



Technical Bulletin
CAFRI/2023/03

Agroforestry Research & Technologies for Farmers' Welfare

SALIENT ACHIEVEMENTS

CAFRI@35



ICAR-Central Agroforestry Research Institute

Krishivaniki Vihar, Jhansi 284003, Uttar Pradesh

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Citation

Arunachalam, A., Ramanan S.S. and Handa, A.K. (2023) Salient Achievements. Technical Bulletin CAFRI/2023/03, ICAR-Central Agroforestry Research Institute, Jhansi 284003, Uttar Pradesh, India; 43 p.

Technical Bulletin No.: CAFRI/2023/03

Year: 2023

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Acknowledgement:

The institute is a National Research Lab of Indian Council of Agricultural Research and is supported by several agencies such as ICRAF, CIFOR, ICRISAT, FAO, UNEP, NABARD, DST, DBT, NMPB, MANAGE, NRAA and other state agencies.

Published by:

Director
ICAR-Central Agroforestry Research Institute
Jhansi 284003, Uttar Pradesh, India

Printed at :

Classic Enterprises, Jhansi 284003, Uttar Pradesh, India
7007122381, 9415113108

FOREWORD



Agroforestry as a sustainable land-use system has the potential to meet our economic and ecological needs. The Indian Council of Agricultural Research has been proactive in this direction and established a dedicated Institute for agroforestry on the 8th May 1988 in Jhansi, Uttar Pradesh. I am delighted to commend the R&D initiatives and achievements of ICAR-Central Agroforestry Research Institute which is completing 35 years of its establishment on 8th May 2023. The institute has developed promising agroforestry models for different agroclimatic zones and has been able to deliver on to the requirement of the states through its All India Coordinated Research Project (AICRP) on Agroforestry. In particular, I appreciate the efforts of scientist colleagues of ICAR-CAFRI in bringing out this document enlisting 35 salient achievements as the institute completes its 35 years.

I am sure, the institute would continue its efforts further to commensurate the notification of the Ministry of Agriculture and Farmers; Welfare, Government of India as a Nodal Agency for agroforestry under RKVY for imparting technical support.

I congratulate the authors for bringing out this publication.

A handwritten signature in blue ink, appearing to read 'Rajbir Singh'.

(Rajbir Singh)
Assistant Director General
NRM Division, ICAR
New Delhi



Preface

Agroforestry as a land use practice owe its origin from beginning of human civilization. Trees and other woody perennials invariably important components of farming as practiced by all agrarian communities world over. Afforestation, reforestation and planting trees on agriculture landscape were considered as one of the best options of sustainable food production vis-à-vis environmental security. In India, organized research on agroforestry got initiated with the launch of an All India Coordinated Research Project (AICRP) on Agroforestry by the Indian Council of Agricultural Research (ICAR), New Delhi in 1983. This was institutionalised as a National Research Centre for Agroforestry (NRCAF) at Jhansi, Uttar Pradesh on 8 May, 1988. This institute is renamed as the ICAR-Central Agroforestry Research Institute. During the last thirty-five years, the institute has conducted basic, applied and strategic research on agroforestry through the network collaboration and external funded projects and demonstrated the technologies developed in farmers' field and disseminated relevant information through a series of training programmes, publications and consultancies to stakeholders including state departments, scientific organizations, social institutions and research scholars. This document gives an overview of its salient achievements in research, extension and human resource development in agroforestry.

- **Authors**



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ICAR-CAFRI



Overview of ICAR-CAFRI

ICAR-Central Agroforestry Research Institute (ICAR-CAFRI), formerly the National Research Centre for Agroforestry, is a multidisciplinary premier research institute of the Indian Council of Agricultural Research (ICAR) with a major focus on integrating trees, crops and livestock on the same farmland. The Institute is in Jhansi, Uttar Pradesh (25.5° N 78.5° E), India and has a total area of 254.859 acre. CAFRI is the only dedicated research institute of the country working on key research areas of agroforestry. CAFRI has developed robust agroforestry models and package of practices for different climatic conditions covering small and marginal farmers, and provides technical backstopping to the States and stakeholders.

History

- ICAR initiated a network project for organized agroforestry research in 1983 i.e., All India Coordinated Research Project on Agroforestry.
- The National Research Centre for Agroforestry (NRCAF), as a unit of ICAR was established on 8th May 1988.
- Renamed as Central Agroforestry Research Institute (CAFRI) on 1st December 2014.

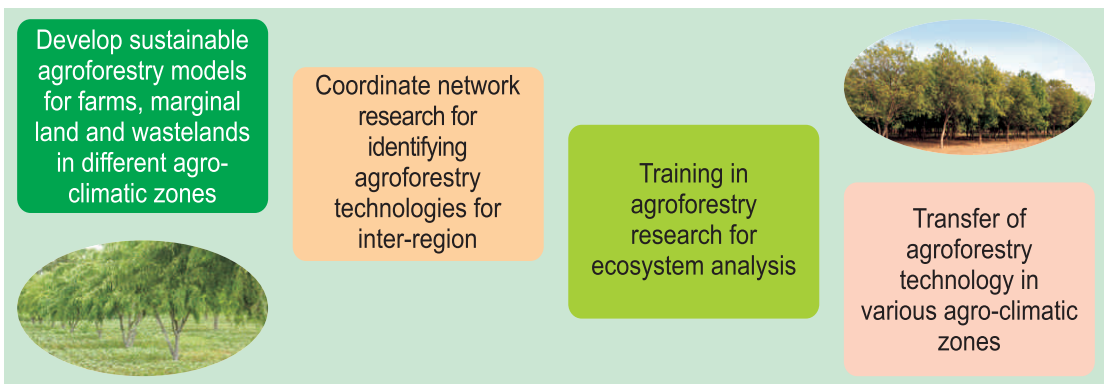
Vision

To improve the quality of life of rural people by integrating perennial crops in agricultural landscape for harnessing social, economic and environmental benefits.

