Seed production	It produces abundant fertile seed annually.
Seed dispersal	Ripe pods get blown down to the ground by wind. The animals, which feed on the pods also help in seed dispersal.
Seed germination	The pods or seeds remain lying on the ground takes place only during monsoon as good soaking of the seed is necessary before germination.
Seedling establishment	Factors determining seedling establishment are: **(a)** Amount of light. **(b)** Competition from weeds. **(c)** Availability of moisture. **(d)** Soil condition.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting,
Seed collect^{n} time	Seeds are collected between June & July.
Seed storage method	Seeds should be stored in gunny bags or tins or baskets in airtight container in a cool place.Such properly stored seed retains viability for many years. No. appreciable fall of germination capacity was noticed up to three years.
No. of seed kg^{-1}	There are about 9000 seeds kg^{-1}, germinative capacity: 30%, plants per kg of seed: 1310

Pre-sowing treatment of seed : The outer coat of babul seed is very hard and impermeable & some pre- sowing treatment is necessary for better germination. The following gives better results.

(a) Immersion in cold water for 48 hours before sowing.**(b)** Immersion in hot water (80^{0}C for about 30 minutes.**(c)** Soaking in conc. H_2So_4 (90%) for 10 to 30 minutes.**(d)** Cow dung treatment. **(e)** Clippping treatment: The outer coat is cut with sharp knife leaving a small opening through which moisture can penetrate.

6. Diseases, pests and parasites of Babul:

(i) Insect pests: The four most destructive pests of babul are *Coelosterna scabrator, Psiloptera fastuosa, P.Coerulia* and *Aeolesthes holosericea. C.Scabrators* is a dangerous root borer, whereas the others strip the bark off the shoots and branches.

7. Wood properties:

Wood colour	Sapwood is whitish, heartwood is pinkish white to light red when first exposed, turning reddish brown with age.
Weight	Wood is moderately heavy to heavy (Sp. gr. 0.8, wt. 817 -865 kgm^{-3}).
Strength	Wood is strong.
Hardness	Wood is hard.
Seasoning	Moderately refractory wood to seasoning. It seasons well even in the log. It is liable to split in the hot weather and should be converted under shade.
Working quality	It is somewhat difficult to saw. It works well by hand, finishes to a good surface, takes a fair polish.
Calorific value	4,224 calories

8. Uses of Babul:

(i) Fuelwod: Excellent fuel wood. **(ii) Heartwood:** An extract of the bark, leaves and pods is used for dyeing cotton and silks. **(iii) Lac:** Babul is a good host of lac. **(iv)Timber:** Favourite wood for art-making, agricultural implements etc. Babul is used as an avenue tree. **(v) Tanin:** Bark of babul contains 12-19% tannin. **(vi) Gum:** the gum exudes from wounds in the bark, mostly during March to May. Good quality babul gum is used in calico-printing and dyeing, as a sizing material for silk and cotton, and in the manufacture of paper. It is used as an adhesive though its adhesive strength is lower. Gum is used in diarrhoea, dysentry, diabetes, sore-throat etc, **(vii) Seeds :** Seeds are eaten roasted or raw in times of food scarcity.
(viii) Leaves and pods: The leaves are an excellent fodder and are extensively lopped for this purpose. **(ix) Thorny branches:** Use for fencing material.

(2)

L. N. : Chiuri	**E. N.: Indian butter tree**
B.N.: *Aesandra butyracea*	**Sapotaceae**

1. Natural occurance: It occurs in Nepal between Terai to 1500m.

2. Morphological characteristics:

Leaf	The leaves, which are crowded towards the ends of the branches, are large. They are oval–oblong in shape, leathery and have soft hairs on the undersides.
Flower	Flowers are white, in clusters below the leaves.
Fruit	Fruit is fleshy, oval, containing a single seed.
Seed	Seeds are elongated with a thin seed coat.

3. Silvicultural characteristics:

Light	Light demander tree.
Frost	Somewhat frost hardy.
Drought	Drought resistant.
Associates	It is often associated with Sal forest in Terai and *Schima-Castanopsis* forest in sub-tropical zone.
Browsing	Leaves are palatable, so seedlings are seriously damaged by browsing animals.
Coppice	Ir coppices well.
Tree nature	It is a fairly large deciduous tree.

4. Artificial regeneration:

Preferred propag^{n}	Seedlings.
Seed collect^{n} time	Fruits ripen between June and August.
No. of seed kg^{-1}	100 fruits kg^{-1}, 450 to 1000 or more seeds kg^{-1}.
Seed extract^{n}.	Do not remove the seeds from the flesh until just before sowing.
Seed storage method	Recalcitrant seed. Seeds are kept in fruit and do not store fruits for more than 2-3 days.
Viability of seed	Seeds remain viable for 2-3 days.
Seed treatment	All flesh should be cleaned off.
Seed sowing time	June to August.
Duration of germ^{n}	Starts in 1-2 weeks and may continue for 4 weeks.
Germ^{n}. percent	Germination percent is high as 80%.

Nursery period	**For Seedling: <1000m:** 11-13 months, **>1000m:** 23 to 25 months.
Best planting size	20cm tall seedling with root collar more than 6mm in diameter and very strong tap root.

5. Uses:

Fuel wood	Wood weighs about 640 to 830 kgm^{-3}. It is a good fuel wood.
Fruits	Fruits yield a high quality vegetable ghee (Indian butter) called as *chiuri* ghee which is widely used for burning in lamps, in sweet meats and for soap manufacture.

(3)

L. N.: Badahar	**E. N. : Monkey Jack**
B.N.: *Artocarpus lakoocha*	**Moraceae**

1. Natural occurrence: It grows froms Terai to 1300m, occasionally 1600m.

2. Morphological characteristics:

Leaf	Alternately arranged leaves are simple, large and elliptical in shape.
Flower	Flowers appear on the leafless branch. Male and female flower arise from different points. Male flower, which are yellow and fleshy looking, usually fall to the ground soon after they appear.
Fruit	Fruit is large and fleshy.
Seed	Seed having fleshy within seed coat.
Bark	Bark is dark brown, exfoliating in small, round, woody peels, reddish inside.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Soil	It grows best on deep permeable soils with a good supply of moisture, and does not thrive on poor soils, often occurs on the bank of river.
Coppice	It coppices well.
Associates	It is mostly occurred in Sal forest.
Browsing	Young plants are liable to damage by browsing animals.
Tree nature	It is a large deciduous tree with spreading crown and clear straight bole.

4. Natural regeneration:

It takes place from the seed and that are dispersed by birds and other animals.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, cutting, root suckers.
Seed collec^{n}. time	Fruits ripen between late June and early August.
No. of seed kg^{-1}	1900 to 5000 seeds kg^{-1}.
Seed extract^{n}.	Flesh should be removed from the fruit.
Seed storage	Recalcitrant seed.
Viability of seed	Seeds lose their viability within a few days (2 days).

Seed treatment	Flesh should be removed from seeds immediately before they are sown.
Seed sowing time	Seed should be sown immediately after collection (July to early August)
Duration of germ^{n}	**<1500m**: germination begins about two weeks and is completed 1-2 weeks later, **>1500m:** takes a longer period.
Germination (%)	80% from fresh seed.
Nursery period	**For Seedling:** 11 months after sowing, at the beginning of rains.
Best planting size	Seedling will be 25-35cm in height with 5 to 7 mm root collar diameter.

6. Forest pathogens: The tree is susceptible to damage by *Alternaria tenuis*.

7. Wood properties:

Wood Color	Wood is yellowish brown when fresh but turns dark brown after exposure.
Weight	Heavier than other *Artocarpus species* (Weight 640 kgm^{-3})
Working Quality	Wood saws and works well, finishing to a smooth surface but do not take satisfactory polish.
Strength	It is fairly strong wood.
Durability	Timber is durable both in exposed situations and under water.Wood is resistant to white ants and marine borers.
Preservative treatment	It seasons well without difficulty but logs should be converted soon after felling.

8. Uses:

Timber	It is a popular wood for house construction work, medium–weight furniture and boat building.
Fodder	Leaves are highly used as fodder. They contain about 16% crude protein.
Edible food	Fruit is edible; pickle is made from unripe fruit.
Tannin	Bark is a good source of soluble tannin and can be used for tanning purposes.
Others	It is planted as a shade or ornamental tree.

(4)

L. N.: Tanki	
B.N.: *Bauhinia purpurea*	**Caesalpinaceae**

1. Natural occurrence: It is found throughout Nepal from Terai to1600m.

2. Morphological characteristics:

Leaf	Simple leaves are partly divided into two slightly pointed lobes, by a cleft that goes half way down. Veins are arranged palmately, radiating out from the top of leaf stalk; base of leaf is like heart.
Flower	The purple or lilac colored flowers are large and fragrant.
Fruit	Pods are flat, fairly thick, slightly curved and pointed.
Seed	Each pod contains 10 to 15 brown, compressed seeds.
Bark	It has dark grey or brown bark, & young branches are covered with short, stiff hairs.

3. Silvicultural characteristics:

Light	It is a moderately light demander.

Frost	Frost hardy.
Drought	Drought resistant.
Fire	It is susceptible to damage by fire.
Associates	It is commonly associated with *Shorea robusta and Schima- Castanopsis* forests.
Coppice	It coppices well.
Browsing	Young plants are severely damaged by browsing animals.
Tree nature	It is a medium sized, evergreen ornamental tree.

4. Natural regeneration:

Seed prod^{n}	Seeds ripen between February and May.
Seed dispersal	By wind.
Seed germ^{n}	Germination takes place during rainy season.
Establishment	Seedling can establish easily if they are protected from browsing animals etc.

5. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting; stump planting, and branch cutting.
Seed collec^{n} time	February to May.
No.of seed kg^{-1}	4,000 to 5,000 seeds kg^{-1}.
Seed extract^{n}	Pods are dried in the sun and allow opening.
Seed storage	Orthodox seed. Seeds are dried thoroughly in the sun for several days, put in a polythene bag, seal tightly and keep in a cool place.
Viability of seed	Proper stored seeds can retain their viability for at least 12 months.
Seed treatment	Not necessary. However soaking the seeds for 24 hours, changing the water 3-4 times during this period may help reduce fungal attack during and after germination.
Seed sowing time	**<1000m:** Mid-May, **1000-1500m:** early March, **>1500m:** August.
Duration of germ^{n}	Germination starts about 5-10 days after sowing & completes 1-2 weeks later.
Germ^{n} percent	Germination is high (70-90%)
Nursery period	**For Seedling: <1500m:** less than 6 month, **>1500m:** 11 month.
Best planting size	20-30cm tall seedlings with root collar diameter is about 4-5mm or more.

6. Forest pathogens: The species is heavily parasitized by *Dendrophthoe falcata, Fomes lignosus* or *Hyposoxylon ustulatum* attack the roots and kill most of them.

7. Wood properties:

Wood Color	Wood is greyish red.
Weight	Wood is soft and light (weight 576 kgm^{-3}).
Working Quality	It is very easy to saw and work, and takes good polish.
Durability	Wood is not much durable; liable to attack by wood borers and white ants.
Seasoning	Timber seasons without cracking and should be converted green and open–stacked under cover.

8. Uses:

Timber	Timber is used for agricultural implements. It is also suitable for scantlings and rafter in inferior construction works.
Fuel wood	Wood is used as fuel wood.

Fodder	Leaves are used as fodder; contain 12.6-29.7% crude protein.
Edible food	Seeds are edible, which contain 27.31% crude protein. Flowers, buds are eaten as vegetable and also pickled.
Tannin	Bark is used in dyeing and tannin materials.
Ecological value	It is planted in gardens as an avenue tree, since it bears fragrant flowers.
Medicinal value	Stem bark has astringent properties and is used in diarrhoea. Root is carminative and root bark is poisonous.
Other	Bees are the most attract to the flowers, making the tree a useful one for bee-keepers.

⑤

L. N. : Koiralo	
B.N. : *Bauhinia variegata*	**Caesalpinaceae**

1. Natural occurrence: It is found in Nepal throughout from Terai to1900m.

2. Morphological characteristics:

Leaf	Leaves are rather broader than deep, rigidly, sub-coriaceous, and deeply cordate.
Flower	Flowers occur on the upper leafless branches, they are pink or white and quite large.
Fruit	A pod, which opens.
Seed	Seed is large, flat and rounded.
Bark	Bark is grey, with long vertical cracks.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	Drought resistant.
Fire	It is susceptible to damage by fire.
Soil	It can tolerate to poor dry sites, but growth is stunted. It prefers well-drained, deep, fertile, porous soil, does not withstand water logging.
Coppice	It coppices well.
Associates	It is commonly associated with Shorea *robusta* and *Schima–Castanopsis* forest, but it occurs frequently in *Pine-Schima* forest.
Browsing	Young plants are severely damaged by browsing.
Tree nature	It is a small to moderate sized deciduous tree.
Other	Though it belongs to leguminosae family, it does not have rhizobial nodules on the roots.

4.Natural regeneration: ~ same as Tanki except seeds ripen between March & May.

5. Artificial regeneration: ~ same as Tanki except **i).** Seed collection time is March to June. **ii).** No. of seed kg^{-1} is 2500-3500 seeds kg^{-1}. **iii).** Seed sowing time is **<1000m:** April, **1000-1500m:** early March, >**1500m:** August.

6. Diseases, Pests and Parasites: i. the tree is seriously damaged by the Phytophagus mite, *Eutetranychus uncatus*. **ii.** Plant is heavily parasitized by *Dendrophthoe falcata*.

7. Wood properties:

Wood Color	Wood is greyish brown.
Hardness & weight	Moderately hard wood (Air dry wt. is 70 kg per cu.m.)
Working Quality	Wood saws and works well without any difficulty.
Strength	Wood is strong.
Calorific value	20,100 $KJkg^{-1}$.
Seasoning	It seasons well without any difficulty.

8. Uses:

Timber	Timber is used for agricultural implements.
Fuel wood	It is a good fuel wood.
Fodder	A good fodder tree, about 19% crude protein content with a digestibility of 25%.
Edible food	Buds and flowers are edible.
Tannin	Bark is used for tanning and dyeing.
Gum & resin	The tree exudes a gum.
Medicinal value	Root is carminative and is used in dyspepsia. Bark is astringent, tonic and anthelmintic. It is useful in skin disease, ulcer and leprosy. Dried buds are used for the treatment of diarrhoea, dysentry, worms, piles etc.
Others	Bark yields fiber. Leaves are used for the preparation of *bidis*.

(6)

L. N. : Lapsi	
B.N. : *Choerospondias axillaris*	**Family: Anacardiaceae**

1. Natural occurrence: This is a fairly common tree of the temperate forests of Nepal with an altitude range between 950 and 1900m.

