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Connecting the fragmented forests by the opportunity of vertical dual land use

(Plantation of dwarf species, preferably medicinal plants in RoW of transmission lines as compliance of the existing mandatory condition under FC Act, 1980)

India has a robust legal framework for the conservation of nature and natural resources. Plantation of dwarf species (preferably medicinal plants) in right of way (RoW) of transmission lines is a unique mandatory condition stipulated in stage-I approval of the projects of forest land diversion under Forest (Conservation) Act, 1980. It provides a unique opportunity of vertical dual land use by differentiating the vertical space above the land for different uses. However, assessment of the available vertical space and selection of suitable tree species for this limited vertical space is crucial for the effective compliance of this condition. In the present study, a total of 1080 projects of forest land diversion for transmission lines (with at least stage-I approval) in different states/UTs of India (as available on PARIVESH portal from 15.07.2014 to 18.06.2022 at 10:00 pm.) were reviewed. Various aspects of the existing practices including safety, species selection, estimates, cost of plantation, spacing of seedlings, phyto climatic zones and vegetation types etc were examined. The analysis of available vertical and horizontal space in total 21 combinations of specifications in transmission lines of various voltage levels was conducted. 'V'-type string is found to be more suitable to accommodate taller dwarf plants. A list of 200 perennial dwarf species of different phyto climatic zones of India is given along with their distribution and available propagation techniques. A differential height model of plantation and method of calculation of vertical and horizontal space (K-value) for relatively taller (T-value) dwarf plants is proposed with the objectives of effective compliance of this condition under Forest (Conservation) Act, 1980 and prevention of the fragmentation of forests.

Key words: Forest fragmentation, Dwarf species plantation, Dual land use, Propagation technique, Plantation model, Transmission lines, Right of Way.

Method of calculation of horizontal and vertical space, selection of appropriate species and differential height plantation model is proposed for plantation of dwarf species in RoW of transmission lines.

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Introduction

With its amazing potential, India is sustaining about 17% of world's population with only 2.4% of world's geographical area. A robust legal framework of Acts, Rules and guidelines is also available for various types of land use specially for forest areas. However, the land scarcity in India requires a careful and rationalized land use planning for every purpose including agriculture, urbanization, industrialization, forests, biodiversity and water resource etc.

In India, the diversion of forest land for non-forest purpose comes under the purview of Forest (Conservation) Act, 1980 (referred hereafter as FCA). The section-2 of FCA restricts diversion of forest land for non-forest purpose without prior approval of Central Government. The applications for such prior approval are processed through PARIVESH portal (https://parivesh.nic.in) of Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India. The procedure for processing of applications wasnotified in the Forest (Conservation) Rules, 2003 (as amended up to August, 2017) and now in the Forest (Conservation) Rules, 2022. The stage-I approval (*In Principle Approval*) stipulates several conditions including deposition of levy in the form of Net

Present Value (NPV) and Compensatory Afforestation (CA). Besides these, certain other conditions including deposition of cost of catchment area treatment plan, wildlife management plan, soil-moisture conservation plan, penal compensatory afforestation and dwarf species plantation etc may also be stipulated in various categories of projects. All the funds are to be deposited in CAMPA account. The stage-II approval (*Final approval*) is granted after mandatory compliance of conditions stipulated in stage-I approval. The Central Government has also delegated powers of such prior approval to state governments, integrated regional offices and regional empowered committees up to the certain area for specified purpose.

In FCA, the transmission line projects are categorized as linear projects. Like other categories of projects, several conditions including that of NPV, CA etc. are stipulated in stage-I approval of transmission line projects. However, plantation of dwarf species in right of way (RoW) is unique condition in transmission line projects only (Box 1). In compliance of this condition, scheme for plantation of dwarf species (preferably medicinal plants) is prepared by concerned user agency in consultation with state forest department and its cost is deposited in CAMPA account. The plantation is conducted by forest department of concerned state/UTs.

In transmission lines, a minimum vertical clearance between conductors and any object is essential as specified in Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 (Table 2). The MoEF&CC has also issued guidelines for minimum clearance (MoEF&CC, 2019) (Table1). Since, limited vertical space is available under transmission lines, the selection of species becomes crucial for the effective compliance of condition of dwarf species plantation.

Box 1: Condition of dwarf species plantation

The standard condition in para 5.2(iv)(b) of handbook of FCA (MoEF, 2004) states "*Plantation of dwarf species (preferably medicinal plants) in right of way under the transmission lines*". The general and standard condition no. (I)(9) in part-C of handbook of FCA issued in 2019 (MoEF&CC, 2019) states "*The User agency in consultation with the State Forest Department prepare a detailed scheme for creation and maintenance of plantation of dwarf species (preferably medicinal plants) in right of way under the transmission line for execution of the said scheme to the State Forest Department".*

In present paper, the practices followed in different states/UTs, for dwarf species plantation were reviewed and various aspects of safety, species selection, estimates, cost of plantation, plantation area of RoW, spacing, Forest Types etc. were examined. The condition of dwarf species plantation (preferably medicinal plants) provides a very good opportunity in terms of objective, site and fund etc., for the conservation and propagation of even those forest species which were left in conventional plantation/ afforestation drive, including Red List species. However,

Table 1 : RoW and Minimum clearance as perguidelines of FCA issued by MoEF & CC

1.	**Guidelines issued vide F.N.5-2/2017-FC dated 28-03-2019**			
	10.1: Transmission through bare conductor(s):			
	Transmission Voltage	**RoW width (m.)**	**Width clearance below each conductor or conductor bundle for stringing (m.)**	**Minimum clearance between conductor & trees (m.)**
	11Kv	7	Not required	2.6
	33KV	15	Not required	2.8
	66KV	18	Not required	3.4
	110KV	22	Not required	3.7
	132KV	27	Not required	4.0
	220KV	35	Not required	4.6
	400KV S/C vertical delta configuration	46	3 twin bundle, 5 triple bundle	5.5
	400 KV D/C	46	7	
	+/- 500KV HVDC	52		7
	765 KV S/C (With delta configuration)	64	7 quadruple bundle 10 hexagonal bundle	9
	765 KV D/C	67		
	1200 KV	89	To be decided	13
	The clearance of the lower conductor of 11kv and 33 KV overhead lines should be as per CEA regulation 58(3) and 58(4) or above max. trunk height of elephant, whichever higher.			
2.	**Guidelines issued vide F.No.7-25/2012-FC dated 19.11.2014 (MoEF & CC, 2014)** In case of transmission lines passing through elephant reserves/corridors, additional clearances of 6 m. over and above minimum clearance as stipulated under CEA regulation.			
3.	**Guidelines issued vide F.No.FC-11/157/2019-FC dated 01.01.2020 (MoEF & CC, 2020)** In dwarf species plantation over small areas (b elow 0.1 ha), the user agency in consultation with State Forest Department shall identify degraded forest areas of not less than 1 ha.			

Table 2 : CEA (Measures relating to Safety & Electric Supply) Regulations, 2010 (Relevant to forest clearance and forestry operations)

Regulation No.	Alignment/ Type	Voltage (kV)	Minimum Clearance (m.)	
58	**Clearance above ground of the lowest conductor of overhead lines**			
58(1)(i)	across a street	Upto 650 V.	5.8 (Vertical)	
58(1)(ii)		>650 V. up to 33kV	6.1 (Vertical)	
58(2)(i)	along any street	Upto 650 V.	5.5 (Vertical)	
58(2)(ii)		>650 V. up to 33kV	5.8 (Vertical)	
58(3)(i)	elsewhere than	upto 11kV, if bare	4.6 (Vertical)	
58(3)(ii)	along or across any	upto 11kV, if insulated	4.0 (Vertical)	
58(3)(iii)	street	>11kV but upto 33 kV	5.2 (Vertical)	
58(4)	-	>33 kV	5.2 (+0.3 m. for every additional 33kV or its part) (minimum 6.1m. along/across street) (Vertical)	
58(5)	High Voltage Direct	100 kV	6.1 (Vertical)	
	Current (HVDC)	200 kV	7.3 (Vertical)	
	lines	300 kV	8.5 (Vertical)	
		400 kV	9.4 (Vertical)	
		500 kV	10.6 (Vertical)	
		600 kV	11.8 (Vertical)	
		800 kV	13.9 (Vertical)	
60	**Clearance of lines of voltage up to 650 Volts from buildings (the expression "building" deemed to include any structure, permanent or temporary)**			
60(2)(i)	for any flat roof/varandah roof/open balcony/lean-to-roof			
60(2)(i)(a)	when line passes above the building		2.5 (Vertical)	
60(2)(i)(b)	when line passes adjacent to the building		1.2 (Horizontal)	
60(2)(ii)	**for pitched roof:**			
60(2)(ii)(a)	when line passes above the building		2.5 (Vertical)	
60(2)(ii)(b)	when line passes adjacent to the building		1.2 (Horizontal)	
61	**Clearance from buildings of lines of voltage exceeding 650 V (the expression "building" deemed to include any structure, permanent or temporary)**			
61(2)(i)	Vertical Clearance	>650 V. up to 33kV	3.7	
61(2)(ii)		>33kV	3.7 m. plus 0.30 m. for every additional 33kV or part thereof	
61(3)(i)	horizontal	>650 V up to 11kV	1.2	
61(3)(ii)	clearance	>11kV up to 33kV	2.0	
61(3)(iii)		>33kV	2.0 m. plus 0.3m. for every additional 33kV or part thereof.	
61(4)	**High Voltage**	**Voltage**	**Vertical**	**Horizontal**
	Direct Current	100 kV	4.6	2.9
	(HVDC)	200 kV	5.8	4.1
		300 kV	7.0	5.3
		400 kV	7.9	6.2
		500 kV	9.1	7.4
		600 kV	10.3	8.6
		800 kV	12.4	10.7
64(3)	No material/earth work/Agricultural produce dumped/stored, no trees grown below or in vicinity of, bare overhead conductors, or lines to contravene the provision of regulations 60 and 61.			
65(3)	No soil cutting within 10 m. from tower structure of =/>132 kV without permission.			

a detailed study of documents of various projects reveals that there is a lot of confusion and lack of options/awareness in selection of appropriate dwarf species and planning/designing the plantation schemes. Therefore, a set of dwarf species for different regions of country are also recommended along with planning/ design pattern of plantation. This documentation will also be helpful in exploiting the great opportunity of conservation and propagation of less known forest species including medicinally important and Red List species.

Material and Methods

The data for analysis of transmission line projects is primarily taken from the PARIVESH portal (https://parivesh.nic.in) of MoEF&CC, GoI. This portal contains detailed information of proposals received on or after 15.07.2014 only. Therefore, available records of 1080 projects (up to 18.06.2022 at 10:00 pm.) of transmission lines in different states/UTs across India, in which at least stage-I approval has been granted, were analyzed for the present study. The documents of compensatory afforestation schemes, stage-I approval,

Table 3 : Number of examined projects of transmission line* (as on PARIVESH portal upto 18.06.2022 at 10:00 pm)

S.No.	State/UT	Stage-I*	Stage-II	Total	Forest area (ha)
1	A & N	00	00	00	00
2	Andhra Pradseh	10	06	16	292.3088
3	Arunachal Pradesh	09	16	25	1888.2359
4	Assam	07	04	11	467.072
5	Bihar	21	10	31	39.07512
6	Chandigarh	00	02	02	0.3634
7	Chhattisgarh	21	04	25	874.5636
8	Dadar & N.H.	02	00	02	4.7485
9	Daman & Diu	00	00	00	00
10	Delhi	04	01	05	64.0041
11	Goa	01	03	04	97.8117
12	Gujarat	61	99	160	526.39174
13	Haryana	34	64	98	256.13466
14	Himachal Pradesh	07	21	28	459.2233
15	J & K	04	00	04	9.352
16	Jharkhand	24	15	39	968.42324
17	Karnataka	16	06	22	89.980176
18	Kerala	03	01	04	0.794
19	Lakshadweep	00	00	00	00
20	Madhya Pradesh	07	53	60	1594.5713
21	Maharashtra	30	04	34	2405.571
22	Manipur	04	01	05	514.526
23	Meghalaya	03	00	03	16.129
24	Mizoram	00	01	01	104.77
25	Nagaland	00	00	00	00
26	Orissa	24	11	35	1154.2667
27	Pondicherry	00	00	00	00
28	Punjab	44	122	166	86.774702
29	Rajasthan	47	52	99	513.6222
30	Sikkim	22	04	26	114.6914
31	Tamil Nadu	03	08	11	47.366415
32	Telangana	06	13	19	260.894
33	Tripura	05	13	18	429.8052
34	Uttar Pradesh	80	19	99	1014.9
35	Uttarakhand	06	16	22	663.5
36	West Bengal	02	04	06	52.9548
	Total	**507**	**573**	**1080**	**15012.82**

*Stage-I includes the projects under process for stage-II.

dwarf species plantation schemes, demand note, compliance reports, satge-II approval etc were studied. A database of rates, spacing, species and protection measures etc of CA schemes and dwarf species plantation schemes was prepared. The rules and guidelines of FCA, plantation schemes and Transmission linesas available on website/portals of respective Ministry/Authority/ Dept. and e-greenwatch (https://egreenwatch.nic.in) portal were studied in detail. The naturally growing dwarf species in various regions, states and districts of India were selected from flora, published materials and authentic online resources (Hooker, 1872-1897; Duthie, 1903-1929; Brandis, 1921; Kanjilal, 1933; Kanjilal *et al.,* 1934-40; Chowdhery and Wadhwa, 1984; Rao, 1985-1986; Shetty and Singh, 1987-1993 etc.). The compilation of propagation techniques of various species (including herbs, shrubs, and trees) has generated another database of more than 800 species. However, for present article, only reference of propagation techniques of dwarf species of only a particular height range is given. The appropriate dwarf species grown in nurseries of forest departments of various states/UTs as evident from the uploaded schemes of CA and dwarf species plantation have also been included. The data for analysis of available vertical and horizontal space was taken from the various prevailing rules, regulations and guidelines of MoEF&CC and Ministry of Power, Government of India or its subordinate organizations.

Result and Discussion

The list of 1080 examined proposals of transmission linesof various states/UTs (with atleast stage-I approval) as available on PARIVESH portal (from 15.07.2014 upto 18.06.2022 at 10:00 pm) is given in Table 3. In 05 States/UTs (A&N, Daman & Diu, Lakshdweep, Nagaland and Pondicherry), no any transmission line project was processed on this portal on or after 15.07.2014. Highest number of transmission line projects was processed in Punjab (166), Gujarat (160), Rajasthan (99), U.P. (99) and Haryana (98). The forest area diverted for transmission lines is highest in Maharashtra (2405.571 ha), followed by Arunachal Pradesh (1888.2359 ha), M.P. (1594.5713 ha), Odisha (1154.2667) and U.P. (1014.9 ha). Project FP/OR/TRANS/14204/2015 involves highest area (461.1496 ha) of forest land diverted in a single transmission line project. Similarly, project FP/HR/TRANS/122760/2021 involves lowest area (0.0011 ha) of forest land diverted in a single transmission line project (Table 4). It is important to mention that condition of dwarf species plantation is stipulated only in above ground transmission lines. The outcomes of present study are discussed under the points mentioned in Box 2.

The Current practices of dwarf species plantation

Species used in existing practices of dwarf species plantation

A total of 60 species (Box 3) are found to be used in dwarf species plantation, as mentioned in various documents of projects like site specific estimate, model estimate, demand note, approval letter, recommendation letter and compliance letter etc. of 1080 examined projects and websites of state forest departments. In many states the name of species is not mentioned in any of the uploaded documents.

The *Zizyphus* spp. is most commonly mentioned as dwarf species, followed by *Annona* spp. In several projects (like that of Odisha), *Zizyphus* spp. and *Annona* spp. are mentioned in stage-I approval letter issued by concerned Regional Office/State. In several states annual short-livedherbs like Tulsi (*Ocimum sanctum*), Kalmegh (*Andrographis paniculata*), Gokhru (*Tribulus terrestris*), Shankhpushpy (*Convolvulus microphyllus*) andPora Amlokhi (*Phyllanthus acidus*) etc. are being used. In some states perennial herbs like *Aloe vera*, *Withania somnifera*, *Agave americana, Asparagus racemosus* etc are being used. In some other states annual/biennial tall herbs/bushy plants like *Ricinus*

Box 2: Outcomes of present study

1. **The current practices of dwarf species plantation:**
   - **1.1.** Species used in existing practices of dwarf species plantation
   - **1.2.** Existing plantation technique (Pattern, Spacing, Protection method, estimate & Levy)
   - **1.3.** Similarity with CA schemes
   - **1.4.** Common Errors and probable reasons
2. **Analysis of available vertical and horizontal space for dwarf plants in RoW**
   - **2.1.** Vertical Space
   - **2.2.** Horizontal Space
3. **Appropriate methods and Recommendation:**
   - **3.1.** Eco-classes of forests and their distribution in India
   - **3.2.** Proposed plantation model (pattern, spacing, height, species and Protection Measures)
   - **3.3.** Natural perennial dwarf species, their distribution and propagation techniques
   - **3.4.** Miscellaneous and summary of recommendations

Table 4 : Transmission line projects with highest and lowest diverted forest area (as on 18.06.2022)

Project Number	Detail	State/UT	Forest (ha)	Status (and date)
I. Top five Projects in terms of highest area of diverted forest land				
FP/OR/TRANS/14204/2015	Angul to Jharsugoda	Odisha	461.1496	Stage-II (08.11.2019)
FP/MH/TRANS/29180/2017	Raigarh to Pugalur	Maharashtra	432.6791	Stage-I (05.09.2018)
FP/MH/TRANS/17702/2016	Raipur Rajnandgaon Warora	Maharashtra	284.2797	Stage-I (26.03.2018)
FP/MP/TRANS/17449/2016	Vindhyachal to Jabalpur	M.P.	241.0995	Stage-II (18.09.2020)
FP/AR/TRANS/40560/2019	Naharlagun to Gerukamukh	Arunachal P.	230.44	Stage-I (17.03.2022)
II. Top five Projects in terms of lowest area of diverted forest land				
FP/HR/TRANS/122760/2021	From Sub-station Tajpur	Haryana	0.0011	Stage-I (07.04.2021)
FP/HR/TRANS/21664/2016	Errection of PCC Pole	Haryana	0.0011	Stage-II (19.01.2017)
FP/GJ/TRANS/24987/2017	Jetpar Maliya	Gujarat	0.00182	Stage-II (10.06.2021)
FP/GJ/TRANS/149397/2021	Underground, Dhola-Ujalvav	Gujarat	0.0021	Stage-I (09.02.2022)
FP/GJ/TRANS/119389/2021	Underground, Nichi Mandal	Gujarat	0.0021	Stage-II (31.03.2022)

Box 3 : Species as available in uploaded documents for dwarf species plantation*
(in many projects/states any species is not mentioned in any of the uploaded documents)

