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GUIDELINES FOR TESTING AND RELEASING OF VARIETIES AND CLONES OF FORESTRY SPECIES



**INDIAN COUNCIL OF FORESTRY
RESEARCH AND EDUCATION**

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**Approved by Director General, ICFRE in the
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Brief Background

The guidelines for testing and releasing of tree varieties and clones were approved in 2008 by Ministry of Environment, Forest and Climate Change, Govt. of India vide its letter no. F. No. 1-19/2008-RT dated 4th November 2008. This is first revision of the guidelines that were approved in 2008. The revised guidelines are approved by Director General, ICFRE with due consent of MoEF&CC, New Delhi vide their letter no. 1-13/2013-RT dated 10.09.2021.

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GUIDELINES FOR TESTING AND RELEASING OF TREE VARIETIES AND CLONES OF FORESTRY SPECIES

DEFINITIONS

- Clone** : The genetically uniform individuals (ramets) propagated vegetatively from a single sexually produced individual (ortet)
- Clonal test** : A field planting of 'several to many' clones to estimate relative performance of different genotypes (clones), but not necessarily provide information on breeding behavior
- Entry** : A newly developed line / strain / clone included for genetic evaluation in the multi-location trials
- Gene Bank** : Large collection of germplasm representing materials from various parts of the world for long term genetic improvement programme
- Genotype** : The specific set of genes possessed by an individual, both expressed and recessive
- Genotypic X Environmental interactions** : Changes in rank or levels of performance among individuals when tested in different environments through clonal and progeny trials
- Germplasm** : All materials produced by sexual and asexual means used for plant production
- Mass selection** : Breeding method whereby seed from a number of individuals is selected to form the next generation
- Population improvement** : Improvement of random mating population through a scheme of selection with or without progeny tests. It is essential to keep inbreeding to a low level
- Progeny test** : A test in which the breeding values of the parents are evaluated and ranked on the basis of the performance of their offspring
- Provenance** : The geographic origin of population, mostly of the ultimate natural origin, implying where the population evolved prior to human intervention
- Pure line** : Progeny of a single homozygous self-pollinated plant
- Ramet** : An individual vegetative propagule of an ortet called ramet.
- Recurrent selection** : In cross-pollinated populations, scheme of selection (on the basis of phenotype or progeny tests) followed by inter-mating (in all combinations) of the selected plants or their selected progeny to produce the population for the next cycle of selection. In this kind of selection, more than one cycle of selection is practiced
- Trait or character** : A distinctive but not necessarily invariable feature exhibited by all individuals of a group and capable of being described or measured. A character of a given individual will have a certain phenotype as determined by the individual's genotype and environment

Variety : A distinctive seedling population of trees, bamboo and medicinal plants, usually that possesses enough desirable characteristics to be commonly cultivated. Though in agriculture and horticulture all the plants with in a variety are usually quite uniform genetically, in forestry the variability within a variety is much greater.

ABBREVIATIONS

AMMI	:	Additive Main effects and Multiplicative Interactions
AIVTC	:	All India Variety Testing Committee
DUS	:	Distinctness Uniformity and Stability
FDCs	:	Forest Development Corporations
GDP	:	Gross Domestic Product
ICAR	:	Indian Council of Agriculture Research
ICFRE	:	Indian Council of Forestry Research & Education
IPRs	:	Intellectual Property Rights
MAI	:	Mean Annual Increment
MLT	:	Multi Location Trial
MoEF&CC	:	Ministry of Environment Forest & Climate Change
NBSS& LUP	:	National Bureau of Soil Survey and Land Use Planning
NDC	:	Nationally Determined Contributions
OFT	:	On Farm Test
PPV&FRA	:	Protection of Plant Varieties and Farmers' Rights Authority
RVTC	:	Regional Variety Testing Committee
SFDs	:	State Forest Departments
ToF	:	Trees outside the Forest
VRC	:	Variety Releasing Committee

1. INTRODUCTION

India is a wood deficient country. Although the per capita consumption of wood and wood products are among the lowest in the country, the demand is high due to a large population and the rapid economic progress made during the last two decades (Shrivastava and Saxena, 2017). In India, bulk of wood production now comes from trees outside forests (ToFs) covering an area of around 9.13 million ha, which is 2.70 % of geographical area of the country (Anonymous, 2015). According to State of Forest Report (Anonymous 2019) total forest and tree cover in India has increased to over 8,021 sq km, which is 24.93 % total forest cover of the country. The domestic production is unable to fulfill the need which is limited by many factors. India's forests have the lowest productivity $0.45 \text{ m}^3 \text{ ha}^{-1} \text{ year}^{-1}$ compared to the world average of $2.1 \text{ m}^3 \text{ ha}^{-1} \text{ year}^{-1}$. Similarly forest plantations also have low productivity of $0.77 \text{ m}^3 \text{ ha}^{-1} \text{ year}^{-1}$. The per capita forest area is 0.06 ha which is just one-tenth of the world average (Shrivastava and Saxena, 2017).

The current policy of forest management is not to use the natural forests for any commercial extraction of wood and timber and their demand to be entirely produced outside the forests. The total wood production in the country during 2015 is 456 million m^3 of which wood produced from natural forests is a meager 1.25 million m^3 . Major portion of wood produced is used as fuel wood for meeting domestic energy needs (Shrivastava and Saxena, 2017). The total timber and allied (pulp, ply) wood production is 71 million m^3 and around 18 million m^3 is imported (25%) which is worth USD 6.7 billion to meet the gap in the demand. The import projection for 2030 is 31.5 million m^3 (Shrivastava and Saxena, 2017).

There are new requirements like creating carbon sinks to fight climate change events. India is committed to meet the Nationally Determined Contributions (NDC) of 2.5 to 3 billion tonnes of additional carbon sinks by 2030 under Paris Agreement, 2015. Out of this NDC, 1.92 billion tonnes will be met from natural forests and the rest from Trees outside the Forest (ToF). Considering the international commitments and the necessity to meet the domestic demand of 153 million m^3 of timber and wood by the year 2020, it is essential that the productivity of forestry plantations are enhanced both in terms of quantity of wood and its quality (Gera, 2019).

There is a limitation to extract wood for industrial purposes from natural forests. In fact, just about 3.18 % wood for industrial purposes supplied by the natural forests and large proportion is either supplied from trees outside forests (ToFs) or imported (Shrivastava and Saxena (2017)). The productivity of ToFs can be enhanced by cultivating promising fast growing short rotation genetically improved planting stock. The country ranks first in the extent of plantation area for Eucalyptus (3 million ha), Teak (2.6 million ha) and Casuarina (0.8 million ha) and another 1-2 million ha of plantations of other tree species (ICFRE 2019). According to Shrivastava and Saxena (2017) during 2016 out of total industrial timber requirements of 70.90 million m^3 , plantation forests alone supplied 44.34 million m^3 of wood and rest was supplied from other sources including natural forests (1.205 million m^3), Forest Development Corporations (1.97 million m^3), bamboos (5.38 million m^3) and imports (18.01 million m^3). Ironically, fuelwood consumption was

recorded to as high as 385.25 million m³, which calculated to about more than 88 % of total estimated wood consumption. All above mentioned facts indicate utmost necessity to increase productivity of tree plantations to meet future demand for wood and wood products as well as environmental services.