2. Morphological characteristics:

Leaf	Alternately arranged compound leaf which are crowded towards the ends of branches. Each leaf is divided into 6 to 8 pairs of leaflets and 1 terminal leaflet.(i.e, imparipinnate). Leaflets vary in shape from oval to lance like.
Flower	The flowers, which bloom between April and May, are small and greenish-white. They are borne in bunches at the ends of branchlets.
Fruit	The furits, which ripen between November & December, is an oblong drupe, rounded at both ends and yellowish when ripe.
Seed	Seeds are contained within a stone.
Bark	The bark of young tree is grey and smooth, while that of old tree is slightly fissured, cracked and scaly.

3. Silvicultural characteristics:

Light	Light demander.
Frost	**Seedlings:** Frost tender and mature trees are frost hardy.
Soil	It has moderately tolerant of low fertility and dry soil.

Coppice	It coppices well.
Associates	It is commonly associated with *Schima-Castanopsis* and Oak forest.
Tree nature	Leaves are palatable so they are severely damaged by browsing animals.
Tree nature	It is a medium to quite large deciduous tree.
Other	It does not produce fruit if planted below 950m, though the tree will grow.

4. Natural regeneration: ~ takes place from the seed, which is dispersed by birds.

5. Artificial regeneration:

Preferred propag^{n}	Seedling, hardwood cuttings
Seed collect^{n} time	October–January.
No. of seed kg^{-1}	300 stones kg^{-1} & 1500 seeds kg^{-1}. A single stone contains up to five seeds.
Seed extract^{n}	The stones are removed from the flesh by soaking the fruits and rubbing together. The seeds are not extracted from the stones.
Seed storage	Orthodox seed, well-dried seed should be stored in sealed tight container.
Viability of seed	Seed will viable for two year. Use of smaller kernels should be avoided.
Seed treatment	All flesh should be removed.
Seed sowing time	**< 1500m:** late February, **>1500m:** August. Whole stones should be sown.
Duration of germ^{n}	Usually starts 3-4 weeks after sowing and may continue for 2 or 3 months.
Germination (%)	80% when fresh.
Nursery period	**For Seedling: <1500m:** 5 months, **>1500m:** 11 months.
Best planting size	20-35cm tall seedling with more than 3.5mm root collar diameter and well-lignified stems, strong tap roots and many fibrous roots.

6. Wood properties:

Weight	Wood is soft and light, weighing about 400 kgm^{-3}.

7. Uses:

Fuel wood	Its fuel wood is very inferior so it is rarely used.
Fodder	Leaves are used as fodder but not a very large scale.
Edible food	This species produces an edible fruit from which *Achar* and sweets are made.

(7)

L. N. : Khanyu	**E. N. : Fig**
B.N. : *Ficus cunia Syn. F. semicordata*	**Family: Moraceae**

1. Natural occurrence: Khasru khanyu: Terai to 2000m, **Rai khanyu:** 1400-2000m.

2. Morphological characteristics:

Leaf	Leaves are alternate, oblong-lanceolate, and very unequal sided, acuminate & serrate.

3. Silvicultural characteristics:

Light	Light demander.

Frost	Somewhat frost hardy.
Drought	In its natural range, drought seldom occurs.
Fire	Fire tender.
Soil	It can grow on a wide range of soil type.
Coppice	It coppices well.
Associates	It is found in *Schima-Castanopsis*, as well as Sal forest.
Browsing	Young plants are liable to damage by browsing animals.

4. Natural regeneration: Natural regeneration takes place from seeds, which are dispersed by birds.

5. Artificial regeneration:

Preferred propag^{n}	Seedlings, hardwood cuttings.
Seed collec^{n} time	July to October.
No. of seed kg^{-1}	1 to 3.5 thousand per gram.
Seed extraction	The fleshy contents of the figs are squeezed into a bucket of water. Mix well and allow the seed to settle to the bottom. The water suspended pulp is thrown away. Repeat until the seed is clean.
Seed storage	Orthodox seed. Thoroughly dried seeds in the sun are put in the sealed tightly container and are kept in a cool place.
Viability of seed	Seeds will viable for two years.
Seed treatment	It is not required.
Seed sowing time	**<700m:** late Feb-early March, **700 to1500m:** early Aug, **> 1500m:** early Aug.
Germination (%)	Germination percent is low.
Nursery period	**For Seedling:** Usually 11 months for August sown seed or 4-5 months for seed sown in February- March.
Best planting size	20-25cm tall seedlings are the optimum size for planting.

6. Uses:

Fodder	Leaves are used as an excellent fodder. Leaves contain 11.89% crude protein.

(8)

L. N.: Dudhilo	**E. N.: Fig**
B.N.: *Ficus nerifolia* Syn.: *Ficus nemoralis*	**Family: Moraceae**

1. Natural occurrence: It occurs between 900 and 2200m. It mainly grows at higher altitude than other figs

2. Morphological characteristics:

Leaves are gradually tapering to a point; veins 10-12 pairs; leaf stalks 1-2cm smooth; figs 5-8mm; branchlets reddish.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	In its natural range, drought seldom occurs.
Fire	It is fire resistant since foliage contains high amount of water.

Soil	Capable of growing on a wide range of soil type. It tolerates soils of high pH.
Coppice	It coppices well.
Associates	It is found in *Schima-Castanopsis* forest.
Browsing	Young plants are liable to damage by browsing animals.

4 . Natural regeneration: Natural regeneration takes place from seeds that are dispersed by birds.

5. Artificial regeneration:

Preferred propag^{n}	Seedlings, hardwood cuttings.
Seed collec^{n} time	June- August.
No.of seed kg^{-1}	1.5 to 3 thousands per gram.
Seed extract & storage	**Same as Khanyu.**
Viability of seed	Seeds are viable for one year.
Seed treatment	It is not required.
Seed sowing time	**<1500m:** Early August**, >1500m:** March to April.
Duration of germ^{n}	Germination of seed takes place for 2-3 weeks.
Nursery period	**Seedling:** Usually 11 months for August sown seed or 4-5 months for seed sown in February to March.
Best planting size	20-25 cm tall seedlings are the optimum size for planting.

6. Forest pathogens: In nursery, white grubs can cause considerable damage by eating the roots.

7. Uses:

Fodder	Leaves are used as an excellent fodder. Leaves contain 13% crude protein.

(9)

L. N.: Dabdabe	
B.N.: *Garuga pinnata*	**Bursearaceae**

1. Natural occurrence: It occurs in Nepal up to 1300m.

2. Morphological characteristics:

Leaf	Leaves are imparipinnate, often covered with red galls.
Flower	Flowers are yellow or greenish white, polygamous.
Fruit	Drupes that are yellowish green to black, globose, fleshy.
Seed	Each drupe contains 3-4 stones.
Bark	Bark is greyish brown, exfoliating in large irregular flakes.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost tender.
Drought	Drought sensitive.
Fire	Fire resistant.
Soil	It grows on a wide range of soil type. Soil of Sal will suit for *Garuga*.
Coppice	It coppices well and produces root suckers.
Associates	The tree occurs sporadically in mixed deciduous forest and is a common

	associate of Teak and Sal.
Browsing	Young plants are liable to damage by browsing animals.
Tree nature	It is medium sized deciduous tree with a straight cylindrical bole.
Other	The trees are able to tolerate a moderate growth of grass and low weeds.

4. Natural regeneration: It takes place through seeds, which are dispersed by birds. The drupes fall to the ground.

5. Artificial regeneration:

Preferred propg^{n}		Seedlings, cuttings, air layering.
Seed collect^{n} time		Seeds are collected between June and September.
No. of seed kg^{-1}		4,000 to 5,000 kernels kg^{-1}
Seed extract^{n}		The pulp should be removed as soon as possible after the seed has been collected.
Seed storage		Orthodox seed; well dried seed can be stored in sealed container.
Viability of seed		Viability of properly dried and stored seed can retain for at least 1 year.
Seed treatment		Soak the seed in hot water.
Seed sowing time		July.
Germination (%)		44%.
Nursery period	**Seedling**	Seedling will be ready for next monsoon planting.
	Stump	Stump can be prepared from one-year-old seedling.
Rest planting size		15-25cm tall seedlings with 4 -5mm root collar diameter.

6.Wood properties:

Wood Color	Sapwood is large and white, heartwood is reddish brown.
Weight	Wood is light to moderately heavy (Sp.gr. is 0.64 & wt. is 41lb/cu.ft).
Working quality	Timber is easy to saw and work.
Strength	Wood is strong.
Calorific value	**Sapwood:** 4,828 calories, **heartwood:** 4,909 calories.
Durability	Heartwood is fairly durable but the sapwood is perishable.
Seasoning	Heartwood can be air-seasoned with good results, but sapwood behaves unsatisfactorily.
Grain & texture	Wood is uneven-grained and coarse- textured.

7. Uses:

Timber	It is used for planking, canoes, boxes, drums, cabinetwork & house building.
Fuel wood	The wood is used as fuel. It gives charcoal of fair quality.
Fodder	Leaves and shoots are used as fodder.
Edible food	Drupes are eaten raw, cooked or pickled; they are strongly acidic and possesses cooling and digestive properties.
Tannin	Bark and leaf galls are used for tanning.
Gum & resin	Tree yields a greenish-yellow gum resin of no particular economic value.
Ecological value	Being fire-resistant and easy to propagate, it is valuable for afforestation.
Medicinal value	The juice of the stem is used as remedy for the opacity of conjunctiva. Leaf juice along with honey and other ingredients is given for asthma.
Paper and pulp	Pulp is suitable for brown wrapping paper.

(10)

L. N.: Siltimur	
B.N.: ***Litsea cubeba***	**Family: Lauraceae**

1. Natural occurrence: It occurs between 1000 to 2700m, particularly in areas of rather heavy rainfall, on North and North West.

2. Morphological characteristics:

Leaf	Leaves are aromatic when crushed, lanceolate, tapering to a long point, alternate.
Flower	Flowers are small, in 4-6 flowered heads, enclosed by large concave bracts in buds. Male and female flowers are on different trees.
Fruit	Fruits borne on a cup formed from the persistent perianth.

3. Silvicultural characteristics:

Light	Moderate light demander.
Frost	Frost hardy.
Soil	It can grow on a wide range of soil type; it prefers well drained, moist, fertile soil.
Browsing	Young plants are liable to damage by browsing animals.
Coppice	It coppices well.
Tree nature	It is a medium sized evergreen tree.

4. Artificial regeneration:

Preferred propag^{n}	Seedling, stem cutting.
Seed collect^{n}. time	Seed should be collected between August and September.
No. of seed kg^{-1}	14,000 seeds kg^{-1}.
Seed extraction	Flesh should be removed.
Seed storage	Recalcitrant seed. Seed must be kept moist.
Viability of seed	Viability loses very rapidly.
Seed treatment	Fleshy seed coat must be removed before sowing.
Seed sowing time	Seeds sow immediately after collection within a week in Aug-Oct.
Duration of germ^{n}.	Seed of siltimur does not germinate until the following spring, if it is sown after September, otherwise it will germinate 4-6 weeks after sowing.
Germination (%)	More than 60%.
Nursery period	**Seedling:** It can be planted out in the monsoon after 11-14 months.
Best planting size	**Seedling:**20-35cm in height, with root collar diam. of more than 3.5 mm.

5. Wood properties: Weight: wood weighs about 580 kgm^{-3}.

6. Uses:

Fuel wood	Wood is primarily used as a fuel.
Fodder	It is a moderate quality fodder.
Medicinal value	Fruits are used as a spice to cure for stomach disorders.
Others	An oil is extracted from bark, leaf and fruit.

(11)

L. N. : Kutmiro	
B.N.: *Litsea monopetala*	**Lauraceae**

1. Natural occurrence: It occurs in Nepal from Terai to 1500m.

2. Morphological characteristics:

Leaf	Leaves are alternate, oval or elliptic in shape, leathery. **Top surface:** Dark green and smooth. **Lower surface:** Rust color covered with hairs.
Flower	Flowers appear in May, white or pale yellow in color, umbels.
Fruit	Fruit ripens between June &July, which turns black.
Bark	Bark is dark grey or light brown, smooth, but slightly furrowed with age.

3. Silvicultural characteristics: ~ similar as siltimur except **i). Soil:** It grows best on loamy soils. It can grow on poor soil and gentle slope facing southwest. **ii). Associates:** It is commonly found in Sal forest.

4. Artificial regeneration: ~ similar as Siltimur except **i). Seed collection time:** The seed ripens between late May and early August. **ii). No. of seed kg^{-1}:** 53,00 seeds kg^{-1}. **iii). Seed sowing time:** Seed should be sown immediatley after collection within a week. **iv). Duration of germ^{n}:** Kutmiro starts to germinate two weeks after sowing and is completed after two weeks.

5. Uses:

Timber	Wood is used for agricultural implements. It weighs about 610 kgm^{-3}.
Fodder	One of the most important fodder trees. Leaves contain 14-17% crude protein.

(12)

L. N.: Kimbu	E. N.: White mulberry
B.N.: *Morus alba*	**Moraceae**

1. Natural occurrence: It is commonly found from Terai to 2400m. This is a tree which is originated in China, where it grows wild often reaching a large size. It is now spread extensively throughout the Asia, and also to Europe and Japan.

2. Morphological characteristics:

Leaf	Leaf is longish, pointed, oval or lance like, sometimes with irregularly toothed edges and occasionally lobed. Leaf base is 3 veined, rounded and cordate.
Flower	Tree flowers between February and April. The flowers are small and white, with male and female flowers are on different stalks. The flower spikes are short.
Fruit	The fruit, which ripens a couple of months later, is a small, oblong, purple or white berry, and is usually produced in profusion.
Bark	The bark on young tree is light colored and smooth, but with age becomes darker and vertically fissured.

3. Silvicultural characteristics:

Light	Shade bearer.
Frost	Moderate frost hardy.
Drought	Drought tender.
Fire	It is susceptible to damage by fire.
Soil	It needs deep, well-aerated, loamy soils for the best growth. They can survive on poor sites, so it is used for reclaiming, ravines and other degraded lands, but the growth will be stunted.
Coppice	It coppices and pollards well.
Associates	It is found in *Aesculus-Juglans-Acer* forest.
Browsing	Young plants are severely damaged by browsing animals.
Tree nature	It is a deciduous & monoecious tree or shrub with a fairly cylindrical straight bole.
Other	Tree is liable to damage by winds. It grows rapidly in the early stages and reaches maturity at an early age.

4. Natural regeneration: The natural regeneration occurs through seeds, which are dispersed by birds and animals.

5. Artificial regeneration:

Preferred propg^{n}: (i) Cuttings **(ii)**. Seedlings **(iii)**. Hardwood cuttings i.e, are taken in January or February when the trees are leafless **(iv)** Stumps: have good results. **(v)** Grafting: grafts develop better root systems than the seedlings, layering or cuttings. In Japan, grafting is widely used.		
Seed collecn. time		Fruit should be collected when it ripens between April and July.
No. of seed kg^{-1}		450,000 seeds kg^{-1}.
Seed extract^{n}		Pulp should be rubbed off the seed, which is then washed with water and dried in the sun for a few days.
Seed storage		Orthodox seed, the well-dried seed can be stored in sealed-container.
Viability of seed		Viability of seed will remain for 5 years, if seeds are properly stored.
Seed treatment		**(i)** Stratification in moist sand at 5^{0}C for 30-90 days improves germination, or **(ii)**. Soak the seed in water for about a week.
Duration of germ^{n}		Germination begins after 4-5 days and is completed in about 4 weeks.
Germination (%)		Three years old seed has higher germination percentage (60%) than the fresh seed (10%).
Nursery period	**Seedling**	**<1500m:** less than 6 month, **>1500m:** 11 month.
	Stump	One-year-old seedling is suitable for preparation of stump.