1. *Acacia auriculiformes* Benth. (**L.N.:**Akashmoni, Acacia)
2. *Acacia catechu* (L.f.) Willd. (**L.N.:** Khair)
3. *Acacia nilotica* subsp. *indica* (Benth.) Brenan (**L.N.:** Desi Baval, Babool)
4. *Acacia Senegal* (L.) Willd. (**L.N.:** Gorad, Kumatiyo)
5. *Aegle marmelos* (L.) Correa (**L.N.:** Bel, Vilvam)
6. *Agave americana* L. (**L.N.:**Agave)
7. *Agave sisalana* Perrine (**L.N.:** Sisal)
8. *Ailanthus excelsa* Roxb. (**L.N.:**Perumaram, Mahaneem,Pedda, Bende, Mundaigachh)
9. *Albizia lebbeck* (L.) Benth. (**L.N.:** Siris, Vagai, Bage)
10. *Aloe vera* (L.) Burm.f. (**L.N.:** Ghritkumari, Khorpad, Chal Kunwari, Kalabanda)
11. *Alstonia scholaris* (L.) R.Br. (**L.N.:** Jantala, Chhatwan, Chitwan, Saptparni, Daivapala)
12. *Anacardium occidentale* L. (**L.N.:** Kaju, Geru,Andima)
13. *Andrographis paniculata* (Burm.f.)Nees (**L.N.:**Kala Chirayata, Kalmegh, Urakiriyatu)
14. *Annona squamosa* L. (**L.N.:** Shariffa, Sitha, Sitaphal, Katal, Sitaphalam)
15. *Asparagus racemosus* Willd. (**L.N.:** Shatawar, Shatabari, Satamuli, abiruvu)
16. *Averrhoa bilimbi* L. (**L.N.:** Rohdoi)
17. *Averrhoa carambola* L. (**L.N.:** Kordoi)
18. *Azadirachta indica* A.Juss. (**L.N.:** Neem, Veppai)
19. *Balanites aegyptiaca* (L.) Delile (**L.N.:**Hingod, Hingot)
20. *Bauhinia racemosa* Vahl. (**L.N.:** Boga Kanchan, Jhinjheri, Banraji)
21. *Bauhinia tomentosa* L. (**L.N.:** Iruvatchi, Mandara)
22. *Berberis aristata* DC. (L.N.: Kasmal)
23. *Buchanania lanzan* Spreng. (**L.N.:** Achar, Piyar, Priyaluvu, Char, Chironjee)
24. *Calamus floribundus* Griff. (**L.N.:** Jati bet)
25. *Calotropis procera* (Aiton) W.T.Aiton (**L.N.:** Aak)
26. *Carissa carandas* L. (**L.N.:** Karonda)
27. *Cassia fistula* L. (**L.N.:** Amaltas, Sonalu, Garmado, Garmaro, Chahui, Sunari, Ngaingaw, Konrai, Kakke)
28. *Cassia siamea* Lam. (**L.N.:** Chakundi)
29. *Commiphora wightii (Arn.) Bhandari* (**L.N.:** Guggal)
30. *Convolvulus microphyllus* Sieber ex. Spreng. (**L.N.:** Shankhpushpy)
31. *Cordia gharaf* Ehrenb. ex Asch. (*C. sinensis* Lam.) (**L.N.:**Liyar, Gundi, Desi Gunda)
32. *Dalbergia* ***sissoo*** Roxb. ex DC. (**L.N.:** Sheesham)
33. *Emblica officinalis* Gaertn. (**L.N.:** Amla, Heikru, Usiri, Ciehu, Nelli)
34. *Ficus religiosa* L. (**L.N.:** Peepal)
35. *Gliricidia sepium* (Jacq.) Kunth (**L.N.**: Saranga, Seemai agathi, Madri)
36. *Holoptelea integrifolia* (Roxb.) Planch. (**L.N.:** Kanji, Chilbil, Nata Karanja, Dhauranjan, Charal)
37. *Jatropha curcas* L. **(L.N.:**Ratanjot, Bherenda, Bongoli)
38. *Madhuca longifolia* (J.Koenig. ex L.) J.F. Macbr. (**L.N.:** Eluppai, Maul, Mahua, Illuppa)
39. *Mallotus philippensis* (Lam.) Mull.Arg. (**L.N.:** Sinduri, Rohini, Kesari, Raini, Kamala)
40. *Meyna spinosa* Roxb. ex Link. (**L.N.:** Kutkura, Helu, Gurbeli, Huloo)
41. *Moringa oleifera* Lam. (**L.N.:** Sahjan, Munga, Nugge)
42. *Ocimum sanctum* L. (**L.N.:** Tulsi)
43. *Oroxylum indicum* (L.) Kurz. (**L.N.:** Bhat ghilla, Sonachhal)
44. *Phyllanthus acidus* (L.) Skeels (**L.N.:** Pora Amlokhi)
45. *Pongamia pinnata* (L.) Pierre (**L.N.:** Karanj, Kanjhi, Kenja, Pungam, Pongam)
46. *Psidium guajava* L. (**L.N.:** Amrud)
47. *Ricinus communis* L. (**L.N.:** Arand, Veranda)
48. *Salvadora persica* L. (**L.N.:** Pilu, Piloo)
49. *Schumannianthus dichotomus* Gagnep. (**L.N.:** Pati Doi)
50. *Sesbania grandiflora* (L.) Poir (**L.N.:** Bokphul, Agust)
51. *Syzygium cumini* (L.) Skeels. (**L.N.:** Jamun)
52. *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. (**L.N.:** Arjun)
53. *Terminalia bellirica* (Gaertn.) Roxb. (**L.N.:** Bahera)
54. *Terminalia chebula* Retz. (**L.N.:** Harr)
55. *Tribulus terrestris* L. (**L.N.:** Gokhru, Gokshura)
56. *Vachellia planifrons* (Wight & Arn.) Ragup., Seigler, Ebinger & Maslin (**L.N.:** Kodaivel, Kodavelam, Odevara)
57. *Vitex negundo* L. (**L.N.:** Pachatia, Nirguni, Sindwar)
58. *Withania somnifera* (L.) Dunal (**L.N.:** Ashwagandha)
59. *Zanthoxylum alatum* Roxb. (**L.N.:** Tirmira, Timroo)
60. *Ziziphus mauritiana* Lam. (**L.N.:** Ber, Bordi, Bogori)
61. Besides above species,the documents of a large number of transmission line projects mentions terms like *Ziziphus* spp., *Annona* spp., conifers and other Broad leaved plants etc., without clear identity of species.

***L.N.:** Local Names of few languages/regions are given above in english

communis is used. In many states usual tree plantation species like *Ailanthus excelsa*, *Albizia lebbeck, Azadirachta indica*, *Buchanania lanzan*, *Dalbergia sissoo*, *Emblica officinalisFicus religiosa, Holoptelia integrifolia*, *Madhuca longifolia*, *Syzygium cumini*, *Terminalia arjuna*, *Terminalia bellirica*, *Terminalia chebula* etc are used as dwarf species which are actually tall or medium sized trees and may not be appropriate. More interestingly, invasive alien plants like *Acacia auriculiformes* and *Calotropis procera* etc are used as dwarf species. In some projects terms like conifers and other broad leaved plants are mentioned.

Above findings indicate that in most of the states selection of species is not appropriate. Plantation of short-lived annual herbs like *Ocimum sanctum* etc. or tall and medium sized trees is not as per the spirit of the condition of dwarf species plantation. Also, the species like *Acacia auriculiformes* and *Calotropis procera* etc have been documented as exotic and invasive plants (Misra, 2020).

Existing plantation technique (Pattern, Spacing, Protection method, estimate and Levy)

In most of the states, the block plantation pattern is followed for dwarf species and levy is calculated on per hectare basis. In some states, linear plantation pattern is also followed and levy is calculated on per kilometer basis. Delhi is found to be unique in plantation pattern of individual trees and levy is calculated based on SoR of individual trees. The estimates and other records reveal that in most of the states, dwarf species plantation is conducted with similar spacing of 2x2 m^2, 3 x2 m^2 and 3x3 m^2 as in other afforestation/plantation schemes. Interestigly, the similar spacing of 2x2 m^2, 3 x2 m^2 and 3x3 m^2 is followed even for annual short-lived herbs like *Ocimum sanctum*, *Andrographis paniculata*, *Tribulus terrestris*, *Convolvulus microphyllus* etc. which seems irrelevant. The pit size (1.5' × 1.5' or 1'×1'), levy and estimate rates are also similarfor trees as well as annual short-lived herbs.

In most of the states the advance work is conducted in year '0' or year '1' of plantation and involves temporary nursery, pit digging, protection works etc. Mostly, temporary nursery works are included in estimate of advance works. However, in few states like Rajasthan, the estimates of nursery and advance works are different and cost of both is summed for levy. In few states like Andhra Pradesh, the estimates reveal that advance work and plantation work are conducted in same year and cost/works of both are included in same estimate. In most of the states, similar nursery works and advance works like germination bed, transplantation in polybag, hoeing-weeding, 1'×1' plantation pit etc are mentioned even for short lived annual plants like *Ocimum sanctum* etc. and levy is also charged like that of tall or medium sized trees used in other afforestation schemes. In states like Jharkhand, bamboo gabion is used for fencing/protection while in Odisha entire length is protected by barbed wire fencing. Few states like Rajasthan provide cattle proof trench (trench fencing). However, transmission lines are linear and traverse the forests, fragmenting it into fragments. Therefore, trench and barbed wire fencing may not be appropriate in the cases where forest patches/fragments are situated on both sides of transmission line. It prohibits movement of wildlife. Trench/barbed wire fencing may be appropriate in cases where forest is situated only on one side of transmission lines. The gabion fencing seems to be appropriate protection measure amongst the existing measures. The cost of plantation is more in linear plantation with Gabion. The cost with barbed wire and RCC pillars is even much higher.

Similarity with CA scheme

In most of the states the rate of dwarf species plantation is same as that of CA schemes with 1111, 1100 and 1000 plants/ha. In few states like Andhra Pradesh, the rate is same but no. of plants is reduced to 400/ha as against CA scheme of 1111 plants/ha. In few states like Jharkhand and Rajasthan, a state level model estimate of dwarf species plantation is followed. The practice of model estimate seems to be appropriate to avoid errors. However, in few states the model estimate of dwarf species has same rate of works as in other afforestation estimates and plant size is not considered for spacing, pit size, levy etc.

Common errors and reasons

In some projects, good analysis was conducted for dwarf species plantation scheme. However, in most of the projects, several important aspects are not considered. The SoR used for other plantation schemes is used for dwarf species plantation also. For the compliance of phrase '*dwarf species* (*preferably medicinal plants*)' in stage-I approval, the most common herbaceous medicinal plants are incorporated in schemes but even for these herbaceous plants, measurements, plantation/nursery prescriptions etc. remain similar to tree species and the levy is also calculated based on same rate as in CA and other tree plantation. Based on review of project documents uploaded on PARIVESH portal, the common errors and probable reasons are listed in the Box 4.

Analysis of available vertical and horizontal space for dwarf plants in RoW

The data for vertical and horizontal clearance in relevant guidelines was calculated with reference to the point of maximum sag of conductors in transmission lines of different voltage levels at 85°C and the displacement of conductors due to swing at 35° angle (Ministry of Power, GoI, 2020). It is important to mention that in the present study, all the subsequent calculations for safety clearances are minimum and the height of the plants is maximum as per the existing guidelines (Fig. 1 and Fig. 2). However, the height of tower may be optimized to accommodate relatively taller dwarf plants. Moreover, there is wide range of specifications of transmission lines including voltage levels, conductor type and string type etc. and it is not possible to find data for every specification. Therefore, the analysis of available vertical and horizontal space for plants is conducted only for 21 combinations of specifications (Table 6).

Vertical space

The outcome of analysis of vertical space for plants is given in Table 5. For this analysis, the vertical clearance of conductors from ground is considered as per section- 58, 60 and 61 of CEA regulation, 2010. The available vertical space for plants is analyzed only for the transmission lines of particular voltages as given in FCA guidelines viz. F.N.5-2/2017-FC dt. 28-03-2019 and F.No. 7- 25/2012-FC dt.19.11.2014.Table-5 reveals that the vertical space of 2 to 3.6 m. is available for plants in transmission lines of various voltages and accordingly species of this height range should be planted.

Box 4: Common Errors and probable reasons

Common Errors

1. Calculation of area of RoW for dwarf species plantation.
2. Selection of non-appropriate species including:
   - **a.** Annual short lived herbs like Tulsi (*Ocimum sanctum*), Kalmegh (*Andrographis paniculata*), Gokhru (*Tribulus terrestris*), Shankhpushpy (*Convolvulus microphyllus*) etc. and ephemeral bushes like Arand (*Ricinus communis*) etc.
   - **b.** Invasive alien species like *A. auriculiformes*, *Calotropis procera* etc.
   - **c.** Tall and medium sized trees like *Ailanthus excelsa*, *Albizia lebbeck, Azadirachta indica*, *Buchanania lanzan*, *Dalbergia sissoo*, *Emblica officinalis*, *Ficus religiosa, Holoptelia integrifolia*, *Madhuca longifolia*, *Terminalia arjuna*, *T. bellirica*, *T. chebula* etc.
3. Spacing of 2x2 m^2, 3x2 m^2 or 3x3 m^2 and pit size of 1'x1' or 1.5'x1.5' (as in usual tree plantation) even for dwarf species and also for annual short lived herbs like *Ocimum sanctum*, *Andrographis paniculata*, *Tribulus terrestris*, *Convolvulus microphyllus* etc.
4. Provision of nursery works like germination beds, transplantation in polybags etc for annual short lived herbs.
5. Same rate of levy demand for trees as well as annual herbs.
6. Same protection measure for trees as well as annual herbs.
7. Barbed wire fencing or cattle proof trench of RoW even in the projects/places where transmission line passes through the forest.
8. Felling of naturally growing dwarf tree species and trees of safer height (as evident from tree enumeration list) to clear RoW for construction of transmission lines irrespective of the vertical height of conductors.

Probable reasons of errors

1. Lack of options of species in usual plantation schemes.
2. Lack of awareness of propagation/nursery techniques and quality planting material of indigenous dwarf species.
3. Lack of proper inventory of local forests.
4. Lack of SoR/model estimate of dwarf species plantation.
5. Project proposals/user agencies are concerned more about area and the vertical height of conductors is not consideration in scheme preparation.
6. Safety Standards/measurements of RoW of transmission lines are not mentioned in project proposals submitted by user agency.
7. No accountability of user agency in compliance/implementation except depositing the levy amount.

"In general, everyone wish to raise good plantations. However, lack of options and awareness seems to be the major reason of these errors".

Table 5 : Analysis of Available vertical space for plants (m.)

Voltage (kV)	Clearance above ground from lowest conductor (CEA, 2010)	Minimum clearance between conductor & trees (FCA Guideline F.N.5-2/2017-FC dated 28-03-2019)	Available vertical space for plants
--	L	M	O
Upto 11kV	4.6	2.6	2
>11kV to 33 kV	5.2	2.8	2.4
>33 kV:	**5.2 (+ 0.3 m. for every additional 33kV or its part)**		
66kV	5.2+0.3 = 5.5	3.4	2.1
110kV	5.2 + (0.3 x 3) = 6.1	3.7	2.4
132kV	5.2 + (0.3 x 3) = 6.1	4	2.1
220kV	5.2 + (0.3 x 6) = 7.0	4.6	2.4
400kV D/C&S/C	5.2 + (0.3 x 12) = 8.8	5.5	3.3
765kV D/C&S/C	5.2 + (0.3 x 23) = 12.1	9	3.1
1200kV	5.2 + (0.3 x 36) = 16	13	3
500 kV HVDC	10.6	7	3.6
As per FCA Guideline F.N.5-2/2017-FC dated 28-03-2019: The clearance of the lower conductor of 11kv & 33 KV overhead lines should be as per CEA regulation 58(3)&58(4) or above max. **trunk height of elephant, whichever higher.**			
As per FCA Guideline F.No.7-25/2012-FC dated 19.11.2014: In case of transmission lines passing through elephant reserves/corridors, additional clearances of 6 m. over and above minimum clearance as stipulated under CEA regulation.			

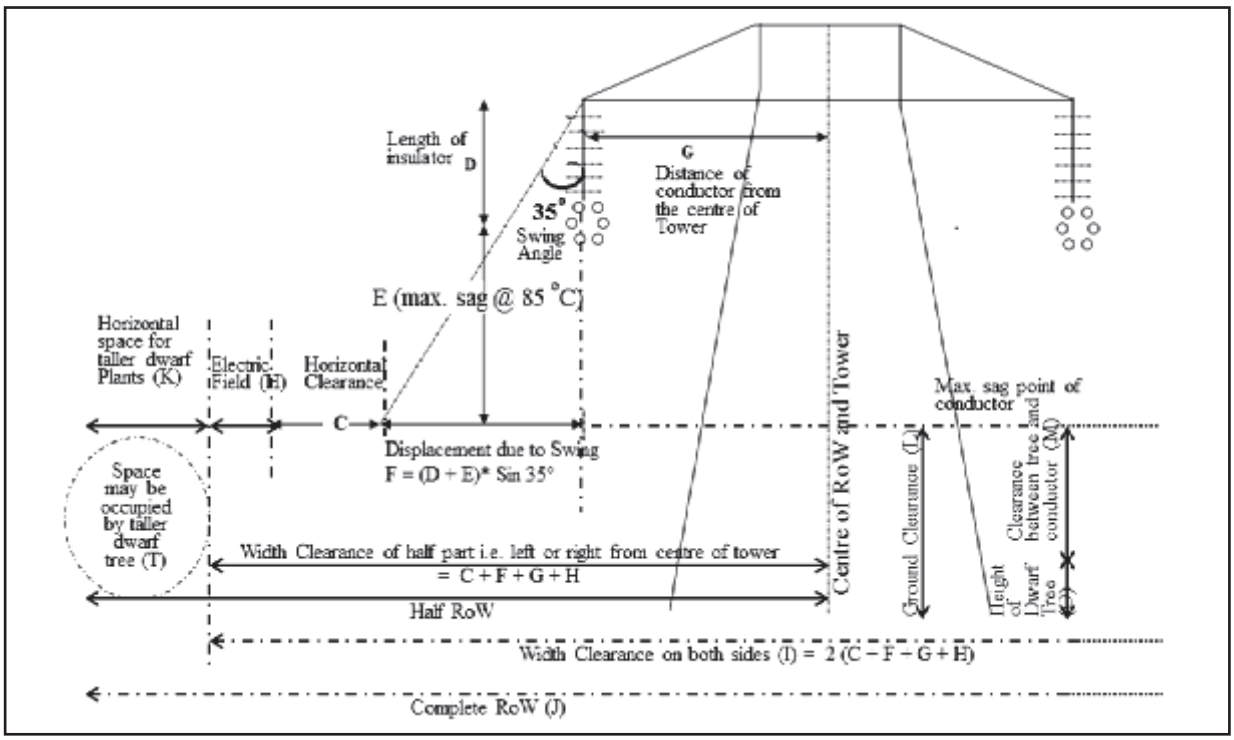


Fig. 1 : Diagrammatic representation of various distances in Row of transmission line with I-String (Symbols are corresponding to column numbers in table 5 and 6)

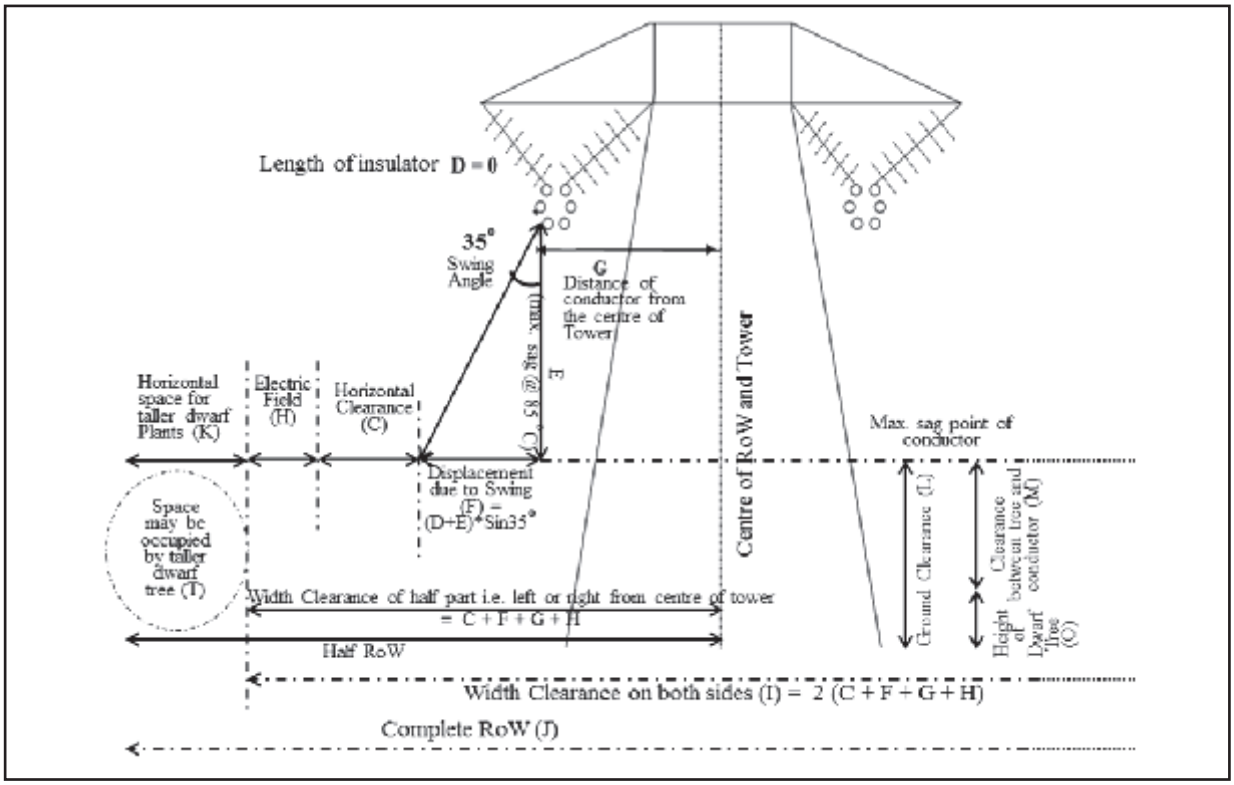


Fig. 2 : Diagrammatic representation of various distances in Row of transmission line with V-String (Symbols are corresponding to column numbers in table 5 and 6)