2. GENETIC IMPROVEMENT AND DEVELOPING TREE VARIETIES

Tree improvement which combines application of breeding and silvicultural techniques has been successfully undertaken for different tree species throughout the world. Genetic improvement through selection and breeding is aimed at developing varieties possessing a high level of adaptability, fast growth, tolerance / resistance to biotic and abiotic stresses and superiority in any specific economically important trait for which the species is grown in plantations. Since trees have long gestation period, the breeding cycle is also long due to which the tree varieties available for planting is less compared to that of agricultural crops.

Despite the difficulties faced in tree breeding, a number of divergent lines have been developed for *Eucalyptus tereticornis* (Ginwal *et al.*, 2004), *Eucalyptus camaldulensis* (Verma *et al.*, 1994; Vargese *et al.*, 2008), *Casuarina* (Kumar and Gurumurthi, 2003; Nicodemus, 2020), *Tectona grandis* (Dakshindas and Gogate, 1995), *Gmelina arborea* (Kumar, 2007, Kumar *et al.*, 2003), *Populus deltoides* (Jones and Lal, 1989) and are being used in breeding and tree improvement. Since all these species are cross pollinated, varieties are developed as vegetatively propagated clones. Clones ensure capturing of both additive and non-additive genetic variation and help in raising plantation with uniform growth and wood properties.

Eucalyptus and poplars are the most popular forestry species that have been extensively planted as clones (Chandra, 1998; Lal, 1998, 2014; Vikas, 2016; Chander, 2017). Clonal plantations increased overall wood production in plantations, increased the quality of wood and brought down the rotation period. They substantially enhanced income to farmers, secured raw material availability to paper, plywood and match wood industries and provided livelihood to nursery operators in rural areas. The major difficulty faced in the production and distribution of these clones was lack of common identity to different clones planted. Since there was no mechanism of evaluation and approval of the new varieties developed, the same clone was propagated and supplied with different names depriving the growers the assurance of planting the most suitable variety. It severely hampered the control measures when Eucalyptus plantations were affected by the gall wasp epidemic. The relative resistance / susceptibility of different clones could not be clearly established to arrive at decisions on clones that have to be avoided in plantations. Further, a well established procedure for releasing of new varieties is essential to determine the intellectual property rights of breeders and the organizations that invested resources for developing such varieties. The enactment of Protection of Plant Varieties and Farmers Rights Act in 2001 further necessitated to strengthen the varietal development and protection of IPR in the forestry sector.

3. VARIETIES/CLONES RELEASED (TILL 2020) THROUGH APPROVED GUIDELINES

A set of guidelines were developed to systematically conduct the testing and release of new varieties and clones by ICFRE in the year 2008 and the same were duly approved by then Ministry of Environment and Forest, Govt. of India vide its letter no. F.No. 1-19/2008-RT dated 4th November 2008. These procedures in the guidelines served well to facilitate release of new varieties and clones during the past decade. So far 47 clones and varieties of different species developed by various Institutes have been released by ICFRE. These new clones/ varieties belong to *Casuarina* (19), *Eucalyptus* (15), *Dalbergia sissoo* (1), *Melia dubia* (10) and *Rauwolfia serpentina* (2) (Table 1).

Table1. Tree varieties/ clones released so far by adopting the guidelines of 2008

Sl No.	Species	No. of clones released	Year of release	Name of clones/varieties	Characteristic Features	Region
1	<i>Casuarina equisetifolia</i> #	4	2010	IFGTB-CE1 IFGTB-CE2 IFGTB-CE3 IFGTB-CE4	Fast growth Straight stems	State of Tamilnadu, Karnataka and union territory of Puducherry
		3	2014	IFGTB-CE5 IFGTB-CE6 IFGTB-CE7	Adaptability to sodic soils	Peninsular India (Southern States and Union territory of Puducherry)
2	<i>Casuarina junghuhniana</i> #	2	2014	IFGTB-CJ9 IFGTB-CJ10	Fast growth, straight stem, drought tolerance	Peninsular India (Southern States and Union territory of Puducherry)
		5	2014	IFGTB-WBC-1 IFGTB-WBC-2 IFGTB-WBC-3 IFGTB-WBC-4 IFGTB-WBC-5	Suitability to windbreak agroforestry	Peninsular India (Southern States and Union territory of Puducherry)
3	<i>Casuarina</i> hybrid# (<i>C. equisetifolia</i> x <i>C. junghuhniana</i>)	5	2017	IFGTB-CH1 IFGTB-CH2 IFGTB-CH3 IFGTB-CH4 IFGTB-CH5	Fast growth, straight stem, drought tolerance	South India

4	<i>Dalbergia sisoo</i> #	1	2011	FRI-DS-014	Fast growth and tolerance to <i>Fusarium solani</i> causing dieback	In Northern India
5	<i>Eucalyptus camaldulensis</i> #	4	2010	IFGTB-EC1 IFGTB-EC2 IFGTB-EC3 IFGTB-EC4	Fast growth	States of Tamil Nadu and Andhra Pradesh
		7	2014	IFGTB-EC5 IFGTB-EC6 IFGTB-EC7 IFGTB-EC8 IFGTB-EC9 IFGTB-EC10 IFGTB-EC11	Fast growth, tolerance to gall infestation	Peninsular India (Southern States and Union territory of Puducherry)
6	<i>Eucalyptus tereticornis</i> #	3	2017	FRI-ET-31, FRI-ET-32, FRI-ET-35,	Fast growth	Northern India
7	<i>Eucalyptus</i> hybrid# (<i>Eucalyptus camaldulensis</i> x <i>E. tereticornis</i>)	1	2011	FRI-EH-001	Fast growth	Northern India
8	<i>Melia dubia</i> Cav. *	10	2017	FRI-MD-032, FRI-MD-075, FRI-MD-231, FRI-MD-232, FRI-MD-235, FRI-MD-241, FRI-MD-256, FRI-MD-261, FRI-MD-262, FRI-MD-349	Fast growth	Northern India
9	<i>Rauvolfia serpentina</i> * (a perennial medicinal shrub)	2	2017	TFRI-RS-1 TFRI-RS-2	Higher root yield and Reserpine content	Central India

Clones, * Variety

Many of these new varieties/clones are now widely planted by farmers, forest departments, forest development corporations and wood based industries. Some of the varieties/clones have been licensed to industries and private nurseries for commercial propagation and supply to the tree growers. The licensing to commercial organizations located at different parts of the country ensures the large scale multiplication and supply of the new varieties/clones to farmers and other tree growers leading to increase in the area of cultivation. It is estimated that around

50,000 ha have been planted with the new varieties during the last five years, which is expected to double in the next two years. As per the current policy on IPR management in ICFRE, a portion of the royalty earned through commercialization of new varieties is ploughed to further the varietal development so that more superior varieties will be developed to replace the currently planted ones.

4. RATIONALE AND SCOPE OF REVISED GUIDELINES

The existing guidelines served well to release 47 varieties/clones of nine taxa possessing different adaptability and end-use characters and suitable for planting in different parts of the country during the period from 2010 to 2017. The experience gained through the functioning of Implementation Team, Regional Variety Testing Committees and observations made by Members of Variety Releasing Committees show that the guidelines have to be suitably modified to make them up to date and capable of servicing to the current and future needs of varietal release. In particular the following aspects were considered to revise the existing guidelines.