6. Diseases, pests and parasites of kimbu: (i) *Phyllactinia corylea* affects mulberry leaves **(ii)** Mulberry trunk rot is caused by *Polyporus hispidus.***(iii)**. longicorn beetle (*Sthenias griesator*) bores tunnels or girdle the stem. **(iv)**. Scale insects (*Ceroplaster spp.)* affect stems and branches of the tree. They suck the sap and ultimately kill the plant.

7. Wood properties:

Wood Color	Sapwood is white to yellowish white; heartwood is bright yellowish brown or golden brown, darkening after exposure.
Working quality	The wood is easy to saw, work, turn, bend & finish, it peels well on a rotary lathe.
Strength	Wood is fairly strong.

Calorific value	**Sapwood:** 19,500 $KJkg^{-1}$, **heartwood:** 20,900 $KJkg^{-1}$.
Durability	Timber is moderately durable under cover.
Preser. treat.	It does not require antiseptic treatment.
Seasoning	It seasons well with care and can be kiln- seasoned without difficulty.
Hardness	Wood is moderately hard to hard.
Other	Wood has elasticity and flexibility.

Uses of *Morus alba*:

1. Mulberry leaves:
(i) Leaves are useful as cattle fodder, they are nutritious and palatable. Leaves contains 13.99% crude protein**. (ii)** Young leaves and twigs are sometimes eaten as vegetable**. (iii)** Leaves are a good source of ascorbic acid. They also contain Carotene, Vitamin B, Folic acid and Vitamin D. **(iv**) Leaves are extensively grown for rearing silkworms. The preferential food value of mulberry leaf for silkworm larvae is attributed to the presence of three stimulant factors i.e, an attractant, a biting factor and a swallowing factor. The absence of any one of these factors inhibits feeding by larvae .**(v)** leaves possesses diaphoretic and emollient properties.

2. Mulberry fruits: (i) Fruits are eaten fresh or made into juice, stews and tarts. They may be squashed and fermented to yield spirituous liquors. **(ii)** Fruits is laxative and cooling is used for sore throat, dyspepsia and melancholia.

3. Mulberry wood: (i) Mulberry wood is used chiefly for hockey sticks, tennis and badminton rackets, cricket bats and stumps and other sport goods **(ii)** Wood is suitable for house building , agricultural implements, furniture and turnery. **(iii)** Wood is a medium quality fuel wood **(iv)** Wood contains tannins (32%).

4. Mulberry bark: (i) Stem bark is fibrous which is used for paper-making in China and Europe. The fibre is also used in textile industry.**(ii)** Bark is used as the purgative and vermifuge.

5. Mulberry root: It possesses anthelmintic and astringent properties.

(13)

L. N. : Kaphal	
B.N. : *Myrica esculanta*	**Myricaceae**

1. Natural occurrence: It is found in Nepal between 1000 and 2300m. It is a tree of the sub-tropical and temperate zones.

2. Morphological characteristics:

Leaf	The alternately arranged leaves, which are crowded towards the ends of the branchlets, are lance-like in shape. The leaves are leathery, smooth on the top but with resinous dots on the under sides.
Flower	The minute green flowers, which are separated into male and female, are borne in catkin like spikes. The male ones are long and drooping while the female ones are erect. These flowers appear between July and Nov.
Fruit	The fruit is small, round and somewhat compressed and is covered with small pimples when ripe, the fruit is red and succulent.

3. Silvicultural characteristics:

Light	It is a moderate light demander.
Frost	Frost hardy.
Fire	Fire resistant.
Soil	It can grow on a wide range of soil type but it prefers well–drained , fertile and deep soil.
Coppice	It coppices well.
Associates	It is commonly associated with *Schima-Castanopsis* and oak forest.
Browsing	Leaves are palatable so they are severely damaged by browsing animals.
Tree nature	It is a small to medium sized evergreen tree.

4. Natural regeneration: It takes place from the seeds that are dispersed by birds**.**

5. Artificial regeneration:

Preferred propag^{n}	Seedling.
Seed collect^{n} time	Fruit ripens between April and July.
No. of seed kg^{-1}	About 8000 seeds kg^{-1}.
Seed extract^{n}	The pulp should be removed from the seed, washed and then dried.
Seed storage	Orthodox seed. The well sun dried seed should be stored in seal-tight container.
Viability of seed	About 6 months.
Seed treatment	None.
Seed sowing time	Seed should be removed immediately after collection.
Duration of germ^{n}	Seed takes about 1 month to germinate.
Germination (%)	55-75%.
Nursery period	**Seedling:** About one year in nursery.
Best planting size	15-20cm tall seedlings with 4-5 root collar diameter.

7. Wood properties: Weight of wood weighs about 750 kgm^{-3}.

8. Uses:

Fuel wood	Wood is used as a fuel.
Edible food	Fruit is edible when ripe & can be made into a very refreshing drink in the hot weather.
Medicinal value	The bark is astringent and anti-septic, is widely used for various local medicines. The powdered bark is taken as a snuff for asthma, catarrh and cough. The bark powder is used to fish poison.

L. N.: Mayel, mel	**E. N.: Wild pear**
B.N.: *Pyrus pashia*	**Rosaceae**

1. Natural occurence: It occurs between 1450 and 2500m, distributed throughout the temperate Himalayas.

2. Morphological characteristics:

Leaf	Alternately arranged leaves are simple, broadly oblong and slightly pointed, with fine, rounded teeth on the edges.
Flower	Flowers which usually appear between March and April with the new leaves, are white, borne in bunches at the ends of short branchlets.
Fruit	Fruit is round, greenish brown when unripe, and darker on ripening.
Seed	Seeds are dark and shiny.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	Drought resistant.
Soil	It has moderately tolerant of low fertility and dry soils.
Coppice	It coppices readily and produces abundant root suckers.
Associates	The tree is commonly associated with Oaks and Rhododendron at the higher levels of its range, and *Pinus roxburghii* in its lower range.
Browsing	Leaves are palatable so they are damaged by browsing animals.
Tree nature	It is a small or medium-sized deciduous tree.

4. Natural regeneration: It takes place from the seeds, which are dispersed by birds and animals. Fruit is favoured by birds when over-ripe and black. Monkeys prefer the unripe fruits.

5. Artificial regeneration:

Preferred propag^{n}	Seedlings, hardwood cuttings, root suckers.
Seed collec^{n} time	Fruits ripen between November and January.
No. of seed kg^{-1}	70,000 to 110,000 seeds kg^{-1}.
Seed extraction	Do not remove the seeds from the flesh until just before sowing.
Seed storage method	Recalcitrant seed. Seeds are kept in fruit and do not store fruits for more than 2-3 days.
Viability of seed	Seeds loose their viability quickly after extracted from the fruit.
Seed treatment	All flesh should be removed.
Seed sowing time	Seeds are sown immediately on to a raised bed.
Germination (%)	78% of large fresh seeds are used.
Nursery period /Seedling	After 6 months in the nursery, seedlings are ready for planting during monsoon season.

6. Wood properties:

Wood Color	Wood is light reddish brown.
Hardness	Wood is hard and close grained.
Weight	Wood weighs about 700 kgm^{-3}.

7. Uses:

Timber	Wood is used for walking sticks, combs etc.
Fuel wood	It yields comparatively good fuel.
Edible food	Fruit has a hard, astringent flesh, which is edible.
Medicinal value	The juice of the fruit is used for medicinal purposes.
Other	It is a spiny hedge plant.

L. N.: Dhaincha, Agasthi	T. N.: Agathi
B.N.: *Sesbania grandiflora*	Papilionaceae

1. Natural occurrence: It is grown between Terai to 1000m. It is native to Malaysia.

2. Morphological characteristics:

Leaf	Leaves are abruptly pinnate, leaflets 41-61, linear-oblong, glabrous.
Flower	Racemes, 2-4 flowers, short, axillary, flowers with showy, fleshy white, pink or crimson petals.
Fruit	Pods are pendulous, flat and somewhat four –cornered.
Seed	Pods contain 15-30 seeds.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost tender.
Drought	Drought resistant.
Fire	Fire sensitive.
Soil	It can grow on a wide range of soil type. Plant grows best on black cotton soil and is self-productive where the surface soil is loose and uneven.
Coppice	It coppices well.
Browsing	Young plants are liable to damage by browsing animals.
Tree nature	It is a short-lived, quick growing, soft-wooded, deciduous tree.

4. Artificial regeneration:

Preferred propag^{n}.		Seedlings, stump.
Seed collect^{n}. time		Seeds are sown between October-November.
No.of seed kg^{-1}		17,000 viable seeds per kg.
Seed extract^{n}.		Pods are dried in the sun and allow opening.
Seed storage method		Orthodox seed, well-dried seed can be stored in sealed container.
Viability of seed		Viability of seed remains for at least 2 years.
Seed treatment		Soak the seed in hot water.
Seed sowing time		March- April.
Germination (%)		87% from 12 months old seed.
Nursery period	**Seedling**	Seedlings will be ready for monsoon planting.
	Stump	One-year-old seedling is suitable for preparation of stump.

5. Diseases, Pests and Parasites of Agathi: (i) ***Colletotrichum capsici*** causes seedling blight of Agathi forming elongated or oblong cankers on the collar region of affected seedlings.

6. Wood properties:

Wood Color	Wood is white.
Hardness & Weight	Wood is soft. Wood weighs about 512 kgm^{-3}.
Working quality	It is easy to saw and work.
Durability	Wood is not durable.

Uses of *Sesbania grandiflora*:

(1). Agathi tree: It is grown as a shade and support tree for pepper and betel vines, and as a shade for coconut. The plant is used as effective wind-break in banana plantations, citrus and coffee plantations etc. **(2). Edible food: T**ender leaves, pods and flowers are eaten as vegetable. **(3). Flowers: F**lowers are sweetish in taste and succulent. Flowers are sacred and are valued as offering in the month of kartik in India. **(4). Wood: W**ood is valued for making toys. Charcoal from the wood is used for gun powder. The wood is a possible source of paper pulp. **(5). Bark: B**ark contains gum and tannin. Juice of the bark is used by fishermen for toughening their nuts. It is also used for tanning purposes and for coloring matting. Dried and powdered bark is used as cosmetic in Java. Bark is astringent, bitter, tonic and a febrifuge. A decoction of the bark in small doses is taken against diarrhoea and dysentry. Pounded bark is externally applied to cure scabies. **(6). L**eaves are an excellent fodder containing 36% crude protein. Leaves are excellent source of vitamin C and calcium. Leaves are aperients, tonic, diuretic and laxative and contain a non-poisonous saponin-like substance. Leaves are chewed to disinfect mouth and throat.

CHAPTER: VI

SILVICULTURE OF BAMBOOS AND RATTANS:

SILVICULTURE OF BAMBOOS

1. General description of Bamboos:

Bamboos are tall, perennial, arborescent grasses, belonging to Bambuseae, a tribe under poaceae, comprising four sub-tribes: Arundinarieae, Dendrocalameae, Eubambuseae and Melocanneae.There are 50 genera and approximately 1326 species (excluding the herbaceous bamusoid grasses), generally inhabiting the humid tropical, sub-tropical and mild temperate regions of the world. The bamboos cover more than 18 million hectares of land, of which 75% is in Asia. India alone accounts for more than 50% of the total bamboo reserves in the world. There is not a single native bamboo in the whole of Europe and Antarctica.

2. Distribution:

- Bamboos are found naturally as an understorey in many types of forests.
- The distribution of bamboos is largely governed by rainfall, temperature, and latitude and soil type.
- Most of the bamboos require from 8^0C to 36^0C, a minimum of 100cm annual rainfall and high humidity for good growth.
- They form an important constituent of many deciduous and evergreen forests from sea-level and flat alluvial plains to high mountains up to an altitude of 4000m.
- Bio-climatic distribution of the genera is as follows: species of Arundinaria are found in the alpine region, whereas these and some species of *Bambusa*, *Dendrocalamus*, *Oxytenanthera* and *Phyllostachys* are found in the temperate regions. Sub-tropical genera are *Arundinaria, Bambusa*, *Cephalostachyum*, *Dendrocalamus* etc.
- The moist tropical region is represented by species of *Bambusa*, *Cephalostachyum*, *Dendrocalamus, Melocanna*, *Ochlandra, Oxytenanthera* etc. whereas the dry tropical region mostly has *Bambusa arundinacea* and *Dendrocalamus strictus* etc.
- Bamboos thrive best in monsoonal forests where they attain their maximum development. They dwindle into under-shrubs in the temperate regions and at high altitudes, some species look almost like grasses.

3. Associates of bamboos:

- Bamboos form an important constituent of many deciduous and evergreen forests. They seldom occur in pure form.
- The most important associates of bamboos are *Anogeissus latifolia, Emblica officinalis, Shorea robusta, Tectona grandis, Litsea monopetala, Lagerstroemia parviflora, Grewia spp, Terminalia spp*. etc.
- *Arundinaria spp* grow under Oak, Deodar, Spruce, and Silver-Fir. etc.

4. Flowering:

Most of the bamboos flower and seed gregariously once during the life-time and die soon after. Bamboos can be classified into three groups on the basis of their flowering pattern:

(i) Those that flower annually or nearly so: *Arundinaria wightiana, Bambusa atra* etc.are known to flower annually.

(ii) Those that flower gregariously and periodically: the important species which flower gregariously are: *Bambusa arundinacea, B. .polymorpha, Melocanna baccifera* etc.

(iii) Those that flower sporadically or irregularly: *Arundinaria falcata, Bambusa giganteus, Dendrocalamus strictus, D. hamiltoni, D. giganteus* etc.

- *Dendrocalamus strictus* and *Bambusa tulda* fall within both the second and third group, as they are known to flower both sporadically almost every alternate year and also gregariously at long intervals, the former at 30-50 years and the latter 35-40 years.
- All populations from the same seed, irrespective of locality, start flowering at the same time.

5. Silvicultural characteristics:

- Bamboos are perennial grasses, with woody culms from rhizomes. The rhizomes may be short and thick (Pachymorph) and clustured together. They produce bamboos in well defined clumps.
- Mature bamboo clumps produce new shoots every year throughout the rainy season. These shoots develop rapidly and within two or three months, they reach their full height and diameter.
- The culms remain in the clumps if not cut for about 7-12 years, depending upon the species, dying slowly and being replaced by new culms. If older culms are not removed, they restrict the development of the rhizome system and new shoots.

6. Cultivation:

For cultivation of bamboos, following points should be carefully considered:

(i) Climate:

- The bamboos need warm temperature to grow successfully. Temperature from (-5 to 46)^{0}C is suitable for their cultivation. Areas receiving rainfall between 75 and 500cm or more are suitable for bamboos.

