Technical Bulletin
CAFRI/2023/2

Agroforestry Technologies

ICAR-Central Agroforestry Research Institute

Krishivaniki Vihar, Jhansi 284003, Uttar Pradesh

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Disclaimer: Only those Agroforestry technologies registered with Institute Technology Management Unit (ITMU) of ICAR-CAFRI, as per the guidelines issued for the purpose have only been listed here in this document.

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Index

S.No.	Description	Page
	Foreword	
1	Overview of ICAR-CAFRI	1
2	IP&TM in ICAR	3
3	ITMU of ICAR-CAFRI	5
4	Repository of Tree Germplasms at ICAR-CAFRI	7
5	Category I: New Concept	11
6	Category II: New Process/Methodology, and Unique Germplasm	15
7	Category III: Technologies and Products including Tools and Design	23
8	Category IV: Package of Practice(s)	33
9	Category V: Strategic Knowledge	43
	Institute Proforma to IPR Proposal	53
	Institute Proforma for Germplasm Registration	55

Foreword

भारतीय कृषि अनुसंधान परिषद
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उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन)
Dr. Suresh Kumar Chaudhari
Deputy Director General (Natural Resources Management)

06.03.2023

Foreword

Agroforestry (AF) as a land-use system has the potential to meet our economic andecological needs. Principally, AF is the deliberate inclusion of woody perennials (including trees, shrubs and bamboo) along with agricultural crops and/or livestock on the same piece of land. ICAR has been the front-runner in carrying out AF research in the country. A National Seminar on AF was conducted by ICAR at Imphal in 1979 which led to the formulation of All India Coordinated Research Project (AICRP) on AF in 1983. Initially, this project aimed at the scientific enquiry and analysis of existing tree-based land-use systems. With subsequent findings from this project, a dedicated research institute for AF was established and named as ICAR-Central Agroforestry Research Institute at Jhansi. During the last 4 decades, several technologies and package of practices have been developed by the AF network of scientists across the country and have added to the strategic knowledge for promoting AF in the diverse ecologies of the country. All such approved technologies and other related intellectual property have been compiled in the form a publication titled `Agroforestry Technologies'. This is a first of its kind listing the achievements of ICAR-CAFRI.

I appreciate the dedicated and consistent efforts made by the Institute in publishing this document. I believe it will be useful for industrial stakeholders, farmers, scientific community and policy makers.

(S.K. Chaudhari)

Overview of IAR-CAFRI

About us

ICAR-Central Agroforestry Research Institute (ICAR-CAFRI), formerly the National Research Centre on 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 (214.079 research farm and 40.78 office & residential area). CAFRI is the only dedicated research institute of the country working on key research areas of agroforestry with 31 scientists, 16 technical, 12 administrative and 8 skilled supporting staff as its sanctioned cadre strength. CAFRI has developed robust agroforestry models and package of practices for different agro-climatic conditions covering small and marginal farmers and provides technical backstopping to the states and stakeholders.

History

- ICAR initiated a network project for organized research in agroforestry 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 quality of life of rural people by integrating perennial crops in the 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.

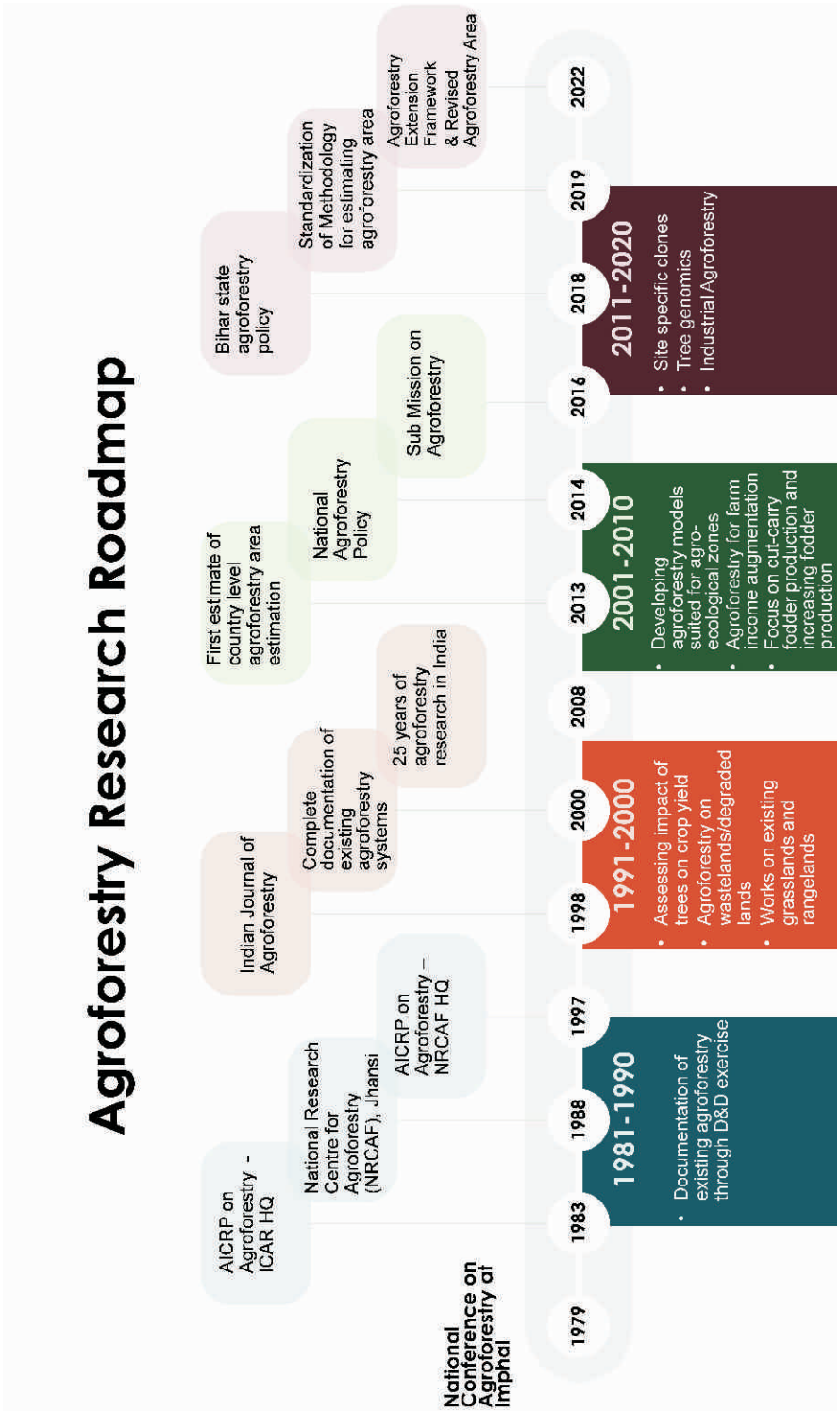
Our Mandate

Develop sustainable agroforestry models for farms, marginal land and wastelands in different agro-climatic zones

Coordinate network research for identifying agroforestry technologies for inter-region

Training in agroforestry research for ecosystem analysis

Transfer of agroforestry technology in various agro-climatic zones



Source: Ramanan *et al.* (2022)

Intellectual Property & Technology Management (IP&TM) in ICAR

Assimilation of IPR dimensions in research management has become absolutely necessary in R&D institutions. Accordingly, ICAR has its Guidelines for Intellectual Property Management and Technology and a decentralized three-tier IP management mechanism is institutionalized in ICAR w.e.f. 2nd October 2006. This system was implemented through XI Plan scheme viz. "Intellectual Property Management and Transfer/Commercialization of Agricultural Technology Scheme". This scheme has contributed to developing an IP environment in ICAR. Its implementation has led to increased IPR-filing (patents, plant variety rights, copyrights, trademarks, etc.). Based on the encouraging lessons learnt during the XI Plan, the scope was expanded the proposed XII Plan scheme is considerably enhanced. The enhanced scope was expanded in the XII Plan scheme as ***'National Agriculture Innovation Fund'*** with three components viz.

- Component I: Innovation Fund (the XI Plan Scheme of Intellectual Property Management and Transfer/ Commercialization of Agricultural Technologies)
- Component II: Incubation Fund (Supporting Agri-business Incubation Centres in institutions developing agricultural technologies)
- Component III: ARYA (Attracting and Retaining Youth in Agriculture), which was implemented through the Extension Division of ICAR.

Objectives of NAIF Component I (Innovation Fund)

1. To promote creativity and innovations in ICAR institutes;
2. To strengthen the institutional mechanism to protect/manage innovations/intellectual properties (IPs) generated within the ICAR/NARS;
3. To understand and attempt as necessary a vigil on infringement, improper exploitation and abuse of the intellectual assets belonging to ICAR/NARS;
4. To augment capacity building in IPRs and technology transfer/commercialization dimensions;
5. To manage new knowledge as per principles in ICAR's new and implemented guidelines/policies.

Component II (Incubation Fund)

1. To establish/transform agri-business Incubator centres as leaders in NARS that would provide technology and skill up gradation, inputs supply and market support leading to promotion of viable enterprises and sustainable employment to entrepreneurs;
2. To undertake last mile scale-up from pilot level of value chain in collaboration with stakeholders;
3. To explore and support appropriate technologies including grassroots' innovations that are vital in future for an accelerated growth and competitive technological leadership;
4. To impart training and capacity building to prospective entrepreneurs; generate value added manpower to compete effectively; and
5. To provide seed money support to potential incubates/entrepreneurs taking up promising innovations or technologies.

Role of IP&TM in ICAR

The Intellectual Property and Technology Management Unit in ICAR is oversees all matters related to intellectual properties and technology transfer/commercialization. ICAR recognizes that a systematic management of its technology products and services while bringing commercial ethos in their transfer and realization at the user end would result in much-needed dividends for the nation. Individual institutes of ICAR are empowered and enabled to enter into licensing contracts or commercial agreements for the commercial transfer of ICAR technologies to the interested parties. A middle-tier consisting of Ten Subject Specific Zonal Technology Management (ZTM) Units is developed to facilitate serious business and strengthen public-private partnerships. These zonal units also project the ICAR technology profiles available at various ICAR institutes located in the respective zones. The central IP and technology management mechanism at ICAR headquarters facilitates techno-legal and policy matters/concerns that may arise on case-to-case basis in the course of developing win-win relationships and also catalyzes public-private relationships at the central level.

Thrust Areas

- Streamlining transfer of ICAR knowledge and technology products through commercial, cooperative and open public routes.
- Joint intellectual property management support in collaborative projects
- Facilitation and advisories in techno-regulatory and policy matters related to intellectual property and technology management.
- Public-private partnerships in technology/know-how transfer and R&D.

Policy & Guidelines

ICAR encourages interested parties to enter into commercial ventures with ICAR technology and knowledge products and services as per the

- ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization (Revised 2018)
- ICAR Guidelines for Internal Evaluation and Forwarding Research Papers to Scientific Journals and Data Management in ICAR Institutes.
- ICAR Rules and Guidelines for Professional Service Functions (Training, Consultancy, Contract Research and Contract Service)
- Empanelment of law firms for Patent - IPR Attorneys-Reg

Source: *ICAR-IP&TM website (https://icar.org.in/node/131)*

Institute Technology Management Unit (ITMU) of ICAR-CAFRI

ICAR established a three-tier intellectual property (IP) management system in 2006 to manage the intellectual assets, whereby each institute is equipped with knowledge, manpower and freedom of decision, which is governed by its "Guidelines for Intellectual Property Management and Technology Transfer/ Commercialization" (ICAR 2006- which is again revised in 2018). To institutionalize this system, ICAR had also launched a scheme in its XI plan budget, which completed 5 years in 2012. Under this system, Institute Technology Management Units (ITMUs) headed by scientific personnel, were formed at all ICAR institutes. At central level, Intellectual Property and Technology Management (IP&TM) Unit is leading this system by providing budget, technical support in case to case basis and assistance for IP related legal issues.

Institute Technology Management Unit (ITMU) has been constituted at Institute level to facilitate Intellectual Property Management and Technology Transfer/ Commercialization as per the ICAR guidelines with objectives to pursue intellectual property protection, maintenance and transfer/commercialization pertinent to technology(ies) developed at Institute level. ITMU functions as coordinating unit and facilitator to recognize the promising technology(ies) developed, process the filing of patent and maintaining the IP portfolios of the Institute through Institute Technology Management Committee (ITMC). ITMU/ITMC seeks advice/assistance from the Zonal Agro-Technology Management Centres (ZTMCs) at the zonal level and strictly obeys the administrative guidelines/ advisory or policy decisions taken by the ICAR from time to time.