Table 6 : Analysis of Horizontal space for taller dwarf plants (m.) in transmission lines passing through forests

Voltage, Configuration, Conductor type & Design span (m.)	String Type	Horizontal clearance	Insulator Length	Max Sag @85°C	Displacement due to swing	Conductor Distance from tower centre	Electric field at ROW edge (kV/m)	Width Clearance	RoW	Horizontal Space for taller dwarf plants
A	B	C	D	E	F=(D+E)* Sin35°	G	H	I=2(C+F+G+H)	J	2K#=J-I
765kV D/C Vertical ACSR ZEBRA 300 m.	I-String	9	7.6	8.2	9.1	12.5	2.9	67		0
	V-String	9	0	8.2	4.7	10.5	3.7	55.8	67	11.2
	Tension	9	0	8.2	4.7	14.5	-	56.4		10.6
765kV S/C Vertical/Delta ACSR BERSIMIS 300 m.	I-String	9	7.1	9.1	9.3	10.5	3	63.6		0.4
	V-String	9	0	9.1	5.2	9.5	4.1	55.6	64	8.4
	Tension	9	0	9.1	5.2	13	-	54.4		9.6
400kV D/C/ S/C Vertical ACSR MOOSE 300 m.	I-String	5.6	4	8.2	7	7.5	1.5	43.2		2.8
	V-String	5.6	0	8.2	4.7	6	1.7	36	46	10
	Tension	5.6	0	8.2	4.7	9.7	-	40		6
220kV D/C/ Vertical ACSR ZEBRA 300 m.	I-String	3.8	2.5	8.2	6.1	4.6	-	29		6
	V-String	3.8	0	8.2	4.7	4	-	25	35	10
	Tension	3.8	0	8.2	4.7	5.7	-	28.4		6.6
132kV D/C Vertical ACSR PANTHER 200 m.	I-String	2.9	2.3	3.6	3.4	3.9	-	20.4		6.6
	V-String	2.9	0	3.6	2.1	3.5	-	17	27	10
	Tension	2.9	0	3.6	2.1	5.3	-	20.6		6.4
110kV Vertical ACSR PANTHER 200 m.	I-String	2.9	2.1	3.6	3.3	3.2	-	18.8		3.2
	V-String	2.9	0	3.6	2.1	3.2	-	16.4	22	5.6
	Tension	2.9	0	3.6	2.1	4.4	-	18.8		3.2
66kV Vertical ACSR PANTHER 150 m.	I-String	2.3	1.9	2.3	2.4	2.5	-	14.4		3.6
	V-String	2.3	0	2.3	1.3	2.5	-	12.2	18	5.8
	Tension	2.3	0	2.3	1.3	3.5	-	14.2		3.8

Source:

(1). @ All figures and formula in column-A, B, C, D, E, F, G and H are taken from the Appendix-VIII, Table-2 of the guideline no. 3/4/2016-Trans dt. 16.07.2020 of Ministry of Power, GoI. Relevant column no. and text modified to accomodate in present table.

(2). @ All figures in column- J are from the guideline F.N.5-2/2017-FC dt. 28-03-2019 of MoEF&CC, GoI. However, the conductor type is not mentioned in this guideline for all the voltage level and configuration is not mentioned except the voltage level at serial no.2 & 3.

(3). Figures and formula in column no. I and K are derived from the values mentioned in all other columns.

#**Note:** Column no. K is space of both the sides OR say 2K = J – I OR K = (J-I)/2

From Fig. 1 and Fig. 2 and table 6:

(1). Displacement due to swing = (Insulator Length + Max. Sag at 85°C) x Sin 35°

$$F = (D + E) \times 0.57358$$

(2). Width Clearance $= 2 \times \left[\text{Horizontal Clearance} + \text{Displacement due to Swing} + \text{Conductor Distance from tower centre} + \text{Electric field at ROW edge (kV/m)}\right]$

$$I = 2 \times (C + F + G + H)$$

(3). Horizontal Space for taller dwarf plants (for both edge) = RoW Width – Width Clearance

$$2K - J - I$$

$$\text{For one side edge (K)} = \frac{(J - I)}{2}$$

Horizontal space

The horizontal space available for plants is equivalent to the RoW of transmission lines. However, there is scope of plantation of relatively taller species at or near the edge of RoW. The calculation of this horizontal space for relatively taller species is conducted as per the guidelines issued vide no. 3/4/2016-Trans dt.16.07.2020 of Power Ministry, GoI; F.N.5-2/2017-FC dt. 28-03-2019 of MoEF&CC, GoI and provisions of CEA Regulations, 2010. Accordingly, various types of horizontal distances like horizontal clearance, displacement of conductors due to swing at 35°, electric field of conductors and distance of conductors from the centre of tower were summed and the value of sum of these four parameters is termed as 'width clearance' to distinguish this value from the RoW. The value of width clearance was deducted from the value of RoW to find out the space, if any, available for relatively taller plants. The summary of the calculation of horizontal space available for relatively taller dwarf plants in transmission lines of 21 specifications is given in Table 6.

Appropriate methods and Recommendation

Eco-classes of forests and their distribution in India

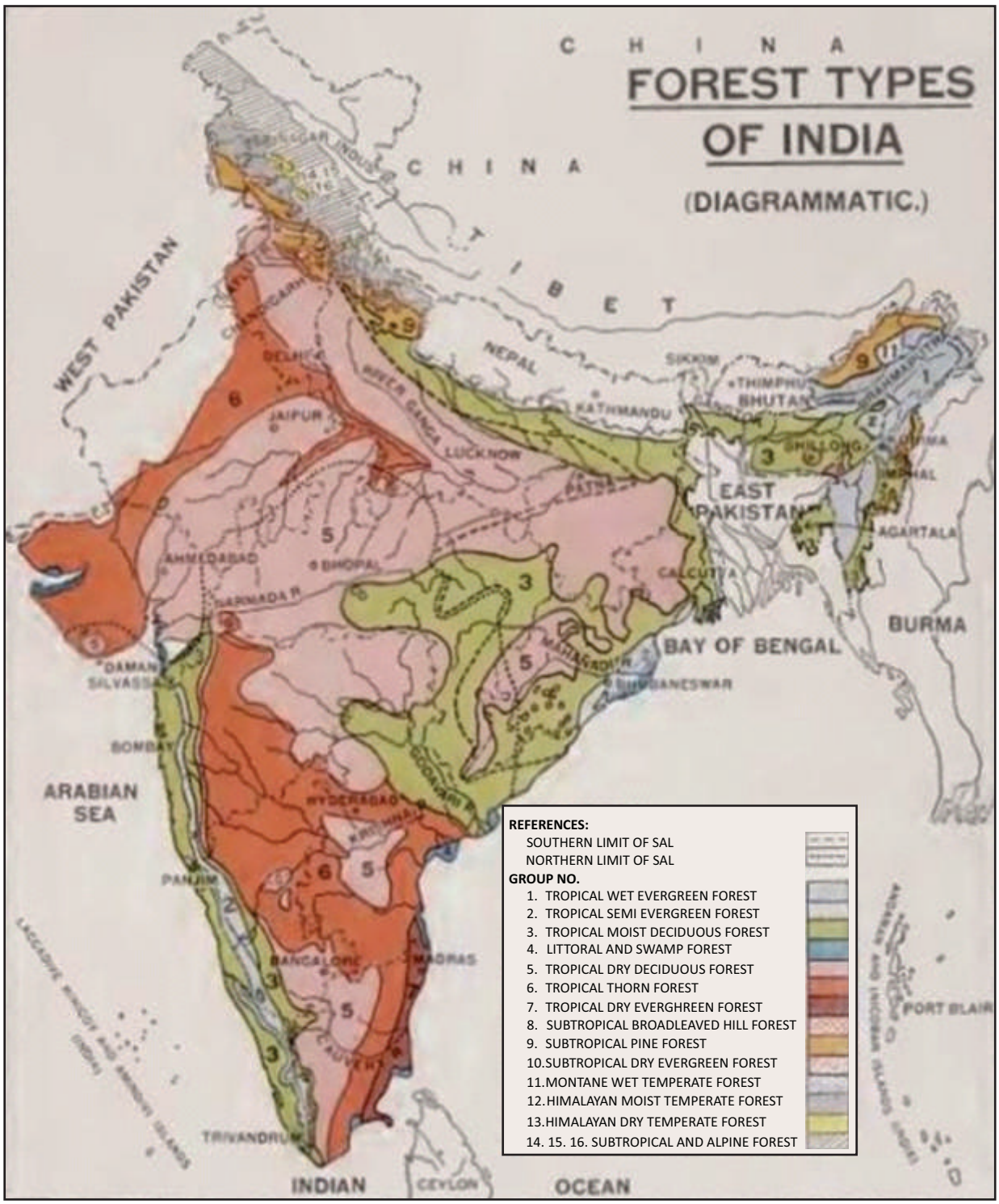
The levy of forest land diversion under FCA is being calculated based on the categorization of forests of country in certain Eco-Classes (Box 5). Based on the classification of forests of India by Champion and Seth (1968), the distribution of forests of these eco-classes in different states can be located in the Map 1. The distribution of plant species in India as given in Table 8 is taken from the exhaustive survey of literature of pre-independence and post independence times. Therefore, the old names of states, districts may not correlate with the present names. However, the distribution of forest types and plant species in present states and districts may be easily corelated by comparing the locations in Map 1 and a present political map of India.

Proposed plantation model (pattern, spacing, height, species and protection measures)

As discussed above, plantation patterns like block plantation, linear gabion plantation and individual tree/gabion plantation with 2×2, 2×3 and 3×3 m^2 spacing are mentioned in the estimates/schemes of dwarf species uploaded on Parivesh portal. Since transmission lines are linear structures and if sufficient length of forest land is being diverted, both the linear pattern and block pattern with appropriate spacing may be used for plantation. However, since the planted

Box 5: Type of forests for calculation of NPV under FCA

Eco-Class I	:	Tropical Wet Evergreen Forests, Tropical Semi Evergreen Forests and Tropical Moist Deciduous Forests
Eco-Class II	:	Littoral and Swamp Forests
Eco-Class III	:	Tropical Dry Deciduous Forests
Eco-Class IV	:	Tropical Thorn Forests and Tropical Dry Evergreen Forests
Eco-Class V	:	Sub-tropical Broad-Leaved Hill Forests, Sub-Tropical Pine Forests and Sub-Tropical Dry Evergreen Forests
Eco-Class VI	:	Montane Wet Temperate Forests, Himalayan Moist Temperate Forests, Himalayan Dry Temperate Forests, Sub Alpine Forest, Moist Alpine Scrub and Dry Alpine Scrub



Map 1: Forest Types of India
(Source: Champion and Seth, 1968)
(References/labels are re-typed for visibility purpose only)

(The distribution of forests of various eco-classes for calculation of NPV under Forest (Conservation) Act, 1980 can be located in this map).

species are dwarf, the spacing may be confined to 2×2 m^2 and approximate 2500 plants per ha. may be planted. Similarly, the dwarf plants of various appropriate heights may be used in various rows in a planned way. The dwarf plants with relatively more average height may be planted near the edge of RoW than those of below the conductors. Similarly, perennial climber and liana may also be planted at appropriate places. By this differential height plantation method, the dwarf plants of different height may be adjusted and a form of mini-stratification canbe created. The number of rows can be calculated as follows:

For RoW width in even number :

$$\text{Number of Plant rows} = \left[\frac{\text{RoW width}}{2}\right] + 1$$ (With rows at 2m. spacing)

For RoW width in odd number :

$$\text{Number of Plant rows} = \frac{(\text{RoW width} + 3)}{2}$$ (With any two rows at 1m. and all other rows at 2m. spacing)

The height of relatively taller dwarf plants can be calculated (Fig. 3) by taking the clearance between lowest conductor and trees (Table 1 and Table 5) as hypotenuse (M) for the trees to be planted outside the width clearance. The available horizontal space of relatively taller dwarf plants ('K' value in Table 6) may be taken as base of the triangle. The height of the triangle and height of taller dwarf tree ('T' value) can be calculated as follows:

Height of plants in inner rows (O) = L - M

Height of triangle (N) = $\sqrt{(M)^2 - (K)^2}$

Height of relatively taller dwarf tree near edge (T) = L -

Tree with no height restriction (NHR): if K > M

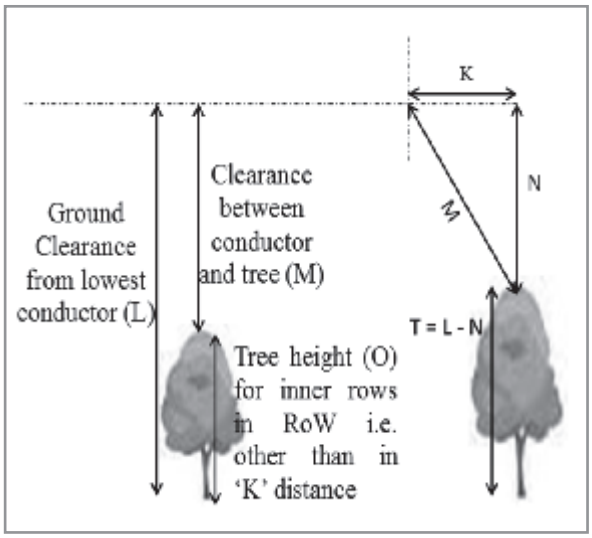


Fig. 3 : Calculation of height (T) of taller dwarf tree

The maximum height of dwarf trees in RoW has been calculated for transmission lines of few specifications (Table 5). The maximum height ('T' value) of taller dwarf plants to be planted at or near the both edges of RoW has also been calculated and presented in Table 7. The Table 7 also gives summary of pattern, number of plant rows in RoW and average height of dwarf species.The examples of proposed plantation model for transmission lines of few specifications are given in Fig. 4, Fig. 5, Fig. 6 and Fig. 7. It is evident from the Table 7 that there is no height restriction (NHR) for the tree at the edge of RoW in cases where the 'K' value >'M' value. However, the crown/branch of such trees should be away from the conductors at minimum distance equal to 'M' value. The Table 6 and Table 7 also reveal that transmission lines with V-string are found to be better because they provide better vertical space and more 'K' value to accommodate more number of taller trees. There is wide range of specifications of transmission lines including voltage levels, conductor type and string type etc. and it is not possible to find data for every specification. Therefore, the analysis of vertical and horizontal space available for plants is conducted in 21 specifications only. Further analysis for a transmission line of particular specification can be made by similar method as per requirement. Moreover, the 'K' valuemay be determined in every specification to plant the taller trees and trees with no height restriction (NHR). The 'V'-type string is more suitable in terms of available horizontal space for taller dwarf plants.

The gabion plantation is most suitable for the protection of plantation in RoW. Since, transmission lines pass through the forests, the cattle proof trench and barbed wire fencing may not be suitable in places where forest is located on both sides of transmission lines.

Natural perennial dwarf species, their distribution and propagation techniques

Literature survey revealed that a large number of dwarf species including herbs, shrubs, climbers, lianas, dwarf trees are naturally growing in forests of various eco-classes. However, the propagation techniques of most of such plants have not been documented so far. The compilation of the available propagation/nursery techniques of various species (including herbs, shrubs, and trees) has generated another database of more than 800 species. However, the vertical height of the plants should be in accordance with the existing guidelines for safety purpose. Further, the plantation of only perennial species can be suitable for the monitoring purpose. Therefore, in present article, only reference of propagation/nursery techniques of dwarf species of only a particular height range is given. However, the propagation techniques of only few perennial dwarf species have been worked outfor in field/nursery. After extensive survey of literature, a list of 200 perennial dwarf species and climbers along with their distribution and few local names in various languages has been

Table 7 : Maximum height of Plant in proposed plantation models in transmission lines of different voltage level

Voltage and Config.	String Type	RoW (m.)	Number of Plants rows															-
			1	2	3	4rd to 8th	9	10	11	12	13	14	15	16	17	18	19	
66kV	I-String	18	2.62	2.1	2.1	2.1	2.1	2.62	-	-	-	-	-	-	-	-	-	Maximum Height of Plants (m.)
(as per	V-String		3.73	2.22	2.1	2.1	2.22	3.73	-	-	-	-	-	-	-	-		
table-6)	Tension		2.68	2.1	2.1	2.1	2.1	2.68	-	-	-	-	-	-	-	-	-	
110kV	I-String	22	2.76	2.4	2.4	2.4	2.4	2.4	2.4	2.76	-	-	-	-	-	-	-	
(as per	V-String		3.68	2.49	2.4	2.4	2.4	2.4	2.49	3.68	-	-	-	-	-	-	-	
table-6)	Tension		2.76	2.4	2.4	2.4	2.4	2.4	2.4	2.76	-	-	-	-	-	-	-	
132kV	I-String	27	3.84	2.32	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.32	3.84	-	-	-	-	
(as per	V-String		**NHR**	3.45	2.23	2.1	2.1	2.1	2.1	2.1	2.23	3.45	**NHR**	-	-	-	-	
table-6)	Tension		3.7	2.28	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.28	3.7	-	-	-	-	
220kV	I-String	35	3.51	2.51	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.51	3.51	
(as per	V-String		**NHR**	3.51	2.51	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.51	3.51	**NHR**
table-6)	Tension		3.80	2.59	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.59	3.80	

*** NHR = No Height Restriction**

Note: It is practically not possible to restrict tree ht. in fraction of m. or cm. Thus, species of suitable height should be selected.

Voltage and Config.	String Type	RoW (m.)	Number of Plants rows													-
			1	2	3	4rd to 21th	22	23	24	25	26	27th to 31st	32	33	34	35	
400kV	I-String	46	3.48	3.3	3.3	3.3	3.3	3.3	3.48	-	-	-	-	-	-	-	Maximum Height of Plants (m.)
(as per	V-String		6.51	4.19	3.39	3.3	3.39	4.19	6.51	-	-	-	-	-	-	-	
table-6)	Tension		4.19	3.39	3.3	3.3	3.3	3.39	4.19	-	-	-	-	-	-	-	
765kVS/C	I-String	64	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	-	-	
(as per	V-String		4.14	3.37	3.10	3.1	3.1	3.1	3.1	3.1	3.1	3.10	3.37	4.14	-	-	
table-6)	Tension		4.49	3.55	3.14	3.1	3.1	3.1	3.1	3.1	3.1	3.14	3.55	4.49	-	-	
765kV	I-String	67	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	
(as per	V-String		5.05	3.85	3.24	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.24	3.85	5.05	
table-6)	Tension		4.83	3.73	3.19	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.19	3.73	4.83	

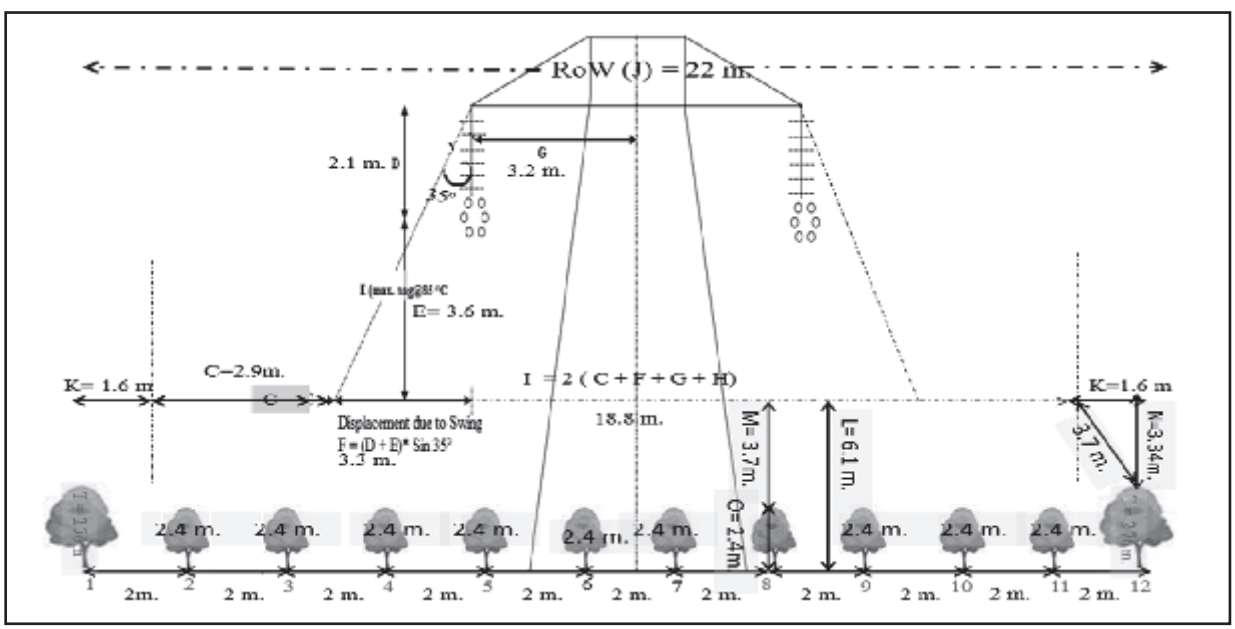


Fig. 4 : Dwarf Species Plantation Model in Row of 110 kV Transmission Line with Vertical config. & I-String

1. Minimum clearances & max. tree height as per guidelines. However, tower height may be optimized to plant taller trees.
2. It is practically not possible to restrict tree height in fraction of m. or cm. Thus, species of suitable height should be selected.