(ii) Soil: The bamboos can be grown on denuded wastelands and watersheds along the eroded river beds, hill slopes etc.

- Bamboos grow on a variety of soils provided there is good drainge without waterlogging.
- They thrive on various geological formations such as sandstones, conglomerates, quarzites, schists and gniesses.
- A majority of the bamboos occur on sandy loam to loamy clay soils.
- Soil moisture is an important factor for the distribution, growth and quality of bamboos.

The natural regeneration and development of clumps are greatly affected by the variation in soil moisture, since the root system is very superficial. Plantations raised on poor and dry soils often do not grow well.

(iii) Manuring: Generally, fertilizer application is not practised yet for plantations but small doses of nitrogenous fertilizers are better to apply in furrows during the first year of planting.

A. Natural regeneration:

Bamboos can regenerate successfully from seeds with ease.

- Gregarious flowering, which starts at some point in the area, gradually spreads in waves, covering the whole area in 3-4 years. Numerous fertile seeds are shed, and with the onset of monsoon, germinate profusely.

- Fire and grazing hazards to natural regeneraion. Weeds and shades also affect the regeneration heavily.

B. <u>Artificial regeneraion:</u>

Bamboos are propagated artificially through seeds, divisions, offsets, and marcotting, stem or rhizome cuttings or by layers.

<u>a. Raising bamboos from seeds:</u>

(i) Before the onset of monsoon, the seeds are sown directly at a depth of 20-30cm in pits, 3-5m apart. Direct sowing of seeds are also done in furrows, 15cm wide and 3-5m apart along the contours.

- One kilogram of seed is sufficient for planting a hectare.
- Seeds decay if they get waterlogged or if germination is delayed due to low soil temperature resulting from early monsoon.
- Regular weeding and soil work should be done. Post monsoonal sowing eliminates the weeds.

(ii) Transplantaion:

Seeds are generally sown in the nurseries before the monsoon (May-June) however, sowing after monsoon is equally efficient.

Nursery beds of 1.2m *12m facing East–West are raised near water sources in humid areas, whereas the beds are prepared sunken in arid and semi-arid areas.

- Sand, soil and farmyard manure in the ratio 1:2:1 are thoroughly mixed in the bed and worked into a depth of 20-30cm.
- Seeds are sown in lines in the bed. Raising the seedlings in polythene bag or in bamboo-baskets facilitates easy transportation.
- Planting is followed by two weedings, accompanied by soil working before the ends of rains.
- *Bambusa polymorpha* is raised through transplanting the nursery–raised seedlings with good success.
- Transplanting is done before the onset of monsoon. Three or four month old seedlings raised in polytube bags or one-year old seedlings along with the rhizomes are transplanted.
- The length of the shoot is pruned to 90cm and most of the leaves are clipped.
- The rhizomes should not be exposed to the sun and are fully covered with the original soil and firmly pressed.

b. <u>Rhizomes:</u>

The rhizomes, when planted, produce mature culms in about half the time taken by the seedlings.

- *Bambusa arundinacea*, *Melocanna baccifera* and *Dendrocalamus longispathus* are regenerated from rhizomes.
- It is very important that the soil around the rhizome should be pressed firmly.
- The selection and careful handling in uprooting the rhizome are important.
- Rhizomes having at least one developed buds are used.

c. <u>Divisions:</u>

The dwarf-bamboos are usually propagated by divisions. The culms, in small clumps of two or three with rhizome attached, are tranplanted immediately before the growing season commences, with as much soil as possible around the rhizomes.

d. <u>Offsets:</u>

- Segments of 1-3 year old culms are used for planting. They consist usually a portion of the old culm with rhizome and roots, cut off above a node at 30-60cm from the ground

of the segments contain three nodes. The branches at these nodes are trimmed to 7.5 to 10cm. They are planted horizontally at least 2.5cm deep in trenches.

- Single-node cutting is planted slightly slanting, the node being underground.
- The planting is done in the third week of June and shade is provided against the direct sun to avoid rapid evaporation.
- Normally a new shoot is produced in the first year sometimes not untill the second year, but all offsets are reported to survive and induce speedy growth.
- Offsets, planted in the late rainy season, usually fail to grow.

7. Protection of plantation: ~ is important.

- The seedlings, both in the nursery and after transplanting, are subject to damage by rats, hares and porcupines, cattle cause heavy damage to the seedlings. Wild pigs eat the tender rhizomes.

8. Preservative treatment of bamboos:

- Although bamboos compare favourably with timbers such as Sal and teak in strength properties, their natural durability is low on account of their susceptibility to insect attack, including termites.
- The treatment of bamboos is the best carried out in green condition. Normally, the branches and leaves are removed. Then they are cut into the required sizes and holes are made at nodal points before dipping in the preservative solution, but this is time consuming. It is easy to dip the freshly cut bamboos into solution with the branches and leaves still possible, they should be kept in water for 2-3 days. The treatment of bamboos in green conditions is the best by the Boucherie process.
- The treated bamboos are dried to keep 10-15% moisture and are expected to last over 15-20 years in the open and 25-30 years under cover.

9. Diseases and pests of bamboos:

Diseases: Approxmately 185 species belonging to the *Ascomycetes*, *Basidiomycetes* and *Deuteromycetes* have been many different diseases affect bamboos in nurseries, plantations and natural forests.

A. Diseases of plantations and natural forests:

(i) Leaf diseases: The main leaf diseases of bamoos are listed below:

(a) Leaf blight: Caused by *Rhizoctonia solani.*

(b)Leaf rust: Caused by no.of pathogens such as *Dasturella divina*, *Puccinia melanocephala*, *Tunicospora bagchii*.

(c) Leaf spots : Caused by a no. of pathogens such as *Ascochyta bambusina*, *Corticium coleroga*, *Phyllachora graminis* etc.

(ii) Bamboo blight : Most destructive bamboo disease caused by the pathogens *Sarocaldium oryzae*.

(iii) Rhizome bud rot: Casued by *Fusarium and Pythium spp*.

(iv) Basal culm rot : Caused by the pathogens *Fusarium moniliforme.*

(v) Culm rot: Casued by *Fusarium spp*.

(vi) Rhizome and root rots: Caused by *Ganoderma lucidum*, *Merulius eurocephalus* and *Poria rhizomorpha*.

(vii) Stem infection: Caused by *Fusarium pallidoroseum.*

(viii) Decay in bamboo: A no.of pathogens cause decay in bamboos both in standing culms and also in bamboos in storage & use, they also affect the rhizomes. Important decay casusing

pathogens in bamboos are: *Amauroderma rugosus, Fomes Spp. Ganoderma lucidum, Polystictus Spp*.etc.

B. Diseases of nursery:

Damping off and root rot diseases cause damage to the nursery seedlings.

10. Uses of bamboos:

(i) Food : Young shoot of several species are commonly used as vegetable. The shoots are used for making curry either alone or in combination with potaoes, tomatoes, cauliflowers, peas, etc.,

(ii) Fodder: Bamboos leaves are very nutritious and palatable, which are an excellent fodder species , leaves of *Bambusa* and *Dendrocalamus* species are among the best bamboos for fodder.

(iii) Timber: Bamboos are extensively used as timber.

- They are preferred because of their easy availability, cheapness, strength, strainghtness, smoothness and lightness combined with hardness and easy to split.
- Bamboos are used in foundations, frames, partition walls, doors, windows,, roofs, etc.
- Large–sized bamboos are commonly used as scaffolding material.
- Various types of building boards are made from bamboos. Single mat and veneer-boards are also made from them.
- Numerous articles of every-day use such as baskets, tool handles, umbrella rods, several fancy articles are made from bamboos.

(iv) Ornament: The living bamboos are planted in the gardens as hedges, boarders and screens and also in mass plantings, in groves and in isolated clumps.

(v) Conservation of soil:

- Bamboos can be grown on steep hill slopes for controlling landslides, where other economic crops do not grow.
- They are also valuable as a windbreak.
- Extensive shallow and fibrous root system and accumulation of leaf-mulch serve as efficient agents in preventing soil-erosion.
- Bamboos are grown to stabilize the shifting sands, and also for stream–bank protection, reinforcement of embankments and drainage channels.
- Besides, bamboos help preserving the fertility of soils through the addition of leaf-litter, maintenance of structure and conservation of moisture.

(vi) Paper-pulp: Bamboos occupy a very important place in papar making.

Bamboos pulp is suitable for preparing printing paper of good quality. It is used for the production of bond-paper, ledger-paper, art-paper, facial tissue paper, paper for air-mail, newsprint etc.

(vii) Rayon-pulp: Bamboos (*Bambusa arundinacea, Dendrocalamus strictus and Melocanna baccifera)* are found to be suitable for the manufacture of rayon-grade pulp and are being used on a large scale in the manufacture of rayon.

(viii) Bamboo-parquet: Bamboo paraquet, strip for aircraft, laminated bamboo, etc. are recently manufactured.

(ix) Banslochan: The hollow internodes of *Bambusa arundinacea, B.vulgaris, Dendrocalamus strictus and Melocanna baccifera* accumulate a substance, generally called as banslochan which are the residue of the watery liquid in the form of amorphous silica in microscopically fine state.

- Banslochan is widely used as a cooling, tonic, and aphrodisiac.
- Banslochan is also used in asthma, cough, poisoning cases, paralytic complaints & others.

Silviculture of rattans:

1. <u>Introduction of rattans</u>: Rattan is derived from the Malay word 'Rotan' which denotes a collective name for the climbing palms called *Lepidocaryoideae* (Meaning scaly-fruited in Greek).

- It belongs to the family Palmae or Arecaceae & the largest sub-family is Calamoideae.
- Dransfield reported that more than 600 species of rattans belonging to 13 genera are distributed world wide concentrated in Africa and South East Asia.
- India and Nepal has significantly less number of species of rattans found in contrast to the South East Asia which holds over 500 species of rattans.
- Pradhan (1997) has stated that only 4 genera and 14 species of canes occur in India. The existing genera in India are *Calamous, Daemonorops, Plectocomia, and Corthalsia*. Three genera are endemic to Africa. The largest rattan genus is Calamous, which has about 370 species.
- In Nepal, only 5 species of rattans are available. They are *Calamus acanthopathus* (Gauri bet), *C.tenuis* (Pani bet), *C.leptopadis* (Dangre bet), *C.latifolia* (Pakhri bet) and Aghori bet.

2. <u>Morphological characters</u>:

Rattans are climbers.

i). Stems: Stems may be very short and erect or even sub-terranean to be called stemless or acaulescent spp. They may be solitary (i.e., single stemed) or clustured (i.e, with many stems in an individual). Stems of the climbing species are long, usually cylindrical with uniform thickness, solid and straw yellow in color. They are extremely strong, tough and elastic. The outer surfce is hard or smooth and shining ; the core is spongy.

ii). Roots: Very little is known about the root. Several swamp rattan species have complex root systems.

iii). Leaf: The leaf is generally divided into three parts-sheath, petiole and the laminar area.

a. <u>Leaf sheath</u>: The stem is covered with sheaths. This is one of the most useful features of rattans for their identifications. Mature sheath may bear a knee, a swelling below the petiole. This is one of the important characteristics in distingushing genera in the sterile state.

b. <u>Petiole:</u> Petiole varies between species and age of the cane. Sometimes the petiole is absent in mature climbing individuals.

c. <u>Laminar:(leaf lets):</u> The leaf is pinnate and pinnae are roof shaped. The leaflets are arranged either regularly or irregularly. The leaflets arrangement is usually a very useful character for diagnosis. In Nepal, leaflets of rattans are found to be of regular and evenly spaced.

iv). Inflorescence: Two modes of flowering are observed in rattan-hapaxanthic and pleonathic. In **hapaxanthic mode**, the flowering is once and is characterized by simultaneous production of flowers after a period of vegetative growth. The flowering and fruiting is followed by the death of stems itself. The flowering occurs at the topmost nodes of the rattans.

In **pleonathic mode**, stems reaching maturity go on producing one to a few inflorescence every year, and the stem has the capability of unlimited growth.

(v) Flowers: Flowers are borne on the ultimate branches of the inflorescence. The branch bearing flowers is known as rachilla. Genus *Calamus* is dioecious i.e., male and female plants are separate.

(vi) Fruit: Rattan fruits are covered with vertical rows of reflexed scales. There is often a beak at the top of the fruit.

(vii) Seed: Inside the fruit, there is usually a single seed, but rarely there are two or three seeds. The seed has an outer fleshy layer, genrally known as Sarcotesta; this is sweet, sour or intensely bitter in taste.

3. Natural occurance:

Rattans thrive on well-drained soils, swamps and near perennial water holes, streams, in tropical and sub-tropical regions of Nepal below 2000m.

4. Rattan distribution in Nepal:

- According to International Network on Bamboo and Rattan (INBAR, 1996) suggests that two genera and eight species of rattans are endemic to Nepal.
- Rattan is distributed to evergreen, semi-evergreen and mixed Sal forests of the tropical and subtrolical regions of the country. Their distributions are uneven within these ranges.
- *Calamus acanthospathus, C. leptospadix, C.tenuis, C.latifolius* is the most common rattan found throughout the Terai region.
- The altitude range of rattan availability in Nepal varies from 75m to 2000m.
- Height of canes has been found to vary from 10m to 30m.
- Of the five physiographic zones of Nepal, rattan is mostly distributed in the Terai and Siwalik. They are also found in the Middle Hills of Nepal.Rattans are not found in the High mountains and High Himal. Due to heavy biotic interference and habitat destruction, natural populations are severely depleted.

5. Description of Rattans found in Nepal: (Family: Arecaceae, Palmae)

Species (1)	**L.N. :Gauri Bet, B.N: *Calamus acanthospathus***
Habitat	It is a climber occurring in the evergreen, semi-evergreen & moist deciduous forests of (Mainly) eastern Nepal. It is distributed from Terai to middle hills up to 2000m. It thrives in moist grey and red clay type of soil.
Associates	This species is associated mainly with trees such as *Dalbergia sissoo, Acacia catechu, Trewia nudiflora , Toona ciliata, Albizzias, Bombax* & *Saccharum* species.
Uses	It is used for making baskets and containers.
Species (2)	**L.N: Dhangre Bet, B.N: *Calamus leptospadix***
Habitat	It is also a climber, which is distributed mainly in the middle mountain of the country. It prefers moist places, having perennial water source. Swamps are its natural habitat. It also thrives well–drained soils.
Associates	It is mainly associated with evergreen trees such as *Syzigium cumini*.
Uses	It is used of making baskets, binding ropes. Fruits are edible when ripe.
Species: (3)	**L.N: Pani Bet, B.N.: *Calamus tenuis***
Habitat	It is a common on climbing ratttan found mostly in waterlogged and swampy areas and permanent water sources in along eastern Nepal (Jhapa 100m) and Bardiya (300m) in western Nepal. It is found in the tropical mixed sal forests. It grows in clumps from rhizomes. Flowering starts from June and fruiting in July–August.
Associates	This species is associated mainly with tropical mixed hardwoods such as *Acacia catechu, Trewia nudiflora, Bombax ceiba, Albizzia spp*. and other species.
Uses	Use of making mats, baskets, and chair-seats.
Species: (4)	**L.N: Pakre Bet, B.N: *Calamus latifolius***

Habitat	It is found in the moist deciduous sal forests and in the foothills of Siwaliks. It is found mostly in Jhapa, Morang, Bara, Parsa and Kanchanpur districts. The altitude varies from 80 to 280m. In the Shuklaphanta wildlife reserve, this species is well protected and is found along permanent waterholes and streams. It thrives in well-drained soils.
Associates	This species is mainly associated with sal, *Trewia nudiflora* and *Syzigium cumini*.
Uses	Highly use for walking sticks, umbrella handles and for furniture making.