- (i) Extending the scope of the guidelines to various types of forestry species to include trees, shrubs, medicinal plants and bamboos.
- (ii) To effect changes in the agroclimatic regions of the country and jurisdictional States assigned to different ICFRE Institutes particularly to those established after the formulation of 2008 guidelines.
- (iii) To make suitable changes in the composition of various team /committees to ensure representation of all stakeholders
- (iv) To update the technical requirements of varietal testing by breeders and to set benchmarks wherever possible for the new varieties proposed to be released.

A Committee constituted by Director General, ICFRE has studied the existing guidelines and consulted all those engaged in varietal development of various species in different Institutes and proposed appropriate changes in the guidelines. The revised guidelines will be adopted for the purpose of varietal testing from 2021. All the ongoing testing programmes which were begun before 2021 will be governed by the 2008 guidelines for the purpose of release. These guidelines will be applicable for the testing and releasing of varieties and clones of forestry species including trees, bamboo, shrubs and medicinal plants.

5. PROCEDURE FOR TESTING AND RELEASING OF VARIETIES AND CLONES OF FORESTRY SPECIES

5.1 Testing Committees

To facilitate the identification and screening of elite genotypes, it is imperative that entire procedure is institutionalized to ensure a time bound schedule of operations. The programme may be carried out jointly by the researchers, foresters and forest based industries through Regional and All India Coordinated Trials. It is thus, proposed to constitute the Regional Variety Testing Committees (RVTCs) and All India Variety Testing Committees (AIVTCs) for uniform testing of selected genotypes in the following manner:

5.1.1 Regional Variety Testing Committee (RVTC)

The institutes of the ICFRE may operate the RVTC for a particular location. The RVTC will consist of one Chairperson, seven Expert Members and a Member Secretary. The tenure of the members will be for a period of two years from the date of notification of constituting the RVTC. This Committee will be constituted by the Director of the Institute in consultation with the Deputy Director General (Research), Indian Council of Forestry Research and Education (ICFRE) and approved by Director General, ICFRE with the composition provided in Table 2.

Table 2. Composition of Regional Variety Testing Committee (RVTC)

S. No.	Position in RVTC	Affiliated Organization
1	Chairperson	Director, Institute of the ICFRE
2	Members (7)	<ul style="list-style-type: none">• Coordinator, Implementation Team• Two subject experts of relevant field other than ICFRE and MoEF&CC,• Four Members from the State Forest Departments (SFDs'), Forest Development Corporations (FDCs'), State Universities, ICAR and other Research Institutions, Wood-based Industries and progressive farmers
3	Member Secretary	Head of the Division of Genetics and Tree Improvement of the ICFRE Institute

5.1.2 All India Variety Testing Committee (AIVTC)

AIVTC will consider proposals for all India release of varieties that were recommended by three or more RVTCs. It will be headed by a Chairperson who is assisted by seven expert Members and a Member Secretary. The tenure of the members will be for a period of two years from the date of notification of constituting the AIVTC. The Director General, ICFRE will be the Chairperson of AIVTC and the Deputy Director General (Research), ICFRE will function as the Member Secretary for AIVTC. The Chairpersons of RVTCs' will be the members of AIVTC on rotation. The committee will be approved by Director General, ICFRE. The composition of the committee will be as given in Table 3.

Table 3. Composition of All India Variety Testing Committee (AIVTC)

S. No.	Position in AIVTC	Affiliated Organization
1	Chairperson	Director General, ICFRE
2	Members (7)	<ul style="list-style-type: none">• Two subject experts from other than ICFRE and MoEF&CC• Three Chairpersons of the Regional Variety Testing Committee• Two ICFRE experts of relevant field
3	Member Secretary	Deputy Director General (Research), ICFRE

5.2 Administrative Regions

In different agro-climatic regions, the soil and climatic conditions show a large variation. On the basis of these variations, the National Bureau of Soil Survey and Land Use Planning, Nagpur (NBSS&LUP) has identified twenty agro-ecological regions in India. It is proposed to make nine administrative jurisdiction of RVTC based on twenty agro-ecological regions and forest types (Table 4 and Fig. 1).

Table 4. Administrative regions for the testing of planting stock

RVTC Zones	Name of the Institute	States/Union Territories	Forest Types	Agro-ecological regions*		
				No	Map unit	Physiography
I.	Himalayan Forest Research Institute, Shimla	Himachal Pradesh, Jammu & Kashmir, Ladakh	Subtropical Pine Himalayan Moist Temperate Himalayan Dry Temperate Sub-Alpine and Alpine	1 14	A13E1 A13C(B)3(6)	Western Himalayas (Cold arid) Western Himalayas (Warm Subhumid)
II.	Forest Research Institute, Dehradun	Chandigarh, Delhi, Haryana, Punjab, Uttarakhand and Uttar Pradesh	Tropical Moist Deciduous Tropical Dry Deciduous Tropical Thorn Shivalik Sal Subtropical Pine Himalayan Moist Temperate Himalayan Dry Temperate Sub-Alpine and Alpine	4 2 6 11 14	N10D(C)2-3(4) M12E1(2) N8D(C)4(3) J3C4(3) A13C(B)3(6)	Northern Plain Western Plain Eastern Plateau Western Himalayas
III.	Arid Forest Research Institute, Jodhpur	Gujarat and Rajasthan	Tropical Dry Deciduous Tropical Thorn Sub-Tropical Broad Leaved Hill	2 5 7	M12E1(2) N9D3(2) K6D3(4-2)	Northern Plain Western Plain Deccan Plateau
IV.	Tropical Forest Research Institute, Jabalpur	Chhattisgarh, Maharashtra, Madhya Pradesh and Odisha	Tropical Wet Evergreen Tropical Semi Evergreen Tropical Moist Deciduous Tropical Dry Deciduous Tropical Thorn	5 7 20 10, 11 12, 19	K6D3(4-2) J6C4(3) N9D3(2) J3C4(3) J2C5(4) ST7C(B/A)4-5 K5D4-3	Deccan Plateau Eastern Plateau Northern Plain Deccan Plateau Eastern Coastal Plain Western Ghats
V.	Institute of Wood Science & Technology, Bangalore	Goa and Karnataka	Tropical Wet Evergreen Forests Tropical Semi-Evergreen Forests Tropical Moist Deciduous Forests Tropical Dry Deciduous Forests Tropical Thorn Forests Subtropical Broadleaved Hill Forests Montane Wet Temperate Forest Littoral and Swamp Forests	3 7 8 9 20	E2B-A(C)6(5) K6D3(4-2) KID4(5) K5E2 K5D4-3	Western Ghats Deccan Plateau