Role of Institute Technology Management Unit (ITMU)

- To make decisions for Intellectual Property Management and Transfer/Commercialization of Technology.
- To pursue all IP protection, maintenance and transfer/commercialization-related matters at the institute level as per the ICAR Guidelines for Intellectual Property Management & Technology Transfer/Commercialization.
- To undertake and pursue the needed steps under the PPV&FR Act required for seeking registration and protection of plant varieties.
- To update the status of IPR protection/maintenance in the data set from time to time
- To make efforts for technology commercialization with the primary objective of technology transfer to end-users.

Business Incubation at CAFRI - ABiC

Institute Technology Management Unit (ITMU) of 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.

- ABiC is the right place where stakeholders are sensitized and know what they ideally want to achieve in their professional life.
- To initiate a good business idea, nurture and establish a unit to promote agroforestry.
- Acceleration to identify and fulfil a need by creating value for the stakeholders and provide them a platform to launch a successful business venture.
- To strengthen the stakeholders to become self-reliant to generate income.
- To generate/provide innovative solutions to meet local and global agriculture and business challenges.

Institute Germplasm Identification Committee (IGIC)

The Institute Plant Germplasm Identification Committee (IGIC) is constituted under the ITMU, led by the Chairmanship of Programme Leader, Tree Improvement, ICAR-CAFRI, Jhansi. It has provision for adoption of need-based tree/crop specialists with reference to the material under consideration, with the approval of Director of the Institute. All the plant germplasm and genetic resources related activities of this institute will be handled by the IGIC committee.

Repository of Tree Germplasms at ICAR-CAFRI

ICAR-CAFRI: The National Field Gene Bank on Neem

The ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi, Uttar Pradesh serves as a National Field Gene Bank of Neem Germplasm. Initially, 276 accessions were assembled at the Field Gene Bank of the Institute from Maharashtra, Andhra Pradesh, Rajasthan, Uttar Pradesh, Madhya Pradesh, Orissa, Haryana, Karnataka and Tamil Nadu through extensive exploration, collection and/or as gifts from some participating institutes/universities in the All India Coordinated Research Project (AICRP) on Agroforestry. Mainly, these accessions were collected from farmer's field. To date, 170 accessions are in our field gene bank. Among these accessions 139 have been registered as indigenous collection (IC) with National Bureau of Plant Genetic Resource (NBPGR), New Delhi.

Neem germplasm conserved at CAFRI field gene bank has become an important source of diversity. These collection serves as a wide gene pool for various economic seed associated traits including oil and azadirachtin yield improvement. The conserved germplasm is being characterized for important morpho-agronomic traits of neem. These materials shall be made available to researchers in both public and private sectors across the world following extant germplasm exchange guidelines. The collections held at the field gene bank are also serving the purpose of restoration of germplasm to the source origin states when native collections are lost due to natural calamities, civil strife, etc. This field gene bank has promoted testing and release of accessions directly as superior varieties in different agroecological region in India.

Field Gene Bank for Neem at ICAR-CAFRI Research Farm

Plant Genetic Resources with ICAR-CAFRI

About 184 promising tree species germplasms were collected and are being 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. The AICRP on Agroforestry centres have been also exploring new species to be incorporated into agroforestry systems. 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 plant species for their compatibility in different agroforestry, the AICRP on Agroforestry centres 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 Popular 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-ecologcial 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.

Institute Technology Management Committee (ITMC)

As per the 'ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization,' an Institute Technology Management Committee (ITMC; short title for Institute Intellectual Property Management and Technology Transfer/Commercialization Committee, IIPM&TCC) has been constituted for addressing Intellectual Property (IP) related matters of the Institution as detailed in the guidelines. An ITMC comprises a chairman (Director), incharge, PME as a member, one program leader as a member, three technical experts as members, One IPR Expert–member (external) and incharge ITMU will act as member secretary. The ITMC is conveyed twice in year minimum. As per the recommendations of the ITMC, the intellectual property is grouped into five categories and coded as CAFRI/IP/I/001 for convenience. The last two segments of the code represent the category (I, II, III, IV, V) and the '001' indicates the entry number.

Category-I
New Concept

1. CAFRI/IP/I/001 Concept of drought proofing of Bundelkhand Region

Shallow open dug wells are commonly situated in Bundelkhand region which are unconfined aquifer (weathered zone) and these are the major source of drinking and irrigation water. Therefore, saturation of weathered zone is the only option for assured supply of water. Gabions in 1 and 2 order stream followed by series of scientifically and technically sound check dams across the drains in a watershed result in drought proofing with enhanced and sustained rural livelihoods. Even with deficit rainfall by about 30 per cent, water crisis in drought prone Bundelkhand region can be averted. The weathered zone could be fully saturated with 600-700 mm rainfall with above interventions. Therefore, concept developed and successfully tested in Garhkundar-Dabar watershed can be replicated in whole of Bundelkhand region particularly in red soil.

2. CAFRI/IP/I/002 Critical limits of shade for crops of agroforestry importance

To decipher the critical limit of shade for major crops of agroforestry, the impacts of various regimes of shade were assessed on the relative performance of the crop based on physiological and biochemical parameters. The identified critical limits of shade would help to reduce the relative loss of crop yield in the agroforestry systems due to shade. This will address the knowledge gap regarding the optimal light requirement for the crop in an agroforestry system

3. CAFRI/IP/I/003 Concept of assessing soil health in agroforestry systems through soil quality index

A unified soil quality index (SQI) which accounts for 15 indicators has been developed to assess soil health under agroforestry systems This index takes into consideration of soil's physical, chemical and biological properties. With the minimum and maximum thresholds for each indicator, it will be possible to assess the health of the system. During the index development, the biomass productivity of the system was correlated with the unified value of SQI for validation

4. CAFRI/IP/I/004 Agroforestry Extension Framework

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 outs 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 agroforestry extension framework will expedite and simplify the process of upscaling agroforestry at the grassroots level.

5. CAFRI/IP/I/005 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 incubations in the country.

6. CAFRI/IP/I/006 Application of scientometric tools in agroforestry

Scientometrics studies involve the collection of scientific literature metadata, their conversion, extraction, duplicate checking, descriptive analysis and network analysis. Investigation of this sort will help in measuring the scientific productivity of authors, the annual growth rate of publications, citation analysis, productive countries and other information. Scientometrics can be applied to assess individual or institutional progress. For instance, in the scientometrics assessment of ICAR-CAFRI, Jhansi explains the constant growth in scientific contributions made in agroforestry research during 2000-2021. The research will help the research managers and policymakers to understand the role, extent and performance of ICAR-CAFRI reconciling its past research focus for setting future targets to enable a dynamic model framework for transformative research in agroforestry with national and global relevance.

7. CAFRI/IP/I/007 Introspection of agro-ecology from agroforestry perspectives

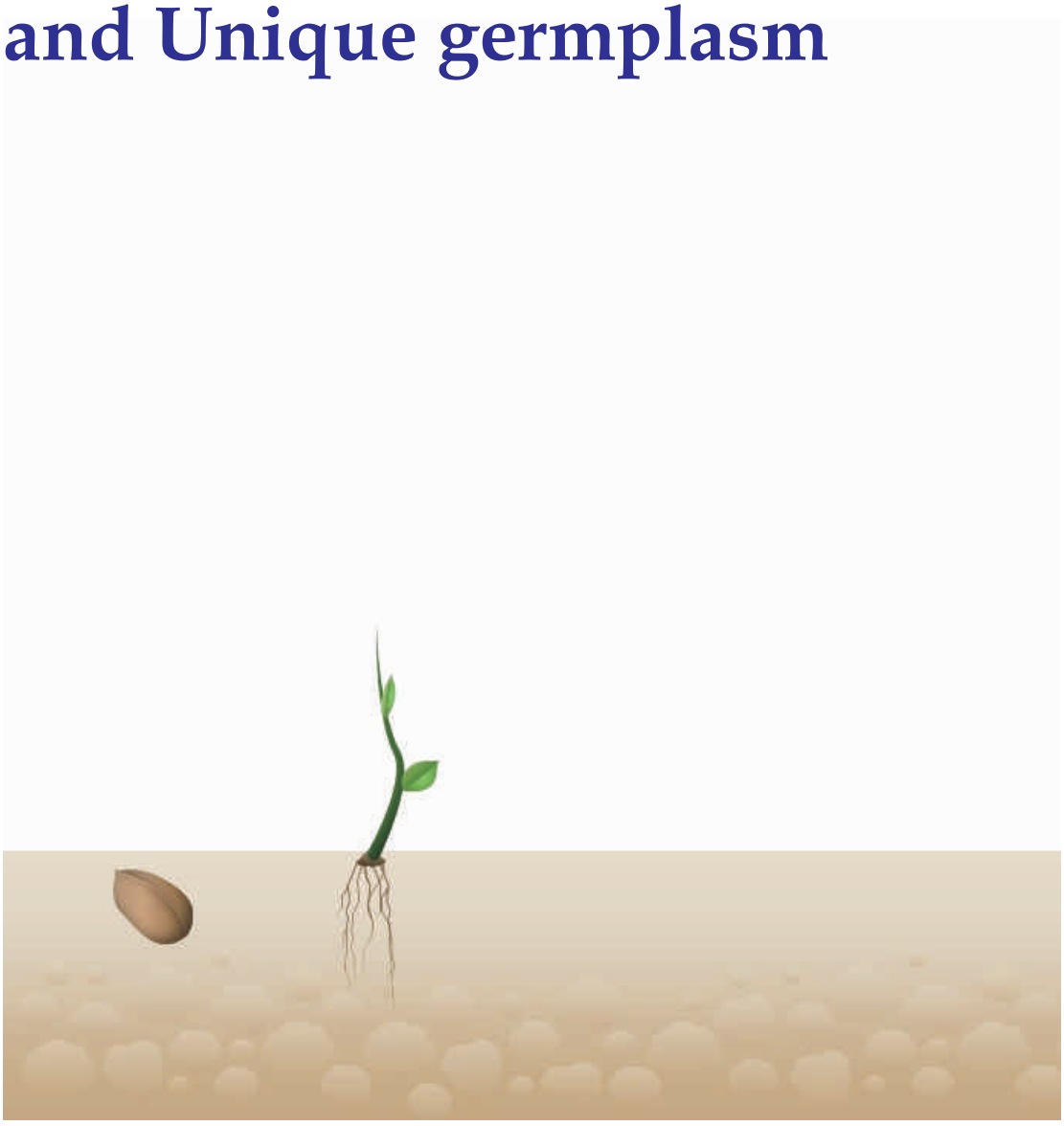
Agroecology as a science focuses on the ecology of the food system. Given that, United Nations in the Food Submit (2021) as well as the researchers are emphasizing that our present food system should adhere to the principles of agroecology. An introspection revealed that agroforestry has more relevance to the scientific domain of agroecology and was observed to adhere to 9 of 13 agroecological principles. Overall observations indicate the opportunity for enabling programmes and projects by taking agroforestry as a futuristic ecological tool to balance environmental principles and various human requirement services for food, fuel, fodder, fibre and fertilizer. Agroforestry as a nature-based solution can help to redefine, refine and reform the existing food systems for ensuring sustainability in food production.

8. CAFRI/IP/I/008 BHAICHARA concept in Agroforestry

Beautifully Harnessing Action & Interest to Create Harmony for Augumenting Resilience in Agriculture (BHAICHARA) – an innovative approach linking Farmer with Field and Fellow. This approach emphasis on farmers opinion and needs first before providing tools and technologies.