6.Cultivation of rattans:

Calamus spp. grow in different situations such as marshy plains at sea-level and on the hills. The canes require a warm, moist atmoshphere and copious watering but water-logged or frequently inunudated areas are not suitable for their cultivaiton. The canes thrive best in sandy loams containing organic manure.

Artificial regeneration: Canes can be propagated through seeds and cutting of rhizoms, root-suckers and offsets.

Propagation of cane from fully mature seeds: Canes are generally propagated through fully mature seeds sown directly or by transplanting. Fully mature seeds should be collected. The seeds are removed from the pulp, rubbed with ash to prevent ants from destroying them and dried. Seeds should be sown fresh, as they lose their viability on ageing. The soil of the seed beds should be loosened carefully. The beds are covered with a light layer of soil and kept well watered; a light thatch also protects them, as too much sun is unfavourable for germination. The seeds start germinating in 14 days, the young leaves appearing 60 days thereafter. Normally, germination takes up to 6 months. The one–year old plants 15cm in height and bearing 4 -5 leaves can be transplanted during rains.

7. Diseases: The fungi *Sphaerodothis coimbatorica* are attacked on the leaves of *Calamus rotang*.

8. Harvesting of rattans:

- When the leaf-sheath loosening and the lowest part of the stem is exposed, the cane is considered ripe for harvesting.
- In some parts of Nepal, the canes are collected throughout the year and other parts during October to March.
- Fresh canes contain a high percentage of mositure. Rainy season or wet atmosphere is not proper for harvesting, as improper drying results in discolouration. Hence, the dry season is the best for harvesting.
- Growth in the first few years is slow; hence it takes 8-10 years for canes to reach maturity. Some canes may be harvested at the early age of six years depending upon the species or locality.
- The canes are cut at the base without damaging or killing the clumps and dragged down from the supporting trees. The first harvest is not of the best quality but subsequent ones are of better quality.
- After the canes have been removed from the supporting trees, the leaves and leaf-sheath are removed.
- In Nepal, the traditional method of harvesting of rattans is still practiced. Local farmers in Bardiya and Kailali districts cut the stems using a sickle. They cut the rattan clump nearly at breast height. Sometimes they cut at ground level and pull the cut stuff. This practice has severe effect on the remaining clump because the fagellium, which has to support the rattan for climbing, drops down on earth thereby reducing the overall

growth. Farmers do not pay attention regarding the damage caused to the other young rattan plants during harvesting. Moreover, they seem to ignore the optimum season for harvesting, and stump height.

9. Drying and storage:

The canes are cut into some definite lengths according to their strength, thickness and uses. They are dried under the sun or over the fire. The undried canes deteriorate rapidly.

10. Processing: The quality of canes can be improved considerably by proper processing.

11. Bleaching and polishing: Bleaching is generally done by fumigation with burning sulfer which makes it less liable to insect-attack. Natural lusture of the cane is lost during bleaching and is restored by polishing.

12. Smoking and treatment of green canes: The canes for walking–sticks are smoked over fire and polished with coconut oil. This gives them a fine reddish brown colour.

13. Grading: After processing, the canes are graded, depending upon the colour, texture, size, length between the nodes, thickness and utility. The best rattans should be strong, light, flexible, have uniform thickness, smooth surface, light yellow colour and resistance to breaking and spliting when twisted or bent.

14. Utilization of rattans:

- Rattan is an ideal raw material for cottage industries. Its industrial use is in for furniture, walkingsticks, polo sticks, umbrella handles, basket making, mats, ropes, and various other articles.
- They are frequently used as cables for suspension bridges. They are used in all kinds of forest works, and are unsurpassed for basketwork.
- Rattans are being mainly used for furniture items such as chair, sofa, cases, television stands, baby carriers, baskets and mats.
- Ornamental value of rattan goods is also highly appreciable.
- The pith is used for making a variety of articles such as handbags and fancy decoration pieces.
- Buds of some rattan species such as *Calamus erectus* are edible. The ripe, cooked fruits of some species are eaten.
- **Ethnic value:** Tharu people believe that rattan is a holy and capable of warding off evil spirits and use rattan stick in temples.
- Cane is also one of the most important items needed in constructing the chamot of Rato Machhendranath, which is being pulled in the Kathmandu valley.

15. Promotions of rattans:

- Rattans are mainly distributed in the Terai, Siwaliks and mid-hills. These physiographical zones are under-pressure of habitat destruction of rattan due to over-exploitation of forestland.
- Of the four species in Nepal, three *Calamus acanthospathus*, *C.leptospadix and C. latifoilus* have been listed as threatened.
- Cultivation of rattans in large scale in farmland and conservation of natural habitat of rattans are the best way for promotion of rattans.

CHAPTER: VII

IMPORTANT EXOTIC TREE SPECIES IN NEPAL

(1)

Acacia auriculiformis	**Family: Mimosaceae**

1. Natural occurrence: It is native to Papua New Guinea and Northern Australia.

2. Morphological characteristics:

Leaf	Leaves are pinnate, rachis modified into a phyllode.
Flower	Flowers are white to rich yellow, fragrant, in slender, axillary spikes.
Fruit	Pods are hard, coiled at maturity.
Bark	Bark is smooth, white and somewhat fissured.

3. Silvicultural characteristics:

Light	Strong light demander
Frost	Frost tender.
Drought	It is more droughts sensitive.
Fire	Fire sensitive.
Soil	Its best growth on the alluvial soil.
Coppice	It coppices well.
Tree nature	It is unpalatable to browsing.
Meteor. cond^{n}	It is a straight medium sized evergreen tree with slightly angular branchlets.
Other	It is a fast growing tree with high germinative capacity.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, stump planting.
Seed collect^{n} time	December-February.
No. of seed kg^{-1}	40,000 to 57,000 seeds kg^{-1}.
Seed extraction	The pods are dried in the sun and beaten to extract the seed.
Seed storage	After drying the seed in sun, it can be kept in sealed container.
Viability of seed	Viability of seeds remains for 6-12 months.
Seed treatment	The seed is treated by soaking in hot water at 80^{0}c and leaving to cool for 15-20 hours.
Seed sowing time	Seed should be sown in March.
Duration of germ^{n}	Germination takes 4-5days.
Germination (%)	Germination is above 60%.
Nursery period	**Seedling:** It will be prepared for July planting.
Best planting size	20-30cm tall seedlings.

6. Forest pathogens: Tree is attacked by *Ganoderma lucidum* and *Stereum nitidulum fungi* and by *angiospermic parasites, Loranthus longiflorus* and *Dendrophthoe falcata.*

7. Wood properties: Weight of wood: about 25,000 KJkg^{-1}.

8. Uses:

Timber	It is widely used for furniture.
Fuel wood	It is a good fuel wood. It burns slowly with no harmful effects apart from some crackling. It makes a good charcoal.
Fodder	It is not browsed by cattle so it is a poor quality fodder.
Tannin	Bark contains 12-16% tannin, content of tannin being more in younger trees.
Ecological Value	It is a good substitute for species of *Eucalyptus* in semi-arid sites, is useful sand binder and is also grown as an ornamental tree. It may be cultivated for lac host.

(2)

Local name: Kalki phool	**English name: Bottle brush tree**
Callistemon citrinus	**Family: Myrtaceae**

1. Natural occurrence: It is native to Australia & can grow successfully from Terai to 1800m.

2. Morphological characteristics:

Leaf	Leaves which are alternately arranged on the twigs have short stalks. Leaves tend to be spirally crowded towards the rather slender branchlets, which hang vertically downwards.
Flower	The red flowers are very distinctive being arranged in bunches towards the ends of hanging branch lets.
Fruit	Fruit is a small, stalkless capsule, containing masses of very fine, red colored seeds.

3. Silvicultural characteristics: i) Soil: It is more suited to swampy ground or seasonally flooded areas.

4. Artificial regeneration:

Preferred propag^{n}	Seedlings, cuttings.
Seed collection time	Seeds ripen between September and March.
No. of seed kg^{-1}	There is about 850,000 seeds kg^{-1}.
Seed extraction	By drying the capsules in the sun on paper sheets, the valves open up and fine red seed is shed.
Seed storage	Orthodox seed. It should be dried and stored in sealed containers.
Viability of seed	Viability of seed remains at least 12 months.
Seed treatment	The hard wood capsules are removed between September and March.
Seed sowing time	**<1000m:** March to April, **> 1000m:** September to October.
Dura^{n} of germ^{n}	Germination takes place in seven days.
Germination (%)	30-40%.
Nursery period	**Seedling:** Seedlings are planted by the on set of monsoon.
Best planting size	20-30cm tall seedlings.

5. Wood properties:

Wood color	Wood is reddish or brown in color.
Hardness	Wood is hard and close grained.

Working Quality	It is easy to saw and work well.
Weight	Wood weighs about 800kgm^{-3}.

6. Uses:

Timber	Timber is used for tool handles.
Fuel wood	It can use for fuel wood.
Ecological value	Its flowers produce abundance of pollen nectar, suitable for bee keeping.

(3)

English name: iron wood	
Cassia siamea	**Family: Caesalpiniaceae**

1. Natural occurrence: it is native to South East Asia from Burma to Indonesia.

2. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost tender.
Drought	**Seedlings:** drought sensitive, **Mature trees:** fairly drought resistant.
Fire	It is fire sensitive, but it recovers soon.
Soil	It prefers well-drained, deep, fertile soils. It can grow on shallow soil, but the rate of growth is stunted. It does not thrive on swampy sites or in areas with heavy growth of *Imperata*.
Coppice	It coppices freely and produces root sucker.
Browsing	It is not eaten by cattle, i.e., unpalatable spp.so it escapes injury from browsing.
Tree nature	It is moderate sized evergreen tree with a spreading crown and many branches.
Other	It does not form root nodules with *Rhizobium spp* and does not fix N_2.

3. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting, stump planting
seed collect^{n} time	Seeds ripen between December-April.
No. of seed kg^{-1}	30,000-40,000 seeds kg^{-1}.
Seed extraction	Seeds are extracting by drying the pods in the sun and then beating them with sticks.
Seed storage	After drying the seed in sun, it can be kept in sealed container.
Viability of seed	Viability of seed retains for many years.
Seed treatment	**For small quantities:** manual scarifications of seed. **For large quantities:** hot water treatment for 15-30sec. & then soaked in cold water for 24 hours.
Seed sowing time	Seed should be sown in February-March.
Duration of germ^{n}	Germination begins after sowing and completes eight days later.
Germination (%)	**Scarified seed treatment:** 72%, **hot water treatment:** 45%.
Nursery period	**Seedling:** Seedling will be prepared for July planting.

4. Wood properties:

Wood Color	Sapwood and heartwood are distinct. **Sapwood:** Pale yellowish white to greyish brown. **Heartwood:** dark brown to black.
Hardness	Moderately hard to hard wood.

Weight	Wood is moderately heavy-to-heavy about 470 kgm^{-3}.
Durability	Heartwood is exceedingly durable.

5. Uses:

Timber	It is used for walking sticks, mallets, also for bridges and posts.
Fuel wood	It is chiefly used as fuel wood. It also makes a good charcoal.
Fodder	Leaves are eaten by cattle, sheep and goats and form a good fodder.
Edible food	Flowers can be eaten as a vegetable in curries.
Tannin	Pods, leaves and barks contain 6%, 7% and 9% tannin respectively.
Ecological value	It is considered to be a very desirable host for *santalum album.*
Other	It is planted as an ornamental and roadside avenue tree.

(4)

Casuarina equisetifolia	**Casuarinaceae**

1. Natural occurrence: It is native to Australia, Indonesia and Polynesia. It is also common on sandy sea-shores in Bangladesh and south–East Asia. It can be grown up to an altitude of 1500m.

2. Morphological characteristics:

Leaf	Leaves are whorled, reduced to minute scales or spine like.
Flower	Flowers are dioecious; **male:** in slender, terminal spikes; **Female:** in ovoid or cone like heads.
Fruit	Fruits are echinate, and hard.
Seed	Seeds are light, membranous.
Bark	Bark is grey, rusty brown, peeling off in vertical strips.

3. Silvicultural characteristics:

Light	Strong light demander
Frost	Frost tender
Drought	Drought hardy.
Coppice	It does not coppice.
Tree nature	It is a tall, straight stemmed and evergreen tree
Meteorological condition	It can withstand low temperature. The tree remains unaffected even by cyclones in coastal areas. Temperature is in the range of ($7\text{-}47^0$c); average annual rainfall (870-3800mm). It needs full bright sunshine.

Soil: The tree thrives best on loose, sandy loams and also on laterite, rich loam soils where the pH varies between 4.8 and 8.4. It can also grow in saline and alkaline soils. heavy and clayey Soils and soils with poor drainage are harmful to the growth. It can grow on poor soil because of the presence of N_2 fixing organism in root nodules.

4. Artificial regeneration:

Preferred propag^n	Direct sowing, entire planting, air layering, root suckers.
Seed collect^n time	Seeds are collected between June and September.
No. of seed kg^{-1}	200,000 and 3 million seeds kg^{-1}.
Seed storage	Dried seed of the most species can be stored in sealed containers for long

	period, without loss of viability.
Viability of seed	Viability of proper stored seed can remain for many years.
Seed treatment	Soak the seed in water for 24 hours.
Seed sowing time	January-February.
Duration of germ^{n}	Germination begins 3 to 4 days after sowing.
Germination (%)	Germination can achieve 70%.
Nursery period	**Seedling:** About 4 month is enough for Terai.

5. Diseases, pests and parasites of Casuarina:

i.) Stem wilt: caused by *Trichosporium vesiculosum.* **ii)**. **Root rots***: Ganoderma lucidum*, *Phytophthora cambivora* etc. **iii). Pathogenic seedling diseases: a). Seedling Blight:** caused by *Pellicularia rolfsii* **b). Bacterial wilt:** caused by *Pseudomonas solanacearum* **iv). Heart rot:** caused by *Fomes fastuosus*, etc. **v).Witches broom:** caused by many *pathogens*. **vi). Leaf spot:** by *Phoma casuarina*. **vii).** Phanerogamic parasites affecting *Casuarina*s are *Cuscutta campestris, Dendrophthoe falkata, D. lanosa* etc.

