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वार्षिक प्रतिवेदन
ANNUAL REPORT
2021

भा.कृ.अनु.प.–केन्द्रीय कृषिवानिकी अनुसंधान संस्थान
झाँसी 284003, उत्तर प्रदेश, भारत

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ICAR-Central Agroforestry Research Institute

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Preface

Agroforestry is the ecologically viable sustainable production system providing ecosystem services that protect the environment and ensure human livelihood. The agroforestry interventions have provided food, fodder, fibre, firewood and timber demands of the growing population in a scenario of decreasing arable land availability, degradation of soil and water resources, increasing pollution hazards and threats to the environment and ecosystem from global warming and climate change.

Through coordinated research efforts, CAFRI has been primarily focusing on these issues since its foundation. Four agroforestry models developed by the Institute have been named by NABARD as bankable agroforestry models. In specific to Bundelkhand, the Institute under the KISAN MITrA project (consortium of ICAR-CAFRI and ICRISAT, Hyderabad) have transformed the livelihoods of eight pilot sites covering~40,000 ha area in the seven districts of Bundelkhand, Uttar Pradesh. Similarly, the work done in the Parasai-Sindh Watershed and Garhkundar-Dabar Watershed by the Institute have been widely recognized in the region. For instance, they have been reflected as best water practices by the NITI Aayog.

The Institute offers, promotes exploratory research for superior germplasms and has the largest germplasm collection of neem and other agroforestry tree species such as Indian rosewood, cactus, malabar neem, teak, karanj, leucaena, chironji, ber, citrus, mango, aonla, bael, guava and fig. To promote the tree cover through social sectors, the institute has developed the different vatika's *i.e.* Rashivatika (Zodiac Plantation), Nakshatra Vatika and NavgrahVatika. The Institute also organized a Tree Plantation campaign on the 16th July, 2021 being the Foundation day of ICAR and planted 9.54 lakh tree seedlings across the country involving ICAR Institutes, KVKs, Agricultural Universities, SMAF Units, Forest Department and others. The introduction of strawberry in Bundelkhand and the NABARD supported strawberry cultivation projects in two Babina and Moth block of Jhansi district was executed by the Institute more efficiently in Jhansi region that gave good income to the project farmers. The Institute has adopted 20 villages in the Bundelkhand region and our scientists are visiting the villages regularly and handholding the farmers and enabling their capacity building as well. Regular training programs are organized by the Institute for various stakeholders in agroforestry.

At the national level, the institute is coordinating the Task Force on Himalayan Agriculture under the "National Mission for Sustaining the Himalayan Ecosystem" of the climate change programme of the Department of Science and Technology, reviewing the agroforestry policy along with the NITI Aayog. Further, the Institute also participates in the international research agenda through ICRAF and ICRISAT work plans.

The Institute Annual Report contains executive summary, accomplishments of various research programmes, important meetings/days observed, information on various awards received by the Institute's scientists and other staff, research publications, participation in trainings, participation in workshops, webinars, meetings, and symposia, and a report on the implementation of SCSP schemes. I appreciate the Institute PME Cell and the report editors' efforts in compiling this document and releasing the report on schedule.

I express my gratitude to Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR, New Delhi for his constant guidance, encouragement, and support. Equally, Dr. S K Chaudhari, Deputy Director General (NRM), ICAR, New Delhi guided, motivated and facilitated the R&D process in agroforestry. Special thanks to Dr. S. Bhaskar, ADG (AA&CC), and the entire NRM Division personnel for their enabling act and assistance. At this point in time, I also record thanks to all my predecessors for maintaining momentum in agroforestry R&D in the Institute.

(A. Arunachalam)
Director, ICAR-CAFRI &
Project Coordinator, AICRP (Agroforestry)

कार्यकारी सारांश

भा.कृ.अनु.प.–केन्द्रीय कृषिवानिकी अनुसंधान संस्थान को भारतीय कृषि अनुसंधान परिषद की इकाई के रूप में वर्ष 1988 के दौरान झाँसी में स्थापित किया गया। संस्थान द्वारा पिछले 34 वर्षों में विभिन्न कार्यक्रम के अन्तर्गत अनुसंधान कार्य किये जा रहे है। संस्थान में किये जा रहे अनुसंधान का कार्यकारी सारांश निम्नलिखित है:

कार्बनिक शासन के तहत लेमनग्रास के साथ एकीकृत अनार के प्रदर्शन पर अध्ययन से पता चला है कि अर्ध–शुष्क परिस्थितियों में अनार – लेमनग्रास – आधारित कृषिवानिकी प्रणाली मध्य भारत के अर्ध–शुष्क क्षेत्रों में नींबू के तेल से अतिरिक्त आय प्रदान करके किसानों की अर्थव्यवस्था को बढ़ावा दे सकती है।

बेर आधारित कृषि–बागवानी प्रणाली में पोषक तत्व प्रबंधन पर शोध से पता चला कि उपचार T_8 (75% आरडीएफ + ट्राइकोडर्मा + काला चना – जौ के साथ बेर) ने अपनी श्रेष्ठता दिखाई, इसके बाद T_6 (75% आरडीएफ+वीएएम + काला चना – जौ के साथ बेर) और T_2 (75% आरडीएफ+ काला चना – जौ के साथ बेर) का स्थान रहा। इस प्रणाली के तहत, रबी के दौरान बोए गए जौ, अवलोकनों से पता चला कि उपचार T_{10} (शुद्ध फसल) और T_6 (75% आरडीएफ + वीएएम + काला चना – जौ के साथ बेर) में 2517 और 2518 किलोग्राम हेक्टेयर की उच्चतम बीज उपज दर्ज की गई और ये अन्य उपचारों की तुलना में काफी अधिक है।

विभिन्न परागकणीय, अमृतमय और कम उपयोग वाले पौधे एकत्र किए गए हैं जिनका न्यूट्रास्युटिकल और औषधीय मूल्य अधिक है। इन्हे एक परियोजना अर्थात "अर्ध–शुष्क उष्णकटिबंधीय में पोषण सुरक्षा के लिए बहुक्रियाशील कृषिवानिकी प्रणाली विकसित करना" के अन्तर्गत एकत्रित किया गया।

स्थायी भूमि उपयोग और बेहतर उत्पादकता परियोजना के लिए कृषिवानिकी आधारित संरक्षण कृषि की परियोजना जुलाई, 2014 के दौरान 03 प्रयोगों के साथ शुरू की गई थी, जैसे कि बेल आधारित कृषिवानिकी प्रणाली, सागौन आधारित कृषिवानिकी प्रणाली और बेल + सागौन आधारित कृषिवानिकी प्रणाली । इसमें 04 मुख्य भूखंड उपचार अर्थात न्यूनतम जुताई–उर्द–सरसों (सीएस–1), न्यूनतम जुताई – मूँग – जौ (सीएस–2), पारम्परिक जुताई – उर्द–सरसों (सीएस–1) और पारम्परिक जुताई – मूँग–जौ (सीएस–2) और 03 सबप्लॉट उपचार (फसल अवशेषों के साथ, फसल अवशेषों के बिना और सुबबुल अवशेषों के साथ)। विश्लेषण ने संकेत दिया कि तीनों प्रयोगों में जुताई उपचारों का उपज और उपज योगदान करने वाले लक्षणों पर कोई महत्वपूर्ण प्रभाव नहीं पड़ा जबकि अवशेषों को बनाए रखने से बीज की उपज में उल्लेखनीय वृद्धि हुई।

लघु वर्षीय पेड़ आधारित कृषिवानिकी प्रणाली के संरचनात्मक विश्लेषण नामक परियोजना में यह पाया गया कि पाँच वर्ष के *मिलिया दूबिया* के पेड़ों में अन्य पेड़ों (*एंथोसिफेल्सा कदम्बा, ल्यूसिना ल्यूकोसिफेला*) की तुलना में औसतन अधिकतम ऊँचाई और व्यास (डी.बी.एच.) दर्ज किया गया है। 4x5 मी. पर लगाए गए *मिलिया दूबिया* में जब अन्तः फसल लगाई गई तो *मिलिया दूबिया* के पेड़ो की औसतन अधिकतम ऊँचाई 12.50 मी. और बिना अन्तः फसल के साथ 12.25 मी. दर्ज की गई। तथा उनका क्रमशः व्यास (डी.बी.एच.) 24.85 से.मी. और 23.07 से.मी. पाया गया। इसी तरह 8x2.5 मी. दूरी पर लगाये गये *मिलिया दूबिया* के पेड़ों के साथ जब अन्तः फसल ली गई तो अधिकतम ऊँचाई (13.20 मी.) और व्यास (12.16 से.मी.) पाया गया। 4x5 मी. की तुलना में, इसके अलावा 8x2.5 मी. की दूरी पर लगाए गए पेड़ों के साथ ली गई अन्तः फसल गेहूँ से ज्यादा पैदावार मिली।

गढ़कुंदर–डाबर वाटरशेड (उपचारित) में चार स्थानों पर अपवाह और मिट्टी के नुकसान की निगरानी की गई। इसी तरह अनुपचारित वाटरशेड से भी गेजिंग स्टेशन से अपवाह और मिट्टी तथा पोषक तत्वों के नुकसान हेतु पानी तथा मिट्टी के नमूने लिए गये। अपवाग का आंकलन स्वचालित डेटा लोंगर और ड्राइवर की मदद से लिया गया। वर्षा आंकलन हेतु वर्षा मापी यंत्र (मेन्युअल तथा स्वचालित) स्थापित किये गये थे।इस अवधि (वर्ष 2021) में उपचारित वाटरशेड में अपवाह कुल वर्षा का 10.2 प्रतिशत रहा और अनुपचारित वाटरशेड की तुलना में मृदा हानि 81.5 प्रतिशत कम दर्ज की गयी। उपचारित वाटरशेड में कुँओं का जल स्तर अनुपचारित वाटरशेड की अपेक्षा 44 प्रतिशत अधिक पाया गया।

शारीरिक अध्ययनों के माध्यम से तुलनात्मक मूल्यांकन से पता चला है कि तनाकृतन पौधों ने गर्मी के मौसम में *पोंगामिया पिन्नाटा* के बीज जनित पौधों की तुलना में बेहतर दक्षता बनाए रखी। पेड़ की तुलनात्मक दक्षता के साथ इसके महत्व को इंगित करते हुए कुछ शारीरिक लक्षणों में विभेदक प्रतिक्रियाएं देखा गया हैं।

पुटेटिव वुड प्रॉपर्टीज पैरामीटर *एल. ल्यूकोसेफला* में बेहतर पल्पवुड गुण थे, जबकि *एल. कोलिन्सि* में ल्यूकेना की पाँच अलग–अलग प्रजातियों *ल्यूकेना ल्यूकोसेफला, ल्यूकेना डायवर्सिफोलिया, ल्यूकेना कोलिन्सि, ल्यूकेना लांसोलाटा* और *ल्यूकेना शानोनी* में से ईंधन की लकड़ी के लिए बेहतर गुण थे। हालाकि बाद वाले में *एल. ल्यूकोसेफला* के साथ लिंगो– सेल्युलोसिक गुणों के तुलनीय स्तर थे, जो लुगदी और बायोएनेर्जी के लिए कच्चे माल का एक नया स्रोत होने का सुझाव देते हैं। इसके अलावा, यह लकड़ी आधारित उद्योगों में उपयोग के लिए बेहतर संकर का

उत्पादन करने के लिए अंतर–विशिष्ट संकरण के लिए दाता माता–पिता के रूप में इस्तेमाल किया जा सकता है।

पोंगामिया पिनाटा के नौ रूपात्मक–शारीरिक और जैव रासायनिक लक्षणों के विपरीत जीनोटाइप का अध्ययन छह जीनोटाइप में प्रारंभिक सहनशील (एन आर सी पी–17, एन आर सी पी–9 और एन आर सी पी–25) और प्रारंभिक अतिसंवेदनशील (एन आर सी पी–6, एन आर सी पी–10 और एन आर सी पी–14) के रूप में सूखे के दबाव और नियंत्रण की स्थिति में किया गया था। सूखा तनाव की स्थिति के तहत सभी माने गए मापदंडों के लिए महत्वपूर्ण अंतर देखा गया। अध्ययन किए गए लक्षणों के आधार पर विषम जीनोटाइप की पहचान एन आर सी पी–9 सहिष्णु और एन आर सी पी–10 अतिसंवेदनशील के रूप में की गई थी। इसके अलावा, शेष चार जीनोटाइप (एन आर सी पी–6, एन आर सी पी–14, एन आर सी पी–17 और एन आर सी पी–25) के लिए आणविक लक्षण वर्णन किया गया था, जो कि पहचाने गए डिफरेंशियल जीन द्वारा पूरे ट्रांसक्रिप्टोम विश्लेषण के अधीन हैं। परिणामों से पता चला कि सूखा तनाव सहिष्णुता के लिए जीनोटाइप के बीच महत्वपूर्ण अंतर अभिव्यक्तियाँ पाई गईं। चार जीनोटाइप में, एन आर सी पी–25 अन्य तीन जीनोटाइप की तुलना में जल्दी सूखा सहिष्णु पाया गया। कुल मिलाकर, यह अध्ययन सूखा सहिष्णुता के लिए पोंगामिया आनुवंशिक सुधार में उपयोगी हो सकता है।

मध्य प्रदेश और उत्तर प्रदेश के बुंदेलखंड जिलों से विभिन्न रूपात्मक विशेषताओं वाले कुल तीस मोरिंगा जर्मप्लाज्म एकत्र किए गए हैं। संग्रह करते समय काफी मात्रा में आनुवंशिक विविधता पायी गई एवं प्रत्येक जर्मप्लाज्म का पासपोर्ट डेटा भी एकत्र किया गया। परिणामों ने बीज अंकुरण और अंकुर उत्तरजीविता विशेषताओं के लिए महत्वपूर्ण भिन्नता के अस्तित्व का संकेत दिया। बीज अंकुरण अध्ययन के आधार पर मोरिंगा जर्मप्लाज्म आपस में अंकुर की लंबाई, ताजा एवं सूखे अंकुर का वजन, अंकुर शक्ति सूचकांक - I और II, औसत अंकुरण दर, औसत अंकुरण समय, सिंक्रनाइज़ेशन सूचकांक, अंकुरण सूचकांक, अंकुरण के वेग के गुणांक और गति के लिए विभिन्न पाये गये जो उनकी इन्हेरेंट शक्ति के कारण हो सकता है। पीसीए और क्लस्टर विश्लेषण से भी कुछ महत्वपूर्ण लक्षणों के बीच सहसंबंध पाये गये हैं। चार जर्मप्लाज्म अर्थात सीएमसी–3, सीएमसी–8, सीएमसी–12, और सीएमसी–24 प्रारंभिक अंकुर वृद्धि प्रदर्शन के आधार पर अधिक महत्वपूर्ण पाए गए।