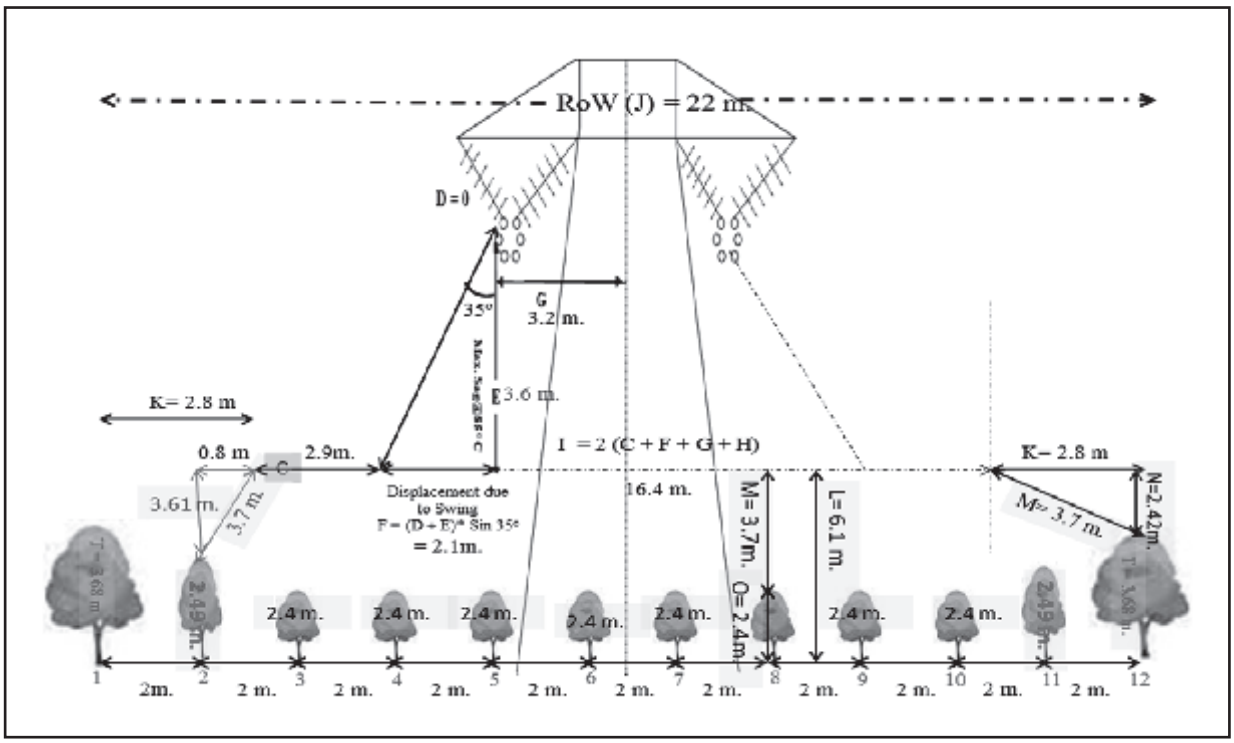


Fig. 5 : Dwarf Species Plantation Model in Row of 110 kV Transmission Line with Vertical config. & V-String

1. Minimum clearances & max. tree height as per guidelines. However, tower height may be optimized to plant taller trees.
2. It is practically not possible to restrict tree height in fraction of m. or cm. Thus, species of suitable height should be selected.

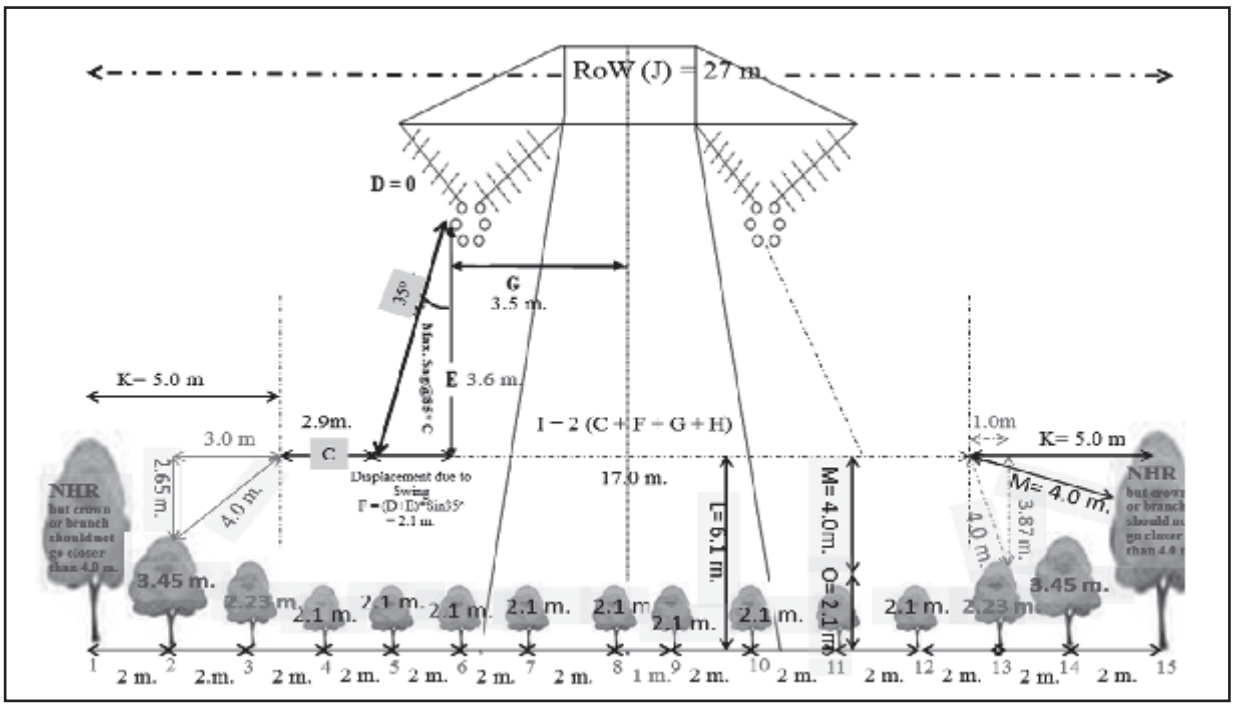


Fig. 6 : Dwarf Species Plantation Model in Row of 132 kV Transmission Line with Vertical config. & V-String

1. Minimum clearances & max. tree height as per guidelines. However, tower height may be optimized to plant taller trees.
2. It is practically not possible to restrict tree height in fraction of m. or cm. Thus, species of suitable height should be selected.

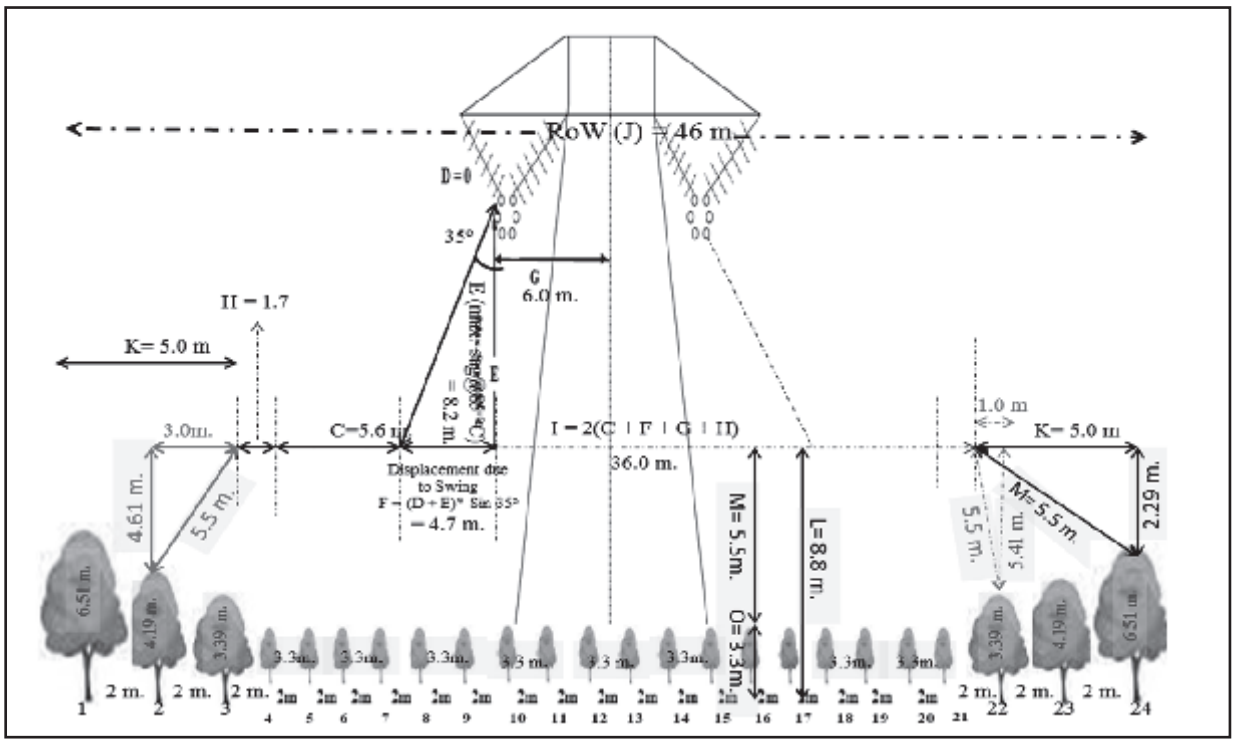


Fig. 7 : Dwarf Species Plantation Model in Row of 400 kV Transmission Line with Vertical config. & V-String

1. Minimum clearances & max. tree height as per guidelines. However, tower height may be optimized to plant taller trees.
2. It is practically not possible to restrict tree height in fraction of m. or cm. Thus, species of suitable height should be selected.

prepared and given in Table 8 along with their propagation method (for India) in field/nursery. Most of these species are of medicinally important and are widely recognized for therapeutic uses.

Miscellaneous and summary of recommendations

In India, the land use planning is very important specially in view of the scarcity of per capita land. The transmission lines are also very essential to meet the power needs of developmental activities in growing economy of country. The transmission lines are linear structures and in spite of the requirement of limited forest land, they have a significant role in fragmentation of large stretch of forests. Also, transmission lines are providing a unique opportunity of dual land use i.e. differentiating the vertical space for vegetation cover as well as transmission line for developmental needs on the same land. Therefore, careful and informed planning of dwarf species plantation in RoW of transmission lines is needed to ensure the good vegetation cover in RoW which is otherwise blank/with degraded vegetation. More than 15,000 ha. of forest land has been diverted for the transmission lines between 2014-2022. A good plantation of dwarf species in RoW will also be important in terms of increase in forest cover along with the conservation and propagation of otherwise less focused indigenous species. The main recommendations of present study for better plantation of dwarf species in RoW are listed in the Box 6.

Box 6:Summary of Recommendations

1. Proper planning of dwarf species plantation including
   - **a.** species selection (perennial dwarf plants of specific ht.)
   - **b.** preparation of model estimate with plantation procedure
   - **c.** nursery protocol for dwarf species (not trees/herbs)
2. Assessment of available vertical and horizontal space for plants by the proposed method.
3. Use of **V- type string** in design of transmission lines.
4. Planting taller spp. at or near the edge of RoW by determining **'K' value** and **'T' value** by the proposed method.
5. Estimate /levy calculation for dwarf species (not tree/herbs).
6. Protection by gabion instead of barbed wire/trench in forests.
7. Since dwarf plants are to be planted, the scheme of 2500 plants per ha. at 2m X 2m spacing should be prepared instead of usual CA scheme of 1000 or 1100 plants per ha.
8. Further research on tower height optimization for taller plants and propagation techniques of dwarf plants.
9. Avoid common errors as listed in the Box- 4.
10. Accountability of User Agency in implementation phase also.

Table 8 : Perennial Dwarf species, their distribution, local names and propagation techniques

S. N.	Botanical name and Local Name	Height and Distribution in India	Reference for propagation/ nursery techniques (for India)
1.	*Abroma augustum*(L.) L.f.; (L.N.: Pisachkarpas, Ulatkambal, Devil's cotton, Devva hatti, Bhangi mara, Melpundi gida)	Up to 3-5 m.; Throughout tropical forests of India particularly in North-East and East Coasts (NMPB, 2008)	NMPB, 2008
2.	*Angelica glauca*Edgew.; (L.N.: Chora, Chohor, Choru, Canda, Coraka, Granthiparna, Ksemaka, Taskara)	4-12 ft., Kashmir to Shimla (FBI, 1879); Western Himalaya from Kashmir to UK (NMPB, 2014)	NMPB, 2014; Dharmveer *et al.,* 2016; ICFRE, 2019b
3.	*Acanthus ilicifolius*L.; (L.N.: Holly Mangrove, Kataki, Kantaliyo, Maramdo, Harkata, Chulli, Nivagur, Harikusa, Vagati)	Mangrove; 1-5 ft. (FBI, 1872), Andhra, KA, KL, OD (FPI Web.)	Kumar, 1999
4.	*Aconitum lethale*Griff. (Syn. *Aconitum balfourii* Stapf.); (L.N.: Vatsanabh, Bachnak)	Up to 2-5 ft. Temperate Himalaya from SK to Garhwal, alt. 8k-10k ft. (FBI, 1872)	NMPB, 2008
5.	*Alpinia galangal* (L.) Willd.; (L.N.: Kulanjana, Galangal, Dhumala, Hirui)	5 ft (FOI Web); throughout India (FBI, 1894)	NMPB, 2008
6.	*Althaea officinalis*L.; (L.N.: Khatmi, Gulkhero, Shemai-tutti)	2-3 ft, Kasmir (FBI, 1872); PB, H.P. (PAC Web.)	Singh, 1964
7.	*Annona squamosa*L.; (L.N.: Sharifa, Sitaphal, Katal, Sitapalam)	Up to 6 m (KPI Web); Domesticated over a great part of India (ITB, 1921)	Khan, 1952; OFSDS, 2019
8.	*Ardisia solanacea* Roxb.; (L.N.: Bonjam, Dhan-priya, Bode, Kakkanjara, Kolarakku, Bugadi, Dikna, Pagada mulaka, Kolurucci)	1.5-4 m. (FOI Web.); UK, UP, Himalaya up to 5000 ft. and throughout India except drier western portion (FUGP)	--
9.	*Aristolochia indica* Linn.; (L.N.: Isharmul, Zarawand Hindi, Kiramar)	Perennial creeper; Lower hills and plains of India, Bengal, AS (NMPB, 2014)	NMPB, 2014
10.	*Asparagus adscendens*Roxb. (L.N.: Satavari, Pili Satawar, Musli Siyah, Shaqqul Misri)	Sub-erect ascending, shrub; PB, HP, J&K, UP, BH, WB, OD, MP, GJ, lower Himalaya up to 2000 m. (NMPB, 2016)	NMPB, 2016
11.	*Asparagus racemosus* Willd.; (L.N.: Satawar, Shaququl, Siepru, Tannir-vittan, Satamuli, Nunggarei, Abiruvu)	Climbing undershrub (ITB, 1921); throughout tropical and subtropical India and Himalaya upto 4000ft. (FBI, 1894)	NMPB, 2008; Surendran, 2014; ICFRE, 2019b
12.	*Atropa acuminata*Royle ex Lindl.; (L.N.: Indian Belladona, Jharka, Shaafu, Naati Beladonna)	Perennial plant 3-6 ft.; Western Himalaya, 6000 to 11000 ft. from Kashmir to Shimla (FBI, 1885)	Kapoor *et al.,* 1952; Hingorani, 1953
13.	*Baliospermum montanum* (Willd.) Müll.Arg. {Syn. *Baliospermum solanifolium*(Burm.) Suresh; *Baliospermum axillare* Blume}; (L.N.: Danti, Dravanti, Dirgha, Naagadanthi, Nepalamu, Dantigaacha)	3-6 ft.; Tropical & Sub-tropical Himalayas, Kashmir to AS, Deccan Peninsula from BH to Travancore (FBI, 1885); 3-6 ft., Sub-Himalayastract up to 3k ft., AS, Khasi hills, Bengal, C.&W. India to Travancore (FUGP)	Tiwari *et al.,* 2007; NMPB, 2008
14.	*Bauhinia racemosa* Lam.; (L.N.: Kathmauli, Jhinjheri, Aapta, Sona, Atti, Tataki, Arampali, Kutabuli, Banraji)	4-5 m.; throughout greater parts of India from Ravi to WB, central and south India, Western Ghats (Luna, 1996);	Rogers, 1911; Prakash *et al.,* 1991; Luna, 1996; OFSDS, 2019
15.	*Bauhinia tomentosa* Linn.; (L.N.: Mandaara, Aachalu, Vana sampige)	4m. (Orwa et al., 2009) W. Penins. (ITB, 1921); UP, C.&S.India to Ceylon (FUGP)	--
16.	*Benkara fasciculata* (Roxb.) Ridsdale {Syn. *Randia fasciculata* (Roxb.) DC.}	6 ft., Bundelkhand, Tropical Himalaya, Nepal to Bhutan, Khasia hills (FUGP)	--
17.	*Berberis aristata*DC. (L.N.: Daruhaldi, Indian Barberry)	2-6 m; Himalayas 2000-3000 m., Nilgiri (NMPB Web.)	Ali *et al.,* 2008; NMPB Web.
18.	*Berberis asiatica*Roxb. ex DC.; (L.N.: Dal-hald, Daruhaldi, Kasmal, Chutro, Githa)	6 ft.; UK, Outer Himalaya from Garhwal to Bhutan, Parasnath (now JH) (FUGP)	--
19.	*Berberis jaunsarensis* (Ahrendt) Laferr. (Syn. *Mahonia jaunsarensis* Ahrendt); (L.N.: Jaunsar Barberry)	Shrub, Chakrata, UK (Tiwari *et al.*, 2012)	Tomar and Kumar, 2020
20.	*Berberis lycium*Royle; (L.N.: Kasmale, Daruhaldi, Chatrol, Kirmora, Ishkeen, Kushmul, Zarch, Kasmal, Kaav Dachh)	6-8 ft., Western Himalaya in dry hot places, alt. 3000-9000 ft., from Garhwal to Hazra (FBI, 1872)	Bahuguna *et al.,* 1988; Naha *et al.,* 1990
21.	*Bergera koenigii* L. {Syn. *Murraya koenigii* (Linn.) Spreng.}; (L.N.: Kari Patta, Karivepillai, Karibevu, Narasingha)	4-6 m.; (NBRIENVIS); Outer Himalaya,, from the Ravi eastward, acending to 5000 ft., AS, Peninsula (ITB, 1921)	Kumar and Parmar, 2000