VI.	Institute of Forest Genetics & Tree Breeding, Coimbatore	Andaman Tamil Nadu	Tropical Wet Evergreen Tropical Moist Deciduous Tropical Dry Deciduous Tropical Thorn Tropical Dry Evergreen	9 19 20	E2B-A(C)6(5) KID4(5) ST7C(B/A) 4-5	Western Ghats Deccan Plateau Eastern Coastal Plain and Island of Andaman and Nicobar
VII.	Institute of Forest Productivity, Ranchi	Bihar, Jharkhand, and West Bengal	Tropical Semi Evergreen Tropical Moist Deciduous Tropical Dry Deciduous Littoral and Swamp	11 12 13 15 16 6,19	N8C5(4) J3C4(3) O8C5(6) J2C5(4) ST7C(B/A) 4-5 Q8B(A)6 N8D(C)4(3)	Northern Plain Eastern Plateau Eastern Plain Northern Plain Eastern Coastal Plain Assam and Bengal Plain
VIII.	Rain Forest Research Institute, Jorhat	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura	Tropical Wet Evergreen Tropical Semi Evergreen Tropical Moist Deciduous Subtropical Pine Montane Wet Temperate Sub-Alpine and Alpine Sub-Tropical Broad Leaved Hill	16 17 18	C13-1A6 Q8B(A)6 D3A6	Eastern Himalayas Assam and Bengal Plain North-Eastern Hills
IX.	Institute of Forest Biodiversity Hyderabad	Andhra Pradesh and Telangana	Tropical Moist Deciduous Forests, Tropical Dry Deciduous Forests, Tropical Thorn Forests, Littoral and Swamp Forests, Tropical Dry Evergreen Forests.	3 8 9 19	K5D4-3 ST7C(B/A) 4-5 KID4(5) K5E2	Deccan Plateau Eastern Coastal Plain

* NBSS&LUP (2015)

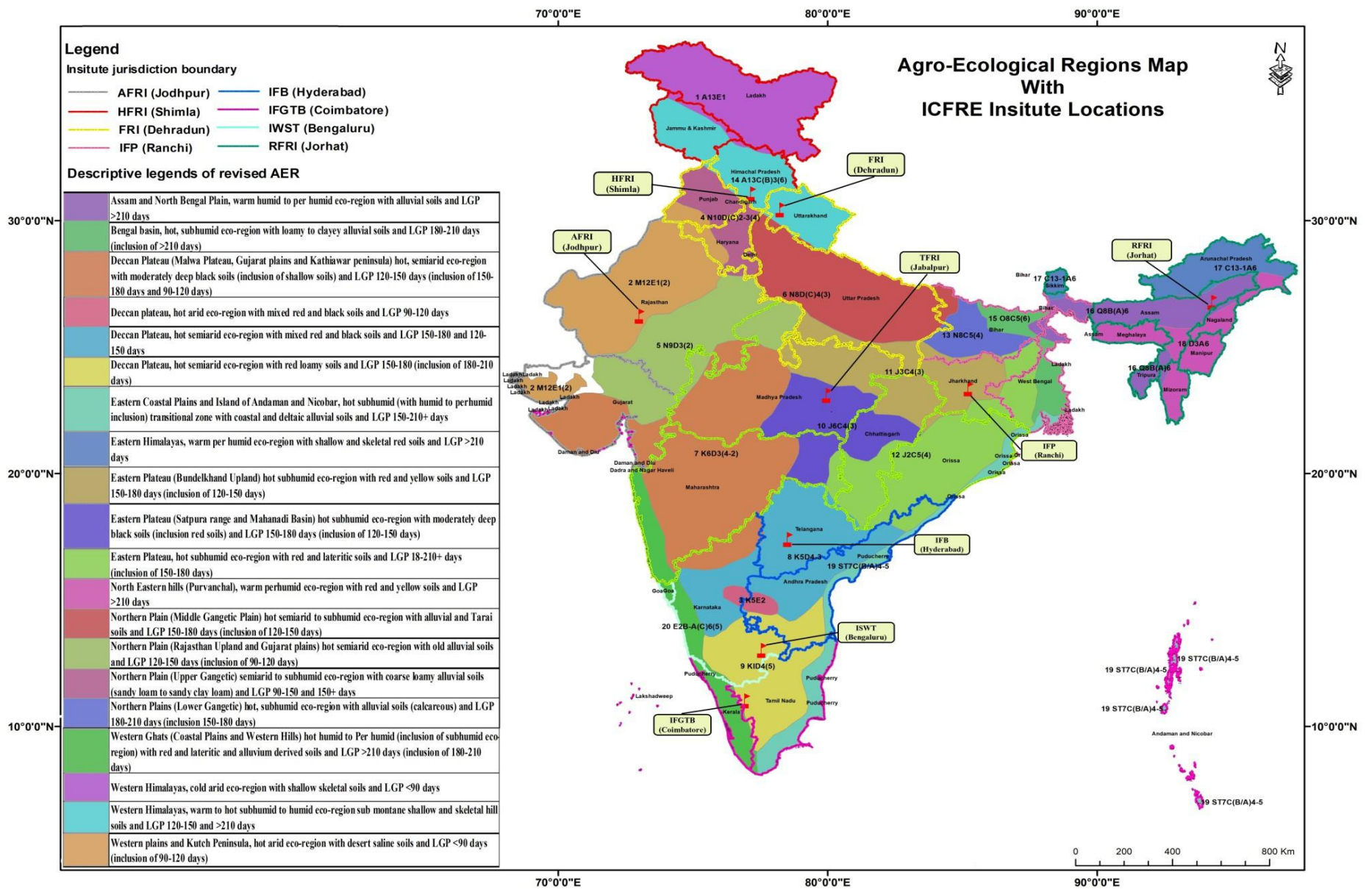


Fig. 1 Nine testing regions of India

5.3 Role of Committees in Varietal Testing

The superiority of various genotypes over checks /controls will be tested in different trials to be conducted at regional and all India basis. The genotypes showing promising results will then be recommended for release under proper name by the RVTC/AIVTC. The released genotypes need thereafter to be popularized through various extension activities (Fig. 2).