वनचारागाह पद्धति में दो प्रकार के वृक्ष सागौन (*टेक्टोना ग्रैंडिस* और *स्वीटिनिया महागोनी*) और दो घास जैसे सेन्क्रस सिलियारिस और *स्टाइलोसैंथेस सीब्राना* लगाए गए थे। यह देखा गया कि टी$_7$ सागौन + महागोनी + चारा + स्टैगर्ड कन्टूर ट्रेन्च में सबसे अधिक घास बायोमास उत्पादन हुआ। मिट्टी में नमी की मात्रा का भी 15 दिनों के अंतराल पर अध्ययन किया गया और पाया गया कि मिट्टी और नमी संरक्षण उपायों के साथ वनचारागाह पद्धति में केवल पेड़ों की तुलना में उच्च नमी दर्ज की गई। मिट्टी में नमी की मात्रा 1.42% (मई) से 12.79% (अगस्त) के बीच रही। कुल 13 इवेंट वर्षा में से, अधिकतम अपवाह एकमात्र महागोनी में उत्पन्न हुआ था जबकि सबसे कम अपवाह सागौन + महागोनी + चारा + स्टैगर्ड कन्टूर ट्रेन्च में हुआ था। इसी तरह टी–7 उपचार में न्यूनतम मिट्टी और पोषक तत्वों की हानि दर्ज की गई।

शोध प्रक्षेत्र में लगे विभिन्न कृषिवानिकी मॉडल्स में *अकेशिया सेनेगल* (कुमट) की जी.बी.एच. बढ़वार 31.0–46.4 से.मी. तथा *अकेशिया निलोटिका* (बबूल) की जी.बी.एच. बढ़वार 37.0–97.2 से. मी. पायी गयी। कुमट एवं बबूल से प्राकृतिक गोंद की उपज क्रमशः 1.85–903.56 एवं 6.29–40.11 ग्राम प्रति वृक्ष पायी गयी। कुमट आधारित बहु–घटकीय मॉडल से 151 कि.ग्रा. नींबू, 58 कि.ग्रा. करौंदा एवं 2080 कि.ग्रा. बेल फल प्राप्त हुए। तुलनात्मक अध्ययन से ज्ञात हुआ है कि मृदा उर्वरता संबन्धित मापदंड मिट्टी की ऊपरी सतह में निचली सतह की अपेक्षा अधिक थे। सर्वाधिक मृदा जीवाश्म (ओर्गनिक कार्बन) कुमट एवं बबूल आधारित सिल्वी–हर्बल मॉडल एवं डिहाइड्रोजनेज एक्टिविटी (21.3 µg TPF/g/day) कुमट आधारित बहु–घटकीय मॉडल में पायी गयी। किसानों के खेत पर लगाए गए विभिन्न कृषिवानिकी मॉडल्स में कुमट की अधिकतम बढ़वार (41.7 से.मी. जी.बी.एच.) गढ़कुंडार वाटरशेड (श्री हिम्मत) में तथा न्यूनतम बढ़वार (18.8 से.मी. जी.बी.एच.) ग्राम अम्बाबाय (श्री मनीराम) में पायी गयी। विभिन्न बायो–फेंस मॉडल्स में कुमट की अधिकतम बढ़वार बायो–फेंस मॉडल III, जोकि आंवले के बगीचे की मेड़ पर दोहरी पंक्ति में लगाए गए हैं, में पायी गयी। वर्ष 2021 के दौरान, किसानों को कुमट के लगभग 6000 पौधे उनकी आय दोगुनी योजना के तहत तथा 1000 पौधे भा.कृ.अनु.प.–भारतीय मृदा एवं जल संरक्षण संस्थान, दतिया को प्रदान किए गए।

गोंद एवं राल संबन्धित स्वदेशी पारंपरिक ज्ञान एकत्र करने हेतु किए गए सर्वेक्षण से ज्ञात हुआ है कि श्योपुर, देवास एवं खंडवा जिले में पाये जाने वाले आदिवासियों का मुख्य व्यवसाय कृषि है जबकि गोंद, राल, जड़ी–बूटी, फूल इत्यादि का संग्रहण आय का सहायक स्रोत है। यहाँ के आदिवासी लोग सलई गोंद प्राप्त करने हेतु सलई वृक्ष के तने की छाल को एक रिंग के रूप में छील देते हैं जिससे लगभग 200–400 ग्राम गोंद प्रति वृक्ष का स्रावण होता है जिसे एकत्र कर लिया जाता है। श्योपुर जिले के आदिवासी *एनोजीसस लेटीफोलिया* (धावरा) से होने वाले प्राकृतिक धावरा गोंद को एकत्र करते हैं, जबकि देवास एवं खंडवा जिले के आदिवासी लोग वृक्षों पर चीरा लगाते हैं एवं उससे होने वाले स्रावण को एकत्र करते हैं। खंडवा जिले के एक गाँव में आदिवासी लोग ईथ्रेक्स (गोंद उत्प्रेरक) का उपयोग भी करने लगे हैं। सामान्यतया ये आदिवासी गोंद से संबन्धित किसी भी प्रकार की मूल्य–संवर्धन प्रक्रिया को नहीं अपनाते हैं हालांकि गोंद की सफाई, छंटाई एवं सुखाने का काम व्यवसायी द्वारा किया जाता है। इस कार्य में लगी

हुई कुशल आदिवासी महिलाएं विभिन्न प्रकार के गोंद के मिश्रण में से सुगंध, रंग एवं आकार के आधार पर अलग–अलग गोंद को पहचानने में सक्षम होती हैं। इस वर्ष *ब्यूटिया मोनोस्पर्मा* (पलास) वृक्ष से साल भर पलास गोंद उत्पादन की तकनीक का मानकीकरण करने हेतु एक प्रयोग की शुरुआत की गयी है। इसी प्रकार, *एनोजीसस पेंडुला* (करधई) की विभिन्न सात संततियों द्वारा एथेफोन के उपयोग से होने वाले गोंद उत्पादन को ज्ञात करने हेतु एक अध्ययन की शुरुआत की गयी।

कुमट वृक्ष के जड़ वितरण स्वरूप पर किए गए अध्ययन से ज्ञात हुआ है कि 1, 2 एवं 3 वर्ष पुराने वृक्षों में मिट्टी को बाँधकर रखने की क्षमता क्रमशः 0.375, 0.672 एवं 17.300 मी.^{3} है। इन वृक्षों में भूमि के ऊपर का जैवभार क्रमशः 57.25 ग्रा., 900.28 ग्रा. एवं 24.02 कि.ग्रा.; भूमि के नीचे का जैवभार क्रमशः 16.45 ग्रा., 322.14 ग्रा. एवं 3.34 कि.ग्रा.; तथा कार्बन के पृथक्करण की क्षमता 35 ग्रा., 581 ग्रा. एवं 13 कि.ग्रा. प्रति वृक्ष पायी गयी। 1, 2 एवं 3 वर्ष पुराने कुमट में जड़–तना का अनुपात क्रमशः 0.287, 0.358 एवं 0.139 पाया गया है।

राजस्थान राज्य के छह जिलों– अजमेर, जोधपुर, नागौर, पाली, सीकर, राजसमंद में कृषिवानिकी क्षेत्र और चयनित प्रजातियों (नीम और खेजड़ी) क्षेत्र का मानचित्रण किया गया है। अनुमानित कृषिवानिकी क्षेत्र नागौर जिले (179000 हेक्टेयर) में सबसे अधिक पाया गया, इसके बाद जोधपुर जिले (132647 हेक्टेयर) का स्थान रहा। साथ ही भौगोलिक क्षेत्र के प्रतिशत के रूप में, नागौर में कृषिवानिकी के तहत उच्चतम क्षेत्र है। राजस्थान के छह जिलों में कृषिवानिकी क्षेत्र लगभग 8.32 प्रतिशत अनुमानित है, चयनित छह जिलों में नीम और खेजड़ी प्रजाति के क्षेत्रफल का औसत क्रमशः 2.04 प्रतिशत और 1.62 प्रतिशत है।

विषम जीनोटाइप एन आर सी पी–9 (सहिष्णु) और एन आर सी पी–10 (अतिसंवेदनशील) की जांच उनके ट्रांसक्रिप्टोम प्रोफाइल के लिए एक HiSeq - 4000 पर RNAseq विश्लेषण का उपयोग करके की गई थी ताकि सूखा सहिष्णुता के आणविक तंत्र को बेहतर ढंग से समझा जा सके। परिणामों से पता चला कि, संवेदनशील जीनोटाइप की तुलना में सहिष्णु जीनोटाइप में अधिक संख्या में डीईजी व्यक्त किए गए थे। तनाव की स्थिति में जीनोटाइप के बीच 128 डीईजी की पहचान की गई। जीओ और केईजीजी पाथवे अध्ययन तनाव प्रतिक्रिया में शामिल कई आणविक तंत्रों और उनके संबंधित सूखे से संबंधित मार्गों की पहचान करता है। रास्ते अर्थात उपापचयी मार्ग, द्वितीयक चयापचयों का जैवसंश्लेषण, पादप हार्मोन संकेत पारगमन, कार्बन चयापचय, एमएपीके संकेतन मार्ग, प्रकाश संश्लेषण और कार्बोहाइड्रेट चयापचय को तनाव की स्थिति में एनआरसीपी–10 की तुलना में एनआरसीपी–9 जीनोटाइप में समृद्ध किया गया था। अंत में, पहचाने गए जीन और टीएफ पोंगामिया में सूखा सहिष्णुता के लिए भविष्य के अनुसंधान और प्रजनन कार्यक्रम के लिए उपयोगी लक्ष्य के रूप में काम करेंगे।

झाँसी जिले के बबीना ब्लॉक के तहत 12 किसानों में से 10 किसान स्ट्रॉबेरी की खेती में सफल रहे और स्ट्रॉबेरी की खेती के परिणामस्वरूप बेहतर विकास प्रदर्शन हुआ। स्ट्रॉबेरी के उत्पादन से किसान की आय में वृद्धि हुई और यह पारंपरिक फसलों की तुलना में 1.2 से 5.7 गुना तक ज्यादा थी। स्ट्रॉबेरी में ड्रिप सिंचाई का उपयोग करके किसान पारंपरिक फसलों यानी गेहूं की तुलना में 75% पानी बचाने में सक्षम थे। इसने किसानों को तीसरी फसल लेने के लिए प्रेरित किया जिससे क्षेत्र की फसल सूचकांक में वृद्धि हुई है।

झांसी जिले के मोठ ब्लॉक के तहत 13 किसानों में से 10 किसान स्ट्रॉबेरी की खेती में सफल रहे और स्ट्रॉबेरी की खेती के परिणामस्वरूप बेहतर विकास प्रदर्शन हुआ। स्ट्रॉबेरी के उत्पादन से किसान की आय में वृद्धि हुई और यह पारंपरिक फसलों की तुलना में 1.06 से 4.5 गुना तक ज्यादा थी।

उत्तर प्रदेश के सूखाग्रस्त बुंदेलखंड क्षेत्र के सात जिलों (उत्तर प्रदेश के बुंदेलखंड क्षेत्र में किसानों की आय दोगुनी करने के लिए किसान मित्र परियोजना की उप परियोजना) में कृषिवानिकी आधारित प्राकृतिक संसाधन प्रबंधन के माध्यम से ग्रामीण आजीविका को बदलने वाली परियोजना को लागू किया जा रहा है। इस परियोजना के तहत सात जिलों में लगभग 40,000 हेक्टेयर क्षेत्र को कवर करते हुए 8 पायलट साइटों में कृषिवानिकी आधारित एनआरएम गतिविधियों की पहल को आगे बढ़ाया गया है। एनआरएम हस्तक्षेप (हवेली कायाकल्प, तालाबों को गहरा करना, और जल निकासी नेटवर्क को गहरा करना) इस अवधि के दौरान पांच जिलों में किया गया था। 2021 में कुल 13 ऐसी संरचनाओं का कायाकल्प किया गया था। इन हस्तक्षेपों ने लगभग 0.22 मिलियन क्यूबिक मीटर (एमसीएम) की भंडारण क्षमता बनाई है। 22 गाँवों (7 जिलों में 8 स्थानों) में बड़े पैमाने पर कृषिवानिकी वृक्षारोपण किया गया है। लगभग 1.0 लाख वृक्षारोपण (सीमा वृक्षारोपण, बांध वृक्षारोपण, फल आधारित कृषिवानिकी प्रणाली, लकड़ी आधारित कृषिवानिकी प्रणाली, और पोषण सुरक्षा वृक्षारोपण) 2021 के दौरान किया गया है।

ओडिशा के बोलांगीर और नुआपाड़ा जिलों में प्राकृतिक संसाधन प्रबंधन और कृषिवानिकी के माध्यम से ग्रामीण आजीविका को सुधारना और पलायन को रोकना नामक परियोजना ओडिशा में शुरू की गयी। इस परियोजना का मुख्य उद्देश्य वर्षा जल संरक्षण से भूजल स्तर को बढ़ाना, कृषिवानिकी, कृषि और पशुधन उत्पादकता को बढ़ाना जिससे किसानों की आजीविकता में सुधार करना है जिससे उनका पलायन रूक सके। इसके अलावा चयनिक तीन गाँवों में माडल साइट विकसित करना भी है। इस वर्ष के दौरान इन–सीटू और एक्स–सिटू वर्षा जल संरक्षण किया गया और कृषिवानिकी के अन्तर्गत किसानों के खेतों पर पेड़ लगाये गये।

Executive Summary

The executive summary of the research and development activities carried out at ICAR-Central Agroforestry Research Institute during 2021 is presented here:

The study on performance of pomegranate integrated with lemongrass under organic regime revealed that the pomegranate-lemongrass-based agroforestry system in semiarid conditions of Central India can improve rural livelihood of the region by providing extra income from lemon oil.