S. N.	Botanical name and Local Name	Height and Distribution in India	Reference for propagation/ nursery techniques (for India)
22.	*Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch. (Syn. *Breynia rhamnoides* Müll.Arg.); (L.N.: Bilisoodi, Kattuniruri, Popagada)	3 m. (FOI Web.); Sub-Himalayan tract, forests of Oudh, Bundelkhand, throughout tropical India (FUGP)	--
23.	*Buddleja asiatica* Lour.; (L.N.: Ninda, Karkkattan, Bhati, Dhura, Dhurbana, Neemda, Karakaane)	2-4m., AP, KA, KL, OD, TN (KPI Web.); Sub-Himalaya& Gangetic Plain, throughout India, to 6800 ft. on Himalaya (FUGP)	--
24.	*Buxus papillosa*C.K.Schneid.; (L.N.: Shamshad)	3-5 m. (EFP Web.); HP, ML, SK, TN, UK (EFI Web.)	Rao, 1953
25.	*Buxus wallichiana*Baill.; (L.N.: Papri, Shamshad, Chikri, Himalayan Boxwood)	Up to 7 m. (Gangoo *et al.*,2007); W. Himalaya to Nepal at 4k-9k ft. (Troup, 1921)	Troup, 1921; Gangoo *et al.,* 2007
26.	*Cadaba fruticosa*(L.) Druce (Syn. *Cadaba indica* Lam.) (L.N.: Kimianu Jhad, Dabi, Khoradu, Thaniyu, Vilunti, Chemudu)	Up to 5 m. (FOI Web.); Central province, Berar, GJ (ITB, 1921); AP, KA, TS, KL, MH,TN (FPI Web.)	--
27.	*Callicarpa macrophylla* Vahl. (Syn. *Callicarpa lanata* Linn.); (L.N.: Daya, Priyangu, Priyaka, Dahiya, Sumali)	2.0-2.5 m.; Throughout N. & E. India up to 1000m. (NMPB, 2016); 4-8ft., UK, UP, WB,AS, Western Himalaya up to 6k ft. (FUGP)	NMPB, 2016
28.	*Calligonum polygonoides*L.; (L.N.: Phog, Phok)	1.5 m (FOI Web.); Dry and Arid districts of North Western India (ITB, 1921)	Kumar *et al.,* 1996
29.	*Canthium coromandelicum* (Burm.f.) Alston (Syn. *Canthium parviflorum* Lamk.); (L.N.: Gangeruki, Kadbar, Kaaki, Balusu, Theravai, Sengarai, Tuthudi, Kandakara)	Up to 3 m., throughout the Deccan peninsula from GJ to MH southwards, BH, OD (Pakaet al., 2020); AP, KA, KL, TS, MH, OD, TN (FPI Web)	--
30.	*Capparis decidua*(Forssk.) Edgew. (Syn. *Capparis aphylla* Roth); (L.N.:Karil, Pichu)	4-5 m (Orwa et al., 2009); Arid and Dry regions of Western Peninsula (ITB, 1921)	Bhargava *et al.,* 2006
31.	*Capparis grandiflora*Wall. ex Hook.f. & Thomson; (L.N.: Dudupi)	2-3 ft., East slopes of Nilgiri (FBI, 1872); S.-W. India, KA, MH, TN (FPI Web.)	--
32.	*Capparis olacifolia*Hook.f. & Thomson; (L.N.: Kotoha, Lokra, Kota-Khar)	6-8 ft., Tropical Himalayan valley from Nepal to AS (FBI, 1872)	--
33.	*Capparis spinosa* Linn.; (L.N.: Kabra)	3 ft. (MBG Web.); KA, KL, MH, TN (FPI Web.); PB, GJ, Western Ghats, Mahabaleshwar, North West Himalaya (ITB, 1921)	--
34.	*Carissa spinarum* L. (Syn. *Carissa opaca* Stapf ex Haines); (L.N.: Jungli Karonda, Garnae, Kharanu, Kavali, Karvand, Karichi)	2-3 m. (FOI Web.); throughout India (Troup, 1921); Sub-Himalayan tract, North India, WB, C. Prov., W. Peninsula (ITB, 1921)	Rao, 1953; Kumar and Parmar, 2000
35.	*Casearia graveolens* Dalzell; (L.N.: Chilla, Phempri, Bhokoda, Mori, Anavinga, Girivudi, Vasanga, Konje, Hanise)	Up to 6 m., Himalayas , Garhwal to SK at 300-2000 m., Eastern &Western Ghats (FOI Web.); UK, UP, west to Chenab, Deccan (FUGP)	--
36.	*Casearia tomentosa* Roxb.; (L.N.: Munjhaad, Munjaal, Chilla, Modgi, Sano bethe, Chilhaka, Katicaal, Chilaka-dududi)	7-8 m. (Talukdar *et al.*, 2021); Throughout India from base of Himalaya to Ceylon (FUGP)	--
37.	*Celastrus paniculatus* Willd.; (L.N.: Malkangani, Pokitai, Bhavamga, Jotishmati, Kariganne, Kougilu, Polulavam, Valuluvai)	Scandent Shrub; KL, OD, TN (FPI Web.); AP, KA, Goa, MH, GJ, MP, UP, AR, PB and HP (FRLHT Web.)	Tiwari *et al.,* 2007; Sharma *et al.,* 2012
38.	*Cephalanthus occidentalis* Linn.; (L.N.:)	6-20 ft., Sub-Himalayan tract, UP, SK, AS (FUGP);Khasi hills, Cachar (ITB, 1921)	--
39.	*Clausena anisata* (Willd.) Hook.f. ex Benth. (Syn. *Clausena willdenowii* W. & A.); (L.N.: Pothi, Kattu-Veppilai, Arpa-til)	6 m. (EFI-BSI Web.); Evergreen forests of the Western Ghats from Sattara southwards, SK, Naga Hills (ITB, 1921)	--
40.	*Clausena excavata* Burm. f.; (L.N.: Narasigha, Bengjari, Diengtyner, Agnijhal, Sam-sweng)	6 m., Tropical evergreen or mixed forests up to 600 m., BH, WB, SK, AS, MZ, ML, OD (EFI-BSI Web.)	--
41.	*Clausena kanpurensis* J.P. Molino; (L.N.: Ratanjot, Rowana, Surjamukha, Tharu)	2 m., Moist Deciduous Forests in Garhwal Himalaya (EFI-BSI Web.)	--
42.	*Clematis smilacifolia*Wall.; (L.N.: Ranjani, Hottuhambu)	Woody Climber (FBI, 1872); SK, Khasi hills, West coasts, south in evergreen forests (ITB, 1921); AP, KL, MH, OD, TN (FPI Web.)	Tiwari *et al.,* 2007

S. N.	Botanical name and Local Name	Height and Distribution in India	Reference for propagation/ nursery techniques (for India)
43.	*Clerodendrum bracteatum*Wall. ex Walp.; (L.N.: Dom-bhetai, Mishimiaoguphu, Bikbi-kelok, Anphui-rachol)	8-20 ft.; SK (FBI, 1885); Himalayas from Nepal to SK, Khasi hills, AS at altitude of 400-1600 m. (FOI Web.)	Basu, 1958
44.	*Clerodendrum indicum*(L.) Kuntze (Syn. *Clerodendrum siphonanthus* R. Br); (L.N.: Bharangi, Chhoti arani, Chingari, Kaasajit, Bhargi, Kirudega, Kuthap, Kavalai, Chinde)	1.5-3 m., throughout peninsular India, from Vindhyas onward to foothills of UK, SK, north-eastern states (NMPB, 2008); 4-8ft., UP,UK to Bengal, SK, AS (FUGP)	Tiwari *et al.,* 2007; NMPB, 2008
45.	*Clerodendrum infortunatum* L. (Syn. *Clerodendrum infortunatum* Gaertn.); (L.N.: Titabhant, Bhant, Bhandira, Peruku, Perukilai, Ibbane, Ittevu Esaga, Parale)	Up to 12 ft., Sub-Himalayan tract from Jumna eastwards, Merwara, Bundelkhand (FUGP); Gangetic Plain, Singhbhum, C. Province, both Peninsula (ITB, 1921)	--
46.	*Clerodendrum phlomides* Linn.f. (L.N.: Agnimantha, Arni, Goniyari, Arani, Taggi, Targi, Munja, Taluddai, Taluki)	1.5-3 m. (FOI Web.); UP, UK, Throughout the drier parts of India from the Punjab and Bengal to S. India (FUGP)	Kumar *et al.,* 2005
47.	*Cocculus laurifolius*DC.; (L.N.: Marpinki, Aadukolli)	Up to 6 m., HP up to 1500 m., PB, UP, KA, TN (EFI-BSI Web.); North-West Himalaya up to 5000 ft., Anamalai hills (ITB, 1921)	--
48.	*Codariocalyx motorius* (Houtt.) H.Ohashi (Syn. *Desmodium gyrans* (L.f.) DC.); (L.N.: Nageswar, Ban Chandal, Naagathagare)	3-4 ft., Dehradun, Siwalik, Outer Himalayafrom Hazara to AS up to 7k ft., through W.&S. India to Ceylon & Burma (FUGP)	--
49.	*Colutea nepalensis*Sims.; (L.N.: Nepal Bladder Senna)	3m. (JAH 2354); Cold Desert of India, inner Himalaya from Afghanistan to Nepal (Singh and Jishtu, 1997)	Singh and Jishtu, 1997
50.	*Commiphora wightii* (Arn.) Bhandari {Syn. *Commiphora mukul* (Hook. ex Stocks) Engl.}; (L.N.: Guggal, Antu, Mukul)	3-4 m., GJ and RJ, some parts of MH, M.P. and KA (ICFRE, 2019b)	Puri and Kaul, 1972; NMPB, 2008; ICFRE, 2019b
51.	*Connarus monocarpus*Linn.; (L.N.: Torolakka, Tolage, Toliga, Sumdari)	Up to 5m. (EFI-BSI Web.); Western Ghats from Konkan southwards (ITB, 1921)	--
52.	*Coriaria napalensis*Wall.; (L.N.: Gangara, Masuri, Makola, Masurya, Machhino, Bhojinsee)	3-4 m. (FOI Web.); Central Himalaya 1.2k-2.5k m. (Mourya *et al.,* 2019); Siwalik, temperate& sub-tropical Himalaya up to 7.5k ft. (FUGP)	Joshi *et al.,* 1992
53.	*Coscinium fenestratum*(Gaertn.) Colebr.; (L.N.: Maramanjal, Daru haridra, Weniwei)	Woody Climber, Western Ghats, in TN and KL (Surendran, 2014)	Surendran, 2014
54.	*Cotoneaster affinis* Lindl. (Syn. *Cotoneaster bacillaris* Wall. ex Lindl.); (L.N.: Riush, Riunsh, Kauso phool, Rhus)	Up to 5m. (FOI Web.); North-West Himalaya, Indus to Sarda, 5k-10k ft. extending to inner dry valleys (ITB,1921)	--
55.	*Crotalaria retusa* Linn.; (L.N.: Ghughra, Ghunghunia, Gulugulуppahalli, Gagra, Kilukiluppai, Pottigilligichacha)	3-4 ft., Dehradun, North Oudh, Agra, Bundelkhand, hotter parts of India from the Himalaya to Ceylon (FUGP)	--
56.	*Crotalaria spectabilis* Roth (Syn. *Crotalaria sericea* Retz.); (L.N.: Ghunghri, Sanni, Tumthang Pipuli, Dingala)	3-4 ft., throughout tropical India, Sub-Himalayan tract, upper Gangetic Plain, on the Himalaya up to 3000 ft. (FUGP)	--
57.	*Crotalaria tetragona* Roxb. ex Andrews; (L.N.: Bhugan)	Up to 6 ft., UK, UP, Sub-Himalayan tract, Garhwal to SK, AS, up to 3.5k ft. (FUGP)	--
58.	*Cryptolepis buchananii* R.Br. ex Roem. & Schult.; (L.N.: Karanta, Shyamlata)	Climbing Shrub; All over tropical sub tropical regions in India (NMPB, 2014)	NMPB, 2014
59.	*Cynanchum acidum* (Roxb.) Oken {Syn. *Sarcostemma acidum* (Roxb.) Voigt.; *Sarcostemma brevistigma* Wt. & Arn.}; (L.N.: Soma, Somlata, Soma Plant)	Leafless, straggling, Jointed Shrub; Dry places of WB, RJ, BH and Peninsular India (NMPB, 2016)	NMPB, 2016
60.	*Cynanchum annularium* (Roxb.) Liede & Khanum (Syn. *Holostemma ada-kodien* Schult.); (L.N.: Jivanti, Khirdodi, Ark pushp, Adapathiyan, Shidodi, Palaikkirai)	Twining shrub; tropical Himalaya, Deccan peninsula (FBI, 1885); Western Ghats and Mysore (ITB, 1921)	NMPB, 2008
61.	*Dendrolobium triangulare* subsp. *triangulare* (Syn. *Desmodium cephalotes* (Roxb.) Wall. ex Wight & Arn.); (L.N.: Kaadu moovile, Naaga thagare, Chipate)	4-5 ft., UK, UP, eastward to Chattagong, up to 4k ft. on outer Himalaya South to Ceylon (FUGP); Sub-Himalayan tract, from Dehradun eastwards, both peninsula(ITB, 1921)	--

S. N.	Botanical name and Local Name	Height and Distribution in India	Reference for propagation/ nursery techniques (for India)
62.	*Derris trifoliata* Lour. {Syn. *Derris heterophylla* (Willd.) Backer ex K.Heyne}; (L.N.: Kalilata, Panlata, Ponnanvalli, Ketia)	Liana; AP, KA, KL, OD, TN (FPI Web.)	Kumar, 1999
63.	*Dichapetalum gelonioides* (Roxb.) Engl. (Syn. *Chailletia gelonioides* (Roxb.) Hook.f.); (LN.:Cherumaram, Katukapikuru)	Up to 5 m., WesternGhats, S. & C. Sahyadris (FOI Web.); Anamalais, Khasi hills, Silhet, Cachar (ITB, 1921)	--
64.	*Docynia indica* (Colebr. ex Wall.) Decne. {Syn. *Eriolobus indica* (Wall.) Decne}; (L.N.: Mahel)	12-15 ft. (FBI, 1879); SK, MN, Khasi hills (ITB, 1921)	Sundriyal and Sundriyal, 2001
65.	*Dodonaea viscosa* Jacq.; (L.N.: Sanatta, Vilayati Mehndi, Sinatham Virali, Mohra, Rasna, Bandaru, Hangarike)	Up to 4 m., Throughout India (EFI-BSI Web.); Merwara (wild), also cultivated, PB, Chota Nagpur, C. & S. India (FUGP)	--
66.	*Elaeagnus latifolia* L.; (L.N.: Ambgool, Nurgi, Nildook, Perunkuliri, Kolungai, Kulangi, Kulari, Hittele, Kerahuli, Hulige)	3 m (PFAF Web.); Subtropical&Temperate Himalaya from Kumaon to SK, Khasi hills, Deccan peninsula (FBI, 1885)	Sundriyal and Sundriyal, 2001
67.	*Elettaria cardamomum*(L.) Maton; (L.N.: Ilaichi, Elatarri, Elaki); (L.N.:Elaichi)	6-9 ft., Western Ghats from Kurg southwards to Ceylon (FBI, 1894)	Evers, 1908; Khan, 1944; Belliappa, 1929
68.	*Embelia ribes*Burm.f.; (L.N.: Bhumi Vidanga, Vizhal, Vavding, Amogha, Ambti, Vayuvilangam, Chitramandula, Baavdinga)	Scandent Shrub; hilly parts of India upto 15k m. from Himalaya to Western Ghat; AR, J&K, HP, M.P., U.P., AS, MH (ICFRE, 2019b)	Surendran, 2014; ICFRE, 2019b
69.	*Eriolaena lushingtonii* Dunn.	4-5 m., AP, KA, KL, TN (EFI-BSI Web.)	--
70.	*Euphorbia royleana* Boiss.; (L.N.: Danda Thor, Chhun, Senhur, Shakar Pitan)	Up to 16 ft., UK, W. Himalaya, Kumaon to Jhelum up to 6000 ft., PB (FUGP)	--
71.	*Eurya arunachalensis* Chauhan	4 m., AR (EFI-BSI Web.)	--
72.	*Eurya cavinervis* Vesque;	1-3 m., Easter Himalaya between 2000 and 3000 m. SK, AS (EFI-BSI Web.)	--
73.	*Eurya japonica* Thunb.; (L.N.: Sakaki)	4-5 m., KA, TN (EFI-BSI Web.); Outer Himalaya, Sikkim eastwards, 3k-6k ft., W.Ghats, Kanara southwards (ITB, 1921)	--
74.	*Flacourtia indica*(Burm.f.) Merr. (Syn. *Flacourtia sepiria* Roxb.); (L.N.: Bilangda, Tambut, Karimuli, Shruvavrikksha)	3-5m (NBRIENVIS); Bengal, W. Penins. (FBI, 1872); Coromandel coasts, Deccan, Kurg, Nilgiris, Travancore (ITB, 1921)	Kumar and Parmar, 2000
75.	*Flemingia macrophylla* (Willd.) Kuntze ex Merr. {Syn. *Moghamia macrophylla* (Willd.) Kuntze, Syn. *Flemingia congesta* Roxb. ex W.T.Aiton}; (L.N.: Samnaskahat, Bhalia, Bhatabaasee, Bhatamaase)	4-6 ft., Dehradun, throughout hotter parts of India (FUGP); 0.6-2.5 m. (FOI Web.); AP, KA, KL, OD, TN (FPI Web.)	Purkayastha, 1969; ICFRE, 2019b
76.	*Flemingia paniculata* Wall. ex Benth	4-6 ft., UK, UP, Kumaon to SK at low elevations, Chota Nagpur (FUGP)	--
77.	*Flemingia strobilifera* (L.) W.T.Aiton; (L.N.: Makhiyati, Poptyo, Kanphuta, Kumalu, Kanalam, Klipti, Nalla Baddu)	5-10 ft. (FBI, 1879); UK, UP, 5-10 ft., Bundelkhand, from Sindh, Rajputan and Bengal to S. India and Ceylon (FUGP)	--
78.	*Flemingia trifoliata* (Jungh.) C.Y.Wu (Syn. *Flemingia involucrata* Benth.)	2-4 ft., Siwalik range, AS, SK, Bengal, C. & W. India (FUGP)	--
79.	*Flueggea leucopyrus* Willd.; (L.N.: Shunar, Ainta, Pandharphali, Kandekuvana, Hooli, Bilihuli, Parpo, Humri, Panduphali)	1.5-4 m. (FOI Web.); UK, UP, Kumaon Himalaya up to 5k ft., PB plain to Kanara & Karnatak, Ceylon & Burma (FUGP)	--
80.	*Flueggea virosa* (Roxb. ex Willd.) Voigt, (Syn. *Fluggea microcarpa* Blume); (L.N.: Safed Chainari, Patala, Belahuli, Perinklavu, Kodarsi, Irubulai, Vedbula)	1-8 m. (EFI-BSI Web.); Dehradun, Rohilkhand, N. Oudh, Gorakhpur, Bundelkhand, Merwara, Bengal, C., W. & S. India (FUGP)	--
81.	*Gardenia gummifera* L. f.; (L.N.: Dekamali, Bikke, Kambimaram, Dikemali, Nadihingu, Sirukkambil, Chittamali)	Up to 3 m. (FOI Web.); Bundelkhand, southwards from Chota Nagpur, Bombay (FUGP)	Sharda and Verma, 2010
82.	*Getonia floribunda* Roxb. (Syn. *Calycopteris floribunda* (Roxb.) Lam. ex Poir.); (L.N.: Pullanni, Pullanji, Varavalli)	6-12 ft., On hot hlls throughout Deccan and AS (FBI, 1879); W. Peninsula, AS (ITB, 1921); KL, OD, TN (FPI Web.)	--
83.	*Glochidion multiloculare* (Roxb. ex Willd.) Voigt.	1-8 m. (EFI-BSI Web.); Sub-Himalayan tract of UK, UP, N. BH, SK Terai, AS, (FUGP)	--