6. Wood properties:

Wood Color	**Sapwood:** orange yellow or pale brown. **Heartwood:** light to dark reddish brown.
Hardness	Wood is hard, close and straight grained and medium to fine–textured.
Working Quality	It works to a hard, smooth surface with care, but requires sharp tools and takes good polish.
Weight & Strength	Wood is heavy to very heavy. Wood is strong.
Calorific value	Calorific value of wood is 4950 kcal/kg.
Durability	Timber is moderately durable both in contact with water and under cover. It is resistant to termites and wood-rotting fungi.
Preservative treat.	Heartwood is partially treatable.
Seasoning	It is difficult to season and is liable to split.

7. Uses:

Timber	It is used for furniture, construction works, plywood, veneer etc.
Fuel wood	One of the best firewood extensively used as fuel and charcoal. It also burns when green. The ashes retain the heat for a long time.
Fodder	Needles are used in compost and are used as manure.
Tannin	The stem bark and root bark contains an appreciable amount of tannin. It dyes wool and silk fabric yellow.
Gum & resin	It is extensively used in reclamation of soil and erosion control. Casuarina is noduled by an actinomycete, *Frankia spp*, and fixes atmospheric N_2.
Ecological value	It is used as a wind break, soil- binder, ornamental and hedges.
Medicinal value	Bark is a tonic and astringent and is useful in diarrhoea and dysentery. The extract of needles exhibits anti-cancer activity.
Paper & pulp	Wood is suitable for the manufacture of paper for writing, printing, and wrapping.
Other	It is recommended for agro- and social forestry.

(5)

Local name: Kapok	**English name: White silk**
Ceiba pontandra	**Family: Bombacaceae**

1. Natural occurrence: Tree is native to American tropics (mainly South America), is naturalized and distributed throughout tropical countries.

2. Morphological characteristics:

Leaf	Leaves are digitately compound divided into 5-8 leaflets.
Flower	Flowers are creamy white, in axillary fascicles.
Fruit	Fruit: a hanging capsule, filled with floss enveloping the seeds.
Seed	Seeds are numerous & black.
Bark	Bark is greyish brown.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	It can withstand slight frost.
Drought	It can withstand long periods of drought.
Soil	Although it grows in poor soils, it prefers good deep, permeable soils for good yields. Laterite & heavy clays are not tolerated. It is highly sensitive to soil salinity.
Tree nature	It is a large deciduous tree, 20-30cm in height with a clear bole of 12m, horizontal branches, and stem often with stout woody conical prickles. It can be planted throughout the hotter region of Nepal.
Meteorological cond^{n}	It requires abundant rains during the growing period and a dry period during flowering. It is a fast growing tree.

4. Artificial regeneration:

Preferred propag^{n}	From seed, stem cuttings, branch cuttings.
Seed collection time	Fruit ripens between March and May.
No. of seed kg^{-1}	There are about 16,000 seeds kg^{-1}.The tree begins to yield fertile seed in the third or fourth year.
Seed extraction	Fruits are dried in the sun, the seed being separated from the floss by shaking the dehiscent fruits in a bag.
Seed storage	Orthodox seed. Seeds are stored in a sealed container.
Viability of seed	Seeds are viable for a year.
Seed sowing time	Seeds are sown in nursery during rainy season or in March.
Duration of germ^{n}	Seeds germinate in a week and seedlings require shade for 5-6 weeks.
Germination (%)	Germination takes place 89%.
Nursery period	**Seedling:** It is suited to be planted after 8-10 months.
Other	Seedling grow 90-120cm tall in six months.

5. Forest pathogens: Leaf spot disease: caused by a bacterium *pseudomonas pentandrum.*

6. Wood properties:

Wood Color	Wood is greyish white or grey without any sharp distinction into heartwood & sapwood.
Hardness	Wood is extremely soft, straight grained, even, coarse-textured.
Working Quality	It is easy to saw and work.
Weight	Wood is light, weight 453 kgm^{-3}.

Durability	It is not durable and is likely to discolor and rot in the log form and is susceptible to insects.
Seasoning	It cannot be seasoned in the log: it requires quick conversion followed by proper air or kiln seasoning.

7. Uses:

Timber	Timber can be used for packing cases, boxes, fence-posts, veneers, matches, furniture, and for violin.
Fuel wood	It is medium quality firewood.
Edible food	Young fruits are eaten raw or cooked into a vegetable.
Tannin	Bark is rich in tannin and is used in tanning leather.
Gum & Resin	The tree yields a dark almost opaque gum, which is given in bowel complaints, painful micturition and gonorrhoea.
Ecological Value	Kapok seeds are rich in protein. They contain higher amounts of digestible protein. They are rich in edible oil, which is also used for burning & in soap making. Seed cake, obtained after extraction of oil, is rich in protein for livestock.
Medicinal Value	Various parts of trees are reputed in indigenous medicine. The roots are stimulant, tonic, diuretic, emetic, and antispasmodic. Roots are useful in diabetes, dysentery and gonorrhoea. Flowers are demulcent and useful in leucorrhea.
Paper & Pulp	Woos is used for bleached pulp which is used for making ordinary paper. The main use of Kapok is for insulating and stuffing purposes in life–belts and life-jackets, in clothing for aviators and sailors.
Others	The floss is obtained from Kapok, which is superior to *Bombax ceiba*.

(6)

Local name: Kapur	**English name: Camphor tree**
Cinnamomum camphora	**Family: Lauraceae**

1. Natural occurrence: It is native of China, Japan, and Taiwan. In Nepal it is planted up to about 2,000m.

2. Morphological characteristics:

Leaf	The leathery and shiny alternate leaves have long, pink brown stalks. The leaves smell strongly of camphor when crushed.
Flower	The small, white or green flowers, are borne in bunches either in leaf axils or at the ends of branchlets.
Fruit	Fruit is a round, one seeded berry. The young fruit is dark green, later turning black as it ripens.
Bark	The bark of old trees is rough and brown, develops long, vertical flat, topped ridges.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	It is sensitive to drought.

Soil	Its best growth is on moist, deep sandy loams, such as alluvial soil near streams. Its growth on poor soil is stunted.
Coppice	It coppices vigorously and shoots grow rapidly.
Meteor. cond^{n}	It is medium to large, evergreen, and handsome tree with often much branched tree with a dense mass of foliage.

4. Artificial regeneration:

Preferred propagation	**i). Entire planting**, **ii). Layering:** air layering requires gallic acid treatment which gives 75% rooting. **iii). Branch and root cutting:** Root cutting possesses good buds, have proved very successful.
Seed collect^{n} time	Fruits ripen between September–November.
No. of seed kg^{-1}	3,500 seeds kg^{-1}.
Seed extraction	Pulp is removed and seeds are dried in the sun.
Seed storage	After drying the seed in sun, it can be kept in sealed container.
Viability of seed	6 months.
Seed treatment	Seeds are soaked in lucked water for 24 hours.
Seed sowing time	Seed should be sown soon after collection since fresh seed gives high percentage of germination.
Durat^{n} of germ^{n}	Seed germinates after 4-5 months.
Germination (%)	55% when fresh, falling to 25% at 6 months and nil at 12 months.
Nursery period	**Seedling:** 20 months.

5. Wood properties:

Wood Color	Wood is greyish white.
Hardness & weight	Wood is moderately hard. Wood weighs about 600kgm^{-3}.
Working Quality & Strength	It is easy to saw and work well. Wood is moderately strong.

6. Uses:

Timber	Wood can be used for cheaper grades of furniture, chess, and tea-boxes, coffins, cabinets & lighter forms of construction such as rafters, scantlings, planking etc.
Ecological value	It is an excellent ornamental and shade tree in parks and gardens.
Medicinal value	Fruits show anti-microbial activity. Bark is used as sedative, antispasmodic, diaphoretic and anthelmintic.
Others	It is a source of camphor obtained from distillation of wood, leaves, roots, branches, twigs, and even from fallen leaves. Camphor can be used in the pharmacy, drugs, insecticide etc. Kernels yield oil which is used for soap making & also substitute for palm oil.

(7)

Local name: Dhupi salla	**English name: Cryptomeria**
Cryptomeria japonica	**Family: Coniferae**

1. Natural occurrence: It is native to the mountainous country of China and Japan. It can grow well between 1500m and 2400m. It is the most suited to cooler, northerly aspects.

2. Morphological characteristics:

Leaf	Leaves are short, stiff, pointed and shaped like an awl. Leaves are arranged spirally on the branchlets in five ranks.
Flower	**Male flower:** clustered at the ends of branchlets. **Female flower:** cone like, rounded and covered with very small leaves.
Fruit	The cones are woody, round, brown and covered with scales.
Bark	Bark is reddish in color and peels off long strips.

3. Silvicultural characteristics: Tree nature: It is an evergreen, attractive tree, much branched with distinct whorls.

4. Artificial regeneration:

Preferred prop^{n}	Direct sowing, bare-root seedling planting, polytube seedling planting.
Seed collect^{n} time	Small cones are collected between August and December.
No. of seed kg^{-1}	300,000 seeds kg^{-1}, 1650 cones per kg, 8kg of cones yield 1 kg of seed.
Seed extraction	Cones are dried to release the seed.
Seed storage	Orthodox seed. Seed should be dried in sun and stored in either calico bags or sealed container or in cold storage.
Viability of seed	Only 5 months when stored in calico bags or up to 2 years in sealed container, or even four years in cold storage at 2^{0}c.
Seed sowing time	Seed is sown immediately onto open beds.
Germination (%)	80% when fresh seed.
Nursery period	**Seedling:** During the second wet season, the seedlings can be planted out bare-rooted in plantation or transferred to containers.
Best planting size	20-30cm tall seedlings.

5. Uses:

Timber	The scented wood is used for tubs, casks, tea boxes, and ornamental chests and in sometimes for building.
Fuel wood	It is also used as fuel wood.
Ecological value	It is mainly planted in Nepal as ornamental tree.

(8)

Local name: Gulmohar	**English name: Gold Mohur**
Delonix regia	**Family: Leguminosae, Caesalpinaceae**

1. Natural occurrence: It is native to Malaysia. It is the best suited from Terai to 1000m in Nepal.

2. Morphological characteristics:

Leaf	Leaves are alternately arranged on the twigs, bipinnate, 15-25 pairs pinnae each pairs have 25 pairs of leaflet.
Flower	Flowers appear soon after the new leaves, which are extremely beautiful. Petals are red on inside, greenish outside and yellowish on curling margins.
Fruit	The stout, woody, reddish brown or black pods are very long.
Seed	Pods contain many yellowish, mottled seeds.
Bark	The smooth grey bark has vertical lines of pale brown corky spots called lenticels.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost sensitive. It is difficult to grow in places where heavy frosts occur.
Drought	It grows on a variety of soils. It is suited to moist as well as dry region.
Coppice	It coppices well.
Browsing	Grazing and browsing sensitive.
Tree nature	It is fairly large deciduous ornamental tree with broad spreading umbrella shaped crown.
Others	It has a shallow root system, which makes it susceptible to blow down by winds.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting.
Seed collection time	Pods are collected during January and February.
NO. of seed kg^{-1}	2000 seeds kg^{-1}.
Seed storage	Orthodox seed, it should be dried and stored in sealed containers.
Viability of seed	Viability of seed remains for at least 5 years in sealed tins.
Seed treatment	Seeds require soaking in hot water for 10 minutes.
Seed sowing time	Seeds are sown during May & June.
Germination (%)	Germination can achieve over 80%.
Duration of germ^{n}	12 months.
Best planting size	20-30cm tall seedlings.

5. Forest pathogens: Root rot: caused by fungi *Ganoderma lucidum*.

6. Wood properties:

Wood Color	Wood is white.
Hardness& Weight	Wood is soft and open grained. Wood weighs about 440 kgm^{-3}.

7. Uses:

Fuel wood	It can be used for fuel wood.
Ecological value	It is mainly planted as an ornamental tree.
Others	It is grown extensively for shade.

(9)

Local name: Masala	**English name: Red gum**
Eucalyptus camaldulensis	**Family: Myrtaceae**

1. Natural occurrence: It is native to Australia, grows quite well from the Terai up to about 1500m.

2. Morphological characteristics:

Leaf	Adult leaves are lance shaped, dull and pale colored on both sides, thin long stalked and have conspicuous veins.
Flower	Flowers are borne in arrangements like the spokes of an umbrella (umbels), each spoke having 5 and 10 flowers at the end of slender stalks.
Seed	The seed capsule is shaped like half a globe and is stalked.
Bark	Bark is smooth, whitish or pale grey or reddish patches. It peels off in strips or in long irregular flakes, but is usually persistent at the base.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	It can tolerate winter drought.
Fire	**Fire tender:** when young; **fire resistant:** when old.
Soil	Eucalyptus prefers deep, fertile soil, with adequate rainfall. It is one of the best species plantations for waterlogged areas.
Coppice	It coppices well.
Associates	It can be planted mixed with *Dalbergia sissoo, Tectona grandis, Leucaena leucocephala*, etc. either on farm forestry, agro forestry or social–forestry.
Browsing	Leaves can be eaten by cattle so seedlings are severely affected by browsing.
Tree nature	These are aromatic, evergreen and generally tall trees, with large trunk and massive, spreading crown.
Other	Intolerant of competition by grass. It has a mycorrhizal association with fungi.

4. Artificial regeneration:

Preferred prop^{n}		Entire planting, stump planting.
Time of seed collect^{n}		Seeds are collected between April and May.
No. of seed kg^{-1}		600,000 to 700,000 viable seeds kg^{-1}
Seed extraction		Capsules are dried in the sun until they open. Seeds are removed from capsules by shaking.
Seed storage method		Orthodox seed, put thoroughly dried seed in a polythene bag, seal tightly and keep in a cool place.
Viability of seed		Viability of seed remains for several years.
Seed treatment		It is not required.
Seed sowing time		**Terai:** first two weeks of May, **Inner Terai and Bhabar:** last two weeks of April for planting in mid-July.
Duration of germ^{n}		Germination starts 4-5 days after sowing and completes a week later.
Nursery period	**Seedling**	**Terai:** 8-10 weeks, **inner Terai:** 10-12 weeks.
	Stump	One-year-old seedling is suitable for stump preparation.
Best planting size		15 to 25cm tall seedling with 3mm or more root collar diameter.

5. <u>Diseases Pests and Parasites of Eucalyptus</u>

(A) Nursery diseases: Damping off: caused by *Fusarium, Rhizoctonia, Phytophthora* and *Pythium* etc., **(B) Plantation diseases. (1) Stem diseases (a)** Root collar canker, **(b)** pink diseases **(c)** Stem canker **(d)** Other cankers. **(2) Root diseases (i) Ganoderma root rot:** caused by *Ganoderma lucidum* **(ii) Cylindrocarpon root rot:** caused by the *Cylindrocarpon lucidum* **(iii) Fusarium wilts:** caused by *Fusarium oxysporum.* **(3) Bacterial diseases: Crown gall:** caused by *Agrobacterium radiobacter.* **(4) Physiological disorders: (i) Gummosis:** caused by physiogenic, pathogenic or biotic factors**. (C) Insects, pests and parasites of Eucalyptus: (1) Root feeders:** caused by termites which is damaged to seedlings and young plantations**.**

6. Wood properties:

Wood Color	Heartwood is red.
Hardness & Strength	Wood is hard & strong wood.
Working Quality	It saws and works well, it takes a good polish.
Weight	Heavy wood, 50lb/cu ft. at 12% moisture; sp. gr. is 0.697 kg/cm^{2}.