The research on nutrient management in ber-based agri-horti system showed that treatment T_8 (Ber with 75% RDF + Trichoderma + Black gram – Barley) performed better followed by T_6 (Ber with 75% RDF + VAM + Black gram – Barley) and T_2 (Ber with 100% RDF + Black gram – Barley). Further, the observations revealed that treatments T_{10} (pure crop) and T_6 (Ber with 75% RDF + VAM + Black gram – Barley) recorded highest seed yield of Barley @ 2517 and 2518 kg ha^{-1} as compared to other treatments.

Different polleniferous, nectriferous and underutilized plant has been collected which have high nutraceutical and medicinal value under the project *i.e.* developing multifunctional agroforestry system for nutritional security in semi-arid tropics.

The project on "Agroforestry based conservation agriculture for sustainable landuse and improved productivity project" was initiated during July, 2014 with 03 experiments *viz.,* Bael based Agroforestry system; Teak based Agroforestry system and Bael + Teak based Agroforestry system with 04 main plot treatments *i.e.*, Min. tillage-Blackgram-Mustard (CS-1); Min. tillage-Greengram-Barley (CS-2); CT-Blackgram-Mustard (CS-1) and CT-Greengram-Barley (CS-2) and 03 subplot treatments (with crop residue; without crop residue and with leucaena residue). Analysis indicated that in all the three experiments the tillage treatments had no significant impact on yield and yield contributing characters. The residue retention and residue addition resulted in significant increase in seed yield and these treatments were at par with each other.

In the project entitled "Structural and functional analysis of short rotation tree based Agroforestry system", it was observed that at five years of age, *Melia dubia* recorded maximum average height as well as diameter at breast height (dbh) than other tree species *i.e. Anthocephalus cadamba* and *Leucaena leucocephala* under study. In 4 x 5 m spacing, *M. dubia* recorded maximum height 12.50 m with inter cropping and 12.25 m without intercrop (pure plantation). The respective diameter at breast height was 24.85 cm and 23.07 cm, respectively. Similarly, maximum height (13.20 m & 12.70 m) and diameter at breast height (25.16 cm & 24.72 cm) were recorded in *M. dubia* grown at 8 x 2.5 m spacing with crop and as pure plantation. As compared to 4m x 5m spacing, higher wheat grain yield was recorded in 8m x 2.5m spacing irrespective of tree species.

Runoff and soil loss was monitored at four locations in Garhkundar-Dabar (GKD) watershed (treated). The untreated watershed was gauged for the same purpose at the outlet. Datalogger based automatic stage level recorders were installed at five sites as well as in control watershed during 2021. Manual and self-recording rain gauges have also been installed to record the rainfall. Runoff from the treated watershed was 10.2% of total recorded rainfall during the period. Soil loss from treated was 81.5% lower in comparison to untreated watershed. Average water column was recorded 4.5 m in GKD watershed, which was found 44% higher than the average water column of open wells of untreated watershed.

Comparative evaluation through physiological studies revealed that the clonal plants maintained better efficiency in hot summer season than the seedling plants of *Pongamia pinnata* in field. Differential responses in few physiological traits have been noted indicating its importance with the comparative efficiency of the tree.

The putative wood properties parameters *L. leucocephala* had better pulpwood properties, while *L. collinsii* had better attributes for fuelwood out off the five different species of *Leucaena viz. Leucaena leucocephala*, *Leucaena diversifolia*, *Leucaena collinsii*, *Leucaena lanceolata* and *Leucaena shanonii*. The latter however had comparable levels of lingo-cellulosic properties with *L. leucocephala* suggesting to be a new source of raw material for pulp and bioenergy. Further, it could be used as a donor parent for inter-specific hybridization to produce superior hybrids for utilization in the wood-based industries.

The contrasting genotypes, nine morpho-physiological and biochemical traits of *Pongamia pinnata* were studied in the six genotypes as early tolerant (NRCP-17, NRCP-9 and NRCP-25) and early susceptible (NRCP-6, NRCP-10 and NRCP-14) under drought stress and control conditions. Significant differences were observed for all the considered parameters under drought stress condition. Based on the traits studied contrasting genotypes were identified as NRCP-9 tolerant and NRCP-10 susceptible. In addition, molecular characterization was done for the remaining four

genotypes (NRCP-6, NRCP-14, NRCP-17 and NRCP-25) by differential gene identified are subjected to the whole transcriptome analysis. The results revealed that significant differential expressions was found between the genotypes for drought stress tolerance. Among the four genotypes, NRCP25 found to be early drought tolerant as compared with other three genotypes. Overall, this study can be useful in Pongamia genetic improvement for drought tolerance.

Thirty Moringa germplasm with varied morphological characteristics have been collected from different Bundelkhand districts of Madhya Pradesh and Uttar Pradesh. A considerable amount of variability was observed while collection. The passport data of each germplasm was collected during the visit. The result indicated the existence of significant variation for seed germination and seedling survival attributes. Young seedlings at 30 days after sowing also exhibited significant differences for seedling length, seedling fresh, seedling dry weight, seedling vigor index-I and II, mean germination rate, mean germination time, synchronization index, germination index, coefficient of velocity of germination and speed of germination in all the germplasm which might be attributable to their inherent vigor. The PCA and Cluster analysis was also performed to dissect the potential relationships among the traits. Four germplasm *viz.*, CMC-3, CMC-8, CMC-12, and CMC-24 were found to be more prominent in terms of initial seedling growth performance.

The study was conducted in the established teak and mahagoni based silvipastoral system. Two tree species namely *Tectona grandis* and *Sweitenia mahagoni* and two grasses *viz.*, *Cenchrus ciliaris* and *Stylosanthes seabrana* were planted in the silvipastoral system. Biomass productivity were estimated among the provisioning services. It was observed that highest grass biomass production was recorded in Teak+Mahagoni+Pasture+ Contour Staggered Trenches followed by Teak+Mahagoni +Pasture+Vegetative Hedge. Dynamics in soil moisture content was also studied at 15 days interval and found that treatments with soil and moisture conservation measures and with pasture component recorded higher moisture content as compared to sole tree. The soil moisture content ranged between 1.42% (May) to 12.79% (August). The contour staggered trenches (CST) and half-moon basin (HMB) trapped soil sediments at the rate of 4.76 t / ha and 1.80 t/ ha, respectively. Out of total 13 event rainfall, maximum runoff was generated in sole Mahagoni whereas lowest runoff was occurred in Teak+Mahagoni+Pasture+ Contour Staggered Trenches (CST). Likewise, minimum soil loss, nutrient loss were recorded in T7 treatment.

In agroforestry models at research farm, the growth of *Acacia senegal* ranged from 31.0-46.4 cm GBH and *Acacia nilotica* between 37.0 and 97.2 cm GBH. The gum yield from *A. senegal* and *A. nilotica* ranged from 1.85 to 903.56 and 6.29 to 40.11 g/tree, respectively. The fruit yield in *A. senegal* based multi-component model was 151 kg lemon, 58 kg karonda and 2080 kg bael. Data on soil fertility revealed that in general, surface soil recorded more values than sub-surface soil. Maximum soil organic carbon was recorded in *A. senegal* and *A. nilotica* based silvi-herbal model and dehydrogenase activity in *A. senegal* based multi-component model (21.3 µg TPF/g/day). In agroforestry models planted on farmers' field, the maximum growth (41.7 cm GBH) of *A. senegal* was obtained in Garhkundar watershed (Shri Himmat) while the minimum (18.8 cm GBH) at village Ambabai (Shri Maniram). Among bio-fence models, maximum growth of *A. senegal* was recorded in double row bio-fence model-III planted on bunds of *Emblica officinalis* orchard. During 2021, 6000 *A. senegal* plants were provided for planting on farmers' fields under the scheme 'Doubling Farmers' Income' and 1000 to ICAR-IISWC, Regional Centre, Datia.

Survey for ITK information revealed that in Sheopur, Dewas and Khandwa, the primary occupation of tribal was agriculture while collection of gums and resins, herbs, flowers *etc.* remains subsidiary source of income. Indigenously, the salai gum is tapped by peeling the bark in the form of a ring to harvest 200-400 g/tree salai gum. In Sheopur, tribal collects naturally exuded gum tears of dhawra (*Anogeissus latifolia*) while in Dewas and Khandwa, the tribal make cuts on the stem. In one village, use of Ethrex was also adopted. Normally, the gum collectors/tribal do not adopt any value addition process, however, cleaning, segregation, drying, *etc.* is done at the end of local traders. The skilled tribal women laborers have the ability to identify and segregate a particular gum tears from a mixed lot probably with the help of specific aroma and shape of the gum tears. For standardizing tapping techniques, an experiment to observe gum exudation in *Butea monosperma* throughout the year has been initiated. Similarly, a study initiated to assess the response of use of ethephon by different seven progenies of *Anogeissus pendula*.

Data on root distribution pattern of *A. senegal* revealed that below-ground root bound soil volume was 0.375 m^3, 0.672 m^3 and 17.300 m^3 in 1, 2 and 3-year-old plant, respectively. The respective values of above-ground biomass were 57.25 g, 900.28 g and 24.02 kg; below-ground biomass 16.45 g, 322.14 g and 3.34 kg; and carbon sequestration potential 35 g, 581 g and 13 kg/tree, respectively. The root to shoot ratio of 1, 2 and 3-year-old *A. senegal* was 0.287, 0.358 and 0.139, respectively.

Agroforestry area and selected species (Neem and Khejri) area in six districts namely- Ajmer, Jodhpur,

Nagaur, Pali, Sikar, Rajsamand from Rajasthan state has been mapped. Estimated agroforestry area was found highest in Nagaur district (179000 ha) followed by Jodhpur district (132647 ha). Also as a percentage of geographical area, Nagaur has highest area under agroforestry. Agroforestry area was estimated to be about 8.32 percent in six districts of Rajasthan. More than 90 percent accuracy was found in mapping agroforestry in all six districts of Rajasthan. Average of Neem and Khejri species area in selected six districts is respectively 2.04 percent and 1.62 percent.

The contrasting genotype NRCP 9 (tolerant) and NRCP10 (susceptible) was investigated for their transcriptome profiles using RNAseq analysis on a HiSeq-4000 in order to have better understanding of the molecular mechanisms for drought tolerance. The results revealed that compared to the susceptible genotypes, the tolerant genotype had more number of DEGs expressed. Between genotypes under stress condition, 128 DEGs were identified. GO and KEGG pathway study identifies several molecular mechanisms involved in stress response and their corresponding drought related pathways. The pathways *viz.* metabolic pathway, biosynthesis of secondary metabolites, plant hormone signal transduction, carbon metabolism, MAPK signaling pathway, photosynthesis and carbohydrate metabolism were enriched in NRCP 9 genotype as compared with NRCP10 under stress condition. Finally, the identified genes and TFs will serve as useful targets for future research and breeding programme for drought tolerance in Pongamia.

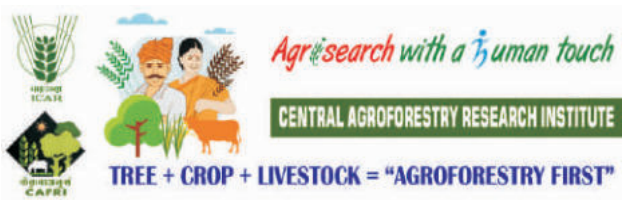
Out of 12 farmers, 10 farmers were successful in strawberry cultivation in Babina block of Jhansi district. The strawberry production led to increase in the farmer's income and it varied from 1.2 to 5.7 times compare to the traditional crops. By using drip irrigation in strawberry, farmers were able to save 75 % water compare to traditional crop *i.e.* wheat. This motivate the farmers to take third crop which may increse the crop index of the region.

Out of 13 farmers, 10 farmers were successful in strawberry cultivation in Moth block of Jhansi district. The strawberry production led to increase in the farmer's income and it varied from 1.06 to 4.5 times compare to the traditional crops.

The project entitled, "Transforming rural livelihood through agroforestry based natural resource management in drought-prone Bundelkhand region, UP (Sub Project of KISAN MITrA project for Doubling Farmers' Income in Bundelkhand region of Uttar Pradesh) is being implemented in seven districts of Bundelkhand region of Uttar Pradesh. Scaling up the initiative of agroforestry-based NRM activities have been done in 8 pilot sites covering about 40,000 ha area across the seven districts of Bundelkhand region of Uttar Pradesh. The NRM interventions (haveli rejuvenation, deepening of ponds, and deepening of drainage network) were undertaken in five districts during the period. A total of 13 such structures were rejuvenated in 2021. These interventions have created a storage capacity of about 0.22 Million Cubic Meter (MCM). A large-scale agroforestry plantation has been done in 22 villages (8 locations in 7 districts). About 1.0 lakh plantations (boundary plantation, bund plantation, fruit-based agroforestry system, timber-based agroforestry system, and nutritional security plantation) have been done during 2021.

The project, "Transforming rural livelihood and check migration through agroforestry in conjunction with natural resource management in Bolangir and Nuapada district of Odisha" is the sub project of "Enabling small holders in Bolangir and Nuapada districts of Odisha to produce nutritious food through agroforestry systems". The main objective of the project is to enhance groundwater recharge through suitable structures to facilitate agroforestry landuse; to improve and optimize crop and livestock productivity; to check the migration and to develop model site of learning in selected patches of three villages. During this year *in-situ* and *ex-situ* water harvesting interventions and agroforestry plantations were carried out in Bolangir and Nuapada distircts of Odisha.