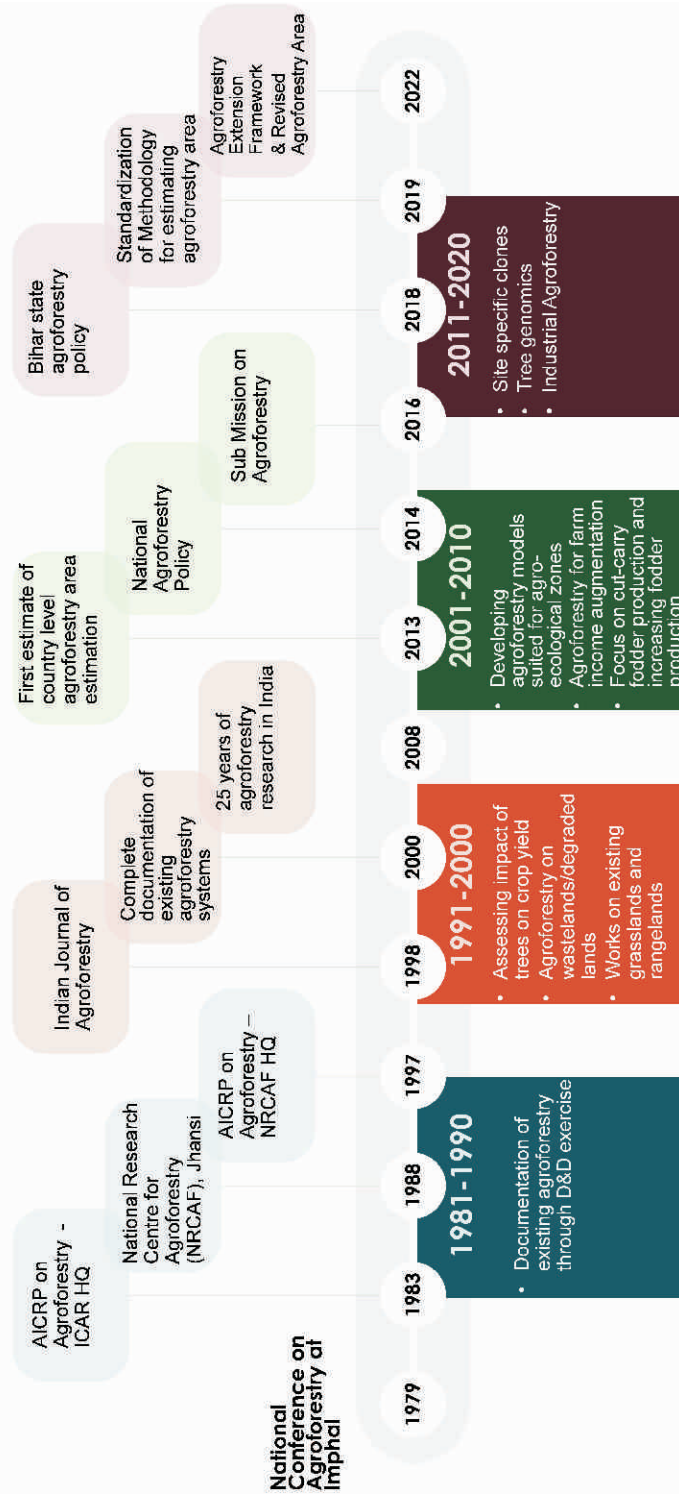
Mission

Integration of woody perennials in the farming system to improve land productivity through conservation of soils, nutrients and biodiversity by augmenting natural resource conservation, restoration of ecological balance, alleviation of poverty and mitigating risks of weather vagaries.

Our Mandate



Agroforestry Research Roadmap



Source: Ramanan *et al.* (2022)



Agroforestry Models and Technologies

Nursery technologies for quality planting material

The successful establishment of an agroforestry system depends on the quality of the planting material used by the farmers. Unlike agricultural crops and livestock component, there is a lack of quality planting material for most of the woody perennials preferred for agroforestry. In this regard, ICAR-CAFRI having working on standardization nursery as well as vegetative propagation techniques for some woody perennials like *Azadirachta indica*, *Dalbergia sissoo*, *Carissa carandas*, *Pongamia pinnata*, *Acacia nilotica*, *Phyllanthus emblica*, *Bambusa vulgaris*, etc.

The Institute has developed and transfer the following nursery technologies to farmers and other stakeholders.

- ❖ Air layering of neem
- ❖ Bench grafting in 'aonla'
- ❖ Bench grafting in Ber (*Zizyphus* spp.)
- ❖ Farmer-friendly technique to multiply *Bambusa vulgaris*
- ❖ Nursery techniques for *Pongamia pinnata*
- ❖ Stem cuttings and air layering of *Pongamia pinnata*
- ❖ Top Working of *Carissa* (wild karonda)

Bankable Agroforestry Models

Developing bankable agroforestry models is one of the mandates of the ICAR-CAFRI and the institute has developed models for the Bundelkhand region. Some of them are

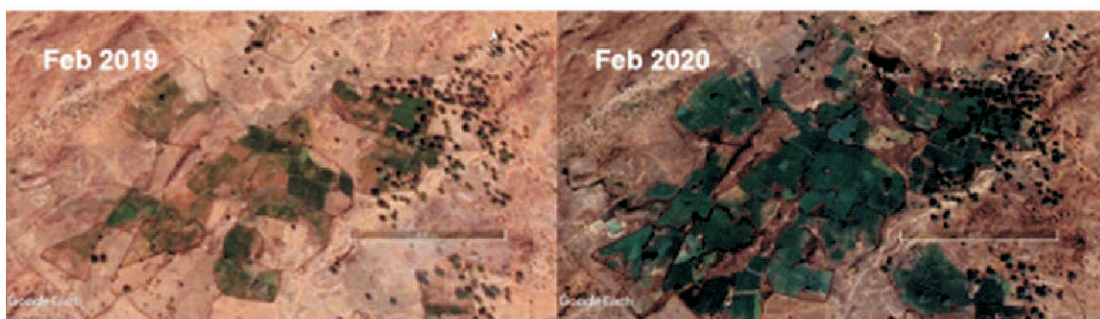
- ❖ Aonla-based agroforestry land use for rainfed conditions
- ❖ *Acacia senegal* based agroforestry
- ❖ Bamboo-based agroforestry models for six agroclimatic zones
- ❖ Bamboo (*Dendrocalamus strictus*) + Sesame (*Sesamum indicum*) based agroforestry model
- ❖ Eucalyptus-based agrisilviculture system
- ❖ *Acacia senegal* based bio-fence model
- ❖ Agave and 'henna' based live fencing systems for soil and water conservation



Acacia senegal
based
agroforestry

Agroforestry-based watershed management

Based on the success of agroforestry-based watershed management in Parasai-Sindh and Garhkundar-Dabar Watersheds in Bundelkhand Region, the institute has transformed the rural livelihood of 22 Villages; 24000 households in the districts of Lalitpur, Jhansi, Jalaun, Hamirpur, Mahoba, Banda and Chitrakoot of Uttar Pradesh. *In-situ* and *ex-situ* interventions created about 3.0 MCM water storage capacity and directly benefited more than 5000 farming families across the villages in terms of enhanced groundwater availability, moisture availability, crop intensification, and much more with indirect benefits such as reducing migration, drudgery reduction and reduced cost of cultivation. *In-situ* harvesting helped to bring 850-acre fallow land under productive cultivation.