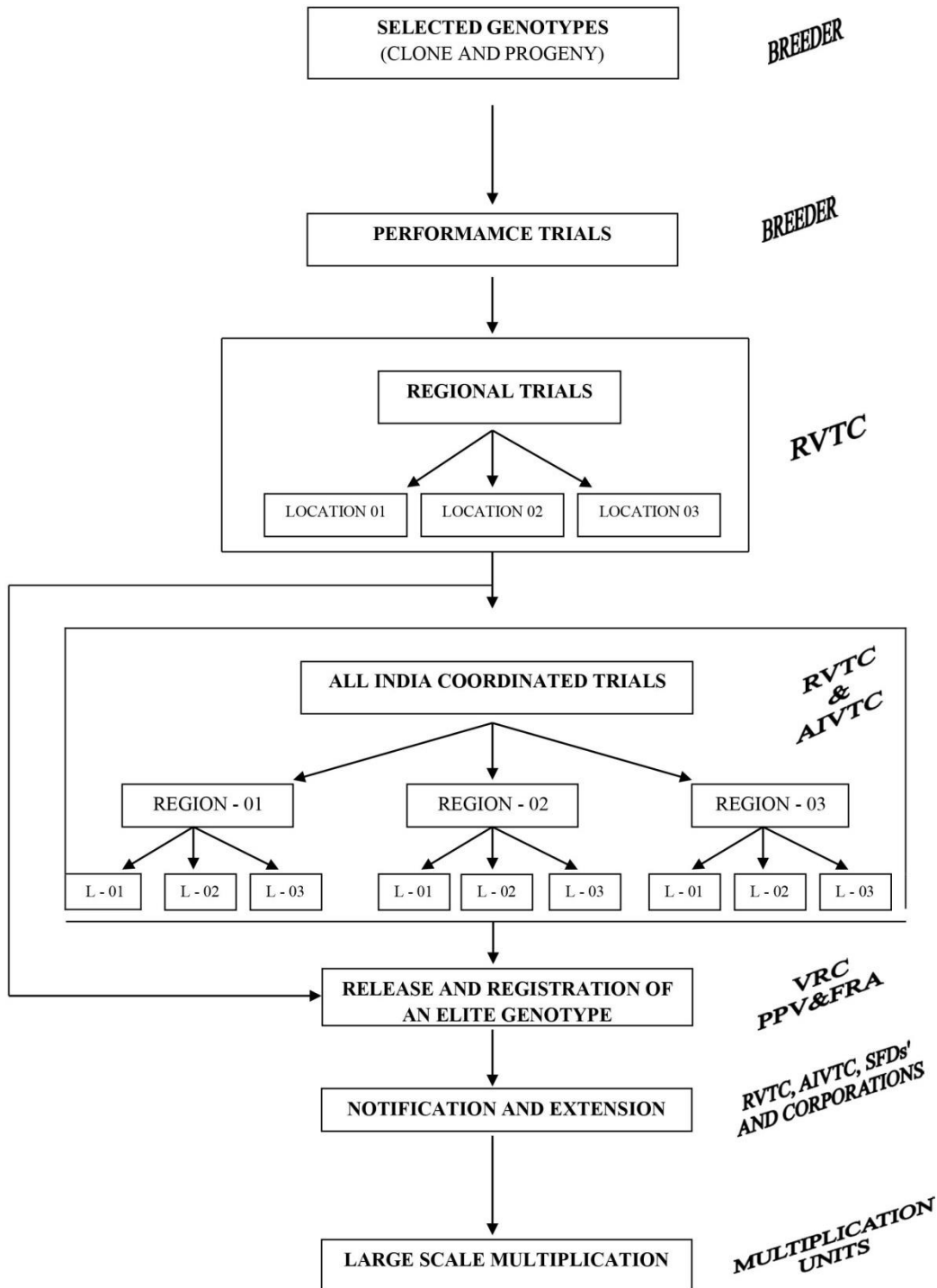
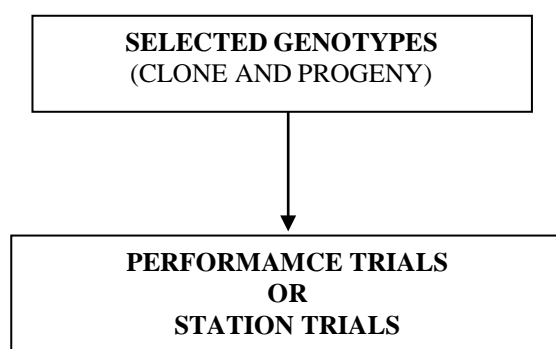


Fig. 2. Different steps in releasing an elite genotype for commercial production

5.3.1 Performance trials

The performance trials are conducted by the breeder/geneticists, who are in the process of development and screening of superior genotype(s). Through performance or breeder's trials superior performers are screened and identified and promoted for regional and All India Coordinated Trials. These trials are conducted at the discretion of breeder and geneticist. The entries for these trials should be selected with high selection intensity. Single tree selections must have been carried out at a minimum intensity of 1 in 1000 for a natural / plantation population or 1 in 100 within a breeding population.

Under these trials, entries are tested in an appropriate statistical design with a minimum of four replications (number of replications may be enhanced to five to six depending upon availability of resources). Uniform conditions are applied to all the entries strictly. All entries are assessed comparatively with check in appropriate spacing and other silvicultural practices. Checks may be selected from locally available planting material with the State Forest Department and nurseries. Yearly observations are collected from these entries and are analyzed and compared. The best performing entries are promoted to the regional trials.



5.3.2 Regional trials

The regional trials will be conducted under the supervision of RVTC to assess and evaluate the performance uniformly. The entries promoted from performance trials of different organizations will be laid out in a minimum of three locations of the region. It is however desirable to conduct testing in more than three locations if genetic resources permit particularly for those species which are under extensive cultivation. Testing in as many contrasting locations as possible strengthens the varietal selection process and also helps in accurate estimation of GxE interactions. If simultaneous testing of same varieties is taken in two or more regions, three trials per region will be accepted. As far as possible the locations of trials should fall in different agro-ecological zones of the areas where the species is widely cultivated for examining their superiority and adaptability in different soil and other environmental conditions. At regional level, all entries are to be tested in an appropriate statistical design with four or more replications adopting the spacing used in commercial plantations. There should be at least 25 surviving trees of a variety available in a trial at the time of final evaluation and ranking of varieties.

All the trials should have as many check / control accessions as possible but invariably the best clone / variety / seed source and an unimproved seed source of

the species should be included to assess the economic gains from the new varieties.

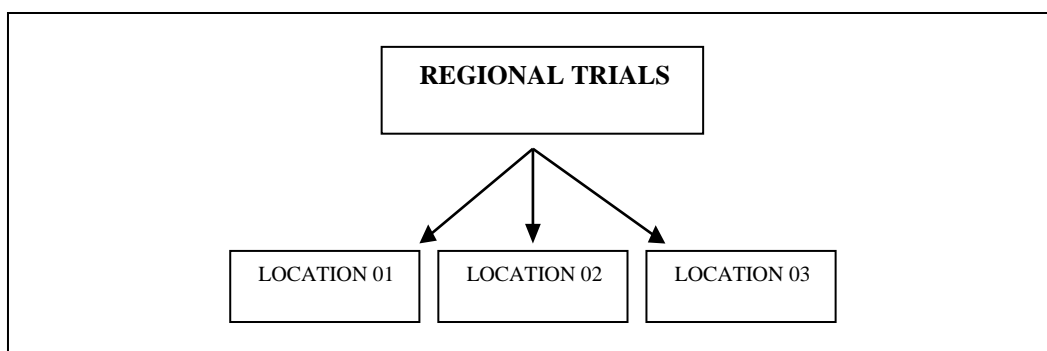
All the trials should be maintained by adopting standard silvicultural practices of the respective species. In order to rank the entries in the trial with high efficiency and to maintain uniform spacing within the trial, a high survival of 80% and above should be maintained.

The minimum duration of testing will be full rotation age for short rotation species (up to six years rotation), half rotation age for medium rotation species (10 to 15 years rotation) and 25% rotation age for long term species (rotation 20 years and above). Observations at yearly intervals are to be recorded on growth, adaptability and incidence of different pests and any other character(s) associated with the end use of the species.

In case of short rotation species which are under advance generation breeding and/or for which both seedling and clonal nursery techniques have been standardized, the clonal / varietal trials may be conducted in two stages. When the Regional Trials are at the half-rotation age, the best performing entries will be planted in On-Farm Tests (OFT) in different agroclimatic zones. Each entry will be planted in large plots of 36 trees or more in three replications to simulate plantation like conditions. The OFTs will be evaluated annually up to half rotation age and the results presented to support the ranking obtained from the Regional Trials while proposing release of varieties. The OFTs can be maintained as demonstration plots until full rotation age to popularize the released varieties.

A clone/seed source will be considered for release only if its performance is equal or superior to the already released clones/ commercially cultivated clone/improved seed source. In cases where multiple generations of breeding has already been undertaken (e.g. Casuarina and Eucalyptus), superiority of new varieties should be at least 10% over the benchmark variety for growth and /or any other economically important quantifiable character.