The study evaluated the performance of four *Rabi* crops (wheat, barley, chickpea and mustard) under four varying spacing of *Melia dubia* (M_1=3x3 m, M_2=8x3 m, M_3=8x4 m and M_4=8x5 m). All the test crops concerning growth parameters, yield attributes and yield performed poorly under *Melia dubia* as compared to sole cropping. But, the effect of tree spacing on test crops was non-significant.Test crops in sole cropping recorded higher grain yield *viz*., wheat (3.02-9.67%), chickpea(1.04-22.72%)and mustard (0.06-3.50%) overthe rest of the treatments.



1. General

Climate change accompanied with land degradation on account of unabated forest destruction worldwide is a serious threat to very sustenance of mankind. Increasing population pressure and its associated demands limit expansion of forests which is already insufficient for healthy ecosystem. This warrants landuse change on wider scale. The problem can be addressed through agroforestry which has proven potential of climate moderation, halting land degradation and increasing biomass production per unit area and time without demanding additional land. Agroforestry landuse is only viable option to avert degradation and bring back agricultural economy in harmony with nature. In India, research and development programmes on promoting agroforestry over the past five decades have been spread over time and regions but, the speedy transition of tree-based farming in the country is still a challenge. This calls for organized efforts in setting priorities and strategies for promotion of tree based farming system through agroforestry research and extension services in India.

ICAR-Central Agroforestry Research Institute (ICAR-CAFRI), formerly the National Research Centre on Agroforestry, located at Jhansi, has successfully served the country for 33 years achieving several milestones in integrating trees, crops and livestock on the same farmland. The institute in its national agroforestry mandate has conducted basic, strategic and adaptive research to systematize the science of agroforestry and has developed robust agroforestry models for different agro-climatic regions across the country, and handholds different states in the country for implementation of the objectives of agroforestry policy through skilling and human resource development program.

VISION

To improve quality of life of rural people through integration of perennials crops on agricultural landscape for economic, environmental and social benefits.

MISSION

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

MANDATE

- Develop sustainable agroforestry practices for farms, marginal land and wastelands in different agroclimatic zones of India.
- Coordinate network research for identifying agroforestry technologies for inter-region.
- Training in agroforestry research for ecosystem analysis.
- Transfer of agroforestry technology in various agroclimatic zones.

INFRASTRUCTURE FACILITIES

Laboratories

ICAR- CAFRI has a main office building with eight well-equipped laboratories (Plant Physiology; Soil Analytical; Plant Protection; Agronomy; Tissue Culture & Biotechnology, Horticulture, Remote Sensing & GIS and Agroforestry).

Library

Library is an integral part of the institute. The institute's library is well furnished and equipped with LAN facilities. Library operations are automated using Koha Library Management Software. List of library holdings are as under:

Holding	Total Collection (Numbers)
Books (including Hindi books)	4629
Periodical subscribed (Indian)	12
Bound back volumes of research journals	2335
Dissertation -M.Sc.	115
Thesis-Ph.D.	29
CD- ROM (Forest Science Database, ICAR, ICFRE)	135
Maps	251
News Paper	07

Agriculture Knowledge Management Unit

ICAR-CAFRI has 100 Mbps Leased Line Internet Connectivity from National Knowledge Network, Lucknow. Web server based Ubuntu LINUX has been installed for hosting the Institute's website (https://www.cafri.icar.gov.in). The entire network administration of computers, internet and website management is looked after by the Agriculture Knowledge Management Unit (AKMU).

Organizational Setup

DIRECTOR & PROJECT COORDINATOR

Governance & Guidance

Research Programmes

- Agroforestry System Research
- Tree Improvement Research
- Carbon & Climate Change Research
- Agroforestry Extension Research

Service Sections

- PME Cell
- Agriculture Knowledge Management Unit
- Library & Documentation
- Administration & Finance
- Farm cum Workshop
- ITMU & IP&TM (NAIF)
- Public Information Cell

NRM Division, ICAR HQ

- QRT (2016-2021)
- RAC (2021-2024)
- IMC (2022-2025)

Network Research

AICRP on Agroforestry

State Agricultural University : Solan, Srinagar, Kahikuchi, Palampur, Ludhiana, Pantnagar, Pusa (Bihar), Faizabad, Jhargram, Bhubaneshwar, Ranchi, Sardarkrushinagar, Fatehpur-Shekhawati, Hisar, Rahuri, Nagpur, Hyderabad, Jabalpur, Dharwar, Mettupalaym, Thrissur, Dapoli, Kattuapakkam, Bengaluru, Jammu (J&K), Shimoga

ICAR Institute : Dehradun, Umiam, Imphal, Gangtok, Karnal, Agartala, Ranchi, Jodhpur, Hyderabad, Jhansi

ICFRE Institute : IFGTB, Coimbatore

HPVA of NRG

Research Farm and Facilities

The Institute Research Farm spreads over 178.029 acres, possessing dug well (5), submersible (4), jet pump (1) and farm Pond (2). About 85% of its acreage is being utilized for various agroforestry based experiments and general crop cultivation. Crop cultivation at Research Farm is totally dependent on rainfall and the operation of the canal during *Kharif* and *Rabi* seasons, respectively. The details of crop and fruit production revenue generated during 2021 are given as under:

Products	Revenue generated from farm produce (₹)
Aonla Fruit	80000.00
Guava Fruit	10000.00
Ber Fruit	2000.00
Bael Fruit	14500.00
Lemon Fruit	4475.00
Fuel wood	12000.00
Total	**122975.00**

During *Rabi* season 2021-22 about 14.05 ha area (5.20 ha under research experiments, and 8.85 ha under general cultivation) was utilized for the cultivation of different crops. The details are given below:

Crop	Sown area (ha)		
	Experimental	General	Total
Wheat (HD2967)	0.70	1.50	2.20
Barley (DWRB92)	-	1.20	1.20
Gram (Jaki 9218)	1.68	1.00	2.68
Mustard (Giriraj)	-	5.15	5.15
Pea	0.25	-	0.25
Linseed	1.50	-	1.50
Taramira	1.00	-	1.00
Rajama	0.07	-	0.07
Total	**5.20**	**8.85**	**14.05**

The institute research farm generated revenue to the tune of Rs. 9.15 lakhs from the sale of grains, fruits, firewood, straw and saplings during the reporting period (2021). The institute research farm also maintains improved machinery and implements for mechanizing the farm operations. Moreover, there is a mini-workshop equipped with a welding and drilling machine, grinder and other tools which are used for repairing and maintenance of available farm machinery. The car washer facility now has also been made functional for washing available official vehicles.

Others

The Institute has computer laboratory, committee room, conference hall and Agroforestry Technology Information Centre (ATIC) and well-furnished Farmers' Training Hostel.

MIS/FMS

Five management modules *viz.,* financial, project (project and scheme code generation), stores (indent creation), human resource (training information, applying leaves) and payroll (information related to transfer and joining of employees) have been supported through MIS/ FMS.

Research and Academic

The institute conducts M.Sc. and Ph.D. courses as well as research in Agroforestry, Horticulture, Environmental Sciences, Plant Protection, Soil Science, Biotechnology and Soil & Water Conservation from different recognized Universities. During 2021, the institute signed MoUs with following institutions for achieving excellence in teaching & research:

Sr. No.	Name of the other Party/Institute entered MoU with ICAR-CAFRI	Date of signing MoU
National/International Organization		
1	Central Ayurveda Research Institute, Jhansi, Uttar Pradesh	1 Nov. 2021
2	ICFRE-Tropical Forest Research Institute, Jabalpur, Madhya Pradesh	29 Nov. 2021
Universities		
1	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh	16 Feb. 2021
2	GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand	19 Jun. 2021
3	Dr. YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh	25 Jun. 2021
4	Dr. YSR Horticultural University, Andhra Pradesh	26 Jun. 2021
5	Mizoram University, Aizawl, Mizoram	1 Jul. 2021
6	Arunachal University of Studies, Arunachal Pradesh	16 Jul. 2021
7	FASAI Rama University, Kanpur, Uttar Pradesh	11 Oct. 2021
8	Central Agricultural University, Imphal, Manipur	1 Dec. 2021

Budget (2021-22)

(₹ in Lakhs)

S.No.	Head	Budget	Expenditure
1.	**ICAR-CAFRI, Jhansi**		
	a. Capital (Grant for creation of Capital Assets)	15.78	15.78
	b. Establishment Expenses (Grant in Aid-Salaries)	750.00	747.23
	c. Grant in Aid-General. Pension Benefits	265.00	265.00
	d. Grant in Aid-General	250.49	250.49
	Total	1281.27	1278.50
2.	**Plan Schemes**		
	All India Coordinated Research Project on Agroforestry (AICRP on Agroforestry)	1154.27	1153.79
	Harvesting, processing and value addition of natural resins and gums (HPVA of NRG)	16.05	16.05
	National Agriculture Innovation Fund (NAIF) Scheme IP&TM	6.01	6.01
3.	**Externally funded projects**		
	a. Transforming rural livelihood through agroforestry based natural resource management in drought prone Bundelkhand region, UP (Sub Project of KISAN MITrA project for Doubling Farmers' Income in Bundelkhand region of Uttar Pradesh)- ICRISAT, Hyderabad	30.71	30.71
	b. Transforming rural livelihood and checking migration through agroforestry in conjunction with natural resource management in Bolangir and Nuapada districts of Odisha- ICAR-ICRAF Work Plan	1.83	1.83
	c. Assessment of genetic potential of neem germplasm for higher yield and oil content through molecular markers- NRAA, Govt. of India, New Delhi	9.00	9.00
	d. Assessment of area under agroforestry systems/ species in agro-climatic zones of India- ICAR-ICRAF Work Plan	10.90	5.90
	e. Whole Transcriptome Sequencing of *Pongamia pinnata* for Drought Stress Tolerance - ICAR-ICRAF Work Plan	0.53	0.51
	f. Evaluating the performance of strawberry cultivation in Babina block of Jhansi district for crop diversification and better economic return at farmer's field - NABARD (U.P.)	19.87	18.30
	g. Evaluating the performance of strawberry cultivation in Moth block of Jhansi district for crop diversification and better economic returns at farmer's field - NABARD (U.P.)	19.90	18.96
	h. Task Force on Himalayan Agriculture- NMSHE (2nd Phase)- DST, New Delhi	268.40	236.36
	i. Support Implementation of National Agroforestry Policy by Enhancing Tree Cover & Production of Wood- FAO, India Office	13.95	10.08
	j. Pilot the solutions of chip-based technology for real-time and RFID-passive monitoring of field genebank and agroforestry species for scaling up- ICRAF-ICAR Work Plan	4.93	0.51
	k. Study of soil-hydrothermal environment under natural vs synthetic mulch	-	-
4.	**Resource Generation**	**Target**	**Achievement**
	2021-22	14.00	10.65
	Swachh Bharat Mission	7.20	7.20
5.	**SCSP Fund**		
	Capital	11.57	11.57
	General	20.80	20.80
	Total	**32.37**	**32.37**

2. Research Achievements

2.1. Agroforestry System Research Programme

NRMACAFRISIL201600100099:

Performance of pomegranate integrated with lemongrass under organic regime

(Sudhir Kumar/Ashok Yadav, Rajendra Prasad and Venktesh Y N)

The data analysis and report writing was done. The study showed that there was no effect of lemon grass on the yield of pomegranate whereas due to shading effect of pomegranate there was slight difference in lemon grass yield when it was intercropped with pomegranate. The vermicompost was more effective than FYM in respect to sustainable crop production and also from the soil health point of view. Integration of lemon grass based agroforestry system under organic treatment lead to improvement in soil fertility and soil properties in terms of pH, EC, SOC, available nitrogen, phosphorous and potassium. Evaluation of bio insecticides and chemical insecticides revealed that Imidacloprid (17.5 SL) was more effective in controlling the pest followed by neem oil and *Verticillium lecani*.

The pomegranate-lemongrass-based agroforestry system in semiarid conditions can improve the farmers' livelihood by providing extra income from lemon oil in semi-arid regions of central India. This project was concluded in the IRC -2021.

NRMACAFRISIL201000200085:

Nutrient management in ber based agri-horti. System

(Sudhir Kumar/Ashok Yadav, Rajendra Prasad, Inder Dev and Venktesh Y N)

The result of ber based agri-horti system revealed that treatment T_8 (Ber with 75% RDF + *Trichoderma* + Black gram – Barley) performed better followed by T_6 (Ber with 75% RDF + *VAM* + Black gram – Barley*)* and T_2 (Ber with 100% RDF + Black gram – Barley). Under the system, barley sown during *rabi,* the observations revealed that treatments T_{10} (pure crop) and T_6 (Ber with 75% RDF + VAM + Black gram – Barley) recorded highest seed yield of 2517 and 2518 kg ha^{-1} and were significantly higher as compared to other treatments. The observations on guar revealed that the treatments T_{10} (pure crop) and T_6 (Ber with 75% RDF + VAM + Guar - Wheat) recorded highest seed yield of 1012 and 995 kg ha^{-1} and was significantly higher w.r.t. other treatments. In fruit flies management study, the Methyl eugenol traps proved better than the Cue lure traps. In respect to micro-nutrients, surface soil of all the treatment plots contained sufficient amount of Zn and Cu with few exceptions. In sub-surface soil, micro-nutrients content declined when compared with surface layer. The data analysis and report writing was done. This project was concluded in the IRC -2021.

NRMACAFRISIL202100500129:

Developing Multifunctional Agroforestry System for Nutritional Security in Semi-arid Tropics

(Ashok Yadav and Arun Kumar Handa)

Through different survey conducted, we identified and collected trees suitable for food forest. The survey were also conducted for development of year round apiary model. We also identified and collected planting material for some polleniferous and nectrifereous tree. Beside this, seed were collected for year round flowering of moringa plants and seedling were raised and later planted in the field also.