Changes in land use from degraded to productive landscape at Birdha village, Lalitpur

Tree-leaf meal based concentrate feed

Usage of tree as fodder source is not popular among the farming community. Yet, tree fodder acts as vital supplement and crucial fodder source during lean season as well as during calamity like floods, drought, etc. Given that there is fodder deficit in the country, it would be apt to promote the usage of tree as fodder source for ruminants. In this regard, the ICAR-CAFRI as part of its AICRP on Agroforestry programme joined hands with Institute of Animal Nutrition (IAN), Tamil Nadu Veterinary and Animal Sciences University in promoting the tree fodder in the form of tree leaf meal-based concentrate feed. This meal consists of maize, wheat bran, deoiled rice bran, soyabean meal, sunflower oil cake, mineral mixture, salt along with tree leaf mix which can provide Digestible crude protein (DCP) of 14% and total digestible nutrient (TDN) of 70%.

Restoration of degraded lands - the Kashmir story

The AICRP on Agroforestry centre in the Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir has developed a technology for restoration through agroforestry in the Hills of Western Himalaya region. Within three years, the

survival rate of fruit trees like apple and apricot was well established and subsequently, this was adopted by other farmers. Also, male *Populus deltoides* and *Ulmus villosa* are two woody perennials which is also recommended for land restoration in the Western Himalayan region.



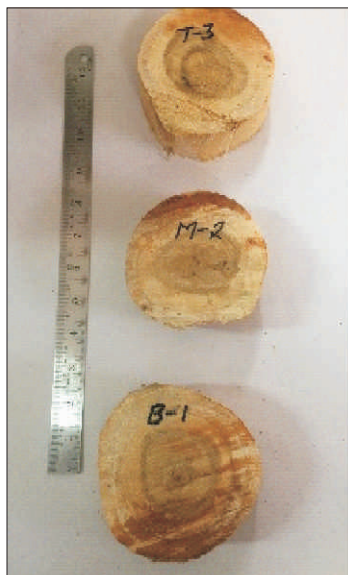
Fodder strategy for Lahaul & Spiti

The district Lahaul and Spiti of the Himachal Pradesh is a typical example for cold desert condition. The livestock is one of the main sources of livelihood and integral part of the economy. Livestock mostly rely on fodder from wild. However, due to increase population coupled with climate vagaries, there has been fodder deficit in these regions. In this context, AICRP on Agroforestry centre in the Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur and ICAR-CAFRI has brought a fodder strategy with inclusion of woody perennials in the form of silvopastoral systems that can be adopted by farmers, and sustain fodder production.

Biofuel focus

- Pongamia genotypes NRCP10 and NRCP20 have been identified as the most distinct and better biofuel properties after screening of 18 different genotypes

- Developed and identified Pongamia-specific SSR markers for genetic diversity
- *Leucaena collinsii* has been identified as an alternative species for bioenergy owing to its optimum basic density, low moisture and ash content, volatile matter and high fixed carbon and calorific value. This conclusion was drawn after screening by physio-chemical properties of five *Leucaena* species.



Leucaena diversifolia



Leucaena shannoni



Leucaena lanceolata



Leucaena collinsii



Leucaena leucocephala



Genetic Resource Conservation

Neem Field Gene Bank

ICAR-CAFRI has the largest field gene bank collections for neem with 136 out of 170 accessions was registered with ICAR-National Bureau of Plant Genetic Resources, New Delhi.



Identified and promoted 11 superior neem germplasms *viz.* VKAF11, VKAF3, VKAF13, VKAF9, VKAF67, VKAF68, VKAF92, VKAF110, VKAF85, VKAF43 and OR05 for high kernel and oil yielding traits under the semi-arid and arid conditions.



VKAF-09



VKAF-13

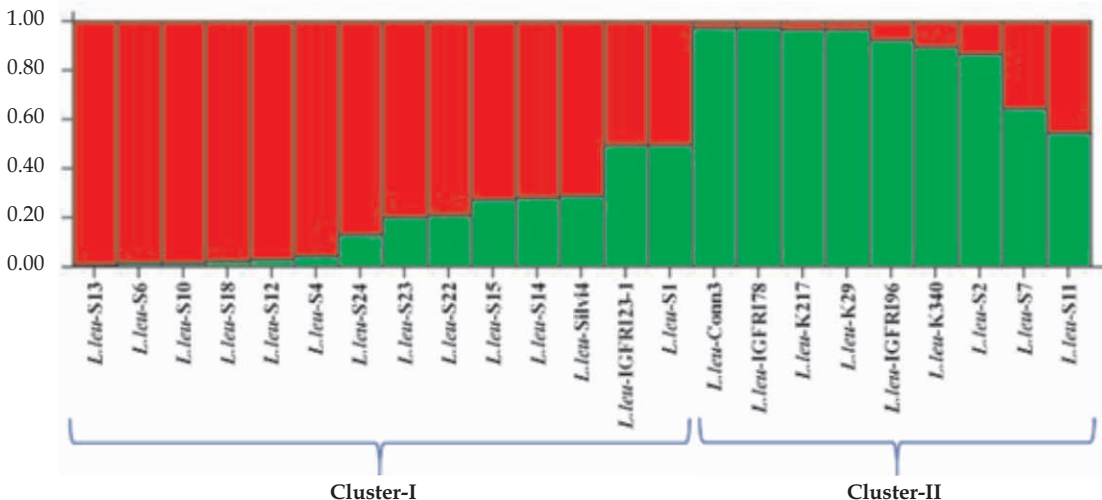


VKAF-11

Leucaena species assemblage

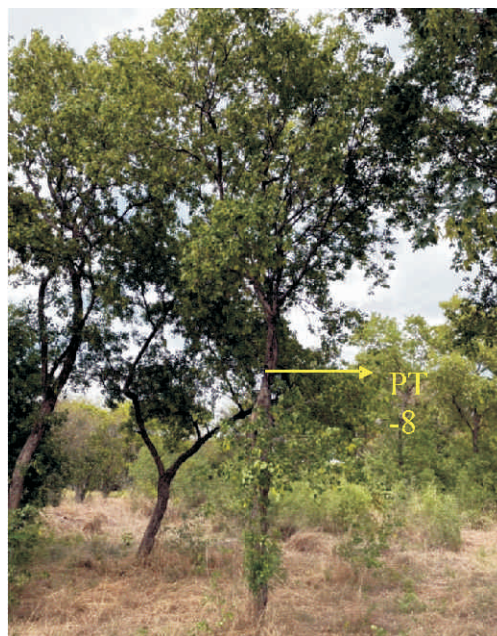
A total of 34 accessions belonging to five different species viz., *Leucaena diversifolia*, *L.shannoni*, *L.lanceolata*, *L.collinsii*, *L.leucocephala* and a hybrid (*L.shannoni* X *L.leucocephala*) were collected.

Identified 11 species-specific SSR markers as a tool to assess genetic diversity and linkage mapping in *Leucaena* sp for genetic improvement. Most distinct genotypes *L. leu-K-217* and *L. leu-S7* have been identified as potential donor parents for transgressive segregants.