After tabulation and analysis, selected entries may be recommended for release at regional level or promoted to the All India Testing Trials under AIVTC. The breeders' trial could even be converted to one of the regional trials by RVTC to save time, manpower, and material.

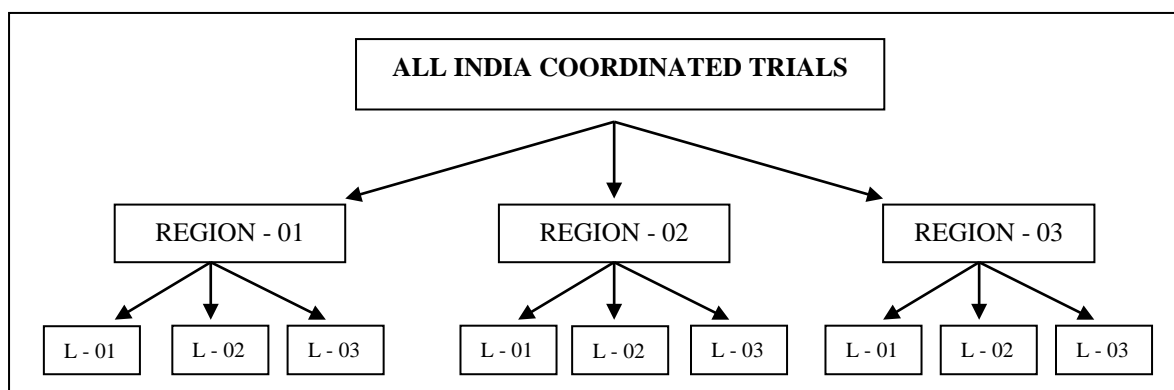


5.3.3 All India coordinated trials

These trials will be conducted under the supervision of AIVTC, and may be called multi-location trials (MLT). The entries in this trial may be restricted to the maximum of five from a single region shortlisted from regional trials. These trials will be conducted to select outstanding entries for the country through the evaluation of best regional entries. The AIVTC will receive entries from different RVTCs' annually. The entries received by AIVTC will be given uniform code for unbiased evaluation. Entries received during the year may become a set, to be evaluated in a minimum of three administrative regions of its distribution.

The AIVTC may provide design and observation sheet for MLTs. It is required to layout MLTs in a minimum of three locations of each of minimum three regions for wider evaluation. In these trials, an appropriate statistical design along with a check will be adopted. All operations are to be completed strictly within specified time frame in all the locations and regions. The planting design, silvicultural operations are to be followed as provided by AIVTC without any alterations.

The MLTs may continue for a minimum of prescribed period and yearly observations on growth, adaptability and incidence of different pests are to be recorded. Additionally, emphasis should also be given on advanced traits like wood properties and suitability for the industry. Top 1 to 5 entries may be recommended for release as a new variety(ies) / clone(s) in the annual workshop of AIVTC.



5.4 Evaluation and Inspection

5.4.1 Submission of entries

It will be the first step in the process of carrying out evaluation and testing of promising entries to be recommended for release and deployment at a commercial scale. The Principal Investigators and/or Co-investigators working on genetic improvement of a particular tree species, bamboo or medicinal plants will conduct breeders' / performance trials themselves. These trials will help in selecting some entries for promotion to the regional trials, to be conducted by the breeder himself using proper statistical design along with a check or control. The control used in this trial need to be the best genotype available in that particular species in the location

or region so that the entries with better performance than the control are selected for further testing.

The entries found promising at breeder / performance trial will be promoted to the RVTC of that particular region. The details of the entry along with the planting material in sufficient quantity should also to be supplied for the test. The entries to be tested along with their details are to be submitted to the Member Secretary, RVTC in a proforma attached as Annexure I. An entry (progeny / clone) will be tested under regional trial and all India trials only as per the preference / choice of the breeder / grower.

5.4.2 Experimental designs

Forestry experiments often require large areas, are usually of long duration and variations in the experimental material are high. Appropriate statistical techniques are required to address these issues. Such experiments cannot be designed using a thumb rule for all the locations/sites involving species with different growth rates and rotation periods. Considerations of plot size, availability of experimental material, shape of land, presence of biotic factors etc. affects the type of design that needs to be adopted for the experiment. All the more important is the analysis across sites to account for multi-location trials, which are inherent in any tree introduction programme. Techniques like bi-plot analysis, joint regression analysis and Additive Main effects and Multiplicative Interactions (AMMI) are available for analyzing data generated from multi-location trials. Stability and adaptability are equally important, as the investments in forestry practices are usually large and any deviation from a logical sequence is bound to affect the results or returns at a later stage.

Designs such as Alpha - designs (row - column designs), incomplete block designs, lattices designs etc., are available to design forest tree varietal trials. In case the numbers of varieties/clones are large, special designs that cover relatively less area and allow comparisons of all the pairs should be used. However, such issues can be addresses only after the details of experimental material, land availability for the experiment, spacing etc., are available. It is therefore, important to consult a statistician for proper designing of experiments and analysis of results.

5.4.3 Evaluation parameters

Though the parameters for evaluation under different trials, both for long and short rotation tree species will vary with species and the purpose for which it is being evaluated, a brief list of morphological parameters to be included for regional and all India trials could be as follows:

- Survival rate
- Height
- Clear bole height (for timber-yielding species)
- Diameter at breast height
- Stem straightness
- Self-pruning ability

- Branching habit
- Incidences of disease
- Incidences of major insects
- Mean annual increment and volume or biomass production
- Any other parameter specific to the species and its end use
(For bamboo and medicinal plants different set of parameters will be considered based on their commercial importance)

However, the list of parameters will change substantially with the type of species viz. trees, bamboo and medicinal plants, or when the end use is very specific. For example if a species (tree or bamboo) is being tested for the production of higher volume of wood and quality pulp then additional parameters needs to be included during the tests. Similar could be the case with medicinal plants whereby the bio-active principles along with the total yield will be main parameter for identification of suitable cultivar.

5.4.4 Timeframe

It is necessary that all the trials are evaluated at least once in a year from the first year. Since trees have a long gestation period continuous assessment of growth and other traits helps in understanding the behavior of different accessions under testing and select them for various purposes. The real testing process starts from the establishment of regional trials. It is suggested that for short rotation pulpwood tree crops like *Eucalyptus*, *Casuarina*, *Gmelina*, *Leucaena*, *Melia*, *bamboo* etc., the evaluation for growth traits may begin from first year and continue annually up to full rotation age (5-6 years). But *Gmelina* and *Melia* varieties are released for plywood / timber a little longer rotation period should be considered and thereby the final evaluation should be at least at the half-rotation age of 7-8 years. The minimum period of evaluation for long-term timber trees should be 25% of the lowest rotation period practiced by the Forest Department / Forest Development Corporation. Evaluation for specific traits like timber quality and pulp yield should start only after quarter or half of the rotation age.

5.5 Implementation Team

Once the entries to be tested are finalized and coded, the planting material will be supplied to the implementation team for the establishment of trials in the fields. The trials established by breeder can also be considered as evaluation trials by the Implementation Team. The Implementation Team will visit the trials periodically and will ensure data recording and updating of plantation registers etc. The team will inspect the growth trends and other valuable parameters for proper interpretation. The team will also ensure that uniform inputs are provided as far as possible to all the trials over the locations and durations.