NRMACAFRISIL201300100091:

Agroforestry based Conservation Agriculture for Sustainable Landuse and Improved Productivity

(Inder Dev, Asha Ram, Naresh Kumar, Lal Chand, Sushil Kumar, Priyanka Singh and Venkatesh Y N)*

***On Study leave w.e.f. 4.10.2021**

The project entitled "Agroforestry based conservation agriculture for sustainable landuse and improved productivity" was initiated during July, 2014 having 03 experiments Bael based Agroforestry system; Teak based Agroforestry system and Bael + Teak based Agroforestry system with 04 main plot treatments *i.e.*, Min. tillage-Blackgram-Mustard (CS-1); Min. tillage-Greengram-Barley (CS-2); CT-Blackgram-Mustard (CS-1) and CT-Greengram-Barley (CS-2) and 03 subplot treatments (with crop residue; without crop residue and with leucaena residue). The experiments are being conducted in split plot design with 03 replications.

Experimental results

During *Rabi* 2020-21, mustard and barley and in *Kharif* 2021 greengram and blackgram were sown as per the treatment details in all the three experiments, and the results in brief of the experiments are presented as under:

Experiment 1: Bael (*Aegle marmelos*) based conservation agriculture system

In bael based conservation agriculture system, during *rabi* 2020-21, the seed yield of mustard varied significantly among tillage treatments. The highest seed yield was observed in crop residue retention followed by leucaena added treatment, however were at par with each other and both the treatments recorded significantly higher yield over the no residue treatment. The addition of crop residue increased the seed yield of barley substantially over no residue treatment (Fig. 1 & 2).

During *kharif* season (2021) it was observed that the seed yield of blackgram in Minimum tilage (MT) and Conventional tilage (CT) plots were non-significant. The residue addition resulted in significant increase in seed yield of blackgram. The yields of crop residue treatment and leucaena treatment were found at par. The seed yields of greengram in both the tillage treatments were found at par. Crop residue retention recorded highest seed yield followed by leucaena residue addition and minimum yield was recorded in control (Fig. 3 & 4).

Bael based system

Experiment II: Teak (*Tectona grandis*) based conservation agriculture system

In teak based CA system, during *rabi* season (2020-21), the seed yield due to residue retention recorded significant higher yield in mustard. The seed yield showed significant increase with crop residue retention and leucaena residue addition over control. However, both the treatments were statistically at par. The data indicated that the grain yield of barley was not influenced by tillage treatments in teak based CA system. In sub plot treatments, crop residue and leucaena residue addition increased the grain yield of barley substantially over no residue application treatment (Fig. 1&2). Among the residue based treatments, the seed yield of blakcgram increased substantially in crop residue addition and in leucaena residue addition over no residue addition treatment. Tillage treatment did not bring significant change in seed yield of greengram (Fig. 3 & 4).

Teak based system

Experiment III: Bael + Teak based conservation agriculture system

The seed yield of mustard during *rabi* season of 2020-21 was not influenced by tillage treatments. However, the seed yield was recorded slightly more in CT than MT plot. The residue addition has resulted in significant increase in the seed yield of mustard over control. Residue addition recorded substantial increase in seed yield in crop as well as leucaena residue addition in sub plots over no residue addition treatment**.** The grain yield of barley ranged from 1139 kg ha^{-1} to 1402 kg ha^{-1} in MT plots (Fig. 1&2).

Seed yield of blackgram was statistically at par in both the tillage treatments. Residue retention had influenced seed yield of blackgram significantly. The highest seed yield was recorded in crop residue retention followed by leucaena residue added plot and minimum in control. However, both the residue added treatments were found at par with each other**.** Seed yield of greengram in MT and CT treatments were non-significant. Among the residue based treatments, the seed yield of greengram increased substantially in crop as well as leucaena residue addition over no residue addition treatment (Fig. 3 & 4)**.**

Teak+Bael based system

Growth parameters of bael and teak in different agroforestry based conservation agriculture systems

Growth parameters (DBH and Height) of bael and teak in all the three systems indicated that there was no significant difference between and among the systems for DBH and height of both the tree species.

This project was concluded during October as the project objective were achieved. A new project on conservation agroforestry was approved during IRC 2021. The chickpea and linseed were sown during the *rabi* 2021-22.

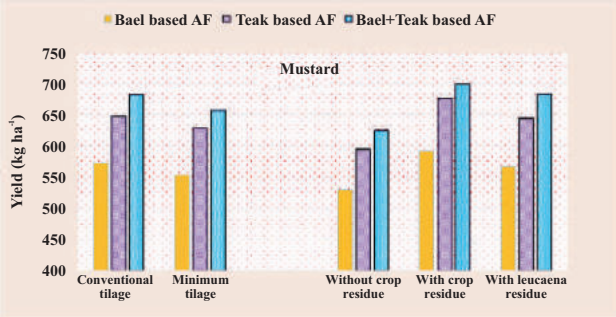


Fig. 1. Grain yield of mustard in different systems

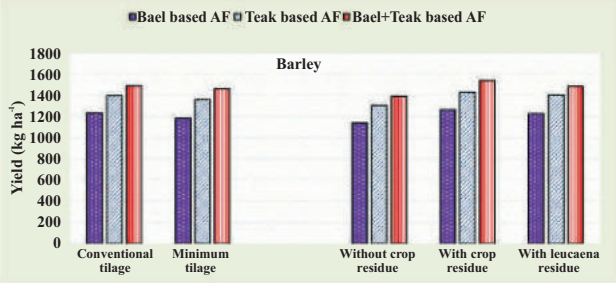


Fig. 2. Grain yield of barley in different systems

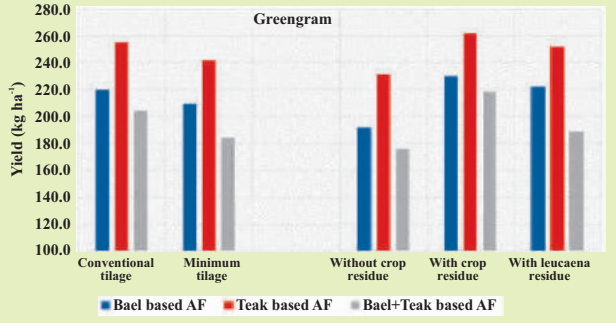


Fig. 3. Grain yield of greengram in different systems

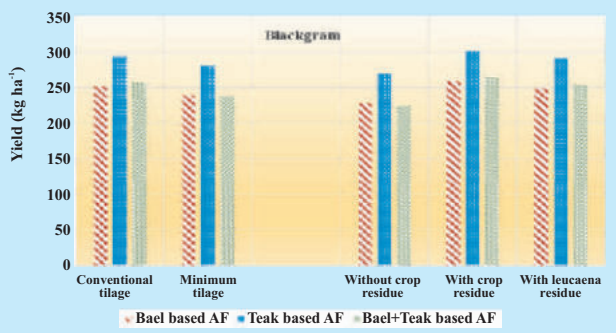


Fig. 4. Grain yield of blackgram in different systems

NRMACAFRISIL201600200100.

Structural and functional analysis of short rotation tree based Agroforestry system

(Naresh Kumar, Asha Ram, Inder Dev, Kamini and Priyanka Singh)

The project entitled "Structural and functional analysis of short rotation tree based Agroforestry system" was started in the year 2016 at experimental farm of Central Agroforestry Research Institute, Jhansi. Three fast growing tree species *viz.*, *Anthocephalus cadamba, Melia dubia* and *Leucaena leucocephala* were planted at two spacings *i.e.* 4 x 5 m and 8 x 2.5 m under seven treatments *viz.*, T_1-*Anthocephalus cadamba*+ crop, T_2 - *Melia dubia* + *crop,* T_3 - *Leucaena leucocephala* + crop, T_4 - *Anthocephalus cadamba* (Pure plantation), T_5 - *Melia dubia* (Pure plantation), T_6 - *Leucaena leucocephala* (Pure plantation) and T_7 - Pure crop (*Kharif/Rabi*) with three replications under RBD. Black gram – wheat crop sequence was being taken in this project.

The growth performance of these tree species as well as tree-crop interactions were studied in agroforestry system. Sixteen numbers of plants of each tree species have been planted in each plot (16 m x 20 m = 320 m^2). This project was concluded in the IRC -2021.

The growth data of tree species were recorded and performance of wheat crop (as intercrop) was studied. Due to aberrant weather conditions, *kharif* crop (Black gram) could not be grown during 2021.

The observations on height and diameter at breast height (dbh) of *A. cadamba, M. dubia* and *L. leucocephala* were recorded. It was observed that at five year age, *Melia dubia* recorded maximum average height as well as diameter at breast height (dbh).

In 4 m x 5 m spacing, *M. dubia* recorded maximum height 12.50 m when intercrop was grown and 12.25 m without intercrop (pure plantation). The respective diameter at breast height was 24.85 cm and 23.07 cm. *A. cadamba* registered 8.70 m and 8.20 m height; and 16.42 cm and 14.75 cm diameter at breast height when intercrop was grown and without intercrop (pure plantation), respectively. Among three species under study, lowest diameter at breast height i.e.15.62 cm and 14.14 cm with tree height of 10.25 m and 10.10 m was observed in *L. leucocephala* with intercrop and pure plantation, respectively.

When these three tree species were planted at 8 m x 2.5 m spacing, maximum height (13.20 m & 12.70 m) and diameter at breast height (25.16 cm & 24.72 cm) were recorded in *M. dubia* grown with crop and as pure plantation. In terms of diameter at breast height, *A.*

cadamba was next best performing tree species having 16.50 cm (with intercrop) and 14.87 cm (pure plantation) diameter, however, the respective value for the height was 8.95 m and 8.50 m. In *L. leucocephala*, the lowest diameter at breast height (15.75 cm & 11.50 cm) was observed with intercrop and pure plantation with 11.80 m and 11.50 m height, respectively.

Intercrop performance

During *Rabi* 2020-21, wheat crop was grown in interspacing of *A. cadamba*, *M. dubia* and *L. leucocephala* rows of both the spacings (4m x 5m and 8.0m x 2.5m). As compared to open field conditions (310.2 g/m^2) significantly lower wheat grain yield was reported in all the agroforestry system with both spacings. The wheat grain yield in agroforestry systems ranged between 50.3 to 195.6 g/m^2. Among the three tree species, highest wheat grain yield was reported with *L. leucocephala* and lowest with *M. dubia*. This might be due to more canopy spread and shade of Melia trees. As compared to 4m x 5m spacing, higher wheat grain yield was recorded in 8m x 2.5m spacing, irrespective of tree species. Due to aberrant weather conditions, *kharif* crop could not be grown during 2021.

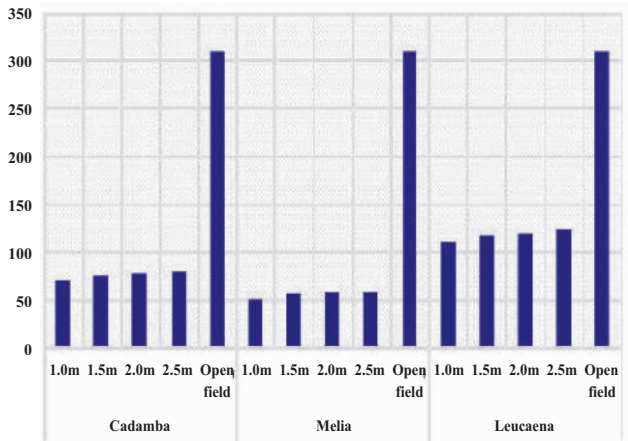


Fig. 5: Wheat yield (g/m^2) under 4 m x 5 m spacing

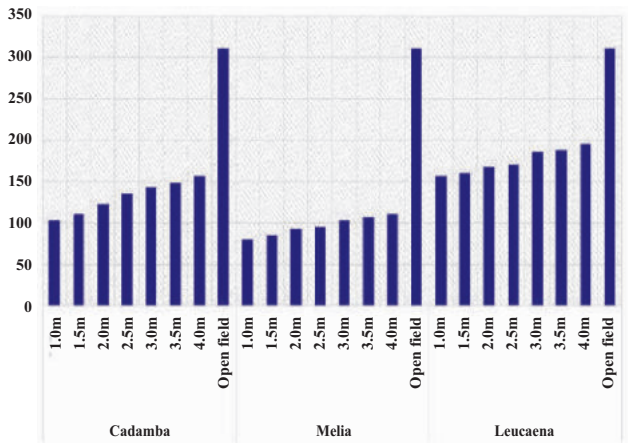


Fig. 6: Wheat yield (g/m^2) under 8 m x 2.5 m spacing

***L. leucocephala* based agroforestry system under SRT**

Melia based agroforestry system under SRT

***A. cadamba* based agroforestry system under SRT**

NRMACAFRISIL20200300121

Temporal evaluation of cropping systems under varying spacing of *Melia dubia* based agroforestry system

(Sushil Kumar, Asha Ram, Naresh Kumar, Sukumar Taria, Priyanka Singh and Rajendra Prasad)

An experiment involving four *Rabi* season crops *viz*., wheat, barley, chickpea and mustard under varying spacing of *Melia dubia* (M_1=3x3 m, M_2=8x3 m, M_3=8x4 m and M_4=8x5 m) was undertaken at the Institute Experimental Farm (Fig 1).Growth parameters, yield attributes andyield of the experimental crops were recorded. Crop growth parameters were recorded at different growth stages (30, 60, 90 and at harvest). Tree spacing did not significantly (p=0.05) influence the performance of test crops. However, recorded data indicated that respective sole crops performed better than their counterparts grown with *Melia dubia* and recorded higher growth parameters, yield attributes and yields. The crop-wise obtained results are summarized as under.

Wheat: Wheat performance was observed poor under the tree as compared to sole cropping. Among tree-based treatments, the poor performance of wheat was observed under M_1. Sole wheat performed better, recorded higher plant height (0.4-9.80%), number of tillers (1.13-46%) length of the spike (0.21-8.63%), number of grain per spike (0.86-5.0%), test weight (1.86-3.80), straw yield (5.17-27.08%) and grain yield (3.02-9.67%) as compared to rest of the treatments.

Chickpea: Likewise wheat, chickpea performed poorly with the tree as compared to the sole cropping. Among tree-based treatments, the minimal plant height, number of branches plant^{-1}, test weight and yields of chickpea were observed with M_1.Across the treatments, sole chickpea performed better recorded with higher plant height (5.51-17.33%), No. of branches plant^{-1} (4.80-9.58%), test weight (1.57-6.60%), grain yield (1.04-22.72%), stover yield (0.40-7.50) and biological yield (0.80-15.55%) over rest of the treatments. However, the highest harvest index (54.76%) was recorded with M_1.