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84.	*Gloriosa superba*L.; (L.N.: Kalhari, Gloro Lilly, Bachnag, Languli, Kallavi, Indai, Kithonni, Mendoni, Agnishikha)	Perennial, tuberous, scandent or climbing herb (ICFRE 2019b); Throughout tropical India (FBI, 1894)	Surendran, 2014; ICFRE, 2019b
85.	*Glycosmis pentaphylla* (Retz.) DC.; (L.N.: Girgitti, Gunji, Selongdi, Pandelu, Menki)	Up to 4m., (EFI-BSI Web.); UK, UP, SK, up to 4k ft., AS, both peninsula (ITB, 1921)	--
86.	*Gomphandra tetrandra* (Wall.) Sleumer (Syn. *Gomphandra polymorpha* Wight)	Up to 3.5 m., N.E. Region, Western Ghats, up to 1000 m. in AS, ML, AR, MH, KA, TN, KL (EFI-BSI Web.)	--
87.	*Grewia abutilifolia* Vent. ex Juss.; (L.N.: Jani Gida, Kowri, Kirmith, Ryna, Guvvatada, Peddatada)	1-5m., (FOI Web); HP, UP, BH, WB, SK, AS, MN, ML, TR, OD, MP, RJ, GJ, MH, GA, AP, KA, TN, KL (EFI-BSI Web.)	--
88.	*Grewia asiatica* Linn.; (L.N.: Falsa, Sanjelhei, Shukri, Phutiki, Phalsa, Chadicha, Unnu)	Up to 12 ft. (FOI Web.); HP, PB, HR, DL, UP, BH, WB, AS, OD, MP, RJ, GJ, MH, AP, KA and TN (EFI-BSI Web.)	--
89.	*Grewia flavescens*var.*flavescens* (Syn. Grewia pilosa Lam. ex Poir.); (L.N.: Raisin, Chapra, Jar Khair, Karkala, Khatkhati)	Up to 6 m., DL, UP, BH, WB, OD, M.P, RJ, GJ, MH, AP, KA, TN, KL (EFI-BSI Web.); Western Peninsula (ITB, 1921)	--
90.	*Grewia hirsuta* Vahl.; (L.N.: Gudsakari, Huktapata, Kukurbicha, Phrongli, Udipe, Govli, Nagabala, Kalunnu, Tavidu, Jibilike)	3-6 m., UP, BH, JH, WB ,AS, ML, OD, MP, RJ, GJ, MH, GA, AP, KA and TN (EFI-BSI Web.); W. Penin (ITB, 1921)	Tiwari *et al.,* 2007
91.	*Grewia orbiculata* Rottler (Syn. *Grewia rotundifolia* Juss.); (L.N.: Jaana, Karijaana)	4-8 m., BH, WB, OD, MP, MH, AP, KA, TN, KL(EFI-BSI Web.); C.&S.India , UP (FUGP); Corom. coast,Nilgiri(ITB, 1921)	--
92.	*Grewia piscatorum* Hance	Up to 3 m., AS and ML (EFI-BSI Web.)	--
93.	*Grewia rhamnifolia* Heyne ex Roth.	Up to 3 m., BH, OD, MP, MH, AP and TN (EFI-BSI Web.)	--
94.	*Grewia tenax*(Forsk.) Fiori; (Syn. Grewia populifolia Vahl.); (L.N.: Nagabala, Gondni, Gangren, Gangan, Phalsa cherry)	3 m.; Arid & semi-arid region (Mohamed *et al.*, 2021); 2-3m., J&K,HP,DL,AS, RJ, MP, GJ, MH, AP:KA,TN(EFI-BSI Web)	Kumar *et al.*, 2005; Mohamed *et al.*, 2021
95.	*Grewia umbellifera* Bedd. (syn.: *Grewia umbellifera* Bedd.); (L.N.: Bilisuri, Bhasmavalli, Kokkivalli, Ghat Crossberry)	3-5 m.; Western Ghats (FOI Web.); KA, KL, MH, TN (FPI Web.); 3-5 m. (FOI Web.); MH, KA, TN, KL (EFI-BSI Web.)	Deshpande and Yadav, 2020
96.	*Grewia villosa* Willd.; (L.N.: Gangeti, Lankas, Karakele, Murike, Murige, Kaadu patanga, Buttigaragale, Kharmati, Chenula)	3-5m., PB, RJ, GJ, MP, MH, AP, KA, TN, KL (EFI-BSI Web.); UP, PB, Rajputana to Travancore (FUGP)	--
97.	*Gymnema sylvestre*(Retz.) R.Br. ex Sm.; (L.N.: Gurmar, Kawli, Lakshmi, Kokilam, Nagapushpi, Meshashringi, Podapatri)	Woody Climber, AP, BH, CG, KA, KL, M.P., MH, OD, TN, U.P. and WB (Pandey, 2012)	Pandey, 2012; NMPB, 2008; ICFRE, 2019b
98.	*Gymnosporia fruticosa*(Thw.) Thw.	8-10 ft., Central Province (FBI, 1872)	--
99.	*Gymnosporia montana*(Roth) Benth.; (L.N.: Tandrasi, Kankada, Kangondi, Vikankar, Kattangi, Dantansi, Dante)	8-12 ft., Tall shrub, PB, Sind, RJ, Central Province, BH, drier districts of the Peninsula (ITB, 1921)	Rogers, 1911
100.	*Gymnosporia senegalensis* (Lam.) Loes. (Syn. *Celastrus senegalensis* Lam.); (L.N.: Henkal)	Up to 2 m. (FOI Web.); UK, UP, Merwara, Bundelkhand, PB, Parasnath and drier parts of C. & S. India (FUGP)	--
101.	*Helicteres isora*L.; (L.N.: Marodphalli, Aantmoraa, Aantedi, Hatedi, Marorphali, Kavargi, Kauri, Murudi, Kevan, Valampiri)	4 m. (NPARKS Web.); UP, UK and eastward along the base of Himalaya, PB & Bengal to S. India & Ceylon (FUGP)	Tiwari *et al.,* 2007;
102.	*Hellenia speciosa*(J.Koenig) S.R.Dutta (Syn. *Costus speciosus* (J.Koenig) Sm.); (L.N.: Keokand, Keumuk, Pevato, Kushtha)	6-9 ft., throughout India from central and eastern Himalaya ascending to 4000ft. To Ceylon and Malacca (FBI, 1894)	Verma and Sharma, 1978
103.	*Hemidesmus indicus*(L.) R.Br.; (L.N.: Sveta Sariva, Anantmool, Ushba, Dudhli, Nannari, Narunenti, Suganda pala, Sogade)	Twinning undershrub; Throughout tropical and sub-tropical India, upper Gangetic plain, Bengal,M.P.,S.India (NMPB, 2008)	Rao *et al.,* 2000; Ramulu *et al.* 2005; NMPB, 2008
104.	*Hibiscus vitifolius*L.; (L.N.: Jangli san, Jungali Kapas, Kaattu vellooram, Adavi patthi, Kaaru patthi, Isuka ravi)	Perennial herb, 3-5 ft.; Hotter parts of India from PB to Ceylon (FUGP)	Tiwari *et al.,* 2007

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105.	*Hippophae rhamnoides*L.; (L.N.: Chharma, Tsermang, Sastalulu, Leh Berry, Sea buckthorn)	3-4 m. (Padmanabham et al., 2016); North-Western Himalaya from Kumaon westwards, alt. 7000-12000ft. (FBI, 1885)	Sankhyan *et al.,* 2003; Raj *et al.,* 2013
106.	*Hippophae salicifolia*D.Don.; (L.N.: Chuk, Tarwa, Willo-Leaved Sea Buckthorn)	10-20 ft.; TemperateHimalaya from Jammu to SK, 5k ft. to 10k. ft. altitude (FBI, 1885)	Sankhyan *et al.,* 2003; Chauhan *et al.,* 2018
107.	*Hyptianthera stricta* (Roxb. ex Sm.) Wight & Arn.; (L.N.: Bano dadri)	5-10 ft., UP, UK up to 4k ft. from Kumaon eastward to Khasia hills (FUGP)	--
108.	*Indigofera articulata* Gouan	2-3 ft., Bundelkhand, Merwara in Rajputana, Sindh, W. & S. India (FUGP)	--
109.	*Indigofera atropurpurea* Buch.-Ham. ex Hornem.; (L.N.: Kathi, Sakana, Sakena, Kala, Bankati, Saakhinu, Neer, Sakhiniyaa)	2-3 m., Kashmir to Bhutan at 700-3200m. (FOI Web.); Outer Himalaya, Hazara to Nepal at 2k-9k ft., Khasi, Naga hills (ITB, 1921)	--
110.	*Indigofera cassioides* Rottler ex DC. (Syn. *Indigofera pulchella* Roxb., I*ndigofera leptostachya* DC.); (L.N.: Hakanu, Kathi, Sakina, Koggi, Chimnati, Gibri, Karkandi)	Up to 12 ft., UP, UK, Merwara, PB, W. Himalaya up to 5000 ft., hilly parts of C., W. & S. India (FUGP); Sub-Himalayan tract, Kalka eastward, both Penins. (ITB, 1921)	--
111.	*Indigofera oblongifolia* Forssk. (Syn. *Indigofera paucifolia* Delile); (L.N.: Jhil, Jhiladi)	4-6 ft., from Sindh to Upper Ganges to Ceylon (FBI, 1875); GJ, N.W., C.&S. India (ITB, 1921); 3-6 ft., DL,UP (FUGP)	--
112.	*Juniperus communis* Linn.*;* (L.N.: Vapusha, Hapusa, Abhal, Aaraar, Haulbera, Abhal, Hauber, Common Juniper)	6-7 ft.; TemperateHimalaya from Kashmir to Bhutan at 9k-15k ft. (FBI, 1885); Srinagar to Kumaon (NMPB, 2016)	NMPB, 2016; Wani, 2018
113.	*Justicia adhatoda* L. (Syn. *Adhatoda vasica* Nees; *Adhatoda zeylanica* Medik.); (L.N.: Vassaka, Basa, Basuti, Aradusi, Arusa)	4-8 ft.; Throughout India ascending to 4500 ft. on Himalaya (FUGP)	Surendran, 2014; ICFRE, 2019b
114.	*Leea aequata* Linn.	2-3m., UP, BH, WB, SK, AR, AS, OD, MP, MH, KA, TN, A&N (EFI-BSI Web)	--
115.	*Leea alata* Edgew.; (L.N.: Chhataver, Chalta, Bon-chalita, Kukurjihba)	Up to 3 m., UP, E. & C. India, up to 1.5k m. in HimalayaHP, UP, BH, WB, SK, AS, AR, ML, OD, MP (EFI-BSI Web.)	--
116.	*Leea angulata* Korth. ex Miq.	Up to 3 m., Coastal belts. Nicobar Islands (EFI-BSI Web.)	--
117.	*Leea asiatica* (L.) Ridsdale (Syn. Leea aspera Edgew.); (L.N.: Banchalita, Koknal, Banchalita, Galeni, Lahasune, Ranabaas, Kumtintuai)	6-12ft.; UK, JH, C.&S. India (FUGP); J&K, HP, UP, BH, WB, SK, AR, AS, NG, MN, MZ, ML, OD, MP, RJ, MH, AP, KA, TN, KL, A&N (EFI-BSI Web.)	--
118.	*Leea compactiflora* Kurz (Syn. Leea bracteata C.B.Clarke); (L.N.: Lang-Kurnu.)	6-16 ft., SK, Khasia hills, 500-4000ft. (FUGP); 2-5 m., UP, WB, SK, AR, NG, AS, MN, MZ and ML (EFI-BSI Web.)	--
119.	*Leea guineensis* G.Don (Syn. *Leea acuminata* Wall. ex Clarke); (L.N.: Koknal)	Up to 5 m., UP, SK, AS, MN, ML, MH, TN and A&N (EFI-BSI Web.)	--
120.	*Leea indica* (Burm.f.) Merr. (Syn. *Leea sambucina* Willd.); (L.N.: Koknal, Karkani, Nalava, Nakku, Amkador, Andilu, Gadapatri, Kurkur, Ahina, Chatri, Kawlkar)	4-10 ft., UK to AS up to 4000 ft., Bengal (FUGP); PB, UP, BH, WB, SK, AR, AS, NG, MZ, TR, ML, OD, MP, MH, Goa, AP, TN, KL and A&N (EFI-BSI Web.)	--
121.	*Leea macrophylla* Roxb. ex Hornem. (Syn. *Leea aspera* Wall. ex G.Don); (L.N.: Hasia Dafer, Hathikana, Gajakarni, Samudrika)	2 m. (KPI Web.); UP, BH, WB, SK, AS, ML, OD, MP, MH, AP, KA, TN, KL, A&N (EFI-BSI Web.)	Tiwari *et al*., 2007
122.	*Leea rubra* Blume ex Spreng	Up to 2 m., WB, AS, ML (EFI-BSI Web.)	--
123.	*Leea setuligera* C.B. Clarke	Up to 2 m., AS, MH (Khandala) and KA (Concan) (EFI-BSI Web.)	--
124.	*Leptadenia reticulata*(Retz.) Wight & Arn.; (L.N.: Jeevanti, Dori, Jumka, Curinil, Dodi, Paalai keeraj, Kalasa, Guttipaala)	Twining shrub; sub-Himalayan tracts of PB, H.P., U.P. and Deccan Peninsula up to an altitude of 900m. (NMPB, 2008)	NMPB, 2008; Kalidas *et al.,* 2011
125.	*Limonia acidissima*Linn.; (L.N.: Kaith, Kotha, Velaga, Katbel, Bela, Belavala, Balavala, Baloola, Kovit, Kapittha)	Up to 8m., PB, UP, MP,WB,MH,AP, KA, TN, KL(EFI-BSI Web.); at 4k.ft. Sutlej to Garhwal, AS, West. Penins. (ITB, 1921)	--

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126.	*Lycianthes crassipetala* (Wall.) R.R.Mill (Syn.: Solanum crassipetalum Wall.)	2-9 ft., Temperate Himalaya, 3000-8000 ft. (FBI, 1885)	--
127.	*Mappia nimmoniana* (J.Graham) Byng & Stull (Syn. *Mappia foetida* (Wight) Miers; *Nothapodytes nimmoniana* (J.Graham) Mabb.); (L.N.: Ghanera, Amruta, Ghanera)	3-8 m. (FOI Web.); Western Ghats from Konkan southwards, generally in evergreen forests, Nilgiris, Anamalais, Palnis (ITB, 1921)	--
128.	*Marsdenia tenacissima*(Roxb.) Moon; (L.N.: Murva, Chinhaur, Jiti, Maruabel, Mendi, Madhulika, Morata, Panjukkodi)	Perennial climber; Tropical hilly tracts of peninsular India, Vindhyan rangeas well as lower Himalayan tract (NMPB, 2008)	NMPB, 2008
129.	*Melastoma malabathricum* L.; (L.N.: Phutkala, Phutuki, Nekkare, Nakeri, Athirani, Lakeri, Rindha Tinisah, Katalai)	Up to 2 m. (FOI Web.); Sub-Himalayan tract, AS, Khasi hills, A&N, Western Peninsula (ITB, 1921)	--
130.	*Merope angulate* (Willd.) Swingle; (L.N.: Limau buaya, Sarawak, Sabah)	Mangrove, 3 m.; From WB eastwards to South-east Asia (NPARKS Web.)	Thatoi *et al.,* 2000
131.	*Mimosa hamata* Willd.; (L.N.: Mundi, Gulabi babul, Undrakampa, Sagari mullu)	Up to 2 m. (FOI Web.); Bundelkhand, Merwara, PB, C. & S. India (FUGP)	--
132.	*Murraya paniculata* (L.) Jack (Syn. *Murraya exotica* Linn.); (L.N.: Hathul, Kamini, Vengaraj, Kunti, Simaali, Mungti)	2.5-3.5 m. (NPARKS Web.); Throughout hotter parts of India from Garhwal to AS, S.India (FBI, 1872)	Tiwari *et al.,* 2007
133.	*Neustanthus phaseoloides* (Roxb.) Benth. {Syn. *Pueraria phaseoloides* (Roxb.) Benth.}; (L.N.: Kadzu, Tropical Kadzu)	Perrennial climbing shrub; found in Himalayas from Nepal to SK, AS at 1000-1300m altitude (FOI Web.)	Kaith, 1948; Dalal and Patnaik, 1963
134.	*Operculina turpethum* (L.) Silva Manso; (L.N.: Trivrit, Turbud, Nisodh, Turpeeth, Nasottar)	Perennial Climber; throughout tropical dry and moist deciduous regions in central and peninsular India (NMPB, 2008)	Tiwari *et al.,* 2007; NMPB, 2008
135.	*Osyris lanceolata* Hochst. & Steud. (Syn. *Osyris arborea* Wall. ex A.DC.); (L.N.: Dalmia, Banigani, Chimat, Lotal, Paral)	2-5 m. (FOI Web.); UP, UK, Sub-Himalayan tract eastwards, Sutlej to Bhutan up to 7000 ft., to C. & S. India (FUGP)	--
136.	*Paederia scandens* (Lour.) Merr. (Syn. *Paederia foetida* Linn.); (L.N.: Gandha Prasarani, Gandhali, Parsarini)	Twining shrub; Lower tracts of Eastern Himalaya, AS, Bengal and BH, North East States up to 800 m. (NMPB, 2014)	NMPB, 2014
137.	*Parrotiopsis jacquemontiana*(Decne.) Rehder (Syn. *Parrotia jacquemontiana* Decne.); (L.N.: Posh, Pohu, Parrotia)	6-12 ft. (FBI, 1879); Kuram valley, Kashmir, Chamba, 8800-8500 ft. altitude (ITB, 1921)	Qaisar, 2002
138.	*Pavetta indica* Linn.; (L.N.: Kankara, Kathachampa, Kukurchura, Papat, Mallikamutti, Jui, Paniphingi, Kakachdi)	Up to 4 ft., UP, throughout the greater parts of India from SK and Bengal to S. India and Ceylon, A&N (FUGP)	--
139.	*Peganum harmala*Linn. (L.N.: Wild rye, Harmal, Gandhiyo)	2.5 ft. (FOI Web.); UP, UK, J&K, Sindh, PB, W. Deccan (FUGP)	Kumar *et al.,* 2005
140.	*Phlogacanthus thyrsiformis* (Roxb. ex Hardw.) Mabb. {Syn. *Phlogacanthus thyrsiflorus* (Roxb.) Nees}; (L.N.: Titaaphul, Sipchang, Chuhai)	3-7 ft. (FOI Web.); UP, UK, Sub-tropical Himalaya up to 4000 ft. from Ravi to Bhutan, AS, Chota Nagpur (FUGP)	--
141.	*Phyllanthus reticulatus* Poir.; (L.N.: Amlakhi, Kamboi, Makhi, Panpoi, Nirnelli, Panjuli, Jandaki, Jojangi, Phajoli, Nallapuli)	1-4 m., almost throughout the country including A&N (EFI-BSI Web.); Throughout tropical India (FUGP)	--
142.	*Phyllodium pulchellum* (L.) Desv. {Syn. *Desmodium pulchellum* (L.) Benth.); (L.N.: Jatsalpan, Ursi,Janukaddi, Salaparni, Sarivi)	3-6 ft., UP, UK, throughout India to Ceylon (FUGP); 4-5 ft., Common in both peninsulas, deciduous forests (ITB, 1921)	Tiwari *et al.,* 2007
143.	*Piper longum*Linn. (L.N.: Pippali, Pipplamul, Filfil Daraz, Pippal, Long Pepper)	Ascending herb; tropical rainforests, AP, A&N; Khasi hills, WB, U.P, M.P, MH, KL, KA and TN (NMPB, 2014)	NMPB, 2014
144.	*Piptanthus nepalensis* (Hook.) Sweet; (L.N.: Suga Phool, Sikasike)	10 ft.; Himalaya, Sutlej to Bhutan, Khasi hills, MN (ITB, 1921)	--
145.	*Pittosporum ceylanicum* Wight; (L.N.: Ketiya)	4-8 m., Endemic to India, TN (Nilgiri Hills at Dodabetta Peak) (EFI-BSI Web.)	--
146.	*Pittosporum humile* Hook. f. & Thomson	1-2 m., ML, Endemic (EFI-BSI Web.)	--