The Implementation Team will meet and undertake field visits normally once in a year. Based on requests received from the Principal Investigators, the team members will visit test plots, verify the interim rankings and interact with the PIs.

Based on the rankings of entries in the tests which attained the age of 25% of testing period, team will recommend a 'Long List' of clones / varieties which normally will not exceed 20% of total entries in the test. These clones must be invariably included in any test established later. A 'Short List' of clones will be recommended by the Team based on ranking at an age of half the testing period which will normally not exceed 10 % of the total entries in the test.

If the varieties under testing are clones, those clones included in the 'Short List' will be subjected to rooting experiments so that the clone-specific propagation techniques can be developed for large scale multiplication of the clone once it is released for commercial cultivation. They will also be studied for various properties with reference to the major end use(s) of the species. If necessary in-house projects will be sanctioned for a period of one year to undertake these studies so that the result are available at the time of final evaluation by the Implementation Team.

Only the short listed varieties should be deployed in On-Farm Tests (OFT) in case of short rotation species. They will have to be evaluated at least up to half- rotation period. The OFTs can directly be taken by breeders or in collaboration with Forest Departments and Industries. In case of collaboration, Material Transfer Agreement should be entered into between breeder and the Collaborator.

Based on ranking in the Regional Trials and performance in the on-farm trials, if any, the Implementation Team will prepare 'Final List' of varieties and submit to the RVTC for recommendation to the Variety Releasing Committee (VRC) for release. The Implementation Team will be approved by Deputy Director General (Research), ICFRE. Implementation Teams at regional and all India level will have the composition given in Table 5.

Table 5. Composition of Implementation Team

S. No.	Position in Implementation team*	Affiliated Organization
1	Coordinator	A tree breeder / geneticist / tree improvement expert of ICFRE Institute
2	Members (5)	<ul style="list-style-type: none"> • One subject expert from other than ICFRE & MoEF&CC, • Two tree breeders or geneticists of the institute(s) of ICFRE, of which one should be the species specialist • One forest statistician • One member from either State Forest Department (SFDs') or Forest Development Corporation (FDCs') or State University or Wood Based Industry

*Note : The Implementation Team will be provided sufficient support staff (contractual or regular) by the ICFRE institutes for effective execution of the ground level works

5.6 Evaluation Mechanism

The Implementation Team will also have the responsibility of the evaluation of the trial at periodic intervals and give its feedbacks to RVTC. In short rotation tree species like *Eucalyptus*, *Casuarina*, *Dalbergia*, *Gmelina* and others, it is recommended that implementation team starts inspection right from first year itself so that even the early trends are known. The team will ensure that all the entries are examined properly without any biasness.

5.7 Availability of Land for Testing

The regional and all India trials will be established in the land earmarked for this purpose. Member Secretary of RVTC in consultation with Director of concerned ICFRE institute shall get the suitable land earmarked for laying trails and ensure that the trails are not disturbed till their evaluation is over. This will be done in consultation with the breeders, where the entries are to be evaluated. The state forest departments should provide quality land for this purpose. When an industrial tree is being tested, various wood based industries and farmers may also be contacted for providing the required land through signing bipartite agreements (Memorandum of Understandings).

6. RELEASE OF ELITE VARIETIES (CLONE / PROGENY)

Elite entries (clones / progenies) identified by RVTC or AIVTC as new variety will be released in the annual workshop of the Variety Releasing Committee (VRC). In this workshop, the Principal and Associate Investigators of the project will be invited.

The proposal for release of identified variety is to be moved in a prescribed proforma by the Principal and Associate Investigators. The proforma and evaluation observations of MLTs at the stages of testing are to be supplied by the Principal and Associate Investigators. Subsequently, Principal and Associate Investigators may incorporate evaluation details of performance, Regional and All India Coordinated Trials in the prescribed proforma and submit to the variety releasing committee (VRC) in a stipulated time. The workshop may consider the proposal for release of variety if it records substantial superiority over the check with regard to yield and / or other traits of economic value. A variety / clone may also be considered for release if it is comparable to the check or control in yield and superior to other important characters like resistance to the pests.

The variety considered for release may be given proper name in consultation with Principal and Associate Investigators following proper procedure / guidelines. Further, they should be permitted for planting in demonstration trials, and multiplied on large scale.

6.1 Variety Releasing Committee (VRC)

The Director General of Forests & Special Secretary, Ministry of Environment Forests & Climate Change, Government of India will be Chairperson of the Variety Releasing Committee (VRC) and Director General, ICFRE will co-chair the VRC. There will be fourteen members and Deputy Director General (Research), ICFRE, as member secretary for the committee as detailed in Table 6. The committee will be approved by Director General of Forests & Special Secretary, MOEF&CC, New Delhi.

Table 6. Composition of Variety Releasing Committee

S. No.	Position in VRC	Affiliated Organization
1	Chairperson	Director General of Forests and Special Secretary
2	Co-Chairperson	Director General, ICFRE (Chairperson, AIVTC)
3	Members (9)	Chairpersons, RVTCs
4	Members (2)	Principal Chief Conservator of Forests (on rotation)
5	Members (2)	Two Specialists with outstanding contributions in the relevant field of genetics and breeding of trees/bamboos/ medicinal plant
6	Member (1)	Representative of bamboo/wood based industries/ or expert of the relevant field
7	Member Secretary	Deputy Director General (Research), ICFRE

The composition of committee can be revised as and when required and additional Members can be included as co-opted members depending on the nature of varieties (trees, medicinal plants and bamboo) submitted for release. The committee is to be formed such that it is broad based and represents states/regions for which clones/varieties are released. The tenure of the members will be for a period of two years from the date of notification of constituting the VRC. The proposal for release of a variety may be submitted by the Principal and Associate Investigators to the Member Secretary, Variety Releasing Committee at least six months in advance to the annual variety release workshop. The proposal may list all the details of identified variety (ies) / clones, its pedigree and methods used for its development.

The Member Secretary, Variety Releasing Committee may screen and scrutinize the proposal in consultation with the Chairperson for validation of the facts supplied in the proforma (Annexure II). The Principal and Co-Investigators may accordingly be informed for detailed presentation in the workshop.

ICFRE will maintain the record of the tested and released varieties in the form of register at ICFRE level, and an accession number will be allotted to the released variety / clone. A certificate for the released varieties will be issued by the Member Secretary, VRC to the concerned breeder/developer. Once the VRC finds a variety suitable for the release, it will issue the details of the variety as per proforma given in Annexure III.

6.2 Gazette Notification and Extension

Once a variety or a clone is released for large scale planting, systematic notification and extension may be carried out. The ICFRE will take necessary steps so that all the released varieties / clones are published in gazette of Government of India within a period of six months from the date of release. The process of notification shall be duly

supported/collaborated by Principal Investigator. The notification should clearly declare that that said varieties / clones can be grown/sold for purpose of agroforestry or medicinal plant or otherwise either in particular state(s) or whole of India, as the case may be.

These varieties further also need to be published in all forestry and related research journals and newspapers along with brief description. It will also appear in annual reports and newsletters so that end users are made aware about promising planting stock. It would be of immense use if the information is also placed on the website of ICFRE and the MoEF&CC.