Fig. 7: Field view of the wheat experiment

Mustard: Mustard also performed poorly with the tree as compared to the sole cropping. The highest and lowest growth parameters, yield attributes and yield were recorded with the sole cropping and M_1, respectively. Among treatments, sole crop recorded the highest plant height (205.78 cm), number of siliqua plant^{-1}(130.44), length of siliqua (6.80 cm), number of grains siliqua^{-1} (16.33), test weight (4.99 g) and yield (1514 kg ha^{-1}).

NRMA/CAFRI/SIL/2021/006/00130

Assessment of soil biological and biochemical characters in predominant agroforestry-based land use systems

(Sovan Debnath and Suresh Ramanan S)

Randomized soil sampling was performed in the field plots of the experimental agroforestry systems and samples were collected in triplicates from topsoil depth (0-15 cm) with the help of a spade. Sampling has been carried out at four agroforestry based land uses *viz.* Teak + cropping, Melia + cropping, Ber + cropping, Anola + cropping, and an agricultural (sole) cropping system. After removal of the organic debris, the collected soil samples were partitioned in to two parts. One part was air dried in shade, processed and sieved through 2 mm sieve and, stored in polythene bags for analysis of soil physico-chemical properties. The other part was sieved through 2 mm sieve and stored in zippered polythene bags at 4ºC for analysis of soil biological and biochemical attributes. Soil moisture content was measured immediately after field sampling.

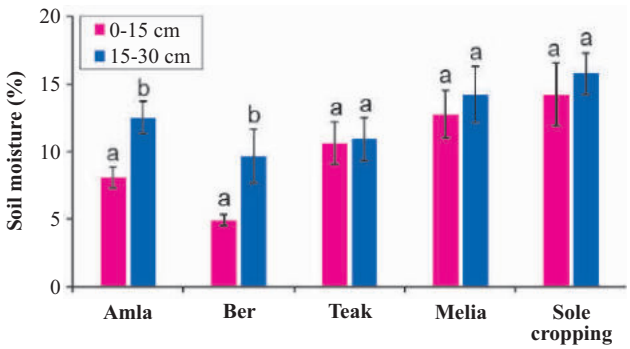


Fig. 8: Soil moisture content of the experimental agroforestry systems. Columns followed by letter in common do not differ significantly at *P* <0.05. Vertical bars on columns represent standard error (*n* = 3).

Fig. 9: Sampling and processing images

2. Research Achievements

2.2. Tree Improvement Research Programme

NRMACAFRISIL200700400071

Comparative studies on seedling and clonal plants of *Pongamia pinnata* with special reference to their adaptability to rainfed dry agroclimate

(Badre Alam, A K Handa, Sukumar Taria, Hirdayesh Anuragi and Alka Bharti*)*

The physiological responses in relation with the photosynthetic carbon assimilation (P_N) and thylakoid electron transport rate (ETR) have been noted in clonal and seedling plants during dry hot summer season. Clonal plants maintained relatively better photosynthetic efficiency than the seedling plants (Fig. 10). Better photosynthetic efficiency in clonal plants than the seedling plants during summer season has been corroborated with the rate of electron transport as well (Fig. 11). Comparative efficiency in clonal plants during dry hot summer has also been reflected in the photochemical efficiency and it has been noted in the maximum quantum yield under dark adapted stage *i.e.* Fv/Fm (Fig. 12).

The differential responses as observed during peak summer conditions between clonal and seedling plants indicated differential functional efficiency which have remarkable impact on the better physiological efficiency in clonal plants than the seedling plants. Low pod formation was observed which was related to higher flower drop from the trees. The functional efficiency has also been reflected through the assessment of the dynamics of leaf water relations (Fig. 13). Analysis for the biochemical assays of the enzyme activities is progressing. The canopy diameter has also been estimated for both clonal and seedling plants in the field (Fig. 14).

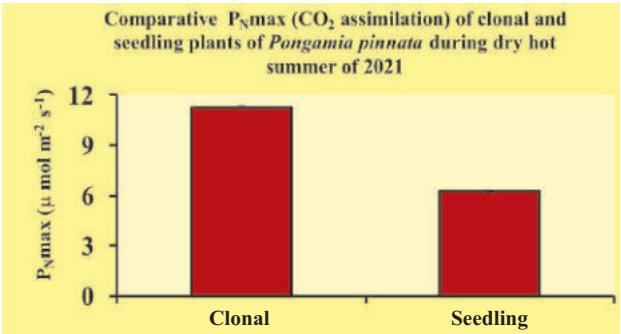


Fig. 10: Comparative CO_2 assimilation (PN max) of clonal and seedling plants of *Pongamia pinnata* under dry hot summer season

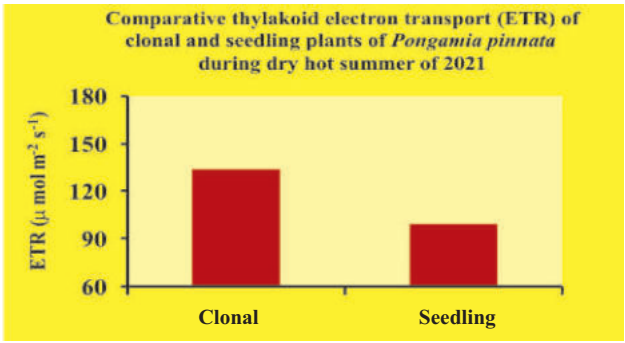


Fig. 11: Thylakoid electron transport rate (ETR) of clonal and seedling plants of *Pongamia pinnata* under dry hot summer season

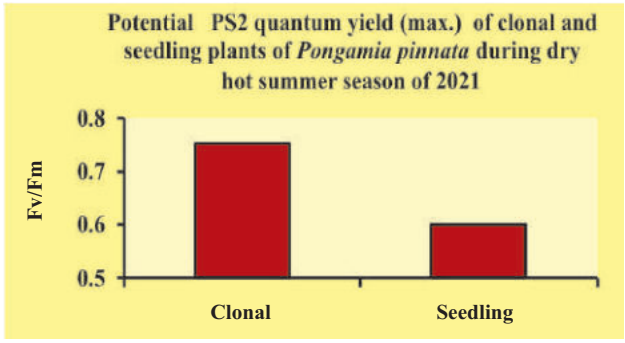


Fig. 12: Comparative potential PS2 quantum yield (max.) of clonal and seedling plants of *Pongamia pinnata* during summer

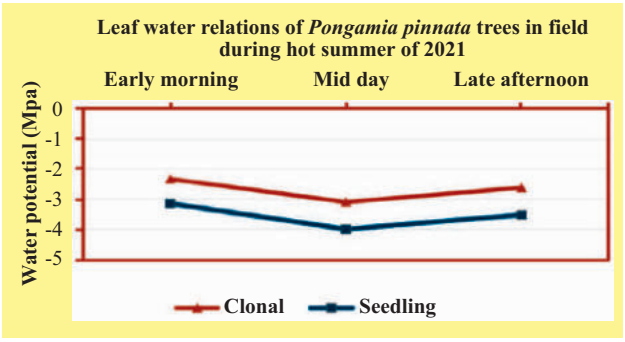


Fig. 13: Dynamics of leaf water relations of clonal and seedling plants of *Pongamia pinnata* under dry hot summer season

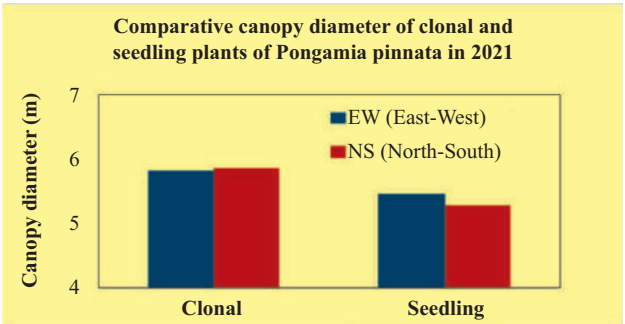


Fig. 14: Canopy diameter of clonal and seedling plants of *Pongamia pinnata* in east-west and north-south directions

NRMACAFRISIL201500100092

Evaluation and characterization of different leucaena germplasm at CAFRI, Jhansi

(K Rajarajan, AK Handa, SB Chavan#/R Vishnu# A K Singh and Maneet Rana)

In this study, the key fuelwood and pulpwood traits were studied on five different species of *Leucaena viz. Leucaena leucocephala*, *Leucaena diversifolia*, *Leucaena collinsii*, *Leucaena lanceolata* and *Leucaena shanonii*. Based on the putative wood properties parameters *L. leucocephala* had better pulpwood properties, while *L. collinsii* had better attributes for fuelwood. The later however had comparable levels of lingo-cellulosic properties with *L. leucocephala* suggesting to be a new source of raw material for pulp and bioenergy. Further, it could be used as a donor parent for inter-specific hybridization to produce superior hybrids for utilization in the wood-based industries.

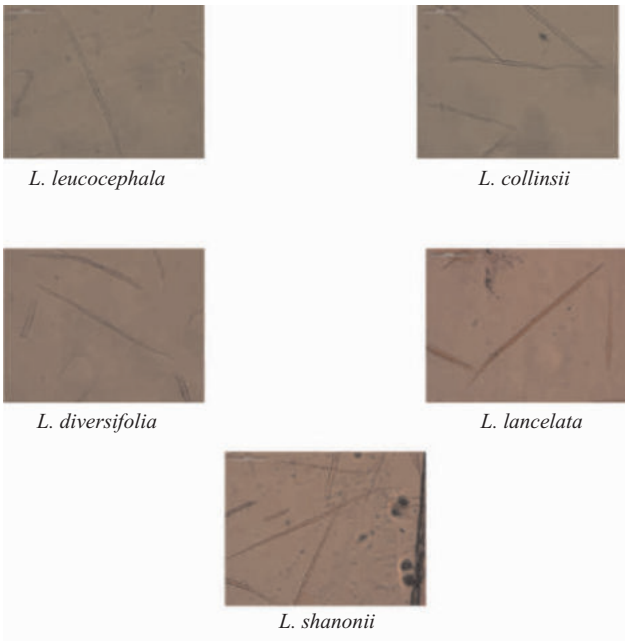


Fig. 15: Wood fibers of five different Leucaena species

Transfer/joined as new position at other institutes

NRMACAFRISIL201801100114

Functional genomics for early drought tolerance in *Pongamia pinnata* genotypes

(K Rajarajan, A Radhakrishnan, Sukumar Taria, H Anuragi, Alka Bharti* and Ashajyothi*)*

In this proposed year, expression analysis with six known candidate genes was carried out. However, the nine morpho-physiological and biochemical traits were studied in these six genotypes as early tolerant (NRCP-17, NRCP-9 and NRCP-25) and early susceptible (NRCP-6, NRCP-10 and NRCP-14) under drought stress and control conditions. Significant differences were observed for all the considered parameters under drought stress condition. Based on the traits studied contrasting genotypes were identified as NRCP-9 tolerant and NRCP-10 susceptible. In addition, molecular characterization was done for the remaining four genotypes (NRCP-6, NRCP-14, NRCP-17 and NRCP-25) by differential gene identified are subjected to the whole transcriptome analysis. The results revealed that significant differential expressions was found between the genotypes for drought stress tolerance. Among the four genotypes, NRCP25 found to be early drought tolerant as compared with other three genotypes. Overall, this study can be useful in Pongamia genetic improvement for drought tolerance.

NRMACAFRISIL201900200118

Collection, evaluation and hybridization of *Moringa* germplasm

(Hirdayesh Anuragi and K Rajarajan)

Moringa oleifera Lam., a member of moringaceae family has been considered as a "Superfood," or "Wonder tree," or "Tree of life" due to its exceptionally high nutritional and therapeutic properties which can cure over 300 human ailments. Further, the drought tolerance and fast growing nature make moringa a very suitable species for agroforestry for ensuring farmland ecosystem restoration, nutritional and livelihood security under current scenario of climate change. India leads in moringa production and own around 80% (US$ 8 billion worth) of global moringa market. By looking at the importance of this species, the current study was aimed at collecting the existing moringa germplasm from possible nearby places and characterize them to identify superior genotypes with year-round fruiting and higher adaptability for water scarce and hot Bundelkhand and other semi-arid regions. A total of thirty moringa germplasm with varied morphological characteristics have been collected from different Bundelkhand districts of Madhya Pradesh and Uttar Pradesh. A considerable amount of variability was observed while collection. The passport data of each germplasm was collected during the visit.

These germplasm were studied in terms of seed germination and early seedling growth performance under partial control shade net condition to identify the most vigorous ones. The result indicated the existence of significant variation ($p \leq 0.05$) for seed germination and seedling survival attributes. Young seedlings at 30 DAS also exhibited significant differences for seedling length, seedling fresh weight, seedling dry weight, seedling vigor index-I and II, mean germination rate, mean germination time, synchronization index, germination index, coefficient

of velocity of germination and speed of germination in all the germplasm which might be attributable to their inherent vigor. The PCA and Cluster analysis was also performed to dissect the potential relationships among the traits. Four germplasm *viz.*, CMC-3, CMC-8, CMC-12, and CMC-24 were found to be more prominent in terms of initial seedling growth performance. This existing variation at early seedling stage could be utilized in futuristic moringa breeding programs.

Furthermore, these germplasm were sown in the field and observed for various morphometric traits. Three germplasm *viz.*, CMC-5, CMC-8 and CMC-12 were identified with early and prolonged flowering and fruiting behavior as well as higher adaptability indicating to be the potential germplasm for further research and utilization. Descriptive statistics, variance analysis, correlation coefficient, PCA and cluster analysis were also performed to evaluate the existing variability. Significant differences ($p \leq 0.05$) in plant height, stem girth, number of primary branches, flower, and pod and seed characteristics were observed among the germplasm. Heritability, genetic advance, correlation and path analysis suggested that number of primary branches, canopy size, high flower numbers and pod length could be important parameters for breeding programs in moringa.