Category-II

New process/methodology, and Unique germplasm



9. CAFRI/IP/II/001 Rainwater harvesting and recycling in Bundelkhand watersheds

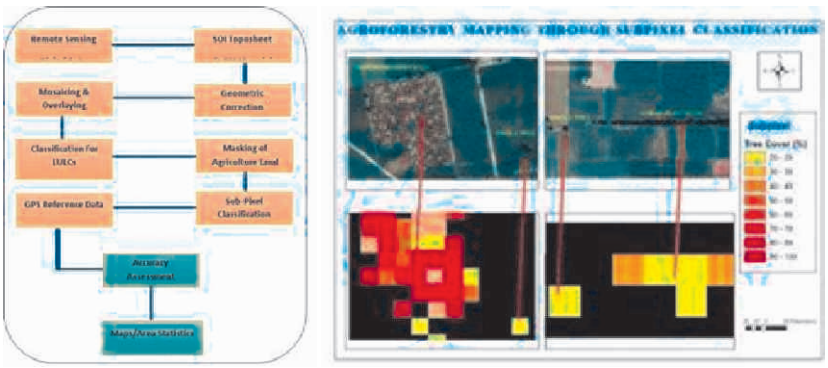
For effective rainwater harvesting on a watershed basis, the ICAR-CAFRI formulated a strategy of laying down 150 gabions check dams of various sizes on 1 and 2 order streams and subsequently constructing eight drop structures/ check dams mainly on 2, 3 and 4 order streams in series enable to store a sizable amount of water. It ensured water availability all over the watershed and increased time for water to infiltrate. Thereby reducing the number of dry wells to 15 per cent in May 2012 from 86 per cent in year 2006. Through this watershed basis approach, the runoff and soil loss reduced by 34 to 46% and 43%, respectively in treated watershed as compared to untreated watershed.

10. CAFRI/IP/III/002 Cost-effective Design of Rain Water Harvesting Structures (RWHS)

This is a technique which was applied in all the checkdams constructed in Garhkundar-Dabar, Domagor–Pahuj and Parasai-Sindh watersheds and these checkdams are serving the community efficiently since 2006 without any repair and maintenance. Construction cost of water harvesting structures (masonry checkdam) and prevention of seepage was reduced through decreased width of foundation after 50 to 70 cm below ground level till depth of foundation. About 10 to 33 cu.m. stone masonry could be saved.

11. CAFRI/IP/II/003 Agroforestry mapping through subpixel classifier

This technology has enables accurate assessment of agroforestry area. This information is essential for both planners and researchers. Researchers need the area estimate for assessment of carbon sequestration potential under agroforestry systems at regional/ country level. For the planning purpose, how much tree cover is still required to be developed to meet the national target of 33 percent. Other agencies like Forest Survey of India may adopt this methodology/ technology for assessment of trees outside forest in rural areas. By this technology, a regular assessment and monitoring can be done at country level.



Source: *Rizvi et al. (2019)*

12. CAFRI/IP/II/004 Design of low-cost check dam using gabion in Bundelkhand region

The low-cost check dam structure was built using gabions inside in Garhkundar-Dabar watershed. Low-cost check dams were on average 32 per cent cheaper and equally efficient as compared to the normal ones. As of now, it does not need any usual repair and maintenance. More than 5000 visitors including students, farmers, development agencies, researchers and policymakers visited the sites.

These structures encourage increased moisture regimes leading to increased cropping area. The design of a low-cost check dam structure has been modified to facilitate the storage of rainwater in addition to reducing flow velocity and controlling soil erosion. This has resulted in a reduction of soil loss and runoff in treated areas as compared to untreated/control areas. Wells in the region have recorded an increase in water level by more than two metres. Water replenishment through the watershed project has reduced the number of dry wells. Now sufficient water is available in the region for drinking and irrigation purposes. Earlier surface water in Nallahs was available for four months only, which is now available for the entire year. Now farmers in the watershed area are increasingly using improved seeds for cultivation.

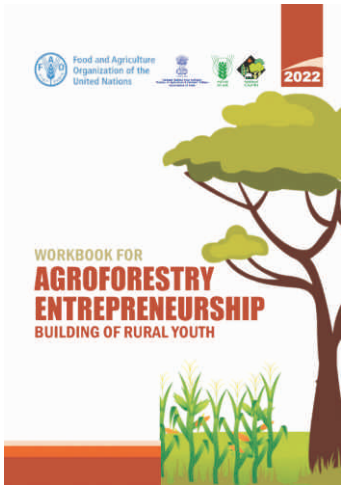
13. CAFRI/IP/II/005 Bundel-2 (PT-2) and Bundel-6 (PT-6) varieties of *D. sissoo*

Superior genotypes of shisham PT-2 and PT-6 have been identified at ICAR-CAFRI (Formerly NRCAF) Jhansi. They are straight, fast in growth and performed well on shallow gravelly red soil under multilocational testing. Improved clones ensured 5-6 m length of clear bole with 14 cm diameter in 10 years with 12m^3/ha /year wood productivity, which was about 30-35% higher over check.

14. CAFRI/IP/II/006 Training manual for agroforestry entrepreneurship building of rural youth

The training manual is ready-to-use material for teaching and training. It deals with:

- Agroforestry Upscaling & Entrepreneurship building of youth
- Planning and developing an agroforestry plan
- Developing and designing agroforestry models at farmers' field
- Young farmer entrepreneurship with agroforestry value chain
- Developing quality planting material
- Developing agroforestry technology
- ICT Tools and applications in agroforestry extension
- Initiatives of GOI for the development of agroforestry



15. CAFRI/IP/II/007 Workbook for agroforestry entrepreneurship building of rural youth

The workbook is a ready to use material for teaching and training. It deals with: How to plan and develop an agroforestry plan? How to develop ad design agroforestry model at farmer' field? And it also deals with farmer entrepreneurship with an agroforestry value chain, developing quality planting material-tree nurseries, developing Agroforestry model technologies. Finally, it provides an insight into the ICT tools application in agroforestry extension.

16. CAFRI/IP/II/008 Gum tapping technique in Butea

The tribes/ gum collectors exploit *Butea monosperma* trees for gum tapping by making deep cuts or incisions on stem bark, which affects tree health with less dividends. Thus, research was carried out involving series of experiments to develop gum tapping technique for *B. monosperma*. Various types of incisions were evaluated. Incision yielding maximum gum was further evaluated for its optimum length, depth and density (number of cuts per feet^2 stem surface area). ICAR-CAFRI has identified the knotching method for maximum gum yield.

17. CAFRI/IP/II/009 Gum-butea based laddu recipe

The gum of *B. monosperma*, known as kamarkas is used in many food dishes. Many household preparations using kamarkas as an ingredient are common in Bundelkhand region. With the help of traditional knowledge, a recipe for preparing laddu using gum-butea (Kamarkas) was standardized. The main ingredients of the recipe for preparing laddu are gum-butea or palas gum (kamarkas) : 50-100 g, desi ghee : 500 g, wheat flour : 1 kg, jaggery/sugar : 500 g, almonds : 75 g, cashew : 75 g, resins (kismis) : 75 g, dry dates : 75 g, makhana : 75 g, dry ginger power : 20 g.

Gum-butea based laddu

18. CAFRI/IP/II/010 Faster and efficient genomic DNA isolation protocol for agroforestry tree species

Agroforestry trees are considered multi-purpose and used as timber, biofuel, fodder tree-based value-added products, etc. There is a need to isolate the genomic data for tree improvement works and this methodology ensures that better isolation of genomic DNA (Deoxyribonucleic acid) from a very less amount of leaf tissue and without liquid nitrogen and ß-mercaptoethanol.

19. CAFRI/IP/II/011 Redefined logarithmic spiral trenching to understand the root structure and distribution of trees

Compared to the classical whole root excavation methodology, this redefined logarithmic spiral trenching technique can effectively reduce the excavation cost. This is suitable for studying root structure and distribution of trees and woody perennials.

Source: Ramanan et al. (2020)

20. CAFRI/IP/II/012 Unique neem germplasm with high oil content/yield

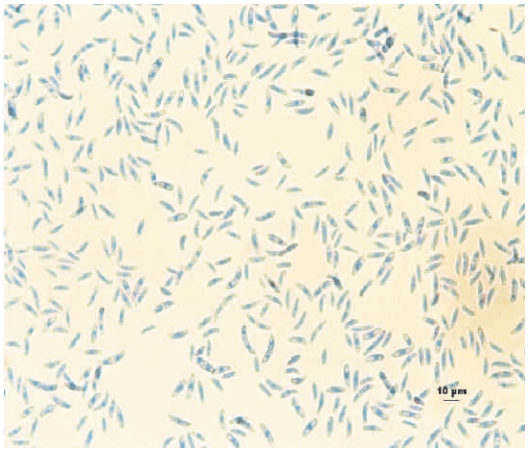
Based on the oil yield traits assessment among the 170 neem germplasms, we have identified VKAF11, VKAF3, VKAF13, VKAF9, VKAF67, VKAF68, VKAF92, VKAF110, VKAF85, VKAF43 and OR05 as the potential germplasm for higher oil content, seed and kernel yield. The evaluation was done at CAFRI itself in a rainfed/semi-arid region. Therefore, based on the evaluation those germplasm was identified could be suitable for rainfed areas.

Source: ICAR-CAFRI

21. CAFRI/IP/II/013 Single strain of *Fusarium solani* causing wilt disease in Malabar Neem

Whitish aerial septate mycelium with dark purple diffusing pigment able to produce abundant microconidia and cover 90 mm dia. within 5 days incubated at 25±2°C temperature. The microconidia were single celled or 1 septate, oval in shape, and the macroconidia 3-5 septate, cylindrical, thick-walled, moderately curved and stout with a blunt and round apical cell and distinctly foot-shaped or notched basal cell.

The pure culture has been isolated and deposited (MCC 9877) in the National Centre for Microbial Resources, Pune.

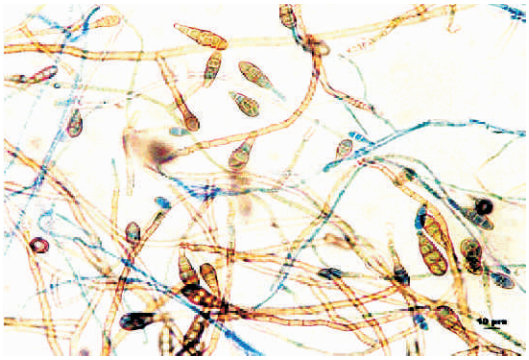


Source: ICAR-CAFRI

22. CAFRI/IP/II/014 Two strains of *Alternaria alternata* causing teak leaf blight

Dark olive greyish-green septate mycelium produces abundant muriform conidia and cover 90mm dia. within 10 days, incubated at 25+2 °C temperature. The multi celled, obclavate to obpyriform conidia with short conidial beaks conidia are produced in branched acropetal chains.

The pure culture has been isolated and deposited (MCC9878) in the National Centre for Microbial Resources, Pune.



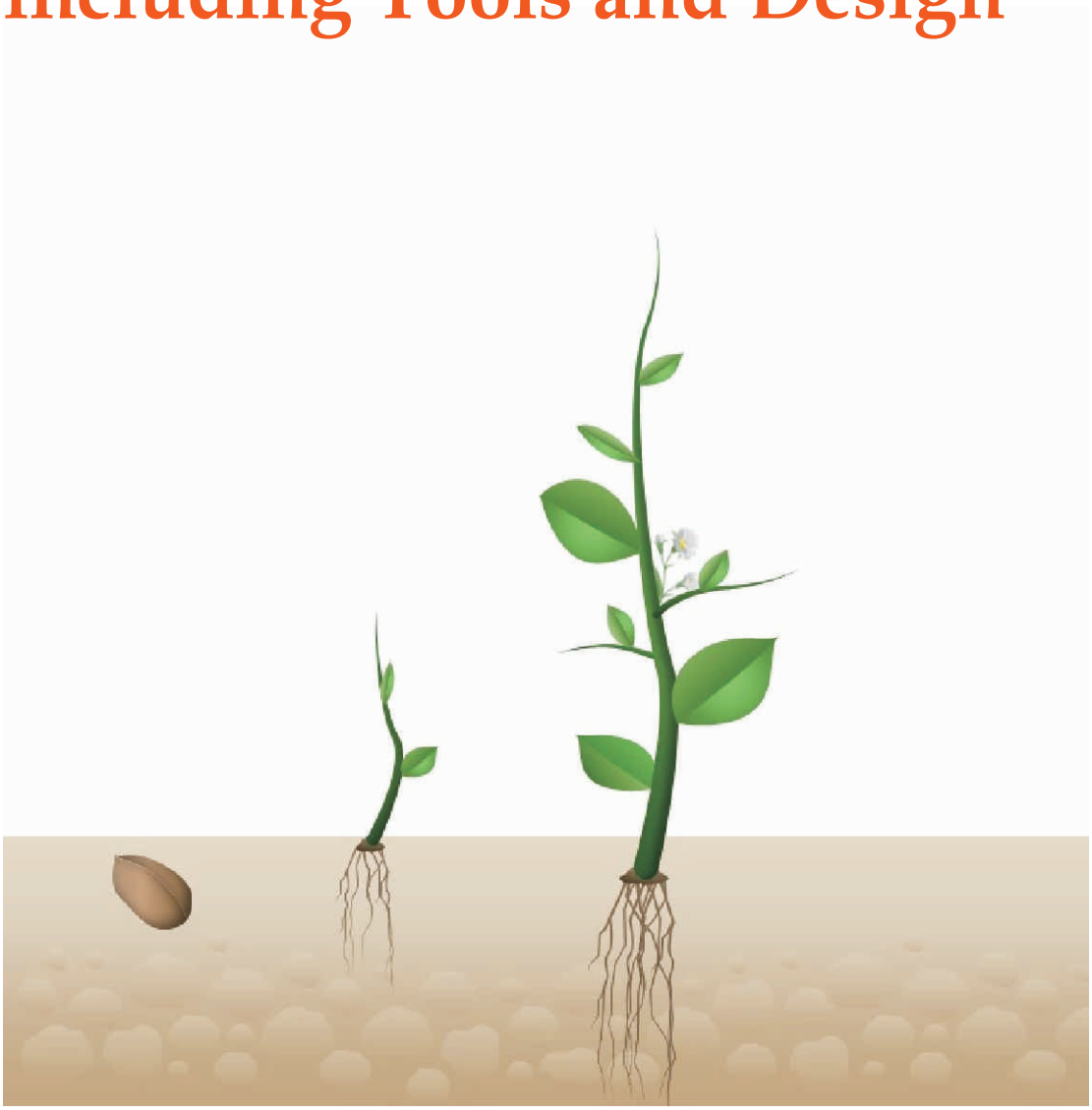
Source: ICAR-CAFRI

23. CAFRI/IP/II/015 Unique methodology to quantify fuelwood from agroforestry

It is a methodology to quantify fuelwood from agroforestry and its opportunity cost. This methodology quantified that about 64% fuelwood for cooking was from agroforestry generating about 1297.4 PJ of calorific energy.