Waterlogging resistant *Dalbergia sissoo*

PT-8 Shisham genotype identified through field trails at ICAR-CAFRI as early short-term flooding tolerant germplasm which can be further utilized for producing quality planting material, and promoted in agro-ecologies alike



Cactus Cafeteria

Cactus is known for its remarkable adaptation to arid and semi-arid climates in tropical and sub-tropical regions. Also identified natural cactus compounds derivatives were shown to be endowed with biologically relevant activities including anti-inflammatory, antioxidant, hypoglycemic, antimicrobial and neuroprotective properties. To utilize cactus under different agroforestry system especially in the dryland area of the Bundelkhand; an effort was taken up to establish a cactus cafeteria with 70 germplasms, 62 from ICAR-CAZRI regional Station, Bhuj, Gujarat, and 8 from Jhansi district. These accessions/varieties are being tried for introduction in different agroforestry system in a phased manner for augmenting income, nutritional and environmental security.



Agroforestry Theme Park

Agroforestry as such provide 5F's - Food, Fodder, Fuel, Fibre and Fertiliser. A dedicated theme park is being established at ICAR-CAFRI to showcase all the 5F's as model and means to promote agroforestry among the farming community. This model theme park established in an area of 0.75 ha with preference to native wood perennials of the Bundelkhand region. It is envisaged that such theme parks shall showcase multiple options for a farmer and other stakeholders for choosing best tree/crop combinations for their respective fields considering agro-climate and soil conditions



The establishment of the agroforestry theme park in CAFRI is being supported by the Indian Society of Agroforestry through GIZ grants. Initially, the three themes to work on are (a) timber, (b) fodder and (c) fruits. Additional thematic systems shall be incorporated across time and space



Digital Products

FarmTree app

Technological advancements like mobile-based learning or m-learning is no longer considered a techno-centric trend and is quickly adopted by a common man including agriculturists. Android-based application (App) forms an essential interface for performing various functions in the android phones. Therefore, apps are becoming very popular due to ease of accessing desired data/information by the target users at their fingertips. ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi, Uttar Pradesh has developed an android platform-based application viz., 'FarmTree' on scientific cultivation practices of 25 promising agroforestry tree species of India. These species includes teak (*Tectona grandis*), bamboo (*Bamboo* species), sandal (*Santalum album*), red sandal (*Pterocarpus santalinus*), mahogany (*Swietenia mahogany*), shisham (*Dalbergia sissoo*), *Ailanthus excelsa*, siris (*Albizia lebbek*), babool (*Acacia* species), subabool (*Leucaena leucocephala*), neem (*Azadirachta indica*), mahaneem (*Melia dubia*), anjan (*Hardwickia binata*), bhimal (*Grewia optiva*), gamhar (*Gmelina arborea*), simal (*Bombax ceiba*), karanj (*Pongamia pinnata*), kadamb (*Anthocephalus cadamba*), poplar (*Populus deltoides*), mangium (*Acacia mangium*), casuarina (*Casuarina equisetifolia*), khejri (*Prosopis cineraria*), eucalyptus (*Eucalyptus tereticornis*), arjun (*Terminalia arjuna*), and gliricidia (*Gliricidia sepium*). The FarmTree provides a user-friendly, bilingual (Hindi and English) e-platform to have necessary and crisp information on these 25 important agroforestry tree species for the farmers to grow at their farm. The information covers various aspects like general descriptions, potential areas, silvi-cultural requirements, nursery techniques, field planting techniques, tending agronomic operations, suitable agroforestry systems, tree protection aspects, yield, utilization and plating material



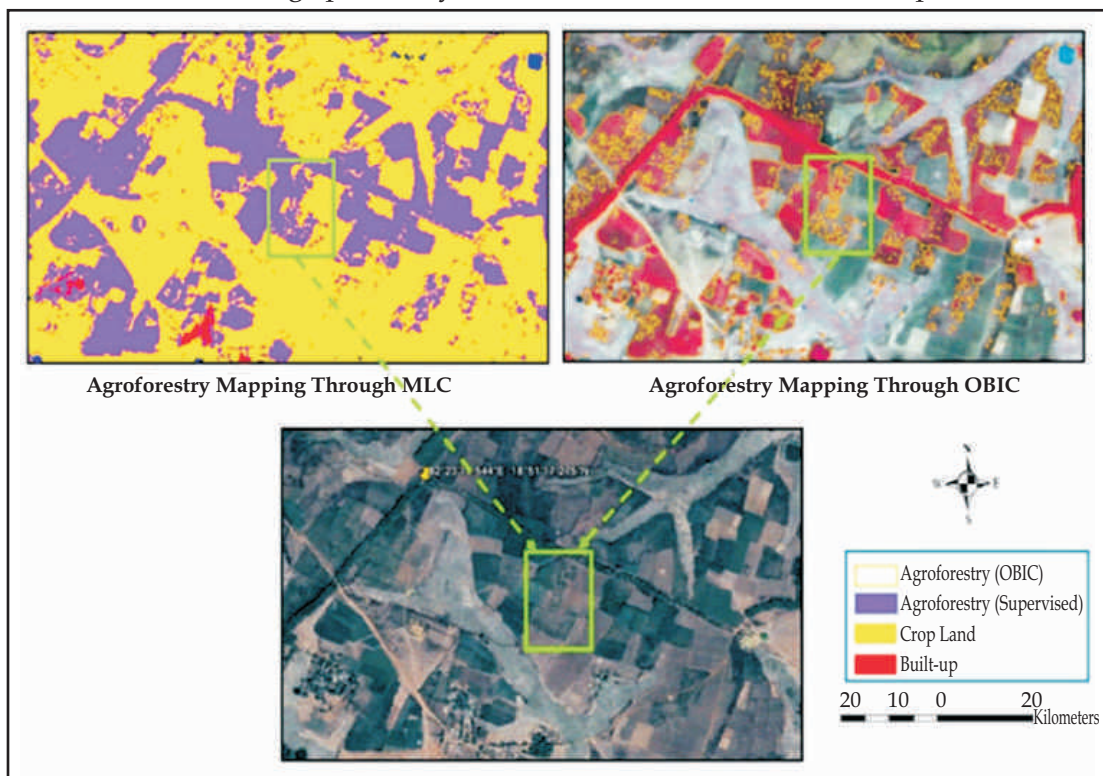
availability of each these tree species. The *app* provides appropriate content supported by relevant photographs making it more suitable for agroforesters, forestry professionals, forest department personnel's, farmers, research students and policy-makers. FarmTree also offers its users an unique opportunity for discussion through public forum, mailing a query directly to the institute by attaching a necessary photograph for effective communication and directly contacting our subject matter experts for getting technical information, planting material availability and possible solution to a specific query. (link: [https://play.google.com/store/apps/details?id= com.cafri.farmtree](https://play.google.com/store/apps/details?id=com.cafri.farmtree)) as well as on institutes official website: <https://cafri.icar.gov.in/>.