*CMC-CAFRI Moringa Collection

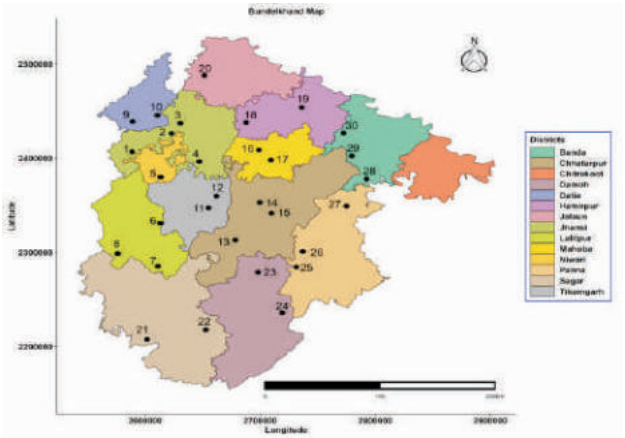


Fig. 16: Bundelkhand map representing number of moringa germplasm collected from different districts

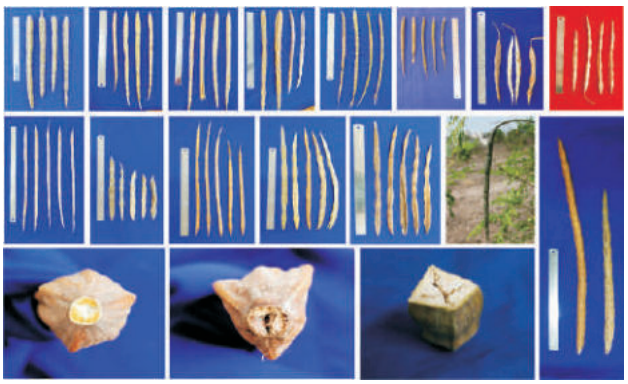


Fig. 17: Variation in pod morphological characteristics

Fig. 18: Bipinnate and tripinnate leaves (a & b), normal and pigmented leaves (c & d) varied flowering behavior (e – i), varied plant architecture (j – n) and field view of moringa germplasm at Research Farm of ICAR-CAFRI, Jhansi (o)

2. Research Achievements

2.3. Carbon & Climate Change Research Programme

NRMA/CAFRI/SIL/2021/011/00135

Ecophysiological dynamics for assessing climate change mitigation potential of contrasting tree populations of *Pongamia pinnata*

(Badre Alam and Rajendra Prasad)

Quite a few number of ecophysiological traits are being studied for primary information for their use for assessing climate change mitigation potential. In this direction, relevant ecophysiological parameters are being estimated in relation to leaf physiological responses. The experiment is being conducted and the analysis is in progress.

NRMA/CAFRI/SIL/2021/012/00136

Assessment of ecosystem services in silvipastoral system in semi-arid conditions

(Asha Ram, Inder Dev and Naresh Kumar)

It was observed that highest grass biomass production was recorded in T_7- Teak+Mahagoni+ Pasture + Contour Staggered Trenches (CST) followed by T_6- Teak +Mahagoni +Pasture +Vegetative Hedge. Dynamics in soil moisture content was also studied at 15 days interval and found that treatments with soil and moisture conservation measures and with pasture component recorded higher moisture content as compared to sole trees. The soil moisture content ranged between 1.42% (May) to 12.79% (August). The contour staggered trenches (CST) and half-moon basin (HMB) trapped soil sediments at the rate of 4.76 t ha^{-1} and 1.80 t ha^{-1}, respectively (Fig. 19). Out of total 07 event rainfall, maximum runoff was generated in sole mahagoni whereas lowest runoff was occurred in Teak+Mahagoni+ Pasture + Contour Staggered Trenches (CST). Likewise minimum soil loss, nutrient loss were recorded in T_7 treatment. The root growth parameters and root binding capacity of grasses were also recorded higher in treatment with soil and moisture conservation measures as compared to sole pasture. This project was concluded in the IRC- 2021.

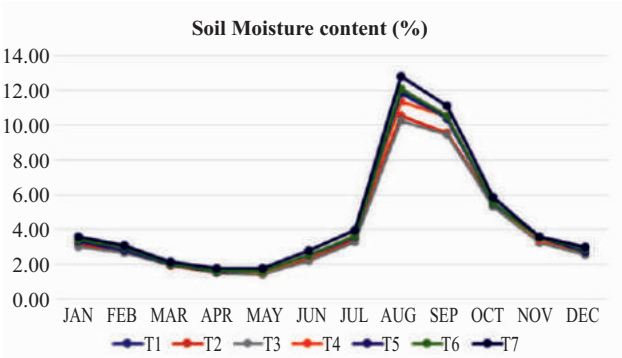


Fig. 19: Soil moisture dynamics in different treatments in silvipastoral system

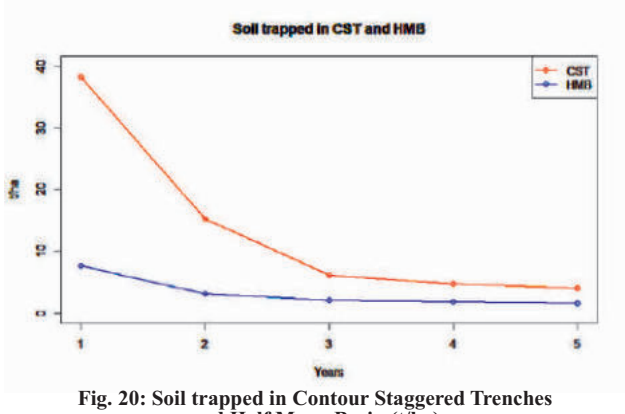


Fig. 20: Soil trapped in Contour Staggered Trenches and Half Moon Basin (t/ha)

Collection of runoff water for soil loss and nutrient loss estimation

Biomass production of *Cenchrus ciliaris* and *Stylosanthes seabrana*

NRMA/CAFRI/SIL/2016/007/00104

Impact of watershed and agroforestry interventions on hydrology and nutrient loss at Garhkundar-Dabar watershed in Bundelkhand region of central India

(Inder Dev, R K Tiwari and Asha Ram)

Runoff and soil loss was monitored at four locations in Garhkundar-Dabar (GKD) watershed (treated). The untreated watershed was gauged for the same purpose at the outlet. Datalogger based automatic stage level recorders were installed at five sites as well as in control watershed during 2021. Manual and self-recording rain gauges have also been installed to record the rainfall. Runoff from the treated watershed was 10.2% of total recorded rainfall during the period. Soil loss from treated was 81.5% lower in case of treated over untreated watershed. Average water column was recorded as 4.5 m in GKD watershed, which was found 44% higher than the average water column of open wells of untreated watershed.

NRMA/CAFRI/SIL/2021/013/00137

Text mining for assessing research trends and gaps of agroforestry perennials: A Big data analysis approach

(Suresh Ramanan S and A Arunachalam)

Following the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta- Analysis), the metadata for one wood perennial- *Ailanthus excels* has been collected and an attempt was also made to refine the metadata so that analysis can be started.

2. Research Achievements

2.4. Agroforestry Extension Research Programme

NRMA/CAFRI/SIL/2021/014/00138

Constraints in Adoption of Agroforestry in Bundelkhand Region of Central India

(R P Dwivedi, Sushil Kumar and Priyanka Singh)

The research project is in its start year and the interview schedule preparation, pilot testing of the Interview schedule and selection of the villages for data collection is under the process.

NRMA/CAFRI/SIL/2021/015/00139

Impact assessment of agroforestry and water conservation interventions on livelihood of farmers in Garhkundar Dabar watershed

(Sushil Kumar and Priyanka Singh)

Project activities for assessing impact of agroforestry and water conservation interventions on livelihood of farmers in Garhkundar-Dabar watershed have been initiated. The secondary information from all the available sources *viz.*, published and unpublished literature collected and reviewed. A proforma as per the need of the project for data collection has been developed.

NRMA/CAFRI/SIL/2021/016/00140

Economic impact of ICAF-CAFRI interventions in Parasai Sindh Watershed.

(Priyanka Singh and R P Dwivedi)

Village survey was conducted and three treated villages namely Parasai, Chhatarpur and Bachauri and three control villages *viz*; Rajapur, Imliya were selected. Survey schedule was prepared and pre-testing of schedule is being conducted.

KISAN MELA, KISAN DIWAS, KRISHAK GOSTHI, VISITS, TRAINING, EXHIBITIONS AND VAN MAHOTSAV ORGANIZED

During 2021, the institute organized various activities and capacity building programmes for transfer of technologies and for creating awareness among the farmers for the adoption of agroforestry (Table 1) depicts the details of training and capacity building programme.

Table 1: List of trainings, exhibitions and capacity building programmes

S.No.	Activities	Date	Location	Participant (Nos.)
1	Tapping of Palas Gum (Kamarkas) in collaboration with Srijan Society (NGO)	22nd January, 2021	Training Centre of National Rural Livelihood Mission, Sirsaud village, Karera block, Shivpuri (M.P)	60 farmers
2	Kisan Mela and Kisan Gosthi	12th March, 2021	ICAR-IGFRI, Jhansi	107 farmers
3	Krishako ko Ber me kaant-chant ka prakshinan karyakram (Ber Pruning)	17-19th June, 2021	Parasai village, Babina block, Jhansi (U.P.)	22 farmers
4	Online Training for Chattisgarh Forest Department Officers	11th August, 2021	Virtual mode	30 forest officials
5	Krishako Ko Ber Me Kalam Baandhane Ka Prakshinan Karyakram (Ber Budding)	1st-3rd September, 2021	Parasai village, Babina block, Jhansi (U.P.)	16 farmers
6	Krishivaniki Aadharit Naveen Taknikiyan in association with Srijan Society funded by NABARD, Kanpur	28th-30th September, 2021	ICAR-CAFRI, Jhansi	25 farmers
7	Krishi Takniki Pradarshini Evam Kisan Mela	1st November, 2021	ICAR-IGFRI, Jhansi	74 farmers
8	Exhibition of different Agroforestry based Technologies	1st December, 2021	Shivrampur village, Niwari, M.P.	43farmers
9	Aoudyaniki Krishi Evam Krishi Udyami Mela	27th December, 2021	Jhansi Paramedical College Campus, Jhansi	66 farmers

Tree Plantation Campaign

On 16th July, 2021, ICAR-CAFRI organized a Nation-wide Tree Plantation Campaign as the part of India@75 *Azadi ka Amrut Mahotsav* on the eve of the 93rd Foundation Day of Indian Council of Agricultural Research (ICAR). Dr. Trilochan Mohapatra, Secretary DARE & DG ICAR, The DDGs and ADGs of ICAR headquarters were also present in the meeting. Dr. A. Arunachalam, Director, ICAR-CAFRI coordinated this program that aimed to plant 10 lakhs tree seedlings. With the support of NARES, SMAF and other partners, 9.54 lakhs tree seedlings were planted across the nation.

Promoted Agroforestry through Poem, Slogans and Punch lines

Popularised and promoted Agroforestry poem, slogans and punch lines of Krishivaniki during Kisan Mela, Kisan Gosthi, Interface meetings, KVKs Gosthi, Exhibitions, State department programmes and among visiting farmers, farm women, *etc.* and mobilized the farmers about agroforestry practices and benefits through dissemination of awareness campaign.

Wide publicity of CAFRI's activities through Local Newspaper coverage

A very good coverage of CAFRI's activities appeared in local newspapers through updating and briefing press people about CAFRI and agroforestry for the benefit of farmers. The brand CAFRI is now visible through daily news papers in and around Jhansi.

Visits organized at CAFRI, Jhansi

During January 2021 to December 2021 more than 2700 farmers' visits were organized at ICAR-CAFRI, Jhansi.

MERA GAON-MERA GARAUV (MGMG)

During 2021, The plantation drive in the MGMG villages was carried out by Scientists of ICAR-CAFRI Jhansi in the selected MGMG villages. The scientists also interacted and created awareness about Agroforestry among the farmers. Organized interface meetings with the farmers of MGMG villages during 2021. Total 3545 plants were distributed to the farmers. The list of clusters (5) and villages (16) are as below:

1. Hastinapur cluster (3 villages- Hastinapur, Karari, Rund Karari), Jhansi, U.P.
2. Domagor cluster (3 villages-Domagor, Dhikoli, Nayakhers), Jhansi, U.P.
3. Ganeshgarh cluster (3 villages- Ganeshgarh, Devgarh, Ramgarh), Jhansi, U.P.
4. Parasai cluster (3 villages- Parasai, Chhatpur, Bachhauni), Jhansi, U.P.
5. Garhkundar cluster (4 villages- Garhkundar, Dabar, Sakuli, Shivrampur), Niwari, M.P.

2. Research Achievements

2.5: Externally Funded Projects

ICAR Network Project

NRMACAFRISOP200800100075

Harvesting, processing and value addition of natural resins and gums

(Rajendra Prasad, A K Handa and Badre Alam)

This Network Project is being implemented at 10 centres coordinated by and headquartered at ICAR-IINRG, Ranchi. The main theme assigned to ICAR-CAFRI, Jhansi is "to develop agroforestry models integrating resin- and gum-yielding trees for livelihood security and horizontal dissemination of technologies". To achieve this broad objective, the centre is implementing five sub-projects *viz.*, i) productivity of gum yielding tree-based agroforestry models; ii) demonstration and development of gum yielding tree-based agroforestry models on farmer's fields; iii) indigenous technical knowledge (ITK) on gum and resin's tapping, applications and post-harvest value addition; iv) standardization of gum tapping techniques; and v) studies on root distribution pattern and above- & below-ground biomass in *A. senegal.* During the year, growth and productivity data of established gum yielding tree-based agroforestry models were recorded. Besides, 7000 seedlings of *A. senegal* were provided to the farmers for planting on their farms. For ITK information, survey of tribal dominated areas of Madhya Pradesh, namely Shivpuri, Sheopur, Dewas and Khandwa districts was conducted. Natural exudation of gum was monitored in both *A. senegal* and *A. nilotica* in established agroforestry models. Root distribution pattern of *A. senegal* was studied along with soil health status of different gum yielding tree-based agroforestry models. The detailed work progress of different sub-projects is illustrated as under:

A. Productivity of gum yielding tree-based agroforestry models: In *A. senegal* based multi-component model (agri-horti-silviculture), maximum GBH (cm), plant height (cm) and canopy spread (m^2) were recorded in *Aegle marmelos*, followed by *A. senegal*, *Citrus limon* and *Carissa carandas*. Survival (%) was maximum in *C. carandas* and minimum in *C. limon*. Pruning of tree's crown was carried out in the month of October *i.e.* before sowing of winter crops. During *rabi* (2020-21) and *kharif* (2021) seasons, *Triticum aestivum* (variety HD 2967) and *Vigna radiata* (variety Sweta), respectively were cultivated as intercrops. In the model, four trees of *A. senegal* exuded gum (78.39 g/tree). In rainfed agri-silviculture model, survival of *A. senegal* and *A. nilotica* ranged between 78-79 and 62-82%, respectively. *A. senegal* recorded maximum survival planted in 10 × 5 m while *A. nilotica* in 5 × 5 m spacing. After nine years of plantation, higher GBH and plant height were recorded in *A. nilotica* than *A. senegal* in almost all the spacing, barring few exceptions.