Category-III

Technologies and Products including Tools and Design



24. CAFRI/IP/III/001 Top Working of Carissa (Wild karonda)

Carissa spinarum is a common shrub on wastelands and barren lands. The technique envisages heading back rootstock (about 15 cm above ground level) in the month of March. Selection of 2-3 coppiced shoots per plant for top working and finally shield budding on the rootstocks in the month of May-June with improved "American redwhite" variety of large fruit Karonda. Meanwhile, shoots emerging on the rootstocks are removed time to time. Initially growth of ultimate plant is slow, however plant growth improves with time. This technology can enhance quality fruit production from waste lands and simultaneously contribute to the protection of degraded lands.

25. CAFRI/IP/III/002 Methodology for early selection of elite trees of *Acacia nilotica*

After assessing the performance of 15 selected families of *A. nilotica* continuously from the seedling stage. Significantly high age-age correlations found between ages 48 and 60 months and also between 60 and 72 months for three traits viz. height, collar diameter and dbh, clearly indicated that growth of trees at an older age is closely related to growth at a younger age. Biomass equations were also developed for this species.

26. CAFRI/IP/III/003 Prevention of seepage through rainwater harvesting structures

Construction of rainwater harvesting structures/pucca checkdam requires huge sums and its efficacy is greatly hampered due to seepage. This technique will stop seepage from old checkdam adopted by different agencies in Bundelkhand region. The technique encompasses excavation of trench up to required foundation level for the structure along the headwall and headwall extension in upstream, cement concrete, cement coating and black cotton without kankar.

27. CAFRI/IP/III/004 Bench grafting in Aonla for production of quality planting material

Scion (8-9 months old) and length of 12-15 cm can be used for cleft grafting. Grafts are then replanted in polythene bags filled with soil+FYM (1:1). After placing grafts in polythene bags they are covered with 2.5 cm wide and 18- 20 cm long polytube (cap).

28. CAFRI/IP/III/005 Bench grafting in Ber (*Zizyphus* spp.)

Bench grafting in ber takes advantage of dormancy in ber and it envisages collecting scion shoot (8-9 months old) from desired variety and cleft grafting on bare rooted stock. They are shifted in polythene bags filled with 1:1 soil FYM mixture and capped with polytube 2.5 x 18-20 cm size. Union takes place within 15-20 days and scion starts sprouting.

29. CAFRI/IP/III/006 Air layering of neem

Superior genotypes of Neem identified on the basis of fast growth, straight bole, fruit yield, oil content and azadirachtin content can be vegetatively propagated. One-year old semi-hard terminal shoots are air layered using 200 ppm IBA wrapped with wet moss grasses in July gives above 70% rooting in layers. Such plants gives fruiting in ensuring summers and facilitate quick evaluation of germplasm for oil content and azadiractin, the active ingredient for insecticidal property.

30. CAFRI/IP/III/007 Vegetative propagation of *Pongamia pinnata* through stem cuttings and air layering

Stem cuttings (15 – 20 cm length) were taken from selected mature mother trees (10 – 12-year-old) during February and treated with IBA 400 ppm for 12 hrs. The stem-cutting tip covered with wax. Then immediately placed in polythene bags (10 x 20 cm) filled with soil+FYM. The stem cuttings are watered and place under partial shade or mist chamber at 25 C and relative humidity 60–70%. Sprouting takes place within a 10 – 15 days and rooting within a month with more than 70 per cent success. The stem cutting plants are ready for plantation in ensuring monsoon season.

31. CAFRI/IP/III/008 Development & testing of age-age correlation models

An age-age correlation is an important tool for early selection of progenies in tree improvement programme to shorten the breeding cycle. The age-age correlation models were developed and employed for *Dalbergia sissoo* and age of early selection is determined. Empirical models were fitted for age-age correlations for tree traits viz. height, diameter at breast height and D2H.

32. CAFRI/IP/III/009 FarmTree mobile *app*

The FarmTree mobile *app* provides a user-friendly, bi-lingual, e-platform to have all basic information on 20 commonly grown promising agroforestry tree species by farmers at their farm. It covers various aspects like common name, botanical name, family, potential area, silvicultural requirements, nursery techniques, planting techniques, tending operations, suitable agroforestry systems, tree protection, yield, utilization and material availability. FarmTree provides appropriate content supported by beautiful original photographs making it more useful for forestry professionals, naturalists, forest department personnel, students and farmers. FarmTree also provides its users a platform of having a discussion on its public forum, sending a query directly to the developers, attaching a photograph for easy communication, contacting experts and knowing how to avail the materials.

33. CAFRI/IP/III/010 Development of Bamboo Based Agroforestry Systems for Six Agroclimatic Zones

This as a coordinated research project with ICAR-CAFRI (Formerly NRCAF), Jhansi, as lead centre and five other centres in different agro-climatic zones viz. Guwahati (Assam), Jhargram (West Bengal), Bhubneshwar (Orissa), Dharwad (Karnataka) and Dapoli (Maharashtra), aimed to develop bamboo based agroforestry models for different agro-climatic zones at each centre. Growth of three bamboo species agroforestry system after three years revealed that mean plant height was recorded maximum in *Bambusa vulgaris* (668.96cm) followed by *Dendrocalamus strictus* (548.53) and *Bambusa tulda* (229.56cm). Clump diameter was heights in *Bambusa vulgaris* (568.85 cm) followed by *D. strictus* (554.69cm) and least in *B. tulda* (327.40cm). Highest mean number of culms/clump was recorded in *B. tulda* (33.96) and least in *B. vulgaris* (25.93). Average number of new culms/clump was highest in *B. tulda* (4.70) and lowest in *B. vulgaris* (1.73). Average height of five culms highest was in *B. vulgaris* (599.28cm), followed by *D. strictus* (473.97cm) and *B. tulda* (186.58cm). Further *B. vulgaris* was found superior to *D. strictus* and *B. tulda* in respect to the length and diameter of 3rd internode.

34. CAFRI/IP/III/011 Plantation/Nursery Kit (Tool Kit) - A Prototype

The comprehensive multipurpose plantation tool kit for nurseries and plantations has the following 22 assemblies. All these 22 tools/items have been kept in a specifically designed, durable, water-resistant and compact bag to make it user-friendly enough to the beginners, practitioners and managers of nurseries. It can meet the requirement in day-to-day working of commercial nursery growers, farm activities in nurseries or kitchen gardens. It is also suitable for urban gardening as well as for practice in nursery operations by students of Forestry, Horticulture and Agriculture.

Source: ICAR-CAFRI

35. CAFRI/IP/III/012 Plant Breeding Kit (Tool Kit) - A Prototype

This readymade 'Plant Breeding Kit' comprises of 35 items that facilitate the whole process of plant breeding and will offer researchers, teachers and students to have all fundamental and essential tools or instruments required for carrying out basic breeding or crossing programs in a diverse range of crop species. Right from sterilization of tools before use to avoid contamination, to emasculation, pollen collection, hand pollination, bagging, tagging, recording observations, etc., all kinds of jobs can be done with relatively a higher efficiency using this kit. It has been designed to be light, handy and, portable.

Source: ICAR-CAFRI

36. CAFRI/IP/III/014 Unique design of bill hook for tapping gum-butea

Traditionally tribal people used to tap gum butea by making cuts with axe which damaged trees and wounds could not healed up in a year to allow gum tapping regularly on year to year basis. Further, the gum yield was also less. To make improvement in this tapping technique and ensure more gum yield, a special bill hook having three side sharp edges (cutting edge, lateral edge and tip or toe) was designed and got fabricated locally for tapping gum butea (Kamarkas) from *Butea monosperma* trees. The wooden handle was fixed at the end of leg. The lateral (upper edge) is used to remove dead bark by sliding billhook upward on the stem of trees. The cutting edge is used to remove small branches and bushes surrounding trees. The tip or toe is used to make incision or cuts on stem surface of the trees With this bill hook the gum yield per unit stem area increases and the wounds are healed up within a year allowing trees to be tapped regularly on year to year basis.

37. CAFRI/IP/III/013 Tree foliage based vermicompost

Agroforestry systems yield diversified outputs in the form of wood (timber, fuel wood), fodder/grasses, fruits, grains, pulses, NWFPS etc. In the process of production of economic outputs, different wastes in the form of weeds, crop residues, leaf litter etc. also resulted from agroforestry systems, which require proper management for their efficient utilization otherwise they create hindrance to the production system.

Conversion of these wastes in compost is one of the best approaches to create wealth out of wastes by utilizing these wastes to improve the soil health and thereby to increase the system productivity. Considering all these aspects, ICAR-Central Agroforestry Research Institute, Jhansi transformed these wastes in nutritionally rich vermicompost (1.2-2.0% N, 1.0-1.5% P and 0.5-0.7% K) by using Eisenia fetida (earthworm species) and cow dung. This approach helps in faster decomposition of different wastes in nutritionally rich vermicompost and vis a vis helps in management of the different wastes. This techniques will be helpful to the farmers which faces a great challenge to manage the farm wastes and generally burn them in the fields and accelerate the global warming through emission of greenhouse gases during burning process.

Source: ICAR-CAFRI

38. CAFRI/IP/III/015 Development of an android-based 'Learn Agroforestry' mobile app for Capsule Course on Agroforestry

The mobile app is one of the pillars of the digital revolution in India and there are more than 1 billion smartphone mobile users in India. It will be an apt time to capitalize it for the upscaling of agroforestry. Training in agroforestry research is one of the mandates of the ICAR-CAFRI. This app will be a window to reach out to

interested candidates to enrich their knowledge of Agroforestry Research and Development Methodologies.

39. CAFRI/IP/III/016 Leucaena specific SSR marker

The estimation of genetic diversity and population structure, 23 accessions of *Leucaena leucocephala* were characterized using morphological and molecular markers. A medium to high degree of genetic variability was calculated among these accessions based on eight quantitative traits. Overall, the high degree of genetic variability described by morphological and molecular markers in *L. leucocephala* can be used as a basic tool for assessing genetic diversity and linkage mapping in Leucaena genetic improvement programs.

40. CAFRI/IP/III/017 Statistical tool for eucalyptus growth study

Eucalyptus is a tree of great economic importance owing to its multiple uses like raw material for pulp and paper production industry along with other utilities (valued for their oil, gum and timber). Non-linear models establishing height-dbh relationship were developed that gave reasonable estimations with high R^2-values. Such, non-linear allometric models have been developed separately for boundary plantation, agrisilviculture system and compact block plantation.