The FarmTree *app* is popular among its users with more than 7000 downloads and 4.7/5 of google play store rating.

Agroforestry Area Assessment: Methodology and Estimation

A major problem in estimating the area under agroforestry is the lack of procedures for delineating the area influenced by trees in a mixed stand of trees and crops. Besides, simultaneous agroforestry where the tree and the crop components grow at the same time and in close enough proximity for interactions to occur is more complex.

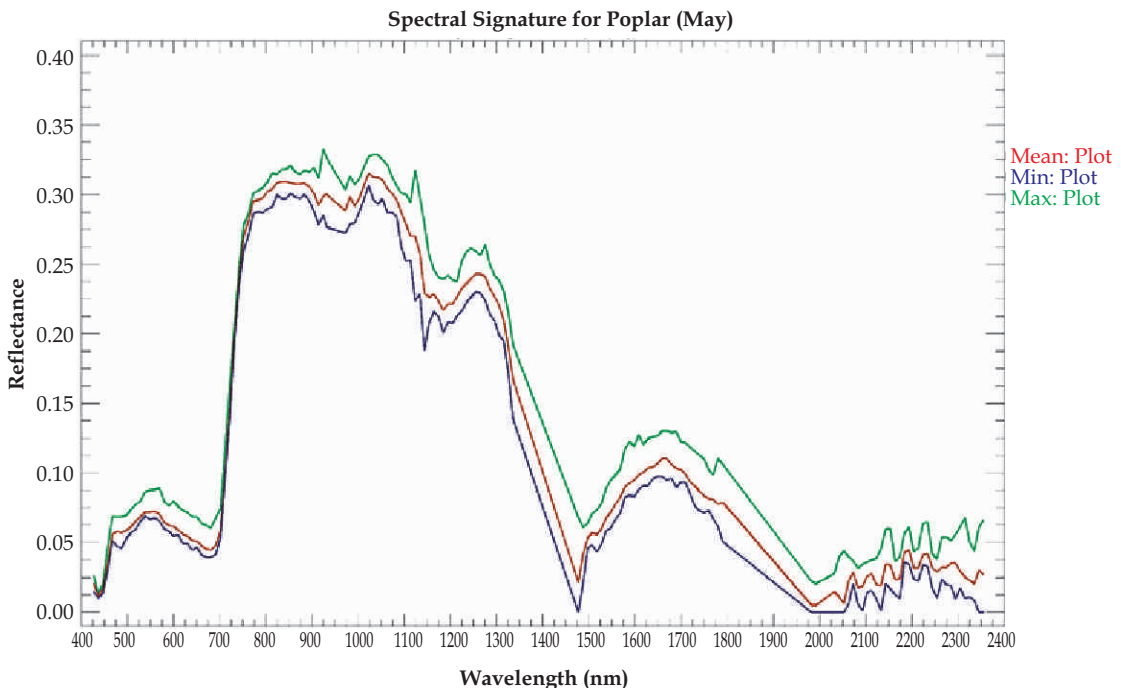


Agroforestry area mapping using different geospatial approach (MLC and OBIA)

An accurate assessment of the area under agroforestry can be done with the help of geospatial technologies as manual (traditional) methods of mapping are expensive and take a relatively long time. Use of geospatial technologies to estimate agroforestry area was initiated in 2007 by the Central Agroforestry Research Institute (CAFRI), Jhansi, using medium-resolution data with a methodology in which areas under agroforestry, forest and plantation are separately identified. Recently in 2022, the overall area under agroforestry area for all 15 agro-climatic zones of India works out to be 28.427 million ha, which is about 8.65 per cent of the total geographical area of the country (328.762 m. ha.). Out of 15 agro-climatic zones, seven zones (1, 3, 5, 7, 11, 12 & 13) have more than 10 per cent area under agroforestry. Agro-climatic zones 1, 5, 7, 10, 11 and 13 have more than 2 million ha of the area under agroforestry

Digital library of spectral signatures for major agroforestry tree species

Library of digital spectral signatures for *Azadirachta indica*, *Embllica officinalis*, *Eucalyptus tereticornis*, *Mangifera indica* and *Populus deltoides* species have been created. These spectral signatures of tree species are generated using high resolution/hyperspectral remote sensing data. Using this methodology, mapping Poplar species was done with more than 90% accuracy in Yamunanagar district of Haryana which is the northern hub of ply/plyboard, matchstick industries. Poplar area was estimated to be 12169.66 ha (9.71%). This poplar area accounted for about 74.7% of total agroforestry area in the district





New Interventions and Initiatives

Haveli - A new design

The rainwater management system locally known as 'haveli' has contributed towards rehabilitating degraded landscapes and changing them into a productive farm in Bundelkhand region of Central India. The haveli system was the lifeline of the region for water security for the last 300 years. Farmers (~1-5%) situated at the upstream of the landscape were harvesting surface runoff in their fields during monsoon by constructing earthen embankments along with provision to drain out water after receding of the monsoon. Farmers traditionally cultivated only during the post-monsoon period, using residual soil moisture along with supplemental irrigation from shallow dug wells. However, this system became defunct due to apathy and poor maintenance. The traditional design of the haveli were also often malfunctioning due to new rainfall patterns and storm events. So, a new design for haveli was designed for water rejuvenation which retains the traditional design whilst also mixing the new innovations, particularly from engineering and design characters that is currently quite popular in the Bundelkhand region.

Introduced Strawberry in Bundelkhand

As effort to diversify crop cultivation and to augment farmers' income, the ICAR-CAFRI introduced strawberry cultivation in the Bundelkhand region. Taking advantage of the optimum weather for cultivation prevailing during November to February, the strawberry cultivation was popularized among the farmers along with the modern cultivation practices such as mulching, drip irrigation and post-harvest methods. Owing to the handholding and guidance of ICAR-CAFRI scientists, the farmers of this region were able to cultivate the strawberry in the open condition with minimum infrastructure requirement. These efforts were carried out in collaboration with state horticulture department and NABARD. To this effort, CAFRI gave a unique package of practice for strawberry cultivation in Bundelkhand and also enabled their post-harvest processing for value-chain development.

The Himalayan Initiative

After the successful completion of Phase-I of NMSHE-Task Force on Himalayan agriculture (headed by ICAR) in the year 2020, second phase of the project was launched in the year 2021 with its secretariat at ICAR-CAFRI. This project is being implemented in consortia mode with 12 institutes from various regions working in a collaborative manner for enabling climate resilience agriculture in the IHR and to bring-out a climate policy document for the entire IHR which will help the government to implement suitable adaptation programs and technologies for climate mitigation and enable the Himalayan agriculture climate-resilient.

Carbon and Climate Change Initiative

In our efforts to adopt and mitigate climate change, the institute has identified the PT-8 of *Dalbergia sissoo* genotype identified as early best performing genotype for short-term flooding tolerance. This conclusion was drawn after screening of 10 accessions. Also, the centre has screened out NRCP-25 of *Pongamia pinnata* has been identified as best early drought tolerant genotype after screening 18 genotypes.