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147.	*Pittosporum napaulense* (DC.) Rehder & Wilson; (L.N.: Raini, tumri, Ekkadi, Vehkali, Khorsane, Phurke, Chettu)	2-8 m., Throughout India, except RJ (EFI-BSI Web.)	--
148.	*Pittosporum podocarpum* Gagnepain var. *podocarpum*	1-3 m., AR, AS, NG, MN, ML (EFI-BSI Web.)	--
149.	*Pittosporum podocarpum* Gagnepain var. *angustatum* Gowda	1-3 m., Endemic to India: MN, ML, NG (EFI-BSI Web.)	--
150.	*Plumbago zeylanica* L.; (L.N.: Chitrak, Chita, Sheetraj, Chitra, Chira, Chitrakmool, Boga agechita, Agni, Vyaala, Ogni)	1.5-2.0 m. Tall; cultivated in gardens throughout India, wild in S.India, WB, parts of M.P. and CG (NMPB, 2008)	Tiwari *et al.*, 2007; NMPB, 2008
151.	*Polhillides velutina* subsp. *velutina* (Syn. *Desmodium latifolium* (Roxb.) DC.); (L.N.: Jagru, Lagavang, Orila, Chimanduri)	3-5 ft., UP, UK, Outer Himalaya up to 4k ft., SK, throughout India to Ceylon (FUGP); Sub-Himalayan tract, both Penins. (ITB, 1921)	--
152.	*Polyalthia korintii* (Dunal) Thwaites; (L.N.: Karuvall, Karuvalli, Kurintipanel)	3-5 m., AP, TN and KL (EFI-BSI Web.); Western Peninsula, Ceylon (ITB, 1921)	--
153.	*Polyalthia suberosa* (Roxb.) Thwaites; (L.N.: Habida-cha, Makhameraphang, Barachali, Kukuriam, Lohania, Mossu)	4-6 m., WB, AS, ML, OD, MP, AP, TN and KL (EFI-BSI Web.); Oudh Forest, Bengal, S. India (FUGP)	--
154.	*Polygala arillata* Buch.-Ham. ex D.Don; (L.N.: Luinche Phool, Marchaa, Ban Ukhu, Karimaa, Mayongwon)	12 ft.; Outer Himalaya from Nepal eastwards, 2000-7000 ft., Khasi Hills, Hills of Western Coasts (ITB, 1921)	--
155.	*Pueraria tuberosa*(Roxb. ex Willd) DC. (Syn. *Hedysarum tuberosum* Willd.); (L.N.: Vidari, Bilaikand, Kudzu, Indian Kudzu)	Spreading, deciduous climber or twining shrub; C. India, ascending up to 1300 m. msl, hills of W. Himalaya (NMPB, 2016)	NMPB, 2016
156.	*Pyracantha crenulata* (D.Don) M.Roem. (Syn. *Crataegus crenulata* (D.Don) Roxb.); (L.N.: Ghingaroo)	5-15 ft. (Singh et al., 2012); Temperate Himalaya in dry places from the Sirmore to Bhutan at 2500-8000 ft. (FBI, 1879)	Singh *et al.,* 2012
157.	*Rauvolfia serpentine* (L.) Benth. ex Kurj; (L.N.: Sarpagandha, Sootranaabhi, Shivanaabhi, Hadaki, Chandrabhaga)	About 75cm.; Humid tropical areas, foothills of Himalaya up to 1300-1400m, almost throughout the country (ICFRE, 2019b)	Badhwar *et al,,* 1955; Sobti *et al.,* 1959; Badhawar *et al.,* 1963; Singh, 1964; Mathur and Singh, 1965; Surendran, 2014; ICFRE, 2019b
158.	*Rheum australe*D.Don (Syn. *Rheum emodi* Wall. ex Meisn.); (L.N.: Amlavetasa, Rewand chini, Rhubarb, Padamchaal)	Perennial stout herb, 1.5-3.0 m. tall; Temperate Himalaya from Kashmir to SK at 2800-4000m. Altitude (NMPB, 2008)	NMPB, 2008; Gopichand *et al.,* 2010
159.	*Ribes orientale*Desf.; (L.N.: Oriental Gooseberry)	2m.; Himalaya at 2000-3500m. from Kashmir to Nepal (Sharma *et al.,* 2005)	Sharma *et al.,* 2005
160.	*Rotheca serrata* (Linn.) Steane & Mabb. {Syn. *Clerodendrum serratum* (Linn) Moon}; (L.N.: Bharangi)	2-4 m.; Scrub forests throughout tropical & sub-tropical parts up to 1500 m., Bengal, OD & peninsular India (NMPB, 2014)	NMPB, 2014
161.	*Sageretia brandrethiana* Aitch.	10-12 ft.; N.W. Himalaya, Indus to Jhelum, up to 5k ft. (ITB, 1921);J&K,PB(EFI-BSI Web.)	--
162.	*Scutia myrtina* (Burm.f.) Kurz (Syn. *Scutia indica* Brongn.); (L.N.: Urudi, Vallivadari, Pinrotari, Sudali, Tuttavi, Gadda-goru)	2-3 m. (FOI Web.); Western Peninsula, Dry hills of Deccan, Ghats of Konkan, in Coorg, Nilgiris (ITB, 1921)	--
163.	*Senegalia senegal* (L.) Britton {Syn. *Acacia senegal* (L.) Willd.}; (L.N.: Kumttha, Kumatiyo, Babul, Shvetakhadira)	6-12 ft., Merwara, Rohtak, Sindh, Rajputana (FUGP); North-western India (FOI Web.)	Gupta *et al.,* 1973; Luna, 1996; ICFRE, 2019a
164.	*Senna alata* (L.) Roxb. (Syn. *Cassia alata*); (L.N.: Chakrathakara, Elakayam, Malamthakra, Seema-agathi)	4 m. (KPI Web.); AP, AR, AS, BH, DL, GA, GJ, HR, HP, J&K, KA, KL, MP, MH, MN, ML, MZ, NG, OD, PB, RJ, SK, TN, TR, UP, WB (EFI Web.)	Tiwari *et al.,* 2007
165.	*Senna alexandrina var. alexandrina* (Syn. *Cassia angustifolia* Vahl); (L.N.: Nilavaka, Savarnapatri, Bhitarvada, Nelatangedu)	Up to 3 ft. (FOI Web.); South India, RJ, GJ and M.P. (Kumar *et al.,* 2005)	Kumar *et al.,* 2005; NMPB Web.

S. N.	Botanical name and Local Name	Height and Distribution in India	Reference for propagation/ nursery techniques (for India)
166.	*Senna auriculata* (L.) Roxb. {Syn. *Cassia auriculata* L.); (L.N.: Tarwar, Tarwad, Tangadi, Tagedu, Avaram, Awala, Avaram)	1-1.5 m. (NPARKS Web.); W. Penins. to Ajmer, Irawaddi valley (ITB, 1921); UP, RJ, C.&S. India to Ceylon (FUGP)	Bennett, 1921; Luna, 1996; Troup, 1921; ICFRE, 2019b
167.	*Sohmaea laxiflora* (DC.) H.Ohashi & K.Ohashi (Syn. *Desmodium laxiflorum* DC.); (L.N.: Asud, Atotti, Orila, Thatla)	3-5 ft., Dehradun, Himalaya up to 6k ft., from Kangra to AS, Bengal, S. India (FUGP)	--
168.	*Solanum donianum* Walp. (Syn. *Solanum verbascifolium* Linn.)	20 ft. (FBI, 1885); UP, UK, throughout India in the tropical and subtropical zones up to 3000 ft. on the Himalaya (FUGP)	--
169.	*Solanum giganteum* Jacq.; (L.N.: Kurti, Paintilikakkoti, paintilikam)	10-25 ft., Mts. Of S. Deccan (FBI, 1885)	--
170.	*Solanum torvum* Swartz.; (L.N.: Bhankatiya, Sundaikkai, Kottuvastu)	8-12 ft., throughout India in tropical regions except western desert (FBI, 1885)	Tiwari *et al.,* 2007
171.	*Solanum trilobatum* Linn (L.N.:)	6-12 ft., W. Deccan Peninsula, from Concan southward (FBI, 1885)	--
172.	*Solanum violaceum* Ortega (Syn. *Solanum indicum* L.); (L.N.: Brihati, Kateli, Jangli bhata, Valutina, Tawkte, Leipung khang)	Shrub, 0.3-1.5 m.; throughout the tropical and subtropical India (NMPB, 2008)	NMPB, 2008
173.	*Spermadictyon suaveolens* Roxb. (Syn. *Hamiltonia suaveolens* (Roxb.) Roxb.); (L.N.: Gidas, Padan hing, Gidesa, Jinsayi)	4-12 ft., tropical& sub-tropical Himalaya up to 5k ft. from Kashmir to Bhutan, hills of C. & S. India from Parasnath to Mysore (FUGP)	--
174.	*Strobilanthes agasthyamalana* Sasidh., Dantas & Robi (Syn. *Pittosporum neelgherrense* Wight & Arn.)	Up to 3 m., Shola forests of Western Ghats, above 1200 m. KA, TN, and KL (EFI-BSI Web.)	--
175.	*Strobilanthes auriculata* Nees; (L.N.: Kapur mingar, Ankaravalli khangrangwon, Pandai, Ramting)	2-6 ft. (Malwa plateau, C. India up to 4000 ft., Chota Nagpur and Central Provinces (FUGP)	--
176.	*Tarenna asiatica* (L.) Kuntze ex K.Schum. (Syn. *Webera corymbosa* Willd.); (L.N.: Bingi Patale, Kare, Tharani, Kuppipoovu)	Up to 6 m., Western Ghats (FOI Web.); Central province, Peninsula both on the West and East side, common (ITB, 1921)	--
177.	*Tephrosia candida*DC.; (L.N.: Lashtia, Ban tor, Kolinji, Bangara, Ghirdi, Bilakshani, Bilokhoni, Sarapunkha)	2.5 m. (FOI Web.); Himalayas tropical zones from Kumaon to Khasia and AS (FBI, 1879)	Homfray, 1937
178.	*Thespesia lampas (Cav.) Dalzell* and Gibs. {Syn. *Azanga lampas* (Cav.) Alef.; *Hibiscus lampas* Cav.}; (L.N.: Katupuvarasu, Bilo Kapasiva, Kondapratti, Kattuparatii)	2-3 m. (FOI Web.); AS, WB, GJ, KA, KL, MH, OD, TN, AP, UP, UK, BH, MP, HR, PB (FOI Web.)	--
179.	*Tinospora cordifolia*(Willd.) Hook.f. & Thomson; (L.N.: Amrita, Guduchi, Giloe, Gurucha, Gulvel, Gurjo, Galo, Chadmika)	Twiner; common throughout tropical and subtropical India (NMPB, 2008)	Rao *et al.,* 2000; NMPB, 2008; Mishra *et al.,* 2010; ICFRE, 2019b
180.	*Turraea pubescens* Hell. (Syn. *Turraea villosa* Benn.); (L.N.: Kapur bhendi)	1-3 m. (FOI Web.); Western Ghats from Mahabaleshwar southward, GJ(ITB,1921)	--
181.	*Uraria picta*(Jacq.) Desv. ex DC.; (L.N.: Prisni parni, Dabra, Pithavan, Tejarali, Sankarjata, Muvila, Ranganja, Isworojota)	3 ft., Sub-Himalayan & Upper Ganga Plain, up to 6k ft., south to Ceylon (FUGP); 60-75 cm., throughout tropical India (NMPB, 2008)	Tiwari *et al.,* 2007; NMPB, 2008
182.	*Vachellia eburnea* (L.f.) P.J.H.Hurter & Mabb. (Syn. *Acacia eburnea* (L.f.) Willd.); (L.N.: Bambolero, Jali, Joli, Pikajali, Kudai vel, Gabbuthumma, Piketumma)	Up to 3 m. (AMPSLC Web.); Dehradun, Siwalik range, throughout the greater parts of India (FUGP)	--
183.	*Vachellia horrida* subsp. *horrida* {Syn. *Acacia latronum* (L.f.) Willd.}; (L.N.: Anegobli, Seethaimul, Kaarodai, Odasithai)	2-4m. (EFI Web.); AP, KA, KL, OD, TN (FPI Web.); Dry hills of Deccan (ITB, 1921)	--
184.	*Vachellia jacquemontii* (Benth.) Ali (Syn. *Acacia jacquemontii* Benth.); (L.N.: Bhu-banwali, Bawali, Bouli, Gulli bouli, Baul)	1.5 to 4.5 m., GJ, PB, RJ, DL, HR, TN, Saurashtra (Mertia *et al.,* 2009); UP, PB, up to 3k ft. on Himalaya, C. Province (FUGP)	Mertia *et al.,* 2009

S. N.	Botanical name and Local Name	Height and Distribution in India	Reference for propagation/ nursery techniques (for India)
185.	*Vincetoxicum indicum*(Burm.f.) Mabb. {Syn. *Tylophora indica* (Burm.f.) Merr.}; (L.N.: Arkaparni, Damabuti, Indian ipecac, Dum vel, Bedaki, Kirumanji, Pitmari)	Climber; Common in penins. India, BH, OD, WB, NE states; plains and hills up to 1000 m. throughout eastern & southern & subtropical regions (NMPB, 2008)	Shah and Kapoor, 1974; NMPB, 2008
186.	*Vitex negundo*L.; (L.N.: Nirgundi, Sindvar, Nocchi, Vavili, Nishinda, Indrani)	2-8m. (NBRIENVIS Web.); Throughout India & N.W. Himalaya up to 5000ft. (FUGP)	Rao,1953; Tewary *et al.,* 2004; Tiwari *et al.,* 2007
187.	*Wendlandia bicuspidata* Wight & Arn.	4-5 m., Endemic to Southern Western Ghats (KPI Web.)	--
188.	*Wendlandia heynei* (Schult.) Santapau & Merchant (Syn. *Wendlandia exserta* (Roxb.) DC.); (L.N.: Kadam, Mimri, Parakatte, Pansira, Tilakah, Katampam, Tellapucu)	Up to 6 m., UP, UK, from the Chenab to SK, C. province, OD, N. Konkan, Deccan (ITB, 1921); Siwalik range, base of Himalaya eastward to Gorakhpur (FUGP)	Mohan, 1939
189.	*Withania somnifera* (L.) Dunal; (L.N.: Ashwagandha, Aksand, Asgandh, Gadde, Angara beru, Penneru, Pevetti, Amukkira)	Undershrub, 1.5m. Height; M.P., RJ, PB, Haryana, U.P., GJ, MH (ICFRE, 2019b)	Tiwari *et al.,* 2007; ICFRE, 2019b
190.	*Woodfordia fruticose* (L.) Kurz (Syn. *Woodfordia floribunda* Salisb.); (L.N.: Dhawai, Velakkai, Godari, Aare, Dhauri)	3 m. (FOI Web.); Throughout the greater part of India ascending to 5000 ft. on the Himalaya (FUGP)	Troup, 1921; Badola, 1987; Joshi *et al.,* 1992
191.	*Zanthoxylum acanthopodium*DC.; (L.N.: Darmar, Nipalidhanya, Tejphal, Tumra, Mukthroobi, Tejaswini, Tejbal, Tejovati)	Up to 6 m., Himalayas and N.E. India, up to 2000 m. UP, W. Bengal, SK, AR, AS, NG, MZ, MN and ML (EFI-BSI Web.)	--
192.	*Zanthoxylum alatum*Roxb.; (L.N.: Darmar, Tejphal, Tumra, Tejaswini, Tejbal, Tumra, Nipalidhaniya)	Up to 6 m.; Warmer valleys of Himalaya, E. Ghats, OD, AP, Naga hills, ML, MZ, MN at 1000-2100m. (Jabeen & Kumar, 2020)	Jabeen and Kumar, 2018; 2020; 2021; Jabeen *et al.* 2021
193.	*Zanthoxylum armatum* DC.; (L.N.: Tejovati, Tumbru, Tejbal, Timur, Timru, Nepali Dhania, Arhrikreh, Ganya, Tirmal)	Up to 6 m.; hot valleys of subtropicalHimalaya, at 700-1000m. in Khasi & Ganjam hills, Vizagpatnam at 1500m. (NMPB, 2008)	Tiwari *et al.,* 2007; NMPB, 2008
194.	*Zanthoxylum oxyphyllum*Edgew.; (L.N.: Mejenga, Onger, Mezenga, Dretsang, Bhainsi timur, Lahara timu)	Up to 5 m., UP, WB, SK, MN, ML and AR (EFI-BSI Web.); Outer Himalaya, UK, 4-9k ft., Khasi Hills, MN (ITB, 1921)	--
195.	*Zanthoxylum pseudoxyphyllum* Babu	Up to 6 m., MN and AR (EFI-BSI Web.)	--
196.	*Ziziphus glabrata* (Heyne ex Schult.)Heyne ex W.&A.; (L.N.: Karattai, Karkala, Kottei Karunkottai, Karakodamaram, Karattai)	6 m., Kashmir, HP, PB, WB, RJ, GJ, MH, TN and Andaman (EFI-BSI Web.)	--
197.	*Ziziphus nummularia*(Burm.f.) Wight & Arn. (Syn. *Ziziphus rotundifolia* Lam.); (L.N.: Jhar-beri, Paragi, Chanya ber)	2-3.5 m. (EFI-BSI Web.); 2.5m. (KPI Web.); Doab, Merwara, Bundelkhand, from PB, RJ to C. & S. India (FUGP)	Rao, 1953
198.	*Ziziphus oenopolia* (L.) Mill.; (L.N.: Makkay, Makai, Tutali, Paragi, Baragi, Harasurali, Cheriyalanta, Surimullu, Siakul)	Scandent, throughout hotter parts (KPI Web.); N.India, Chota Nagpur, Sub-Himalayan tract, Sutlej eastward, both Penins. (ITB, 1921)	--
199.	*Ziziphus rugosa* Lam.; (L.N.: Churna, Suran, Toran, Thodali, tutari, Belahadu, Kanika, Kotta, Mulluhannu, Ghontaa)	3-5m. (EFI-BSI Web.); Sub-Himalayan tract up to 2000 ft., BH, C.Prov., W. Penins. (ITB, 1921); UP, WB, C.&S. India (FUGP)	--
200.	*Ziziphus xylopyrus* (Retz.) Willd.; (L.N.:Bara-ber, Kathber, Gal-ber, Ghatbor, Gotti Chettu, Gotiki, Kodachi, Kodanchi)	Up to 4m., (Gandagule *et al.,* 2013); N.W. Himalaya, C.India, W.Penins. (ITB, 1921); UP,UK,RJ,BH,C.Prov. to Ceylon (FUGP)	Rogers, 1911; Troup, 1921

Abbreviations and online resources mentioned in Table 8:

AMPSLC:http://www.instituteofayurveda.org, **AP:** Andhra Pradesh, **AR:** Arunachal Pradesh, **A&N:** Andaman & Nicobar, **BH:** Bihar, **C.:** Central, **CG:** Chhattisgarh, **DL:** Delhi, **E.:** East or Eastern, **FBI:** Flora of British India, **EFI or EFI-BSI:** efloraindia.bsi.gov.in, **EFP or EFO:** efloras.org, **FOI:** flowersofindia.net, **FPI:**http://flora-peninsula-indica.ces.iisc.ac.in, **FRLHT:** envis.frlht.org, **FUGP:** Flora of Upper Gangetic Plain and of Adjacent Siwalik and Sub-Himalayan tract, **GA:** Goa, **GJ:** Gujarat, **HP:** Himachal Pradesh, **HR:** Haryana, **ITB:** Indian Trees by Brandis, **J&K:** Jammu & Kashmir, **JAH:** Janaki Ammal Herbarium, (CSIR-IIIM) Accession No. 2354; **JH:** Jharkhand, **KA:** Karnataka, **KL:** Kerala, **KPI:** http://keralaplants.in, **L.N.:** Local Name, **MBG:**https://www.missouribotanicalgarden.org, **MH:** Maharashtra, **ML:** Meghalaya, **MN:** Manipur, **MZ:** Mizoram, **MP:** Madhya Pradseh, **N.:** North or Northern, **NBRIENVIS:**http://www.nbrienvis.nic.in, **NE:** North-Eastern, **NG:** Nagaland, **NMPB:** National Medicinal Plant Board (https://nmpb.nic.in), **NPARKS:**https://www.nparks.gov.sg, **OD:** Odisha, **PAC:** https://www.planetayurveda.com, **PB:** Punjab, **Penins.:** Peninsula,**PFAF:** https://pfaf.org,**POWO:** https://powo.science.kew.org, **Prov.:** Provinces, **RJ:** Rajasthan, **S.:** South or Southern, **SK:** Sikkim, **TN:** Tamil Nadu, **TR:** Tripura, **TS:** Telangana, **TSO:** treesandshrubsonline.org, **UK:** Uttarakhand, **UP:** Uttar Pradesh, **W.:** West or Western,**WB:** West Bengal, **Web.:** Website

ऊर्ध्वाधर दोहरे भूमि उपयोग से विखण्डित वनों को जोड़ने का अवसर (वन संरक्षण अधिनियम, 1980 के अन्तर्गत विद्युत पारेषण लाइनों के मार्ग में वर्तमान अनिवार्य शर्त के अनुपालन हेतु बौनी प्रजातियों, अधिमानतः औषधीय पौधों का रोपण)

विनय कान्त मिश्रा

सारांश

प्रकृति एवं प्राकृतिक संसाधनों के संरक्षण के लिए भारत में एक सुदृढ़ वैधानिक तंत्र उपलब्ध है। विद्युत पारेषण लाइनों के मार्ग (आरओडब्ल्यू) में बौनी प्रजातियों (अधिमानतः औषधीय पौधों) का रोपण वन (संरक्षण) अधिनियम, 1980, के तहत वन भूमि अपयोजन परियोजनाओं के चरण-I अनुमोदन में लगाई जाने वाली एक अनूठी शर्त है। यह विभिन्न उपयोगों के लिए भूमि के ऊपर अवस्थित स्थान के ऊधर्वाधर दोहरे भूमि उपयोग का एक अनूठा अवसर प्रदान करता है। हालांकि, इस स्थिति के प्रभावी अनुपालन के लिए उपलब्ध ऊधर्वाधर स्थान का आंकलन और इस सीमित ऊर्ध्वाधर स्थान के लिए उपयुक्त पेड़ प्रजातियों का चयन महत्वपूर्ण है। वर्तमान अध्ययन में, भारत के विभिन्न राज्यों/केन्द्र शासित प्रदेशों में विद्युत पारेषण लाइनों (कम से कम चरण-I अनुमोदन प्राप्त प्रस्तावों) के लिए वन भूमि अपयोजन की कुल 1080 परियोजनाओं (15.07.2014 से 18.06.2022, 10:00 बजे अपराह्न तक, जो परिवेश पोर्टल पर उपलब्ध है) का विश्लेषण किया गया है। सुरक्षा, प्रजातियों के चयन, प्राक्कलन, वृक्षारोपण की लागत, पौधों के बीच की दूरी, पादप जलवायु क्षेत्र और वनस्पति के प्रकार आदि पहलुओं सहित इन परियोजनाओं में बौनी प्रजातियों (अधिमानतः औषधीय पौधों) के रोपण की वर्तमान क्रियान्वयन विधि की समीक्षा की गई। विभिन्न वोल्टेज स्तरों की विद्युत पारेषण लाइनों के कुल 21 विभिन्न संयोजनों में उपलब्ध ऊर्ध्वाधर और क्षैतिज स्थान का विश्लेषण किया गया। 'वी' प्रकार की स्ट्रिंग अपेक्षाकृत अधिक लम्बाई के बौने पौधों को समयोजित करने के लिए अधिक उपयुक्त पाई गई है। भारत के विभिन्न पादप जलवायु क्षेत्रों की 200 बहुवर्षीय बौनी प्रजातियों की सूची उनके वितरण और उन्हें उगाने की उपलब्ध तकनीकों के साथ दी गई है। वन (संरक्षण) अधिनियम, 1980 के अन्तर्गत इस शर्त के प्रभावी क्रियान्वयन एवं वनों के विखंडन की रोकथाम के उद्देश्य एकमात्र उद्देश्य से अपेक्षाकृत अधिक लम्बाई (टी-वैल्यू) के बौने पौधों के लिए ऊर्ध्वाधार और क्षैतिज स्थान (के-वैल्यू) की गणना की विधि और वृक्षारोपण में विभिन्न ऊचांई के पौधों के रोपण का मॉडल प्रस्तावित किया गया है।

References

Ali M., Malik, A.R. and Sharma K.R. (2008). Vegetative propagation of *Berberis aristata* DC. and endangered Himalayan shrub. *Journal of Medicinal Plants Research*, **2**(12): 374-377.