Thereafter, proper extension programme to popularize the identified varieties / genotypes may be carried out vigorously. Advertisements in national and local newspapers and magazines in different languages, highlighting the advantages of the improved planting stock over unimproved stock, are followed regularly. Leaflets giving the details of identified varieties are to be prepared and distributed among the users. Besides, the print and electronic media need to be tapped wherever possible to derive maximum mileage. Regional and national workshops may also be held and researchers, forest officials / managers and wood based industries must be made aware of the improved planting stock and the economic benefits expected to be accrued. It would be appropriate if a notification from the MoEF&CC is released to make mandatory on the state forest departments that further plantations of that particular species will be carried out compulsorily with the released variety only.

6.3 Intellectual Property Rights

Individuals involved in selection of parent /clone /variety will get the credits for the parentage selection or clone selection. The individuals involved in the selection of each parent /clone must be recorded and communicated to the Implementation Team within a year. All the individuals involved in selection will get credit as Initial Breeder in the Certificate issued by ICFRE once the variety is released.

When varieties are tested at regional level, the individuals responsible for conduct of the regional level tests will be the Principal and Co-Investigators for the varieties released.

When varieties developed by different Institutions are exchanged and tested across different regions as part of MLT, any variety found superior in a particular region will be released by the concerned PI who conducted the test in that region. The Initial breeder(s) of the variety will get credit for all the regional or national release.

The varieties that qualify from three or more RVTC can be submitted to AIVTC for all India release. In such cases, the Initial Breeder (s) or PI of the Nodal Centre will become the PI for the All India release and all the PIs and Co-PIs of the regional release involved in the MLTs, irrespective of their regional release will get the credit.

6.4 Registration

The Intellectual Rights of the proposed / released variety need to be safeguarded through its registration with the Protection of Plant Varieties and Farmers' Right Authority, New Delhi (PPV&FRA). Once a variety has been proposed for its release on commercial scale, and the species has already been notified by the Authority, ICFRE must take necessary steps simultaneously for its registration. Principal and

Associate Investigators will furnish details of at least two stable morphological descriptors to ICFRE to facilitate registration of the released variety. The Principal and Co-Investigators will prepare a list of morphological descriptors for the selected and check / benchmark varieties. The descriptors should be based on the DUS characters notified by the Authority. In cases where the species has not been notified for registration, the ICFRE will approach PPV&FRA to initiate the process of development of DUS testing guidelines for that species so that the species gets notified for registration as early as possible.

6.5 Financial Implications

The described procedure of testing and releasing of tree varieties and clones is a technically essential component for enhancing the productivity and also an important step to protect the intellectual property rights of the forestry resources. It is therefore necessary to develop the required infrastructure and resources for testing and releasing of tree varieties and clones. The financial requirements to complete all the procedures in ICFRE institutes will be met by the concerned institute of ICFRE. For other organizations/individuals, ICFRE will charge nominal fee to test their new planting material. The tentative cost for testing and evaluation of different entries supplied by different organizations both at Regional and All India basis is provided in Table 7.

Table 7. Cost of testing varieties for different organizations and individuals

S. No.	Name of the organization	Cost of testing per location	
		Regional	All India
1	State Governments / autonomous and other Government R & D organisations	Rs. 50,000	Rs. 1,00,000
2	Commercial organization /industries	Rs. 1,00,000	Rs.2,00,000
3	Farmers	Rs. 5,000	Rs.20,000

7. CONCLUSION

The entire spectrum of testing and release operations will require about ten to fifteen years of research and extension work with constant monitoring. It is envisaged to obtain the cooperation of the agencies that stand to gain directly by the research findings. The wider canvas and systemization of the process of analysis and transfer of improved planting stock will help in bridging the gap between demand and supply of different woods. It may even be made mandatory that all the State Forest Department and State Forest Development Corporations use only improved planting stock in future plantation programme.

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ANNEXURE I

PROFORMA FOR SUBMISSION OF ENTRIES FOR TESTING AND RELEASE OF TREE VARIETIES AND CLONES TO THE INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION						
Name and address of Principal Investigator						
Name & address of Co-Investigators			1. 2. 3.			
GENERAL INFORMATION						
1.	Species name		2.	No. of entries		
3.	Pedigree of entry(ies)		4.	Method of development (selection, hybridization, etc.)		
5.	Date of supply		6.	Testing duration required		
7.	Locations recommended for testing		i. ii. iii.			
8.	Traits to be tested		i. ii. iii.			
TECHNICAL INFORMATION OF THE ENTRY(IES) BEING SUBMITTED						
Characters	PERFORMANCE IN BREEDERS & PERFORMANCE TRIALS (AGEWISE)					% SUPERIOR OVER CONTROL & AGE/STAGE
	1	2	3	4	5	
Survival rate						
Height						
DBH						
Clear bole height						
Collar diameter						
Straightness						
Crown diameter						
Crown shape						
Branching habit						
Pruning ability						
Flowering						
Fruiting						
Disease						
Insects						
Others						

Signature of the Investigators and head of organization

ANNEXURE II

MID-TERM EVALUATION PROFORMA					
INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION					
Name and address of the evaluator					
Name and address of other team members			1. 2.		
Date of evaluation/period of recording					
Design of experiment					
Other relevant details					
GENERAL INFORMATION					
1.	Date of planting		2.	Design of experiment	
3.	Species name		4.	Common name	
5.	Spacing of trial		6.	No. of entries	
7.	State		8.	Forest Division	
9.	Altitude		10.	Latitude	
11.	Longitude		12.	Temperature	
13.	Soil type		14.	Topography	
15.	Fertilizers		16.	Pit size	
a. Basal dose		b. Top dressing		17. Other silviculture practices	
i.		i.		i.	
ii.		ii.		ii.	
iii.		iii.			
TECHNICAL INFORMATION					
Characters		Static	PHOTOGRAPH OF THE TRIAL		
Survival rate					
Height (m)					
Diameter at breast height (cm)					
Clear bole height (m)					
Collar diameter (cm)					
Straightness					
Crown diameter (m)					
Crown shape					
Branching habit					
Pruning					
Flowering					
Fruiting					
Disease					
Insects					
Others					
STATISTICAL ANALYSIS AND OUTPUTS					
i. Analysis of variance					
ii. Analysis of different genetic tests					
iii. Adaptability analysis					
iv. Stability analysis					
v. Performance over the years and locations					
vi. Ranking of entries (traitwise)					
vii. Conclusion					

Signature of the evaluators

ANNEXURE III

PROFORMA FOR NOTIFICATION OF A VARIETY INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION		
1.	State / Region	
2.	Name of the species	
3.	Name of the variety under which released	
4.	Year of release	
	a. Parentage and details of the pedigree	
	b. Source of material	
	c. Breeding methods	
5.	General characteristics of the variety	
6.	Institute responsible for maintaining the breeding stock	
7.	Details description of the variety /hybrid. Please give minimum of two identifiable and distinguishable morphological characteristic of the variety and hybrid	
8.	Details of the resistance for disease, insects and other pests	
9.	Recommended silvicultural practices	
10.	Recommendation of the VRC on the basis of the workshop	
11.	Signature of the members of VRC	
	Member 1	Member 2
	Member 3	Member 4
	Member 5	Member 6
	Member 7	Member 8
	Member 9	Member 10
	Specialist 1	Specialist 2
	PCCF 1	PCCF 2
	Member Secretary	Co-Chairperson
	Chairperson	