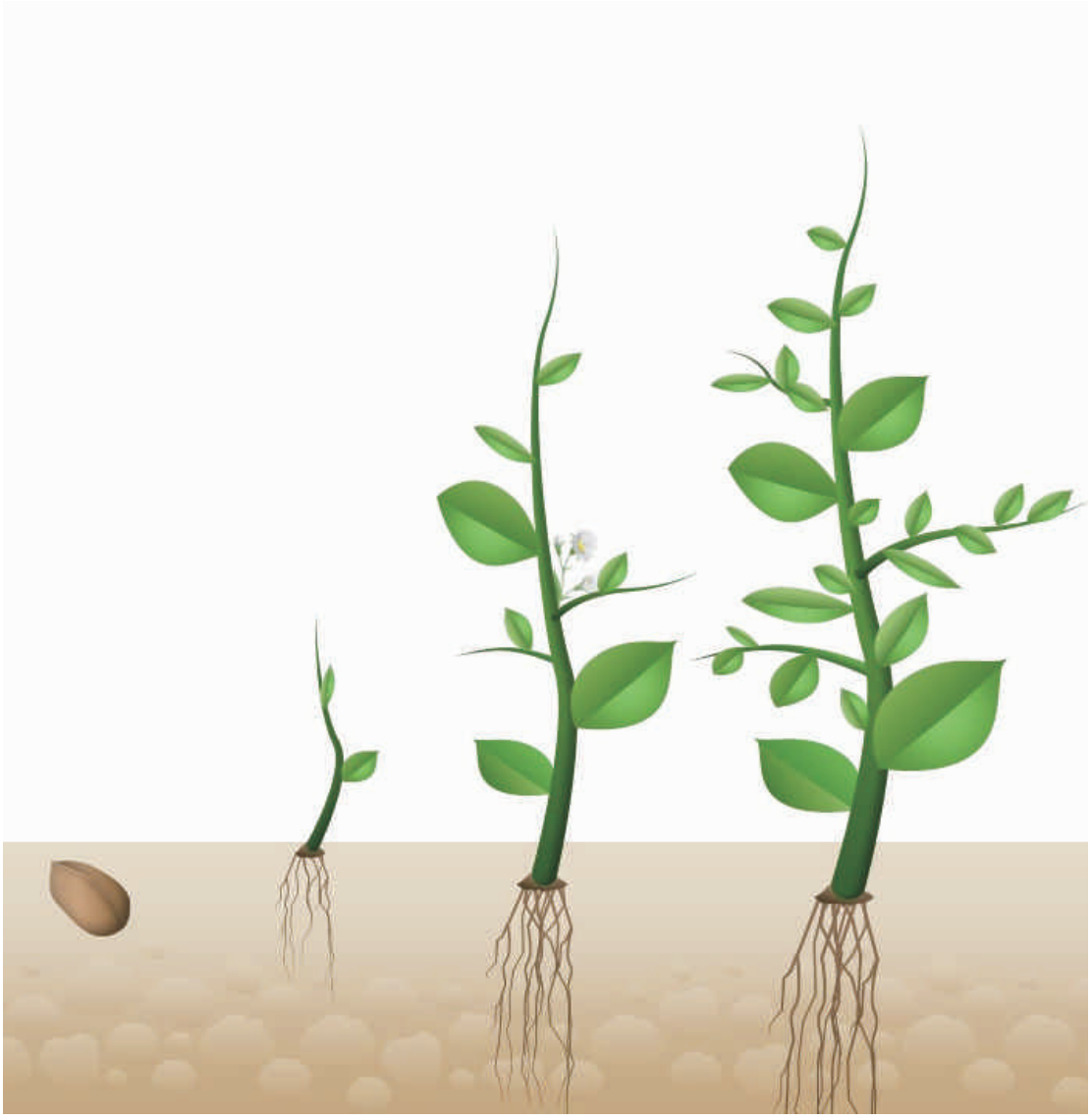
41. CAFRI/IP/III/018 Non-Linear statistical tool for *Acacia nilotica* growth study

Acacia nilotica is one of the most common and important tree species found in dry areas of the Indian sub-continent. As height of the *Acacia nilotica* tree increases with age, its measurement becomes difficult. Further, in case of dense plantations, the canopy diameter is not measurable. So, it is imperative to establish relationships between height and diameter at breast height and also canopy diameter and dbh, which is easily measurable. The non-linear model for height has been developed and validated statistically. Anamorphic height models is helpful in estimating height of the trees in similar age stands.

42. CAFRI/IP/III/019 Farmer-friendly technique for multiplication of *Bambusa vugaris*

Bamboo is the green gold of the 21st century and also known as 'poor man's timber'. *Bambusa vulgaris* was multiplied by burying whole culms at the Research Farm of ICAR-Central Agroforestry Research Institute, Jhansi. The culm planting method resulted in prolific rooting pattern during monsoon season, and on an average 5.7 rooted plants were obtained from every alternate node. Rooted sprouts were separated from each productive node along with fibrous roots attached to it and were planted in polythene bags as new plantlets. This technique of multiplication of bamboo helps in faster establishment of bamboo fence and for producing a large number of plants from scarce planting material.

Category-IV
Package of Practice(s)



43. CAFRI/IP/IV/001 Eucalyptus based agrisilviculture system

Eucalyptus is highly versatile with respect to edaphoclimatic requirements. Improved clones (propagated by cutting) of *E. tereticornis* (C-3, C-6, C-7 and C-10) under block plantation, boundary plantation and agrisilviculture system at 10x2 m spacing in 1 rotation of 5 years enhanced overall productivity on sustained basis. It can be planted as boundary plantation (2x2m in chess board pattern in 2-3 rows) or block plantation (3x3 m) or as agrisilviculture land use (10x2m). The species is highly suited for boundary plantation under agroforestry system in rainfed areas.

44. CAFRI/IP/IV/002 Aonla based agroforestry land use for rainfed condition in Bundelkhand

Aonla can be planted with different planting techniques like sunken method of planting, stone mulching and sunken method of planting associated with deep tillage followed by kharif crop to retain residual moisture and increase the water infiltration into deeper soil layer. In border, different varieties of aonla like NA 6, NA 10 and Krishna can be planted with same method of planting to facilitate proper pollination. The aonla is planted at 10 x 10 m spacing.

45. CAFRI/IP/IV/003 Developing live fencing systems for soil and water conservation

Four live-fence species/species combinations viz., (i) two rows of Karaunda (*Carissa carandas* Linn.), (ii) two rows of lantana (*Lantana camara* Linn.), (iii) one row of rambas/ sisal (*Agave sisilana* Perr. + *A. americana* Linn.) and one row of mehandi (*Lawsonia inermis* Linn.) and (iv) one row of cactus (*Opuntia ficus-indica* Mill.) and one row of *L. inermis* under two method of planting (flat and ridge) were studied to identify the suitable live-fence species, planting method, effect on associated crops and soil and water conservation. Results showed that the ridge method of planting gave on an average higher survival (89.93%), plant height (124.2 cm), CD (2.99 cm) canopy (123.96 cm) of live fence than flat planting survival (86.56%), plant height (114.98 m), CD (2.37 cm) and canopy (120.85 cm). After 36 month of establishment of live fence showed higher root-shoot ratio on ridge method of planting compared to flat method of planting. Among the species *Carissa carandas* recorded maximum root:shoot ratio 0.55 followed by *L. inermis* 0.22 and minimum was in Agave (0.04). The litter fall of bio-fence species were recorded maximum litter of 199 g per 2 m^2 for *L. inermis* followed by *L. camara* 123 g per 2 m^2. Maximum grain production with bio-fence species was recorded with *Carissa carandas* (879 kg ha^{-1}) followed by agave + *L. inermis* and minimum with *L. camara.*

46. CAFRI/IP/IV/004 Standardization of nursery techniques for *Pongamia pinnata*

Seeds stored for three and six months in airtight plastic container and plastic bags showed

high variability. A large percentage of seeds remain viable in storage containers even after six months and can be used effectively for seed storage. Germination value was found maximum in airtight container after 9 and 12 month of storage period (68.35 and 43.43) and minimum in paper bag container (9 12.03 and 6.33) after 9 and 12 months storage, respectively. The trend for mean daily germination (MDG) was similar as compared to other germination parameters and minimum MDG after nine (4.81) and twelve months (3.32) was observed for seeds stored in airtight plastic container. *Pongamia pinnata* can tolerate a wide range of pH and can grow adequately from pH 5 to 8. The results also indicated that seedlings of *Pongamia pinnata* perform well at neutral pH beyond that growth and biomass decreased with increasing level of pH. However, pH 7 recorded maximum germination percentage (91.06%) and germination energy index was 684.3.

47. CAFRI/IP/IV/005 Package of practice for *Acacia senegal* based agroforestry model

The package of practices was developed for a multi-component *Acacia senegal* based agroforestry model. The agroforestry model comprised of five components viz., woody tree- *A. senegal* (gum arabic), three fruit plants (*Aegle marmelos, Citrus lemon* and *Carissa carandas*) and intercrops (black-gram/ green-gram – mustard/ wheat for kharif and rabi seasons, respectively). This model has been designed for smallholder farmers (0.5 ha) in such a way that the payback period from investment on agroforestry is reduced, as long gestation period is an important bottleneck in adoption of agroforestry by farmers.

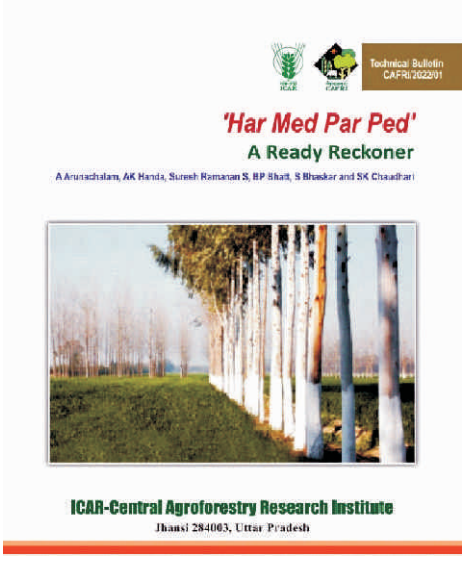
Source: ICAR-CAFRI

48. CAFRI/IP/IV/006 *Acacia senegal* based bio-fence model

In Bundelkhand region, anna-pratha (letting loose cattle which graze openly in farmland) causes about 15% loss in crop productivity of agricultural lands, and farmers face great difficulty in protecting their crops. Research was initiated to develop effective bio-fence model based on *A. senegal*, a gum-yielding tree. Out of four bio-fence models established at research farm, the double row bio-fence model has been found most effective. This model involves double row planting of *A. senegal* along the field boundary. The distance of 1.5 m between two rows and plant to plant within a row was most optimum. Planting was done in staggered manner in two rows. After four years, this bio-fence becomes effective in controlling the entry of stray cattle in the field.

49. CAFRI/IP/IV/007 A ready reckoner on *Har Med Par Ped*

"Har Med Par Ped" is a slogan of the Government of India for enhancing tree cover in the country while also enhancing the income of farmers by advocating agroforestry as an alternative and diversified land-use. This calls for mass awareness about the tree plantation on farm bunds and boundaries so that suitable tree species are chosen for different regions without compromising the prevailing land tenure system. This has a larger canvas of provisioning livelihood and environmental securities together. With these viewpoints, ICAR-Central Agroforestry Research Institute, Jhansi along with its centres of the All India Coordinated Research Project on Agroforestry took the challenge to



Source: ICAR-CAFRI

popularize the concept of farm boundary plantation among the masses including school children and other stakeholders.

This technical bulletin not only provides detailed information on the suitable tree species for plantation on farm bunds/boundaries. It also highlights the ownership and land tenure issues that are attached to the farm landholdings requiring attention considering the socio-cultural implications. The document is useful for all stakeholders in the farm and forest sector to have a common ground to work together and address the mission '*Har Med Par Ped*' with a larger perspective of meeting the country's ecological sustainability by provisioning thirty-three per cent tree cover.

50. CAFRI/IP/IV/008 Strawberry production technology for Bundelkhand

Strawberry is a perennial small herbaceous plant of Rosacea family which has shallow roots and fibrous root and has tap root system. It is one of the most delicious and refreshing fruit in the world.