Calorific value	c.v. ranges between 19,700 and 21,000 kJkg $^{-1}$.
Durability	Durable wood.
Preservative treat.	Treated timber can be used for longer period.
Seasoning	It is highly refractory timber liable to develop severe cracks, warping, twisting.

7. Uses:

Timber	It is used for inexpensive construction such as doors, purlins, and window frames. It is also used for manufacture of packing cases, ballies for scaffolding and electric transmission poles; use for parquet flooring and veneering.
Fuel wood	Provides a good fuel. Saw dust, lops and tops, leaves & bark are used as firewood.
Fodder	Leaves are not severely eaten by goats and cattle.
Edible food	Root, seeds and nectars are a source of food. Bees make a light colored, fine testing honey.
Tannin	Barks are used for tannin.
Ecological value	It is planted as ornamental tree and land reclamation for ravine land, denuded hill slope, canal bank, abandoned cultivated land, grass-land, water–logged areas, and colonization of river banks. It is also planted for shelter belts and wind break.
Medicinal value	Leaves contain oil, which is obtained by distillation; the oil is used for medicinal, industrial, and perfumery purposes. Industrial oil is a useful solvent for varnish, resins, grease, rubber etc.
Pulp& paper	Eucalyptus pulps have long fiber, so it is widely used in the manufacture of paper.

(10)

Local name: Kangiyo	**English name: Silver oak**
Grevillea robusta	**Family: Proteaceae**

1. Natural occurrence: It is native to Queens land and New South Wales, Australia. In Nepal it can be planted up to 1500m.

2. Morphological characteristics:

Leaf	Leaves are alternate, fern-like, dark green above and silvery below.
Flower	Flowers are orange colored, solitary or several together, borne in racemes.
Fruit	Fruit is an oblique, coriaceous follicle.
Seed	It contains 1or 2 seeds, which are, brown, flat and winged.
Bark	Bark is dark grey, deeply fissured into long narrow scales.

3. Silvicultural characteristics:

Light	Light demander.
Frost	**Seedlings** are susceptible to damage by frost; **mature trees** are fairly resistant to frost.
Drought	It is resistant to drought.
Soil	It prefers deep, fertile, moist, well-drained soils.
Coppice	It does not coppice well but pollards well.

Associates	It is generally not lopped for fodder, it is unpalatable to cattle.
Tree nature	It is an evergreen tree with a long conical crown and a straight stem.
Others	It is very sensitive to boron deficiency. Branches are liable to damage by winds.

5. Artificial regeneration:

Preferred propag^{n}	Seedlings.
Seed collect^{n} time	June-September, it produces a good seed every year.
No. of seed kg^{-1}	10,000 seeds kg^{-1}.
Seed extract^{n}	The capsules are dried in the sun and beaten to extract the seed.
Seed storage	After drying the seed in sun, it can be kept in sealed container.
Viability of seed	Viability of seed remains for one year, but germination percent is heavily dropped.
Seed treatment	It is not required.
Seed sowing time	**>1000m**: Aug-Sep.**<1000m:** Feb-Mar. Seed is sown in beds or trays.
Duration of germ^{n}	Germination begins 2-3 weeks after sowing & completes after two weeks later.
Germination (%)	Germination takes place 60-70%.
Nursery period	**Seedling:** >**1000m:** next monsoon, **<1000m:** Just coming monsoon.

6. Wood properties:

Wood Color	Wood is reddish brown in color.
Hardness & Weight	Wood is hard. Wood weighs about 570 kgm^{-3}.It is light wood.
Calorific value	**Sapwood:** 4,904 calories; **heartwood:** 4,914 calories.
Durability & Elasticity	Wood is durable & wood is elastic.
Seasoning	It requires careful seasoning.

7. Uses:

Timber	It is used for ornamental panelling, paraquet floors, furniture, toys, veneering & plywood.
Fuel wood	It is a moderately good fuel wood.
Tannin	The bark contains tannin. The bark also yields a yellow gum, which have medicinal uses.
Paper & pulp	It is suitable for paper and pulp.
Other	It is cultivated as a shade tree in tea & coffee plantations and is commonly planted in garden and avenues. The flowers attract honey and bees.

(11)

Jacaranda mimosifolia	**Family: Bignoniaceae**

1. Natural occurrence: It is native to Brazil; it can be planted form Terai up to about 1600m.

2. Morphological characteristics:

Leaf	Leaves are opposite, bipinnate, pinnae in many pairs, each with 10-24 or more pairs of leaflets.
Flower	Flowers are bluish violet, in loose panicles.
Fruit	Fruit is round, woody and flattened.

Seed	Fruit contains numerous seeds.
Bark	Bark is creamy brown in color, furrowed vertically and cracked horizontally.

3. Silvicultural characteristics:

Light	It is a light demander tree.
Frost	It recovers rapidly from frost damage so it is useful for avenues.
Soil	The plant thrives in well-drained soil and does not tolerate damp situations.
Tree nature	It is an elegant shrub or medium sized deciduous tree, commonly planted in gardens as an avenue and ornamental tree.

4. Artificial regeneration:

Preferred propagation	**i)** Broadcast seed sowing, **ii)** suckers: it can be propagated from the suckers arising from the base of stem.
Seed collection time	Fruits ripen in winter season as collected in February and March.
No. of seed kg^{-1}	There are about 50,000 seeds kg^{-1}.
Seed extraction	Fruits are dried in the sun and seeds are thrashed out.
Seed storage	Orthodox seed, it should be dried and stored in sealed containers.
Viability of seed	Seeds can be stored for up to 2 years.
Seed treatment	It is not required.
Seed sowing time	Seeds are sown in nursery bed in November and December.
Germination (%)	About 50%.
Duration of germ^{n}	Germination starts in a couple of days.
Nursery period	**Seedlings:** Seedlings can be planted in monsoon rain.
Best planting size	20-30cm tall seedlings.

5. Forest pathogens: It is affected by white spongy rot caused by *Palystictus hirsutus.*

6. Wood properties:

Wood Color	Wood is beautiful and fragrant
Hardness & weight	Wood is moderately hard and fine-textured. Wood is heavy.
Working Quality	It is easy to saw and work.

7. Uses:

Timber	Timber is useful for tool handles.
Fuel wood	Wood can be used for fuel.
Ecological value	It is a host plant for the Indian lac insect.
Medicinal value	In South America, bark is used in the treatment of skin diseases and glandular complaints.

(12)

Local name: Ipil Ipil	**English name: Ipil Ipil**
Leucaena leucocephala	**Family: Mimosaceae**

1. Natural occurrence: It is native to Central America, from Mexico to Honduras and also occurs in Peru.

2. Morphological characteristics:

Leaf	Leaves are bipinnate, 4 -8 pairs of pinnae, linear and oblong.

Flower	Flowers are small and whitish.
Fruit	Pods are straight and flat.
Seed	Seeds are 15-25.
Bark	Bark is brownish.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost tender.
Drought	It is drought resistant over longer periods.
Fire	It is fairly resistant to fire.
Soil	It is sensitive to soil pH and does not grow well in acidic soils. It requires innoculation with the N_2 fixing bacteria, *Rhizobium*. It is also sensitive to soil fertility. It prefers deep clayey soils.
Coppice	It coppices strongly.
Browsing	Leaf is highly proteinous and nutritious. So, it is severely damaged by browsing.
Tree nature	It is a large shrub or small evergreen tree up to 20m in height; it sheds leaves during prolonged drought or frost for short period.
Others	In Nepal, it generally successes well on Bhabar Terai soil but have failed on very gravelly and bouldery soils near rivers. Seedlings and older trees have very strong taproots.

4. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting, stump cutting.
Seed collection time		November-January.
No. of seed kg^{-1}		20,000 to 26,000 seeds kg^{-1} or 38-50gm/1000 seeds.
Seed extraction		Pods should be dried in sun and then seeds can be extracted by beating.
Seed storage		Orthodox seed. It should be dried and stored in sealed containers.
Viability of seed		Seed can be stored for many years without losing its viability.
Seed treatment		Immerse seed in hot boiling water for 2-3 minutes & then 24 hours in cold water.
Seed sowing time		**Terai:** First two weeks of May. Above **Terai:** Last two weeks of April.
Durat^{n} of germ^{n}		Germination begins after 3-4 days.
Nursery Period	**Seedling**	Seedling can be ready for July planting.
	Stump	Stump can be prepared from one-year-old seedling.
Best planting size		20-30cm tall seedlings with 4-5 mm root collar diameter.

5. Diseases, pests and parasites of Ipil Ipil (i). ***Psyllid, Heteropsylla cubana:*** causes severe damage to newly developing shoots and young leaves throughout Nepal. (**ii).** ***Ganoderma endochroum:*** causes high mortality in plantations. (**iii). Gummosis:** caused by *Fusarium semitectum.*

6. Wood properties:

Hardness	Wood is hard, medium textured, and closed grained.
Weight	Wood weighs about 540 kgm^{-3}.
Strength	Wood is strong.
Calorific value	Calorific value of wood is 3895 cal/gm. C.v, of charcoal is 7250 cal/gm.

7. Uses:

Timber	Wood can be used for poles.
Fuel wood	It is used as a good fuel wood and makes a good charcoal.
Fodder	Tops, leaves, pods and seeds of the plant are eaten by cattle, sheep and goats.
Edible food	Young shoots and immature pods are eaten as vegetable, fodder contains 15 to 21 % crude protein.
Tannin	Leaves and bark contain tannin as 3% and 16.3% respectively.
Ecological value	It is used as shade and cover plantation in tea, coffee, cocoa, rubber, teak, sal etc. Leaves and twigs are rich in N_2 and K salts, are used in composting It is used for afforesting in grass-land, also wind-break and shelter-belt. It fixes large amount of N_2 and improves the soil fertility.
Medicinal value	It is used to be a worm repellent and also a fish poison.
Paper and pulp	It is used as raw material for paper pulp.
Others	When consumed in excessive quantities, all parts of Ipil Ipil are toxic to monogastric animals like horses, pigs, rabbits and chickens cause great loss of hair, regeneration.

(13)

Local name: Patula salla	
Pinus patula	**Family: Pinaceae**

1. Natural occurrence: It is native to the mountains of eastern Mexico between 1650 and 3000m. In Nepal; it is best suited for planting between 1500 and 2500m.

2. Morphological characteristics:

Leaf	A three-needle pine. Leaves are very slender, hanging down on each side of the branches.
Fruit	Cones are oblique, curve, shining pale brown.

3. Silvicultural characteristics:

Light	Light demander.
Frost	**Seedling:** frost tender, **mature trees:** frost hardy.
Fire	Fire sensitive due to thin bark.
Soil	It is fairly tolerant of poor soils if they are acidic; it is very sensitive to boron deficiency.
Coppice	It is a non-coppicer.
Browsing	Leaves are unpalatable so seedlings are not much suffered from browsing.
Tree nature	It is an evergreen tall tree.
Meteorological condition	In its native country, rainfall ranges from 1000 to 1500mm which occurs mainly in summer season, with a relatively short dry season.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting.
No. of seed kg^{-1}	There are about 100,000 to 150,0000 seeds kg^{-1}.
Seed storage	Orthodox seed, the well-dried seed can be stored in sealed plastic bags.
Viability of seed	Viability of seed remains more than 1 year without serious loss of viability.

Seed sowing time	**<15000m:** September, **>1500m:** March.
Duration of germ^{n}	Germination begins after 2-3 days and is completed 10-20 days later.
Germination (%)	80%.
Nursery period	**For seedling, <1500m:** next monsoon, **>1500m:** 15-16 months.
Best planting size	20-30cm tall seedlings with 4-5 mm root collar diameter.

5. **Diseases, pests and parasites of Patula Salla: i)**. **Brown needle diseases:** more susceptible to damage by it. **ii). Three weak pathogenic fungi**, *Potebniamyces coniferanum, Coniothyrium fuckelii ,Phomopsis occulata* were found on dead and dying shoots. **iii). Die-back:** due to boron deficiency.

6. Wood properties:

Weight	Wood weighs about 370 to 600 kgm^{-3}.
Strength	The wood near the core of tree tends to be rather weak and soft than outer wood, which has better strength properties.

7. Uses:

Timber	Wood is used for boxes, cheap joinery and construction.
Fuel wood	Its wood burns rapidly but produces a lot of smoke.

(14)

L.N: Bangikot	**E.N: Himalayan poplar**
Populus ciliata	**Family: Solisaceae**

1. Natural occurrence: It is indigenous to Nepal. In Nepal, it grows between 2000-3000m, common in western Nepal, not found in central Nepal.
2. Morphological characteristics: ~ are similar as Populus deltoides.

3. Silvicultural characteristics:

Light	Light demander.
Frost	Frost hardy.
Drought	It withstands drought well and can grow on dry hill- sides.
Fire	Young trees are sensitive while old trees are tolerant to fire.
Soil	It thrives best in ravines on well-drained and porous soils. Grow best in soil with pH (5.5-7.5).
Coppice	It does not coppice well but pollards well.
Associates	**Coniferous forest:** blue pine, deodar, spruce, silver, fir etc.**; mixed broad leaf forest** in ravines: *Aesculus indica, Prunus, Cedrela*, Oaks, Maples,etc.
Tree nature	It is a moderate to large deciduous tree with a tall clean straight bole.
Browsing	It is locally an important fodder for goats so seedlings are severely damaged by browsing.

4. Natural regeneration: Natural regeneration takes place by seeds during the early rains. Seeds ripen in May and June. Seeds are dispersed by wind. Natural regeneration through suckers is also very common.
5. Artificial regeneration: ~ may be done through stem cuttings or root suckers, but give the best results.

6. Diseases, pests and parasites of poplars:

A. Diseases of poplars:

1. Root diseases:

a. White root rot diseases: caused by the pathogen *Rosellinia necatrix.***b. Root rot diseases:** caused by the pathogen: *Ganoderma lucidum* **c. Brown root rot diseases:** caused by the Pathogen *Phellinus noxius.* **d. Rhizoctonia** damping off and root rot: caused by pathogen *Rhizoctonia solani.*

2. Stem diseases:

a. Pink diseases: caused by *Corticium salmonicolo* **b. Cytospora canker:** caused by *Cytospora chrysosperma*

3. Foliage diseases:

a. Cladosporium leaf spot: caused by *Cladosporium humile.* **b. Pollaccia blight:** caused *by Pollaccia elegans.* **c. Melamspora leaf rust:** caused by *Melampsora ciliata.*

B. Pests of poplars: many borers and defoliators cause considerable damage, while some other insects produce galls on leaves and branches.