Under NICRA project, the centre also estimated the carbon sequestration potential of the agroforestry systems in the country through survey and simulation modelling (CO2FIX model), mapping of agroforestry area using GIS & Remote Sensing techniques and also based on thermo-tolerance of multi-purpose trees. The net carbon sequestered in agroforestry system in different states worked out to be ca. 11.25 t C ha⁻¹ from the baseline over a simulated period of 30 years. The carbon sequestration potential (CSP) of agroforestry system in the states is 0.35 t C ha⁻¹ yr⁻¹. The carbon sequestration potential was extrapolated based on data available of different district of a particular state. Accordingly, the total CSP in different states varied from 0.032 to 1.849 million tons carbon and total CSP of agroforestry existing in farmer fields has been estimated as 8.13 million tons carbon in 12 agro-climatic zone



Tree Genomics Initiative

Genomic research on trees is motivated by the need to support genetic improvement programmes mostly for food trees and timber, and develop diagnostic tools to assist in recommendation for optimum conservation, restoration and management of natural populations. Over the past two decades, research on forest tree genomics has generally lagged behind that of other agronomic crops. Research on long-lived woody perennials is extending our molecular knowledge and understanding of complex life histories and adaptations to the environment, enriching a field that has traditionally drawn its biological inference from a few short-lived herbaceous species. ICAR-CAFRI organises its genomic research by joining hands with various institutions/organizations. The genomic studies on *Pongamia* which is considered an important biofuel species is first of its kind. Through genomic studies, it is found that drought stress in the early growth stages of *Pongamia* influences negatively on the germination and seedling development. Due to lack of cultivar stability under drought stress conditions, establishment of successful plantation in drought hit areas becomes a major problem. To address this issue drought stress response of four *Pongamia* genotypes has also been studied at morphological, physio-chemical and transcriptome level.



Decisive Role

National Agroforestry Policy – CAFRI's Role

India unveiled the much-needed National Agroforestry Policy (NAP) in 2014 making India the first country in the world to have such policy to promote agroforestry. ICAR-CAFRI has immensely contributed in the development of this policy along with other partners and National Research Centre for Agroforestry (NRCAF) (former name of ICAR-CAFRI) has been mentioned in the policy document for its research, extension and capacity building and related services in the past 35 years.

Partnership in hosting the 3rd World Agroforestry Congress

Over 1,000 people participated in the 3rd World Agroforestry Congress with theme - “Trees For Life”, in India, including people from more than 80 countries – tropical, subtropical and temperate (www.wca2014.org). ICAR-CAFRI along with Indian Society of Agroforestry were the co-hosts of the congress. The congress aimed at expanding global awareness and understanding of agroforestry; share the current status of knowledge and practice of agroforestry and consolidate its research base; build support for agroforestry within governments, companies, academia, NGOs and the media and increase the engagement of the private sector.

Guidelines for Quality Planting Material

To upscale and promote agroforestry among farmers and other stakeholders, easy access to, and unhindered availability of Quality Planting Material (QPM) is a prerequisite. And, to ensure this ICAR-CAFRI has consistently working on developing standardized nursery protocol for different woody perennial of commercial importance. Also, it has developed a national level Guidelines to Produce Quality Planting Material of Agroforestry Species to ensure production and supply of QPM.

Quality Planting Material may be defined as 'the production of uniform, healthy, disease-free planting material raised through seed or vegetative methods with an overall goal to raise the physiological and phytosanitary quality of the plant available to stakeholders to increase productivity'.

Nodal Agency for Quality Planting Material Production, Nursery Accreditation and Seedling Certification

The Ministry of Agriculture and Farmers Welfare, Government of India has designated the ICAR-CAFRI as the Nodal Agency for providing technical support for supply of Quality Planting Material (QPM), accreditation of nurseries and certification of seedlings as a part of the operational guidelines of the restructured scheme of agroforestry under the *Rashtriya Krishi Vikas Yojana* (RKVY).

फ्रेंकलिन एल. खोबुंग
FRANKLIN L. KHOBUNG
संयुक्त सचिव
Joint Secretary



सत्यमेव जयते



आज़ादी का
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No 3-1/2021-NRM-SMAF

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As you are aware that in view of restructured scheme of AGROFORESTRY to be implemented as one of the components of *Rashtriya Krishi Vikas Yojana* (RKVY) for its continuation during 15th Finance Commission period from 2021-22 to 2025-26, ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi has been designated as Nodal agency for providing technical support for supply of Quality Planting Material (QPM) and its certification as well as Accreditation of nurseries as given in the Operational Guidelines of Agroforestry which is as below :-

- i. CAFRI shall extend support through its All India Coordinated Research Project (AICRP) centres on agroforestry situated at various locations around the country and also coordinate activities with other agencies/ institutes like ICFRE, CIFOR-ICRAF, FAO-India, SAUs, CAUs, Private Partners, etc. while facilitating the implementation of the scheme.
 - ii. CAFRI will ensure that all nurseries set up under the scheme comply with the registration and accreditation requirements as laid down by it
 - iii. Certification of QPM from accredited nurseries shall be done as per guidelines laid down by CAFRI in association with empaneled agencies/experts.
 - iv. CAFRI shall provide the standards and modalities for Registration, Certification and Accreditation of Nurseries as well as Certification of QPM from such Registered/Accredited nurseries.
 - v. ICAR-CAFRI will act as Nodal Agency for repository of agroforestry related works with a preamble note to states for providing all related information to CAFRI.
 - vi. CAFRI may undertake project-based activities including transfer of agroforestry technology in various agro-climatic zones, business incubation and training to stakeholders.
2. In view of above, it is requested that CAFRI as the nodal agency may coordinate with the implementing agencies of the States/UTs in providing technical support while implementing the scheme. As the main thrust of the scheme is on supply of QPM, it is important that the nurseries set up by the States/UTs under the scheme conform to the quality standards prescribed by CAFRI and the nurseries developed under the scheme are registered/accredited and the seedlings produced are certified for QPM standards.
3. Further, ICAR-CAFRI as Nodal Agency for repository of all agroforestry related works may coordinate with the State/UT Governments for obtaining necessary information related to the subject.

Yours faithfully,


(Franklin L. Khobung)

Copy to:-

The Pr. Secretary/ Commissioner D/o of Agriculture (All States/UTs).