Source: ICAR-CAFRI

1. **Soil:** Strawberry requires well sandy to loamy soils and grows well in acidic (pH 5.5 -6.5) to neutral soils (pH 7.0).
2. **Climate:** Strawberry is a short day plant and the optimum temperature required for strawberry cultivation is between 20 and 29°C.
3. **Manures and Fertilizers:** Depending on the soil type and the planted variety, a basal fertilizer dose of 25–50 tonnes farmyard manure, 75–100 Kg N, 40–120 kg P_2O_5, and 40–80 kg K_2O/ha may be used. Foliar applications of urea (2%), zinc sulphate (0.5%), calcium sulphate (0.5%), and boric acid (0.2%) are advantageous for quality and better production in addition to the recommended dose of manures and fertilizers.
4. **Irrigation & Fertigation**

   Drip irrigation: Strawberry has shallow root system and needs frequent drip irrigation to maintain the moisture level in the root zone.

   Fertigation: Fertigation is an effective technique for applying nutrients which involves injecting fertilisers through an irrigation system.
5. **Planting time:** The time and planting season for strawberry cultivation depends on the geographical conditions and climate of that particular area. The planting time in different part of the country is given below.

North India: September-January

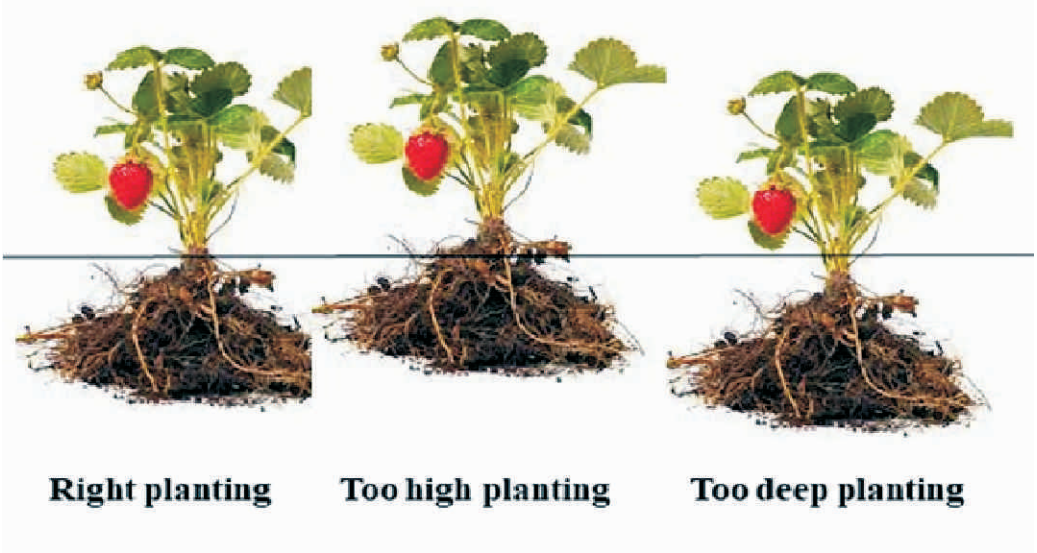
North East India: November-January

South India: November-January & August

Maharashtra: Last week of August-November

Central India: October-November

6. **Planting method & spacing:** For fruit production strawberry plants are grown 30 to 45 cm apart with a distance of 60 to 90 cm between the rows.
7. **Mulching:** Different types of mulching is being used in strawberry i.e. Black / Black polythene, Black / Silver polythene double colour, transparent or white polythene, straw and jute based mulching.
8. **Intercropping:** Strawberry can be planted as intercrops in young orchards. However, alternate interspace between two beds can be viably used to grow different short duration vegetables.
9. **Weeding:** Frequent weeding of strawberry plots is very essential.
10. **Yield and Harvest:** If produce has to be sold into long distance market then fruit should be harvest when it attains 50-75 % maturity and for local market fruit should be harvest when it attains 75-100 % maturity. The yield varied in strawberry from 100 to 1200g/ plant with an average around 400-600 g per plant.

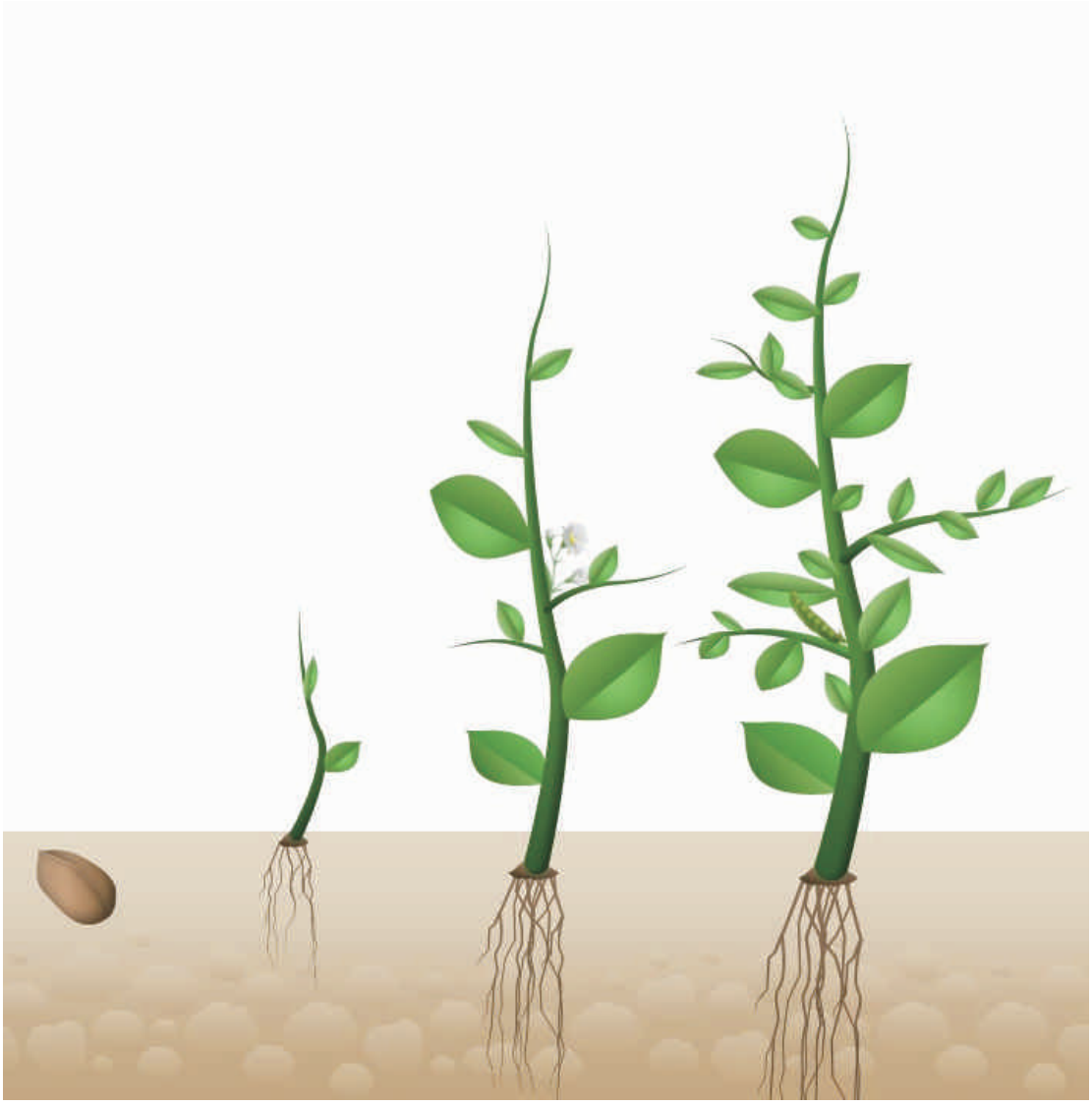


51. CAFRI/IP/IV/009 Bamboo (*Dendrocalamus strictus*) + Sesame (*Sesamum indicum*) based agroforestry model

Seasame is an ideal crop component for the *Dendrocalamus strictus* based agroforestry system. Typically, bamboo lacking taproot system was not ideal choice for agroforestry system owing to the belief that the fibrous root system would compete with crop component. The data suggested that bamboo did not influence the sesame yields during

initial two years, however, yield level got reduced during subsequent years. During 5th year intercropped sesame yield got reduced 15.69% (10m × 10m bamboo) and 10.09% (10m × 12m bamboo) as compared to pure crop. At harvest stage of bamboo (5th year), highest B:C ratio of 2.83 was however observed in 10m×10m bamboo + sesame followed by 2.59 (10m×12m bamboo + sesame) and 1.43 (pure sesame). This bamboo based agroforestry has economic and environmental advantages over the sole crop and due to this, the system could be one of best alternative livelihood options for farmers in the semi-arid tropics.

Category-IV
Strategic Knowledge



52. CAFRI/IP/V/001 Tree-Crop interaction in *Albizia procera*-based agroforestry system in relation to soil moisture, light and nutrients

The growth of *Albizia procera* was less in black gram-mustard crop sequence as compared to soybean-wheat crop sequence. The growth of trees was lowest under soil barrier followed by pruning (70% of plant height). The growth of trees was highest under the treatments where in crops received irrigation. The tree growth was in order of irrigation > pruning > soil barrier.

53. CAFRI/IP/V/002 Screening and selection of efficient vesicular arbuscular mycorrhizae for selected minor fruits - Anola, Ber, Chironji and Lasoda

Aonla, maximum colonization index was recorded in Krishna (22.7%), followed by Kanchan (20.0%), Chakaiya (16.5%) and NA-7 (16.3%) variety. Colonization index in Krishna was at par with Kanchan and superior to Chakaiya and NA-7. Five AM species belonging to three genera namely, *Glomus*, *Acaulospora* and *Gigaspora*, were common in rhizosphere of different Aonla varieties.

Ber varieties/wild relative maximum colonization index was recorded in Banarsi karaka (32.1%) and Seo (32.1%), followed by Ghot (30.0%), Makor (28.6%), Jharberi (28.1%) and Desi (27.8%) and was non-significant. Colonization index of Chironji at its two sites i.e. Jakhlon (27.0%) and Nilkanth (18.9%) were non-significant. Maximum total spore count was recorded for *Glomus* 1 (61), followed by *Glomus* II (29), *Acaulospora* 1 (4) and *Acaulospora* II (2). Among different Lasoda sites, maximum spore count was in ICAR-CAFRI, block plantation (77), followed by ICAR-CAFRI, silvipasture site (60) and in Nareta village (0). Among different soil types, maximum colonization index was recorded in lateritic soil (27.9%), which was significantly more than colonization in red (21.2%) and black soils (17.9). Maximum total spore count was recorded in lateritic soil (376), followed by black soil (221) and red soil (122). Six cultures of *Glomus* sp. and one culture of *Acaulospora* were purified from trap cultures set to isolated AM fungi from rhizosphere of Aonla, Ber, Chironji and Lasoda.

54. CAFRI/IP/V/003 Screening and selection of efficient vesicular arbuscular mycorrhizae for *Jatropha curcas* and *Pongamia pinnata*

Twenty AM species belonging to 2 genera (*Acaulospora* and *Glomus*) were recorded in rhizosphere of *J. curcas* and fifteen AM species belonging to three genera were identified in rhizosphere of *P. pinnata*. Results on evaluation of AMF coupled with in-situ water harvesting for survival and growth of seedlings (sowing during July 2010) showed that after the summer in July 2011, the survival percentage of *J. curcas* reduced from 19 to 8% and from 90 to 48% in *P. pinnata* in black soil. After the second summer (July, 2012), the survival percentage of *J. curcas* and *P. pinnata* reduced to 6 and 47%, respectively. Survival

of *J. curcas* was 74 and 46 %, respectively in red soil and hillock after rainy season, 53 and 34% after winters and 50 and 28 % after summers. Thus, survival of was more in red soil as compared hillock. Best growth in terms of shoot length and collar diameter was recorded in black soil, followed by red soil and hillock soil.

55. CAFRI/IP/V/004 Carbon and Nitrogen dynamics in *Albizia procera-based* agroforestry system

The growth of *Albizia procera* (dbh and height) increased with tree age and increment in dbh and height was almost stable at 5 to 7 years. Tree growth was slightly higher in black gram – mustard as compared to greengram – wheat crop sequence. The growth of pure tree (without crop) was less than trees in the agrisilviculture system. Tree biomass increased with age with a mean annual increment of 6.30 t ha^{-1} $year^{-1}$. Allocation of biomass in different tree components was in the order of branch > root > main bole > foliage. Tree biomass with black gram – mustard crop sequence was comparatively higher than greengram – wheat crop sequence. Among the pruning regimes, unpruned trees had significantly higher biomass than 50 and 70% canopy pruned trees.