7. Wood properties:

Wood Color	**Sapwood:** nearly white, broad; **heartwood:** yellowish white when first exposed, turning yellowish grey or brownish grey with age.
Hardness	Wood is moderately soft.
Working Quality	It saws and works easily.
Weight	Lightwood, specific gravity is 0.456 and average weight is 449kgm^{-3}.
Durability	It is moderately durable under cover and in contact with water, but is liable to insect attack.
Preservative treat.	Treated timber can be used for longer period.
Seasoning	It seasons well and quickly.

8. Uses:

Timber	Timber is suitable for veneers, matchboxes and splints.
Fuel wood	Wood is used as fuel.
Fodder	Leaves are used as fodder for goats.
Ecological value	It is used as an avenue tree, can be used for soil stabilization on slopes.
Medicinal value	Bark is used as a tonic, stimulant and blood purifiers.
Paper & pulp	Wood is suitable for making paper pulp. The pulps have satisfactory strength properties for use in manufacture of writing & printing paper.

Local name: Lahre pipal	**English name: Black poplar**
Populus deltoides	**Family: Salicaceae**

1. Natural occurrence: It is an exotic species for Nepal. Its provenance is North America. It seems to be suited for an altitude of 1600m.

2. Morphological characteristics:

Flower	Leaves are broadly oval, have a pointed tip, toothed edges and a heart shaped base.
Seed	The male and female flower (catkin) grows on different trees before the new leaves. The catkins are pendulous and light yellow. The female catkins are slightly longer

	and stiffer than the male ones.
Bark	**Young tree:** Usually smooth and shiny; **Older tree:** grey or grey-black, rough, quite deeply furrowed.

3. Artificial regeneration: ~ may be done through stem cuttings or root suckers; but root suckers give the best results.

(16)

English name: Mesquite	**Family: Leguminosae**
Prosopis juliflora	**Sub-Family: Mimosaceae**

1. Natural occurrence: It is native to America. It can be grown tropical and sub-tropical parts of arid and semi-arid regions.

2. Morphological characteristics:

Leaf	Leaves are bipinnate with two to four pairs of pinnae.
Flower	Flowers are small, yellowish in dense spikes.
Fruit	Pods are yellow, straight, and cylindrical.
Seed	No. of seeds are 10-30 in a pod.
Bark	Bark is greyish brown.

3. Silvicultural characteristics:

Light	Light demander.
Drought	It is tolerant of very arid conditions (drought resistant).
Soil	It is suitable for dry calcareous (usar) sites in lowland.
Coppice	It possesses excellent coppicing power.
Browsing	Leaves ate unpalatable, so the tree is resistant to browsing.
Tree nature	It is a small, evergreen, spiny tree or shrub with drooping branches, not a common planted tree spp. of Nepal.
Others	It is a fast growing tree spp introduced in Nepal.

4. Artificial regeneration:

Preferred propag^{n}		Direct sowing, entire planting stump planting.
Seed collecti^{n} time		Seeds are collected in May and June in northern India.
No. of seed kg^{-1}		12,500 seeds kg^{-1}.
Seed extraction		Pods should be dried in sun and then seeds can be extracted by beating.
Seed storage method		Orthodox seed. It should be dried and stored in sealed containers.
Viability of seed		Viability of seed remains for long lived, (1 to 2 years) to very long period.
Seed treatment		Since the seed is hard-coated, either scarification is needed or soaks the seed in hot water also gives good result.
Seed sowing time		Seed should be sown in March, and in sunken beds.
Duration of germ^{n}		Germination completes within 14 days.
Germination (%)		Germination takes place 85-95%.
Nursery Period	**Seedling**	One-year-old seedling is preferable for transplanting.
	Stump	At least one-year-old seedling is better for stump.

Best planting size	20-30cm tall seedlings with 4-5mm diameter of root collar.

5. Wood properties:

Wood Color	Woos is dark brown in color.
Hardness	Wood is very hard with irregularly grained, coarse-textured.
Working Quality	Easy to saw and work, finishes to a smooth surface and takes a fine polish.
Weight	Wood is heavy. (Weight 768-929 kgm^{-3}).
Strength	Wood is strong.
Durability	Wood is durable.

6. Uses:

Timber	It is used for fence posts, house building, railway crossties, furniture & turnery.
Fuel wood	Wood is an excellent fuel and makes a first quality charcoal.
Fodder	Pods are an excellent fodder, are eaten during famine.
Edible food	The spongy wall of ripe pods is highly nutritive, a fair source of protein, are edible.
Gum& resin	Tree exudes a gum, which forms somewhat adhesive mucilage and used as an emulsifying agent.
Ecolo. value	Plants are rich in (N, P, and K) nutrients hence it is used for green manuaring.
Medicinal value	Aqueous & alcoholic extract of leaves show a marked anti-bacterial activity against *Bacillus coli*.
Others	Leaves contain 0.8 % of a dark green wax. Flowers are a source of nectar for bees.

(17)

Local name: Asok	
Saraca indica	**Leguminosae, Caesalpinaceae**

1. Natural occurrence: It is indigenous to India. It can be grown almost throughout Nepal between Terai to 750m.

2. Morphological characteristics:

Leaf	Leaves are paripinnate, leaflets 6-12, oblong or oblong-lanceolate.
Flower	Flowers are orange or orange-yellow, very fragrant, in dense axillary corymbs.
Fruit	Pods are flat &leathery.
Seed	Seeds are 4-8.
Bark	Bark is dark brown to grey or almost black.

3. Silvicultural characteristics:

Light	It is a shade bearer.
Coppice	It has a good coppicing capacity.
Tree nature	It is a small evergreen tree, found wild along streams or in the shade of evergreen forests.

4. Artificial regeneration:

Preferred propag^{n}	Direct sowing, entire planting.
Seed collection time	Seeds are collected in September, soon after ripening.
No. of seed kg^{-1}	97 seeds $kg^{-1.}$.

Viability of seed	Seeds viable for only about two months.
Seed sowing time	Seed should be sown as soon as possible after collection.
Germination (%)	Germination is about 100% if the seeds are sown within a month of collection.

5. Wood properties:

Wood Color	Wood is light reddish brown.
Hardness	Wood is soft.
Weight	Wood weighs about 576 $kgm^{-3.}$

6. Uses:

Timber	Timber is used for ploughs and shafts.
Fuel wood	Wood can be used as fuel wood.
Edible food	Pods are used to make very good forage for cattle.
Tannin	Bark contains 6% tannin.
Ecological value	It is frequently cultivated as ornamental and avenue tree.
Medicinal value	**Bark:** cures biliousness, dyspepsia, dysentry, colic, piles, ulcers & pimples. **Leaf:** possesses blood-purifying properties. **Flowers:** flowers pounded in water are used in haemorrhagic dysentry and the dried flowers in diabetes. Flowers are considered to be an excellent uterine tonic.
Religious value	Plant is one of the most sacred trees of the Hindus and Buddhists, flowers being much used for religious ceremonies and temple decorative.

Local name: Sagawan	**English name: Teak**
Tectona grandis	**Family: Verbenaceae**

1. Natural occurrence: **Provenance**: It is indigenous to India, Burma, Java, Indonesian islands and Thailand. It grows from Terai to 700m elevations in areas, where the vegetation is open and there is good drainage.

2. Morphological characteristics

Leaf	Leaves are broadly elliptic or obovate.
Flower	Flowers are small, white, sweet scented & numerous.
Fruit	Fruit is hard, bony, irregularly globose, somewhat pointed at the apex.
Seed	Seeds are 1-3 rarely 4 in a fruit.
Bark	Bark is fibrous, light brown or grey, exfoliating in long, thin strips.

3. Silvicultural characteristics:

Light	Strong light demander.
Frost	Frost tender.
Drought	Drought tender.
Fire	Very resistant to fire.
Soil	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 erodible sites.
Coppice	It coppices as well as pollards very well.
Associates	Teak normally occurs in the mixed deciduous forests in India. The common

	associates are *Acacia catechu, Adina cordifolia, Cassia fistula, Gmelina arborea* .The bamboos found in association with teak are *Dendrocalamus strictus, and Bambusa arundinacea.*
Browsing	It is not readily browsed by browsing animals.
Tree nature	It is a large deciduous tree with rounded crown, clean and cylindrical bole, the stem becomes more fluted and buttressed at the base.
Other	It suppresses all under growth, leaving a bare floor. It is not sensitive to pH. It is moderately wind firm in coastal areas. Teak is uprooted during cyclonic storms.

4. Artificial regeneration:

Preferred propg^{n}		Direct sowing, entire planting, stump planting.
Seed collect^{n} time		Seeds are collected between November & January.
No. of seed kg^{-1}		1200-3100 drupes kg^{-1}.
Seed storage		Orthodox seed .Put thoroughly dried seed in a polythene bag, seal tightly and keep in a cool place.
Viability of seed		Viability remains for 12 months in calico bags, but up to 10 years in sealed container.
Seed treatment		**(i)** Hot treatment seed either for 1-2 weeks at 50^{0}C, or up to two days at 80^{0}C, **(ii)** Fruits are put into jute sacks and left in running water overnight, then spread in the sun to dry the following day. This process of immersion and drying is repeated for 15 days .The fruits are then sown into open raised beds.
Seed sowing time		Seeds are sown between March and April.
Duration of germ^{n}		Germination starts after two weeks and tapering off after six weeks & can continue for six months.
Germination (%)		60-80%, germination is epigeous. At 12 months, germination is better than when fresh.
Nursery period	**Seedling**	Seedlings can be planted during monsoon. (4 -5 months after seed sown.)
	Stump	Stumps can be prepared from one-year-old seedlings.
Best planting size		20-30cm tall seedlings with 4-5mm root collar diameter.

5. Diseases, Pests and Parasites of Teak: (1) diseases (i) wilt diseases: caused by *Pseudomonas solanacearum* in seedling as well as old transplants. **(ii)** *Peniophora rhizo-morpho-sulphurea and Polyporus zonalis* causes root rot **(iii)** C*orticium salmonicolor* causes pink diseases. **(2) Important pests:** by two defoliators: **(i) Teak skeletonizor:** caused by *Hapalia machaeralis* **(ii)**. **Teak defoliator:** caused *by Hyblaea puera.*

6. Wood properties:

Wood Color	**Sapwood:** white to pale yellowish brown; **heartwood:** golden yellow.
Hardness	Timber is moderately hard.
Working Quality	It is easy to saw and work; it can be planted and sanded to a smooth surface which takes a good polish.
Weight	Wood weighs about 720 kgm^{-3}, medium heavy woods, sp. gr are (0.55 to 0.70).
Strength	Wood is strong.
Calorific value	Calorific value is high; **sapwood:** 4,989 calories, **heartwood:** 5,535

	calories, for completely dried wood.
Durability	Heartwood is one of the most durable woods, but the sapwood is not so much durable, perishable and quickly destroyed by rot, white ants.
Preservative treatment	It is very refractory wood to treatment, penetration being practically nil from sides or ends.
Seasoning	Teak is a model wood for air seasoning; it dries quickly and with little or no depreciation. It can be kiln seasoned easily but care is required to ovoid discoloration of wood.
Other	It is almost immune to the attack of white ants, other insects and fungi; it has a good resistance to acids.

7. Uses:

Timber	Timber is widely used for house building, ships and boats, furniture, railway slippers, high quality veneers etc.
Fuel wood	It is an excellent fuel.
Tannin	Leaves contain about 6% tannin and a yellow or red dye, is used for dyeing silk yellow, olive or related shades. Bark contains 7.14% tannin.
Medicinal value	The oily product is obtained by distillation of wood-chips for the treatment of eczema and ringworm. Extract of the leaves showed complete inhibition of *Mycobacterium tuberculosis.*
Paper & pulp	As timber is highly valuable, wood waste and small sized material is only used for pulping which can be used to make writing and printing papers.
Other	The kernels yield 44.5% of fatty oil, which is used to promote the growth of hair, and also in scabies.

CHAPTER: VIII

Glossary of medicinal terms used in the Compilation

Abscesses : Localized collection of pus in a cavity caused by disintegration of body tissues.
Acrid : Bitterly pungent.
Alexileric : Any of certain substances is normal blood serum which destroy bacteria.
Alterative : Gradually restoring the healthy bodily function.
Amenorrhoea : Absence of menstruation.
Anaemia : Quantitative defficienty of the haemoglobin.
Anaphrodisiac : Capable of diminishing sexual desire.
Anthelmintic : Causing removal of worms in the body.
Antibactetial : Preventing germicidal causes.
Antiperiodic : Preventing the return of those diseases which recur, such as Malaria.
Antiscobutic : Preventing worn.
Antiseptic : Preventing toxication.
Antispasmodic : Preventing or curing epilepsy.
Antiviral : Preventing or curing viral attack.
Aperient : Producing a natural movement of the bowels.
Aphrodisiac : Stimulating the sexual organs.
Appetizing : Causing the desire for food.
Asthma : Chronic disease that causes difficulty in breathing.
Astrigent : Causing contraction of the tissue.
Bilious : Suffering or caused by some trouble with bile or the liver.
Bronchitis : Inflamation of the lining of the bronchital tubes.
Cardiotonic : The agents which are used to restore cardiac efficiency and bring about an improvement of the circulation.
Carminative : Expelling gas from the stomach and intestine.
Catarrhal : Inflamation of a mucus membrane, especially of the respiratory tracts.
Cathertic : Evacuating the bowels.
Caustic : Capable of buring , corroding or destroying living tissues.
Chlorosis : A type of iron deficiency marked by a pale yellow green complexion.
Demulcent : Protecting an irritated mucus membrane.
Delirium : A more or less temporary disorder of the mental faculties.
Depilatory : Capable of removing hair.
Diuresis : Excessive discharge of urine.
Diuretic : Increasing the volume of the urine.
Elephantiasis : Cronic disease due to lymphatic obstruction.
Embrocation : Act of embrocating a bruised or diseased part of the body.
Emollient : Having the power of softening or relaxing living tissues.
Emetic : Applied to drugs which cause vomiting.
Epilepsy : A chronic nervous diseases whose attacks cause upset and unconsiousness.
Erysipelas : Acute febrile infectious diseases.
Expectorant : Promotimg expectoration and removing secretions form the bronchial tubes**.**
Febrifuse : Reducing fever.
Galactagogue : Increasing the amount of milk.

CHAPTER: IX

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As human population is increasing rapidly, natural resources particularly forest are being severely depleted due to deforestation results in desertification and change in land use pattern especially conversion of forest land into problematic and difficult sites like denuded hill slopes, abandoned cultivation land, landslide and erosion, road slope failure, etc.

Foresters' main duty is now to conserve the existing forest as well as to launch afforestation program, to increase the productivity of forest and to search alternatives for fulfillment of basic needs of human beings.

This compilation covers widely information on tree species about afforestation techniques, diverse uses, silvicultural and morphological characteristics, wood properties, agro forestry application, silvicultural system etc, that's why, this compilation is quite useful for forestry students, forestry professionals and other natural resource managers.

Author