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Promoting Agroforestry

AICRP on Agroforestry

The All India Coordinated Research Project (AICRP) on Agroforestry was launched in 1983 which is currently serviced by 37 centers. The centers majorly screen and upgrade genetic makeover of selected perennial species for their compatibility in different agroforestry systems. Owing to the systematic efforts, about 184 promising tree species germplasms have been collected and evaluated for its superiority. In this regard, registration of the elite germplasm has been done like shisham by NRCAF (Bundel-1 and Bundel-2) and GBPUAT, Pantnagar (PS 52), poplar clones (L-48/89, L-47/88) by PAU, Ludhiana, Pant Poplar by GBPUAT, Pantnagar, teak clone (PDKV/AF-1) by College of Agriculture, Nagpur and eucalyptus (SRY-16) by MPKV, Rahuri. Similarly, in neem, elite germplasm with high yield and high, stable azadirachtin content have been identified and are further explored for genetic gains. With industrial agroforestry and contract farming gaining popularity, fast growing species like *Melia dubia*, *Anthocephalus cadamba* and *Melia azedarach* were focused in recent years and promising clones like Malabar Neem (*Melia dubia*) - MTP 1, MTP 2 & MTP 3; Kadam (*Anthocephalus cadamba*) - MTP 2 by TNAU centre; and *Melia azedarach* - Punjab Dek 1 & Punjab Dek 2 by PAU centre was also released. Agroforestry research does not focus on timber yielding trees alone, NTFPs trees were also screened for superior genetic gains and clones/varieties like Undi (*Calophyllum inophyllum*) clone KKVCI-03 by BSKKV centre; Imli (*Tamarindus indica*) varieties viz., DTS-1 and DTS-2 by UAS Dharwad centre; and GKVK-17 Tamarind variety for commercial cultivation to Eastern Dry of Karnataka was also released recently.

As the objective is also to screen crop plants species for their compatibility in different agroforestry, the AICRP on Agroforestry centers have also screened crop varieties suitable for specific agroforestry systems (models). For instance, wheat varieties WH 1105, PBW 677, PBW 725, PBW 502, DBW 17, PBW 550 and PBW 621 are suitable for Poplar-based agroforestry system in Punjab region. The findings from RPCAU centre state that Krishna-258, a Til (*Sesamum indicum*) variety is superior and suitable for intercropping up to 5 years in the Shisham (*Dalbergia sissoo*) based agroforestry system in Bihar.

The continuous effort to the AICRP on Agroforestry in the past 40 years has translated to develop agroforestry system (models) specific different agro-ecological reasons of the country. For instance, in Deccan Plateau having 600-1000 mm rainfall can adopt a) Three-tier Agroforestry System for Paddy Growing Area with Teak and Mango as Tree component and Paddy (Kharif); Gram, Black gram, Linseed, Lathyrus (Kharif) as crop component; b) Sapota-Teak based Agroforestry System for Hill Zone of Karnataka with

Teak and Sapota as Tree component and Paddy (Kharif); South African Maize, Sun hemp (Kharif) as crop component; and c) Tamarind based Silvi-horticultural System with *Tamarindus indica*, Eucalyptus and Casuarina as Tree component and Natural grass (DTS-1, DTS-2 and SMG-13 as crop component for pasture/fodder. Similarly for specific agroforestry systems for all the 20 agro-ecological zones along with their economic analysis have been developed for the country.

Prioritizing Areas Suitable for Agroforestry – A joint activity with NITI AAYOG and ISRO

The institute was decisive partner in Prioritizing Areas Suitable for Agroforestry, an effort led by the NITI Aayog in collaboration with the efforts and immense support of National Remote Sensing Agency (NRSA), Hyderabad and Indian Space Research Organization (ISRO). The NITI Aayog has brought an agroforestry suitability map for wasteland greening. The mapping effort is attempting to be an open-source model for 28 States and 4 Union territories for promoting agroforestry

Framework for Agroforestry Extension

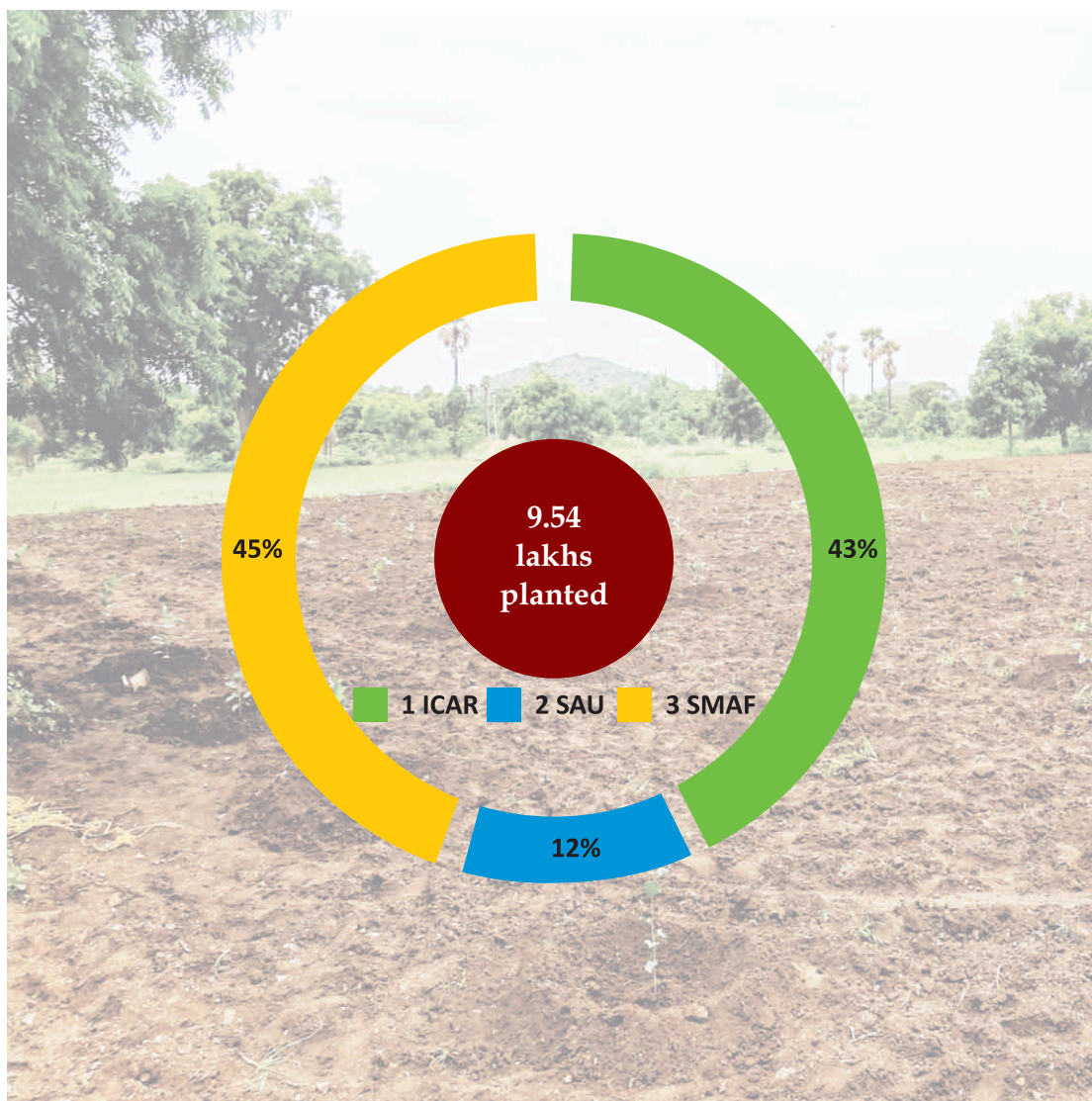
Realizing the impetus of agroforestry, the Government of India adopted the National Agroforestry Policy in 2014, the first of its kind in the whole world. The policy specifically points out the non-existent extension mechanisms for agroforestry and also insisted on addressing it. Efforts are being taken by different organizations to upscale agroforestry in the ground. The institute has developed an agroforestry extension framework which will expedite and simplify the process of upscaling agroforestry at the grassroots level. The agroforestry extension framework will aid in bringing the state departments and ministries to work together. Any upscaling efforts warrants participation of various institutes and organizations and the framework narrated here will serve as template for adoption.