56. CAFRI/IP/V/005 Carbon sequestration potential of agroforestry systems has under irrigated and rainfed conditions: *Albizia procera, Anogeissus pendula, Azadirachta indica, Acacia nilotica, Butea monosperma, Dalbergia sissoo, Embilica officinalis, Eucalyptus tereticornis, Mangifera indica, Madhuca longifolia, Melia azedarach, Populus deltoides* and *Tectona grandis*

The total carbon stock in above, belowground biomass, soil carbon, non-woody litter was 6.2, 4.95, 9.44 and 0.65 t C ha^{-1}, respectively during 2009 and the carbon stocks in these pools would be 12.03, 7.5, 16.21 and 2.34 t C ha^{-1}, respectively after 21-years.The carbon sequestration potential of agroforestry practices in Jhansi districts was 20.6 t C ha^{-1} in 2009 and it would increase up to 35.74 t C ha^{-1} after 21-years. *Albizia procera* accumulated maximum biomass (308.15 t ha^{-1}) at the age of 30-years with 312 trees per hectare. *Dalbergia sissoo* could accumulate only 120.13 t ha^{-1} biomass at same age and tree density. The contribution of individual tree species in total tree population in the district is in order of *Eucalyptus tereticornis* (35.19%) > *Mangifera indica* (23.33%) >*Azadirachta indica* (5.05%)> *Madhuca latifolia* (4.87%)>*Delbergia sissoo* (3.93%). The contribution of *Populus deltoides* in total tree population is 53.2% followed by *Eucalyptus tereticornis* (28.2%) and *Melia azaderach* (14.98%).

57. CAFRI/IP/V/006 Plant traits for shade tolerance of crops under agroforestry

Land productivity per unit area is one of the major prioritized issues for researchers and policymakers. Trees being integral component of agroforestry systems, tree canopy

imposes limitation for light interception to the understory crops. Due to low incident light under the canopy, the resultant shade poses a major constraint for optimal crop productivity in comparison to the sole crop being grown without any trees. Intensity of shade varies from partial to deep depending upon the tree canopy, its growing pattern and the microclimate. Thus, it was essential to understand the acclimation strategies of the crops of agroforestry importance for evaluation and selection for shade tolerance. After comprehensive research various responsive traits have been identified associated with the evaluation of shade tolerance of crop species for agroforestry systems. The identified traits facilitated for better understanding and selection for shade resilience of crops grown in agroforestry systems. Further, the identified traits abetted in selection of a few crops of agroforestry importance for their relatively better shade adaptability and resilience for agroforestry systems.

58. CAFRI/IP/V/007 Administering of agroforestry at the district level

Designing and developing agroforestry system i.e., tree-crop combination at smaller scale at district or farm level needs to be done diligently. As the constraints like market availability, farmer's perception, and lack of awareness about agroforestry plays a major role in challenging the upscaling of agroforestry at district level. In this regard, a blanket approach of recommending a few trees species for the entire state may not be viable. Also, it would be pragmatic only if the recommendations are at district level at the least. In this regard, the CAFRI recommended agroforestry trees based on the performance evaluation of multipurpose trees species in selected districts of different agro-climatic zones across the country.

59. CAFRI/IP/V/008 Conceptual analysis of windbreaks and shelterbelts in agroforestry

In order to highlight the similarity and differences between windbreaks and shelterbelts terminologies, the research weaving approach was adopted following PRISMA guidelines. As per the analysis, usage of one of these terminologies or both was found to be region/country-specific and currently, the windbreak term is mostly used by the scientific community. The analysis also revealed that there is no consistent pattern in usage of these terms among countries like China, USA, Poland, Canada, Russia, New Zealand, etc. In the Indian context, these two terms were regarded as different, yet there is no scientific literature to prove the significant difference. This study concludes that the terms windbreak(s) and shelterbelt(s) can be used synonymously.

60. CAFRI/IP/V/009 Oxygen production potential of trees: Identified research gap

Our findings point out that the oxygen production of trees in India has been quantified based on carbon stock. At present, the empirical method of Nowak is the easiest and simplest methodology to convert carbon stock to oxygen production and it is well-

accepted by the scientific community. The major disadvantage of the empirical equation method is that it doesn't account the nature of tree, growth rate, tree architecture or leaf area. For instance, the fast growing tree like *Casuarina* will have high net oxygen production based on the empirical approach. In real-time, there will be need to estimate the oxygen production potential of trees rather estimating the oxygen released so far by the tree.

61. CAFRI/IP/V/010 Prospecting agroforestry in Sustainable Development Goals (SDGs)

Farming is more than food production, as it encompasses the farmers' welfare too. India is self-sufficient in food-grain production but not ecologically secure, i.e. it is yet to achieve 33% green cover. As land is a scarce resource and existing lands are also degraded in one form or another. Agroforestry not only offers a viable win-win solution for food production as well as for ecological security but also acts as means for restoring marginally degraded lands. It is proven to increase the farmer's income as well as the resilience of the farmers.

It's a strategic knowledge in which agroforestry contributes to 12 out of 17 Sustainable Development Goals and contributions on par with agriculture and forestry.

62. CAFRI/IP/V/011 Ready Reckoner for plant diseases in agroforestry

For farmers to learn about the tree diseases, this ready reckoner on "Plant Diseases in Agroforestry" to start with, focusing on eight major agroforestry species including sandal, malabar neem, eucalyptus, teak, poplar, Indian rose wood, wattle tree and bamboo that are predominant in the Indian farming systems. This ready reckoner will act as a quick guide to identify the tree-specific diseases and advocate and initiate their management at early stages.

63. CAFRI/IP/V/012 Ready Reckoner for insect pest in agroforestry

A ready reckoner on "Insect Pests in Agroforestry" comprising seven major agroforestry species including Teak, Sandal, Eucalyptus, Malabar neem, Poplar, Bamboo and Indian rosewood which are prominent in the Indian agroforestry systems, has been prepared to supplement the needs of agroforestry practitioners those who involved in nurseries and plantation management. This document provides highly useful basic information of tree systematics, distribution, major insect pest variation and their management methods.

64. CAFRI/IP/V/013 Candidate gene for drought tolerance in *Pongamia pinnata* genotypes

Pongamia is considered an important biofuel species worldwide. 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 was studied at morphological, physio-chemical and transcriptome level.

65. CAFRI/IP/V/014 Agroforestry area in India

India has become the first nation to have systematically mapped the country wide agroforestry area. The overall area under agroforestry for all 15 Agro-climatic zones (ACZs) of India was 28.427 M.ha, which is about 8.65% of the total geographical area of the country (328.747 M.ha.). Among the 15 ACZs, seven (1,3,5,7,11 and 13) had more than10% area under agroforestry. ACZs 1 ,5, 7, 10, 11 and 13 had more than 2 M. ha. area under agroforestry. These datasets will help in the planning and management of agroforestry as well as the implementation of the National Agroforestry Policy in different states of India on mission mode.

66. CAFRI/IP/V/015 Distribution of fine roots in *Phyllanthus emblica* ('Aonla') based agroforestry system

The distribution of fine roots in 20-years-old 'aonla' based agroforestry system maintained with a spacing of 10x10 m and average density of 100 trees per hectare with greengram-mustard intercropping revealed spatial variation while sampled across 0-90 cm soil depth. The fine root length varied from 43.83 cm in 0-15 cm soil depth at a distance of 0.5 m from tree base to 2.47 cm in 75-90 cm soil depth at a distance of 1 m from tree base. The fine root length density (RLD) varied from 0.046 cm/cm^3 in 0-15 cm depth to 0.003 cm/cm^3 in 75-90 cm depth. The general trend observed has been that fine root length as well as fine root density decreased with soil depth and also centrifugally from tree base.

67. CAFRI/IP/V/016 HiFoliar nutrient spray is effective when used with KNO_3 in *Zizyphus mauritiana* ('Ber')

Three HiFoliar spray of (KNO_3 1.0%) at 15 days interval during the marble stage of fruits enhanced the growth, fruit quality and yield of 'ber' cv. Seo, preferably during December. In general, most of the fruit characters influenced by application of (KNO_3 1.0%) and (HiFoliar 0.4%+KNO_3 1.0%) except pulp/stone ratio and total soluble sugar. Notwithstanding, it is established that the HiFoliar nutrient is effective only when used with KNO_3.

68. CAFRI/IP/V/017 *Merremia emarginata* as living mulch for weed control, soil stabilization and moisture conservation for maintaining blocks of mother plants

Merremia emarginata also known as the Kidney Leaf Morning Glory can be a potential plant for use as live mulch to stabilize the soil on raised bed planting systems, along the slope of field bunds, boundaries of water harvesting structure etc. It is easily propagated through seeds. It root depth does not go beyond 12 cm and thus do not compete with crop

or orchard saplings. The prostate stem provide 5-6 cm green cover above the soil surface which control weeds as well as ensure soil & water conservation. The morphological traits of *M. emarginata* is therefore provisioning opportunities to be utilised as a live mulch.

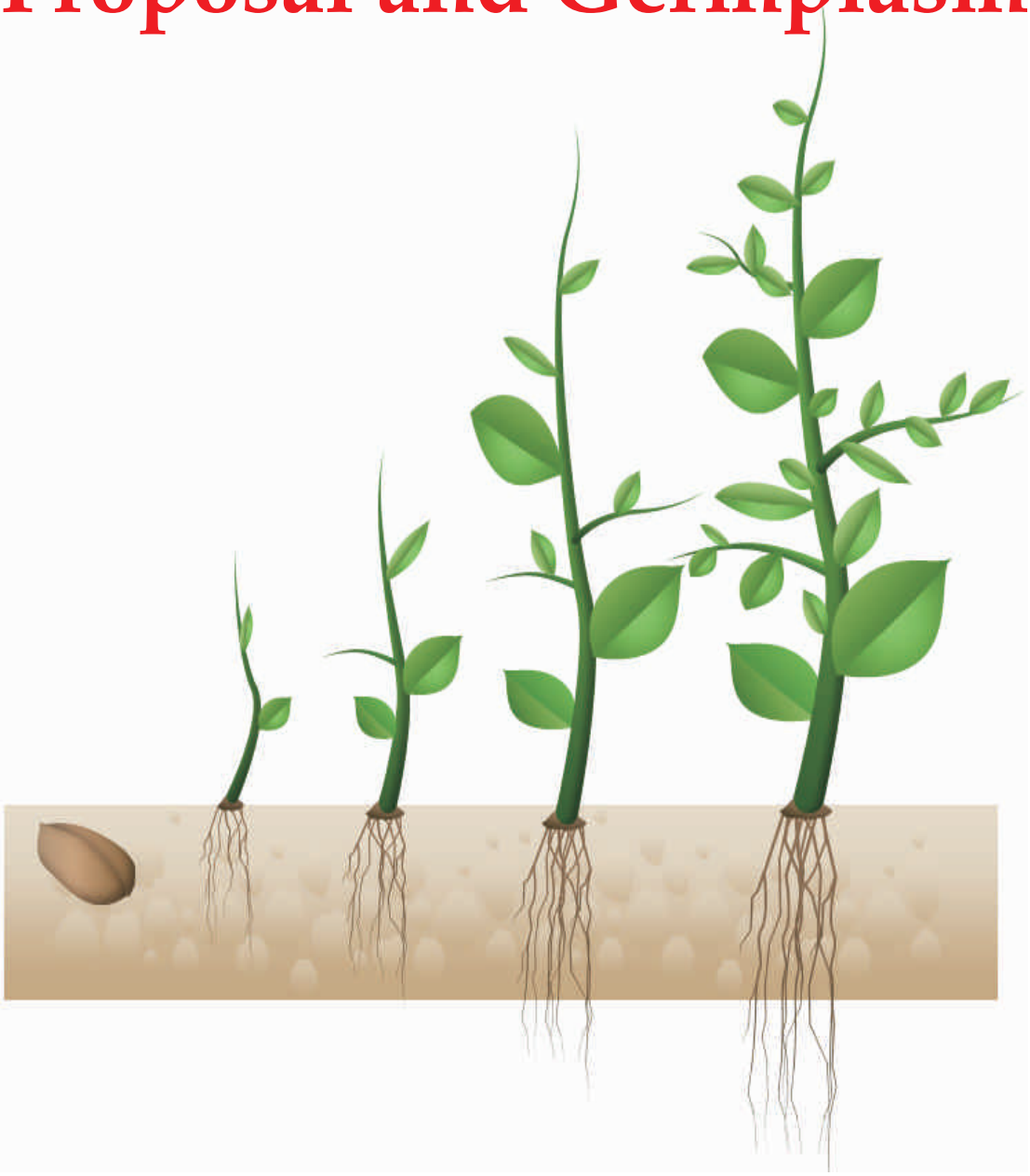
69. CAFRI/IP/V/018 Photosystem-specific physiological factors identified for desiccation tolerance in *Azadirachta indica* and *Terminalia mantaly*

Infrared (IR) imaging, chlorophyll fluorescence imaging and plant phenomic approach revealed the photosystem-specific physiological mechanism of desiccation tolerance in *Azadirachta indica* and *Terminalia mantaly*. Canopy temperature of upper foliage, lower foliage, stem (trunk) region of *A. indica* were quite higher during the hotter periods of the day as compared to *T. mantaly* and maximum photochemical efficiency (Fv/Fm) was maintained in *A. indica* leaves as compared to *T. mantaly* with similar duration of desiccation. Plant phenomic approach indicated that A. indica twig retained more tissue water and maintained canopy volume higher than in *T. mantaly*. This indicates that *A. indica* tree is desiccation-tolerant than *T. mantaly*.