Badhawar R.L., Beri R.M., Karira G.V. and Ramaswami S. (1963). *Rauwolfia serpentina*: Studieson optimum methods of propagation and their effect on production and alkaloidal content of roots. *Indian Forester*, **89**(11): 729-735.

Badhwar R.L., Karira G.B., and Ramaswami S. (1955). *Rauwolfia serpentina*- The wonder drug of India (Rauwolfia, Sarpagandha). *Indian Forester*, **81**(4): 258-268.

Badola K.C. (1987). A note on *Woodfordia fruticosa* Kurz. (Lythraceae). *Indian Forester*, **113**(3): 233-234.

Bahuguna V.K., Rawat M.M.S. and Joshi S.R. (1988). Preliminary studies on seed germination behavior of *Derris lyceum* Royle-An important shrub for reclamation of wastelands in the Himalaya. *Indian Forester*, **114**(4): 181-183.

Basu S.K. (1958). Propagation by cuttings. *Indian Forester*, **84**(5): 284-285.

Belliappa R.S.K.G. (1929). Cardamom cultivation in South Kanara, Madras. *Ind. For.*, **55**(2): 96-99.

Bennett H.C. (1921). Experiments in sowing seeds of *Cassia auriculata* (Telugu-Tangedu, Tamil-Avaram) at Golla, Anantpur. *Indian Forester*, **47**(1): 25-29.

Bhargava R., Verma P., Saroj P.L. and Chauhan N. (2006). Propagation of *Capparis deciduas* through cuttings. *Indian Forester,* **132**(6): 737-745.

Brandis D. (1921). Indian Trees. Constable and Company LTD., London.

CEA. (2010). Central Electricity Authority (Measures relating to Safety & Electric Supply) Regulations. Ministry of Power, Govt. of India.

Champion H.G. and Seth S.K. (1968). *A Revised Forest Types of India*. Manager of Publications, Government of India, Delhi.

Chauhan J.M.S., Bhandari A. and Bhandari M.S. (2018). Effect of hormones on rooting potential of *Hippophae salicifolia* (seabuckthorn) in Agro-climatic zone of Dehradun, Uttarakhand. *Indian Forester,* **144**(9): 863-868.

Chowdhery H.J. and Wadhwa B.M. (1984). Flora of Himachal Pradesh- I-III. BSI, Calcutta.

Dalal S.S. and Patnaik N. (1963). Kudzu cultivation for soil conservation. *Indian Forester*, **89**(7): 468-473.

Deshpande S.M. and Yadav S.R. (2020). Conservation of selected rare and endemic trees from Nortthern Western Ghats. *Indian Forester,* **146**(4): 332-337.

Dharmveer Sood M., `Aziem S., Iqbal K., Hussain A. and Mahto S. (2016). Effect of different growing media on seed germination and growth parameters of *Angelica glauca* Edgew. *Indian Forester,* **142**(11): 1093-1099.

Duthie J.F. (1903-29). Flora of Upper Gangetic Plain and of Adjacent Siwalik and Sub-Himalayan tract, Volume- I to III. Office of the Superintendent of Government Printing, Calcutta, India.

Evers D.J. (1908). Cardamom cultivation in south Mysore. *Indian Forester*, **34**(11): 657-661.

Hooker J.D. (1872-1897). The Flora of British India, Vol. I (1872), II (1879), III (1882), IV (1885), V (1885), VI (1894), VII (1897). Reeve and Co., Kent, UK.

Gangoo S.A., Masoosi N.A. and Banyal R. (2007). Vegetative propagation of *Buxus wallichiana* Baillon. *Indian Forester,* **133**(12): 1703-1705.

Gopichand., Singh R.D., Meena R.L., Singh K.N. and Kumar A. (2010). Effect of plant growth regulators on germination of seed of *Rheum austral* D.Don. *Indian Forester,* **136**(11): 1503-07.

Gupta R.K., Saxena S.K. and Dutta S.K. (1973). Germination, seedling behavior and phytomass of some Acacias in the nursery stage. *Indian Forester*, **99**(6): 352-358.

Hingorani G.R. (1953). Indian Belladona. *Indian Forester*, **79**(1): 36-48.

Homfray C.K. (1937). Nursery and Plantation Notes for Bengal 1935. 4th edition, Bengal Government Press, Alipore, Bengal.

ICFRE. (2019a). Modern nursery techniques, ICFRE Manual. ICFRE, Dehradun.

ICFRE. (2019b). Cultivation of selectedNWFPs, ICFRE Manual. ICFRE, Dehradun.

Jabeen S. and Kumar D. (2018). Root induction in juvenile branch cuttings of *Zanthoxylum alatum* Roxb.: A hard to root valuable tree species of Himalayan Region. *Indian Forester,* **146**(1): 77-80.

Jabeen S. and Kumar D. (2020). Root induction in juvenile branch cuttings of *Zanthoxylum alatum* Roxb.: A hard to root valuable tree species of Himalayan Region. *Indian Forester,* **146**(1): 77-80.

Jabeen S. and Kumar D. (2021). Effect of stooling height of *Zanthoxylum alatum* on propagation through shoot cuttings. *Indian Forester,* **147**(11): 1137-1139.

Jabeen S., Kumar D. and Ginwal H.S. (2021). Development of protocol for propagation of *Zanthoxylum alatum* through mound layering. *Indian Forester,* **147**(8): 762-766.

Joshi N.K. and Dhiman R.C. (1992). Multiplication of Indian Chir Pine seedling by cuttings in nursery beds. *Indian Forester*, **118**(2): 89-95.

Joshi N.K., Sharma S., Shamet G.S. and Dhiman R.C. (1992). Studies on the effect of auxin and season on rooting stem cuttings of some important shrubs in nursery beds. *Indian Forester*, **118**(12): 893-900.

Kaith D.C. (1948). A note on tropical Kudzu. *Indian Forester*, **74**(11): 382-383.

Kalidass C., Glory M. and Manickam V.S. (2011). Effect of Gibberellic acid on germination and seedling growth in *Leptadenia reticulata* (Retz.) W. & A. (Asclepiadaceae). *Indian Forester,* **137**(1): 83-87.

Kanjilal P.C. (1933). A forest flora of Pilibhit, Oudh, Gorakhpur and Bundelkhand. Narendra Publ. house, Delhi.

Kanjilal U.N., Kanjilal P.C. and Das A. (1934-40). Flora of Assam. Bishen Singh Mahendra Pal Singh, Dehradun.

Kapoor L.D., Chopra I.C. and Nath S. (1952). A note on the germination of seeds of Indian Belladonna. *Indian Forester*, **78**(1): 34-35.

Khan A.H. (1944). A note on the departmental cultivation, collection and curing of Cardamoms in evergreen forests of Madras Presidency. *Indian Forester*, **70**(4): 106-111.

Khan M.S. (1952). *Annona squamosa* Linn. *Indian Forester*, **78**(9): 469-470.

Kumar J. and Parmar C. (2000). Standardization of sexual and asexual propagation techniques for some wild fruits of Sub-Himalayan region. *Indian Forester*, **126**(8): 870-873.

Kumar Rajiv (1999). Artificial regeneration of Mangroves. *Indian Forester*, **125**(8): 760-769.

Kumar S., Parveen F. and Narain P. (2005). Medicinal Plants in the Indian Arid Zone. CAZRI, Jodhpur.

Kumar V., Nagavani H.C., Kumar D. and Singh V.P. (1996). Propagation and growth studies of *Calligonum polygonoides* (Phog*). Indian Forester*, **122**(5): 377-382.

Luna R.K. (1996). *Plantation Trees*. International Book Distributors, Dehradun, India.

Mathur C.M. and Singh S.P. (1965). Cultivation of *Rauwolfia serpentina* in Kota Forest Division (Rajasthan). *Indian Forester*, **91**(4): 239-242.

Mertia R.S., Prasad R. and Singh J.P. (2009): *Banwali (Acacia jacquemontii Benth.)- A multipurpose shrub of Arid Zone*. Central Arid Zone Research Institute, Regional Research Station, Jaisalmer.

Ministry of Power (2020). Guidelines for payment of compensation in regard to Right of Way (RoW) for transmission lines in urban areas. (issued vide *no. 3/4/2016-Trans dt. 16.07.2020*) Ministry of Power, Government of India.

Misra V.K. (2020). Inventory of Invasive Alien Plants in India. *Indian Forester*, **146**(5): 385-409.

Mishra Y., Usmani G., Chawhaan P.H. and Mandal A.K. (2010). Propagation of *Tinospora cordifolia* (Willd.) Miers. Ex Hook.f. & Thoms. through mature vine cuttings and their field performance. *Indian Forester*, **136**(1): 88-94.

MoEF (2004). Handbook of Forest (Conservation) Act, 1980 and Forest Conservation Rules, 2003

(Guidelines and Clarifications), (issued vide F.No.2-1/2003-FC dated 02-07-2004). Ministry of Environment, Forests and Climate Change, Government of India.

MoEF&CC (2014). Guidelines on Forest (Conservation) Act, 1980 (issued videF.No.7-25/2012-FC dated 19.11.2014). Ministry of Environment, Forests and Climate Change, Government of India.

MoEF&CC (2019): Handbook of Forest (Conservation) Act, 1980 and Forest Conservation Rules, 2003 (Guidelines and Clarifications), (issued vide F.N.5-2/2017-FC dated 28-03-2019)**.** Ministry of Environment, Forests and Climate Change, Government of India.

MoEF&CC (2020). Prior Approval under Section-2 (ii) of Forest (Conservation) Act, 1980 of Central Government for various transmission lines under construction/proposed in the forest areas (issued vide F.No.FC-11/157/2019-FC dated 01.01.2020). Ministry of Environment, Forests and Climate Change, Government of India.

Mohamed M.B.N., Shukla A.K., Keerthika A., Gupta D.K., Meena S.R., Choudhary K.K. and Mehta R.S. (2021). *Current Science*, **120**(10): 1557-1558.

Mohan N.P. (1939). Artificial regeneration of *Wendlandia exserta* DC. *Indian Forester*, **65**(12): 725-730.

Mourya N.R., Bargali K. and Bargali S.S. (2019). Impacts of Coriaria nepalensis colonization on vegetation structure and regeneration dynamics in a mixed conifer forest of Indian Central Himalaya. *Journal of Forestry Research*, **30**(1): 305–317.

Naha Kalyan, Hajam A.G. and Chand L. (1990). Trials on propagation of shrubs in Kashmir. *Indian Forester*, **116**(12): 938-941.

NMPB. (2008). Agro-techniques of Selected Medicinal Plants, Vol.-I. National Medicinal Plants Board, Deptt of AYUSH, Min. of Health and Family Welfare, Govt of India.

NMPB. (2014). Agro-techniques of Selected Medicinal Plants, Vol.-II. National Medicinal Plants Board, Deptt of AYUSH, Min. of Health & Family Welfare, Govt of India.

NMPB. (2016). Agro-techniques of Selected Medicinal Plants, Vol.-III. National Medicinal Plants Board, Ministry of AYUSH, Govt of India.

OFSDS. (2019). Nursery Technique of Common Forest Tree Species used in Plantations under OFSDP-II.Odisha Forestry Sector Development Society, Forest and Environment Department, Government of Odisha.

Orwa C., Mutua A., Kindt R., Jamnadass R. and Anthony S. (2009). Agroforestree Database: a tree reference and selection guide version 4.0 (http://www.worldagroforestry.org/sites/treedbs/tree databases.asp)

Padmanabhan P., Correa-B.J. and Paliyath G. (2016). Berries and related fruits. Encyclopedia of Food and Health, page- 364-371 (https://www.sciencedirect.com/science/article/pii/B978012384947200060X).

Paka S., Paleti J., Naganagar P. R., Ranga R., Kalukuri B.P. and Boggula N. (2020). Nutritional and Therapeutic Benefits of Medicinal Plant *Canthium parviflorum* Lam. (Rubiaceae): A Review. *Scholars Academic Journal of Pharmacy*, **7**: 211-218.

Pandey A.K. (2012). Cultivation Technique of an Important Medicinal Plant *Gymnema sylvestre* R. Br. (Gurmar). *Academic Journal of Plant Sciences,* **5**(3): 84-89.

Prakash R., Chaudhri D.C. and Negi S.S. (1991). *Propagation practices of Important Indian Trees*. International Book Distributors, Dehradun.

Puri D.N. and Kaul R.N. (1972). Effect of size of stem cutting on *Commiphora mukul. Indian Forester*, **98**(4): 252-257.

Purkayastha B.K. (1969). Studies on the introduction of *Moghania macrophylla* for cultivation of Lac. *Indian Forester*, **95**(8): 560-566.

Qaisar K.N. (2002). Propagation of *Parrotia jacquemontiana*, an economically important shrub of Kashmir through root suckers. *Indian Forester*, **128**(6): 709-710.

Raj X., Janifer Ballabh B., Murugan M.P., Dhar P., Tayade A.B., Warghat A.R., Chaurasia O.P. and Srivastava R.B. (2013). Effect of auxins on adventitious rooting from hardwood cuttings of *Hippophae rhamnoides* under Ladakh Kimalayas. *Indian Forester,* **139**(3): 228-231.

Ramulu D.R., Murthy K.S.R. and Pullaiah T. (2005). Vegetative propagation of *Hemidesmus indicus* R.Br. by stem cuttings. *Indian Forester,* **131**(11): 1505-1508.

Rao H.S. (1953). Vegetative cultivation and forest tree improvement. *Indian Forester*, **79**(3): 176-183.

Rao P.S., Venkiah K., Murali V. and Satyanarayana V.V.V. (2000). Macro propagation of some important medicinal plants of Andhra Pradesh. *Indian Forester*, **126**(12): 1265-1269.

Rao R.S. (1985-86). Flora of Goa, Diu, Daman, Dadra & Nagarhaveli. Vol.- 1 & 2. BSI, Calcutta.

Rogers C.G. (1911). Report on the raising of forests with field crops (Agri-silvicultural method) in the Chirodi Reserve, Amraoti Division from 1902-03 to 1909-10. *Indian Forester*, **37**(1): 8-20.

Sankhyan H.P., Sehgal R.N. and Bhrot N.P. (2003). Effect of growth hormones and seasons of propagation of different seabuckthorn species through cuttings in cold deserts of Himachal Pradesh. *Indian Forester*, **129**(10): 1300-1302.

Shah N.C. and Kapoor L.D. (1974): Culture and propagation of *Tylophora indica* (Burm.f.) Merr.: The asthma herb. *Indian Forester*, **100**(10): 632-635.

Sharda A.K. and Verma S.K. (2010). Air-layering in *Gardenia gummifera* L.f. *Indian Forester,* **136**(2): 266-268.

Sharma A., Venugopal C.K., Vasudeva R., Manjunath A.V. and Hegde L. (2012). Propagation of an endangered medicinal plant species, *Celastrus paniculata* through root cuttings. *Indian Forester,* **138**(8): 722-725.

Sharma S., Kumar S., Thakur K.S. and Negi P.S. (2005). Study on effect of pre-sowing treatments of germination of *Ribes orientalis* Desf. seeds. *Indian Forester,* **131**(5): 667-672.

Shetty B.V. and Singh V. (1987-1993). Flora of Rajasthan, Vol.- 1, II and III. BSI, Calcutta.

Singh J. (1964). Trials on cultivation of some medicinal and aromatic plants in Punjab. *Indian Forester*, **90**(8): 500-510.

Singh R., Negi P.S., Arya M.C. and Ahmed Z. (2012). Propagation technique of *Crataegus crenulata*: A multipurpose plant of Mid Himalayan hills. *Indian Forester,* **138**(2): 169-172.

Singh R.P. and Jishtu Vaneet. (1997). *Cotula nepalensis* Sims. - an important shrub of cold desert region of India. *Indian Forester*, **123**(7): 637-642.

Sobti S.N., Abrol B.K., Handa K.L. and Chopra I.C. (1959). Cultivation of *Rauwolfia serpentina* in Jammu and Kashmir. *Indian Forester*, **85**(4): 233-236.

Sundriyal M. and Sundriyal R.C. (2001). Seed germination and response of stem cuttings to hormonal treatment in six priority wild edible fruit species of Sikkim Himalaya. *Indian Forester*, **127**(6): 695-706.

Surendran T. (2014). Vegetative propagation of selected medicinal plants for enrichment of resources. KFRI Research Report No: 489, KFRI, Peechi, Thrissur, Kerala.

Talukdar A.L., Mannan A.M., Nijhu R.S. and Khatun A. (2021). (*Casearia tomentosa* Roxb: A comprehensive review on botany, traditional uses, phytochemistry and pharmacology. *Journal of Pharmacognosy and Phytochemistry*, **10**(5): 108-110

Tewary D.K., Vasudevan P. and Santosh. (2004). Effect of plant growth regulators on vegetative propagation of *Vitex negundo* L. (Verbenaceae). *Indian Forester*, **130**(1): 45-52.

Thatoi H.N., Mishra P.K., Ouseph A. and Acharjyo L.N. (2000). Rooting of stem cuttings of *Cerbera manghas* (L.) and *Merope angulata* (Kurz) Swingle through application of growth regulators: A tool for conservation of endangered Mangroves. *Indian Forester*, **126**(9): 985-992.

Tiwari R.K.S., Ojha B.M., Shambharkar V.B., Singh V. and Rajput M.L. (2007). A study on the performance of *in vitro* and *in vivo* germination of propagatory materials of certain medicinal plants. *Indian Forester,* **133**(7): 979-985.

Tiwari U.K.L., Adhikari B.S. and Rawat G.S. (2012). A checklist of Berberidaceae in Uttarakhand, Western Himalaya, India. *Check List*, **8**(4): 610–616.

Tomar A. and Kumar D. (2020). Propagation of *Mahonia jaunsarensis* from divergent sites of Chakrata Hills. *Indian Forester,* **146**(12): 1181-1182.

Troup R.S. (1921). The silviculture of Indian Trees, Volume- I to III. Oxford at the Clarendon Press.

Verma V.P.S and Sharma B.K. (1978). A note on method of propagation of *Costus speciosus* (Koen.) SM. *Indian Forester*, **104**(10): 703-705.

Wani M.A. (2018). Rooting response of hardwood stem cuttings of Juniper to exogenous hormone treatment. *Indian Forester,* **144**(12): 1179-1187.