National Repository of Agroforestry Information

ICAR-CAFRI has been notified as the Repository for Agroforestry Information in the country by the Ministry of Agriculture and Farmers Welfare, Government of India. The institute has its strength drawn from All India Coordinated Research Project on Agroforestry and 35 years of R&D experience across the country. The Institute has been providing technical support to the Sub-mission on Agroforestry, state forest departments and other stakeholders.

Largest ever tree plantation campaign in the ICAR

To address the call of the Prime Minister, ICAR-CAFRI conducted a brainstorming session on “Har Med Per Ped” and carried out a National Level Tree Plantation Drive on the eve of the Indian Council of Agricultural Research (ICAR) Foundation Day, the 16th July, 2021. Overall, active participation from the National Agricultural Research & Education System (NARES) and Sub-Mission on Agroforestry (SMAF) units aided in making this national tree planting campaign a success. We were able to achieve a close figure of about 9.54 lakhs to the fixed target of 10 lakhs seedlings.



Contribution of NARES and SMAF Units

Seed Museum

ICAR-CAFRI established a seed museum of agroforestry exhibiting seeds of woody perennials, grains, crops, flowers, and vegetables, for the benefit of students and farmers. As of 2022, the collections record seeds of about 115 woody perennials, 10 medicinal plants and 20 grass species.



Spiritual Vatikas

Establishment of these Vatikas is important not only for aesthetic and ornamental value but also for biodiversity conservation. Spiritual Vatikas are associated with plantation of trees based on religious and spiritual beliefs. Religious and traditional beliefs, cultural mores, and practices play a significant role in conservation of environment and biodiversity. Recently, various educational and research institutes in India have established 'Spiritual Vatikas' in their premises to support biodiversity conservation. Institute has also established its spiritual Vatika, Star-Tree plantation, Rashi Vatika, and Solar Plantation. Culturally, tree planting has been promoted in similar forms like sacred grooves and temple trees throughout India and other south-east countries like Thailand and Cambodia. Associating trees to the ethnic and religious sentimental values of the people can serve as means for conserving tree genetic resources and increasing the tree cover area of the country.



Trees in Cities Challenges

Globally, trees are a viable and potential tool to ameliorate climate and weather. International agencies are now emphasizing the importance of trees in cities as well, for their invaluable ecosystem services. In this regard, the United Nations Economic Commission for Europe and FAO has launched the Trees in Cities Challenge (<https://treesincities.unece.org/>). This tree planting programme was launched at the UN Climate Action Summit in 2019 which encourage the mayors and district administration to join hands with organizations thereby formally committing to plant a pre-determined number of trees in their city and to strengthening sustainable management of urban and peri-urban trees and forests. The city of Jhansi, Uttar Pradesh has found a place in this program, as facilitated by the ICAR-Central Agroforestry Research Institute that has been also designated as the focal point by the Jhansi Nagar Nigam for the 'Trees in Cities Challenge' implementation.





HRD and Capacity Building

Reaching the unreached: Working with and for farmers

ICAR-CAFRI is consistently organizing outreach programs for taking agroforestry technologies to farmers' field. The main objective to impart skill and improve the socio-economic conditions of the farming community. In total, CAFRI has been successful in reaching out to 26000 farmers through several programme such as *Mera Gaon-Mera Garauv*, SC-SP, TSP and others. Apart from this, farmers of various villages are motivated to adopt agroforestry practices at their field by scientists of the institute. Furthermore workshop/field days, *Kisan Mela* and *Kisan Gosthi* organized by CAFRI on various occasions from time to time. All these have contributed significantly to the adoption of agroforestry *vis-à-vis* socio-economic transformation.

CAFRI as education hub

The ICAR-CAFRI has taken efforts to agroforestry education in the country. The efforts include conducting specially designed Capsule Course on Agroforestry as well as CAFRI being research centre for M.Sc. and Ph.D. students based on Memorandum of Understanding with educational institutes across the country. Twenty such MoUs have been signed and more than 30 PhD research scholars have been benefited through these educational modules.

Agroforestry Business Incubation Centre (ABiC)

Agroforestry Business Incubation Centre of ICAR-CAFRI facilitates incubation of new startup/entrepreneurs and enterprises for innovation technologies by providing need based physical, technical, business and networking support, facilities and services to test and validate their venture before successful establishment of enterprises, IP/deemed IP and transfer/commercialization of technologies in agroforestry and allied sectors. This centre will be unique compared to the agri-business incubation in the country. ABiC activities includes thematic areas like are plant nursery; semi-processed items like juice, jam, pulp, gum & resin, etc.; tree seed marketing; timber and wood-based products; fibre and flosses; biofuels and briquettes; essential oils; mini-clonal technology and agroforestry models. ABiC is first of its kind in the northern India.

Promoting Agroforestry based Business Opportunities and Creating an Ecosystem for Entrepreneurship





Vision for Future

Towards Future

The Institute is striving hard to cater the need of various stakeholders in agroforestry sector by carrying out strategic research. On this context, the institute research has been reoriented into four programmes - 1) Agroforestry System Research 2) Tree Improvement Research 3) Carbon and Climate Change Research and 4) Agroforestry Extension Research. Each of these programmes will be looking into new areas like

- Ethno-agroforestry
- Aqua-agroforestry
- Conservation agroforestry
- Ecosystem services assessment
- Indigenous species-based agroforestry
- Good Germplasm management practices
- Tree Genomics
- Agroforestry Mapping
- Agroforestry Atlas of India
- Agroforestry database repository
- Niche modelling and Climatic modelling
- Strategic Agroforestry Extension and Outreach
- Agroforestry Business

As the institute stepping into the 36th Year of its establishment, the scientific and technical staff of ICAR-CAFRI will spear head and assure to deliver more for the betterment of the nation through progressive agroforestry science-led development.





Published by

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