70. CAFRI/IP/V/019 Quantification of carbon sequestration potential of agroforestry systems in varied edapho-climatic conditions

The carbon sequestration potential of the agroforestry at country level has been estimated using Dynamic CO2FIXv3.2 model of existing agroforestry systems for a simulation period of 30 years. The observed number of trees on farmers' field in these districts varied from 1.81 to 204 per hectare with an average value of 19.44 trees per hectare. The biomass in the tree component varied from 0.58 to 48.50 Mg dry matter ha^{-1}, whereas, the total dry biomass (tree and crop) ranged from 4.96 to 58.96 Mg ha^{-1}. The soil organic carbon ranged from 4.28 to 24.13 Mg ha^{-1}. The estimated average carbon sequestration potential of agroforestry systems, representing varying edapho-climatic conditions, on farmers field at country level was 0.21 Mg C $ha^{-1}yr^{-1}$. At national level, the existing agroforestry systems have been estimated to mitigate 109.34 million tons CO_2 annually, which may offset one-third (33 %) of the total GHG emissions from the agriculture sector.

Proforma of IPR Proposal and Germplasm



Institute Proforma to IPR Proposal

Category of IPR Proposed:

- ☐ Category I: New Concept
- ☐ Category II: New process/methodology, and Unique germplasm
- ☐ Category III: Technologies and Products including Tools and Design
- ☐ Category IV: Package of Practice(s)
- ☐ Category V: Strategic Knowledge

Title of the proposal:

Team Leader:

Other Members (Provide justification in Annexure-I):

☐ Institutional ☐ Inter-Institutional

Is the IPR and Technology emerging from any ongoing Institute or Externally funded project? If yes, give details:

Scope of the IPR and Technology in term of commercialization:

I hereby certify that the information given for each of the items listed below is correct.

1. The IPR/technology including products for commercialization is based on a bonafide original idea based on field observation and/or systematic research conducted in the Institute or in villages/farmers' field and is related to mandated activities/programs as per details below.
2. Detailproposed IPR as in Annexure II
3. The proposal has been thoroughly checked by the team leader and all members (including the investigators from other organizations, if any) and are satisfied with its form and content.
4. Due credit of contributorship is being given to all research outputs based on individual contributions and the sequence in which the authors' names appear has been decided by consensus. (Annexure I)
5. The proposal for this referred case has not been submitted earlier and/or simultaneously submitted to any other agency (In case, if it was submitted earlier to another agency and got rejected, then may mention the reason thereof)

6. Due diligence was observed with high resource use efficiency of the Institute for developing and utilization of the proposal.
7. The Proposal on approval for commercialization shall be dealt with utmost caution for realizing its potential for Institute benefit.

Date: _____

(Signature with name and designation of the team leader* on behalf of all the other Members involved)

Comments of the Program Leader

(Signature of the Program Leader)

Comment of ITMU

(Signature of the ITMU In-Charge)

Approved/Not Approved

(Signature of the Institute Head)

**By signing this proforma, the team leader takes full responsibility for all requisite consent of all those who are involved in the proposal*

Annexure-I

Justification of the involvement of team members as listed below:

Term	Definition
Conceptualization	Ideas; formulation or evolution of overarching results/experiment goals and aims
Methodology Software	Development or design of methodology; creation of models, Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidencecollection
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team
Project Administration	Management and coordination responsibility for the research activity planning and execution
Funding Acquisition	Acquisition of financial support for the project leading to research work/technology.
DataCuration	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse
Formal Analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data
Validation	Verification, whether as a part of the activity or separate, of the overall replication/reproducibility of results/experiments and other research outputs
Resources including documentation	Provision of study materials, reagents, materials, patients,y laborator samples, animals, instrumentation, computing resources, or other analysis tools
Visualization including drawing and design	Preparation, creation, specifically visualization/ data presentation
Any other	Please specify

Annexure-II

Title of the IPR proposed:

1. **IPR regime**
2. **Details of the proposal**
   - ☐ New process/methodology/technology/ products
   - ☐ Modification of the existing process/methodology/technology/ products
3. **The uniqueness of the IPR proposed (Tick the relevant):**
4. **Economics involved in developing the IPR**
5. **Potential for commercialization**
6. **Clientele**

Institute Proforma for Germplasm Registration

Application for Institute Germplasm Identification Committee

(To be submitted to the Chairman, IGIC, CAFRI, Jhansi-284003

Please refer to guidelines for filling the application form and codes (Annexure-I)

1. **Application status (code)** [N] [R]
2. **Crop Name** [ ]
3. **Botanical Name** [ ]
4. **Crop Group (Code)**
5. **Biological status of the material to be registered**
6. **Identity**
7. **Criteria for registration [Unique feature(s) maximum three]**

   I. [ ]

   II. [ ]

   III. [ ]
8. **Nature of genetic material(Code)** [ ]
9. **Quantity deposited (Actual)** [ ]
10. **Value referred to (Code)** [SC] [CM] [AC]
11. **Basis of eligibility (Code)** [AR] [PR] [CT] [OT]

For Use of IGIC, CAFRI

(i) Application number.....

(ii) Date of application.....

(iii) Whether new or revised? .....

(iv) If revised, Date of 1st Application.....

(v) If validation test suggested whether report attached.....

(vi) Action taken
- a) Forwarded for registration
- b) Sent for validation
- c) Incomplete, sent for revision

(vii) Whether approved or rejected.....

(viii) Date of approved or rejection.....

(ix) Reference Number.....

(x) Validation test suggested [Y] [N]

(xi) Notified on: (Code).....

(xii) Remarks: .....
.....

12. **Has it been registered/protected anywhere** Y N

13. **Manuscript (one-pagenote on proposed germplasm enclosed)** Y N

14. **Particulars of the scientist(s)/person(s)/ organisation/farmer/farming community who developed germplasm/genetic stock**

Name (Dr/Ms/Mr)

Designation

Address

Tel: Fax:

E-mail:

Name (Dr/Ms/Mr)

Designation

Address

Tel: Fax:

E-mail:

15. **(A) Passport information of germplasm**

IC/ECNo.	Other Identity	Source	Place of origin Tehsil/Distt/ Provinc	Genes if any identified

Farmers/community Contribution ,if any,

(B) Pedigree of the genetic stock

Pedigree **Breeding method**

(Code)Fax:

16. **Salient characteristics/chief botanical and morpho-agronomic description* (attach details)**

S.No.	Trait Description
1.	
2.	
3.	

**Provide salient description of the material as per All India Coordinated Research Project (AICRP) Proforma with comparative data of lines/germplas mover best two checks for unique trait in the form of table.*

17. **Usefulness of identified germplasm/genetic stock**

18. Year of seed production	20. Location of seed production
19. Quantity of seed available	**21. Seed viability (%)**

22. **Additional Information/Remarks (if any)**

UNDERTAKING

1. I/We assure genetic purity and truthfulness with the application.
2. I/We assure that such germplasm does not contain any gene or gene sequence involving terminator technology.

SIGNATURE OF THE ASSOCIATES	SIGNATURE OF THE DEPOSITOR/PROPOSER
Signature	Signature
Full Name	Full Name
Designation & Address	Designation & Address

Annexure-I

Guidelines for Filling Form A and Description of Codes

Codes for filling information in Col.1, 2, 5, 8, 9 [actual], 10, 11, 12, 13 and 16 (b)BreedingMethod] of Form A

Item1:	**Application Status**
N	New
R	Revised
Item2:	**Crop Group**
CL	Cereals
PC	Pseudocereals
MT	Millets
MM	Minor millets
GL	Grain legumes
OS	Oilseeds
PC	Fiber crops
FG	Forage
FT	Fruits
VG	Vegetable crops
SP	Spices
MP	Medicinal and aromatic plants
NC	Narcotics
OR	Ornamentals
FR	Forestry
CC	Commercial crops
OT	Other(SpecifyinCol.19)
Item 5:	**Biological status of materialto be registered**
GP	Germplasm collection
GS	Genetic Stock
RE	Recombinant
MU	Mutant
Item 8:	**Nature of genetic material**
SD	Seed
TR	Tubers/Roots/Bulbs
VP	Vegetative cuttings
WP	Whole plant
OT	Other(Specify in Col. 20)

Item 9:	**Quantity deposited with application**
	Actual
Item 10:	**Value referred to by applicant**
SC	Scientific
CM	Commercial
AC	Academic
Item 11:	**Basis of eligibility for registration**
PR	Published with peer review
CT	All India Co-ordinated trials data
AR	Institute annual report
OT	Any other report
Item 12:	**Has been registered/protected any where**
Y	Yes
N	No
Item 13:	**Manuscript (One Page Note) submitted**
Y	Yes
N	No
Item 16(b):	**Breeding method used**
IN	Introduction and selection
MS	Mass selection
PS	Pedigree selection
PL	Pure line selection
RS	Recurrent selection
BC	Backcross method
OT	Other (Specify in Item 19)

PROFORMA FOR PASSPORT INFORMATION

Supplying/co-operatingUnit/Group/Section/Centre: **Date:**

S. No.	National Identity	Collector No.	Donor Institute	Donor/ other Identity	Crop Name	Common Name	Taxonomic Code	Pedigree	Source	Biological Status	Country of Origin	Location	Latitude	Longitude	Altitude	Remarks

Source: In=Institute/NRC/IARCs; F=Famer; M=Market; NGO=Non-Governmental organizations; OT=others; Biological status: W= wild; RC= Released cultivar; LR=Landraces; BL=Breeding line; Mu= Mutant; GS= Genetic stock; OT = others Country of origin; Please provide ISO codes

Annexure-III

CHECK-LIST FOR SCREENING OF APPLICATIONS

The Member Secretary, IGIC at CAFRI shall screen the application along with the annexure and make recommendations to the IGIC for inter alia the following points:

S.No.	ITEM	YES/NO	
1	Whether this is a new application?	Yes	No
2	Whether this is a revised application?	Yes	No
3	Whether same or similar material has been registered earlier?	Yes	No
4	Whether unique or distinguishing characteristics of potential value merit	Yes	No
5	Consideration for registration?	Yes	No
6	Whether documentary evidence or data (as per the guidelines) is provided	Yes	No
7	In support of the claim on potential value of germplasm?	Yes	No
8	State any other economic potential value of germplasm, if possible	Yes	No
9	Whether applicant, institution, university or centre has given	Yes	No
10	Commitment for maintenance and supply of germplasm for use?	Yes	No
11	Whether appropriate size of germplasm sample for long-term storage at	Yes	No
12	National Gene bank or for conservation and maintenance of active	Yes	No
13	Collections at the concerned NAGS has been sent?	Yes	No
14	Whether the applicant has sent maintainer line of the CMS line to the	Yes	No

Signature of the applicant

Annexure-IV

CHECK-LISTFORREVIEWER/EXPERTFORRECOMMENDATION

Recommendation

(I)	Importance of trait	: Scientific/Commercial/Academic
(ii)	Data sufficient as per guidelines (See eligibility criteria in the guidelines)	: Yes/No
(iii)	Validation test required	: Yes/No
(iv)	Recommended for registration	: Yes/No

Signature of the Expert
(with seal)

Agroforestry Business Incubation Centre

ABiC

Institute Technology Management Unit (ITMU) of 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 business ventures of the incubates in agroforestry-based enterprises. Also, the IP/deemed IP are commercialized for creating an ecosystem for entrepreneurship. 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.

Promoting Agroforestry based Business Opportunities and Creating an Ecosystem for Entrepreneurship

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