In silvi-herbal model-I, *Terminalia arjuna* showed maximum survival (100%), followed by *A. senegal* and *A. nilotica*. Maximum plant height (cm) was recorded in *A. senegal* and minimum in *T. arjuna*. In silvi-herbal model-II, *T. arjuna* showed maximum survival (100%), followed by *A. nilotica* and *A. senegal*. Highest GBH, plant height and canopy spread were recorded in *A. nilotica*.

In silvi-herbal model-I, maximum survival of lemongrass was recorded in 100 × 125 cm (76.38%) and minimum in 100 × 50 cm (66.98%) and in silvi-herbal model-II, similar trend was recorded (Figure 21). In block plantation of *A. senegal* on rocky hillock, plants attained mean height of 489.1 cm with GBH of 26.6 cm. In gum gardens, survival was higher in *A. senegal* than *B. monosperma*. The GBH, plant height and canopy spread of *A. senegal* was relatively higher in old gum garden than in new gum garden.

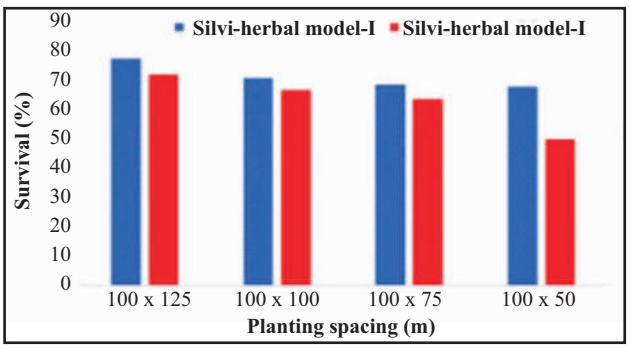


Fig. 21: Survival (%) of lemongrass in silvi-herbal models

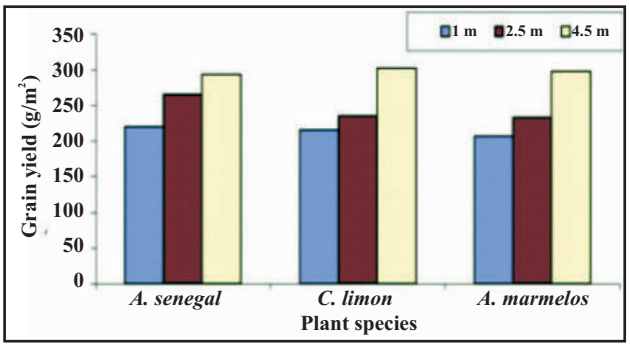
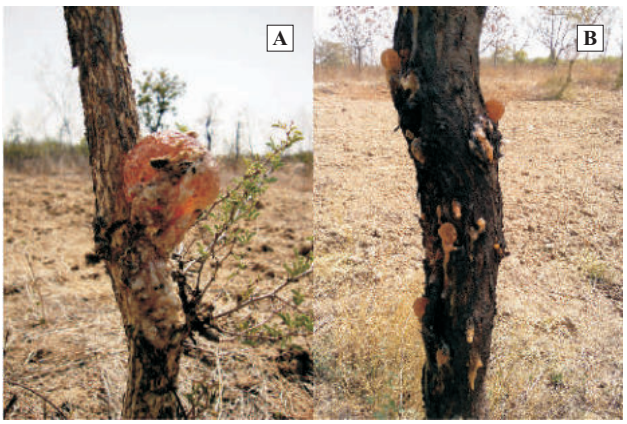


Fig. 22: Effect of woody perennials on seed yield (g/m^2) of wheat in agri-horti-silviculture model

During *rabi* season of 2020-21, *T. aestivum* (variety HD 2967) was sown in *A. senegal* based multi-component agri-horti-silviculture model. Plant growth and yield attributes of *T. aestivum* were recorded at three distances *viz.*, 1.0, 2.5 and 4.5 m from stem-base of *A. senegal*, *A. marmelos* and *C. limon*. Tree species significantly affected seed yield and above-ground dry biomass. Maximum grain yield was recorded under *A. senegal* which was at par with the yield under *C. limon* (Figure 21). Distance from tree trunk significantly affected all the recorded parameters. From this model, a total of 151 kg lemon, 58 kg karonda and 2080 kg bael fruits were harvested.

***Acacia senegal* based multi-component agri-horti-silviculture model at CAFRI research farm. A- Intercrop (wheat), B- Bael, C- Lemon and D- Karonda.**

During summer season, natural exudation of gum in different fields of *A. senegal* was observed. Gum yield ranged from 17.59–138.79 with mean of 78.39 g/tree in agri-horti-silviculture model; 4.03–903.56 with mean of 119.41 g/tree in rainfed agri-silviculture model; 3.76–73.04 with mean of 27.92 g/tree in old gum garden; 2.39–171.61 with mean of 35.98 g/tree in new gum garden; and 1.85–184.93 with mean of 27.93 g/tree in block plantation in rocky hillock. Maximum number of gum tears/tree (4.11) was recorded in *A. senegal* based multi-component agri-horti-silviculture model while minimum (1.88) was in new gum garden. Similarly, yield of gum from *A. nilotica* was also observed, which ranged from 12.04–30.24 with a mean of 19.10 g/tree in silvi-herbal model and 6.29–40.11 with average of 14.29 g/tree in rainfed agri-silviculture.



Natural exudation of gums. A- *A. senegal* and B- *A. nilotica*.

Soils of different agroforestry models *viz.*, silvi-herbal model, gum gardens (new and old), progeny and plus tree trials of *Anogeissus pendula*, block plantation of *A. pendula* (field no. 33) and *A. latifolia* (field no. 34) were characterized during 2021-22. For the purpose, soil samples were collected from two layers (0-15 and 15-30 cm) of the tree's rhizospheres (*i.e.* <1.0 m distance from tree-base). Soil depth affected the soil properties. Soil pH and EC was higher in sub-surface in all the models, barring few exceptions. SOC, all major (N, P and K) and micro-nutrients (Fe, Mn and Zn) were higher in top layer of the soil in almost all the models, barring few exceptions. In silvi-herbal model wherein lemongrass is planted, similar trend was recorded.

Observation on soil dehydrogenase activity (DHA) was also recorded. In *A. senegal* based agri-horti-silviculture model which consisted of *A. senegal*, *A. marmelos* and *C. limon*, soil samples were taken from 0.5, 1.0, 2.0, 4.0 and 6.0 m distance from tree-base and at each distance, from two soil depths (0-15 and 15-30 cm). Results showed that as the distance from tree-base increases, the value of DHA increases. Soil DHA was comparatively higher in surface soil. Results also suggested that different woody perennials exhibit variable effects on soil DHA (Figure 23). In rainfed agri-silviculture model wherein *A. senegal* and *A. nilotica*, planted in three different spacing (10×10, 10×5 and 5×5 m), also showed almost similar results. Plant spacing affected the soil DHA; it was recorded maximum in 5 × 5 m and minimum in 10 × 10 m spacing. The values of soil DHA was relatively higher in surface soil.

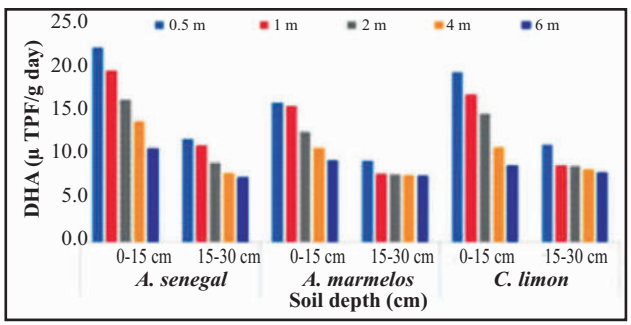


Fig. 23: Soil DHA in *A. senegal* based agri-horti-silviculture model

B. Demonstration and development of gum yielding tree-based agroforestry models on farmer's fields: After 12 years of planting, *A. senegal* recorded relatively more survival (up to 59.5%) than *A. nilotica* (up to 50%) at Garhkundar watershed area. On the field of Shri Thakur Das, most of the planted seedlings were inadvertently damaged by the tractor during ploughing, hence data was not reported. On the farm of Shri Himmat, maximum growth and survival (%) was recorded in *E. officinalis*, followed by *A. senegal* and *C. carandas*. At the farm of Shri Ghanshyam, *A. senegal* planted during 2012 showed poor performance in terms of growth; however, survival (%) was comparatively higher than recorded from other two fields. At village Ambabai, 37% survival of *A. senegal* with average height of 305.5 cm and average collar diameter of 18.8 cm was recorded.

Survival (%) of *A. senegal* and horticultural plant species (*C. limon*, *Psidium guajava* and *Punica granatum*), planted during 2017 in the field of 14 farmers of the village Parasai was recorded. In different farmers' fields, survival of *A. senegal* ranged from 44 to 87%, *C. limon* from 25 to 44%, *P. guajava* from 25 to 51% and *P. granatum* up to 18%. The survival (%) of *A. senegal*, *C. carandas*, *C. limon*, *P. guajava* and *Dendrocalamus strictus* planted in various villages/sites during rainy season of 2018 varied from 37 (Dhikoli) to 66% (Talbehat) for *A. senegal*, from 26 (Parasai) to 40% (Dhikoli) for *C. carandas*, from 28 (Parasai) to 40% (Kotkhera) for *C. limon*, from 20 (Kotkhera) to 26% (Dhikoli) for *D. strictus*, and 20% in *P. guajava*.

During rainy season of 2021, casualty replacement was done in bio-fence models. In bio-fence model-1, survival of *A. senegal* and *C. carandas* was 96 and 77%, respectively. *A. senegal* have attained 24.91 mm collar diameter with 151.9 cm height, and *C. carandas* recorded 4.52 mm collar diameter with 40.9 cm height. In bio-fence model-2, 82 and 99% survival of *A. senegal* and *C. carandas*, respectively was observed. In this model, *A. senegal* have attained 23.25 mm collar diameter with 152.7 cm height, and *C. carandas* recorded 4.90 mm collar diameter with 36.2 cm height. In bio-fence model-3, the survival of *A. senegal* in outer row was 91, 91 and 80% in 1.0, 1.5 and 2.0 m spacing, respectively. Similarly, 100, 93 and 88% survival in 1.0, 1.5 and 2.0 m spacing, respectively was recorded in inner row. In this model, planting spacing affected growth of the *A. senegal*. In general, comparatively higher growth in terms of collar diameter and height was recorded from *A. senegal* planted in inner row than that from outer row. In bio-fence model-4 consisting of two rows of *A. senegal* (inner and outer) kept at 1.5 m apart with plant to plant distance of 1.5 m, the survival of 34 and 52% was recorded from inner and outer rows, respectively. Here also, growth of *A. senegal* planted in inner row was relatively higher than that planted in outer row.

During rainy season of 2021, approximately 12000 quality seedlings of *A. senegal* were raised in nursery at ICAR-CAFRI, Jhansi, and out of which, 6000 seedlings were provided to "Doubling Farmer's Income" scheme for planting in seven districts namely Jhansi, Lalitpur, Jalaun, Hamirpur, Mahoba, Banda and Chitrakut of Bundelkhand, Uttar Pradesh. At each site, planting of *A. senegal* was extended on identified farmers. Apart from this, 1000 seedling of *A. senegal* was provided to ICAR-IISWC, Regional Centre, Datia.

C. Indigenous technical knowledge (ITK) on gum and resin's tapping, applications and post-harvest value addition: In selected districts, villages dominantly inhabited by Saharia (Sheopur), Korkoo and Bhilala (Dewas), and Korkoo, Bhilala, Barela and Gond tribes (Khandwa) were surveyed for collecting information on ITK. The main occupation of Saharia tribes in Sheopur district was to cultivate agricultural crops (rainfed farming) on the land allotted to them on *patta* basis. In this district, major livelihood option for the tribal peoples is collection of NTFPs from the forest. In Dewas district, people of Korkoo and Bhilala communities depend upon agriculture, as most of them are having *patta* lands. Some of the landless tribal families depend on the forest for their livelihood security; they collect gum dhawra and salai gum. In Khandwa district, though the gum tapping is strictly banned by the State Forest Department; however, all the tribal communities (Korkoo, Bhilala, Barela and Gond) are engaged in harvesting gum dhawra from the forests.

In all the surveyed villages, the tribal peoples generally peel off the bark (2-3 inches) of *Boswellia serrata* and make a ring along the tree girth and collect gum after 4-5 days. On an average, they collect 200-400 g/tree salai gum. The tribal families in Sheopur do not give any cut or injury to *A. latifolia* and collect naturally exuded gum tears from the trees. However, in Dewas and Khandwa, the tribal peoples generally make cuts on *A. latifolia* using a wooden bat having nails and axe, respectively. Tribal peoples in village Chakra of district Khandwa were using a gum inducer "Ethrex". They generally make cuts with the help of axe on stem surface of *A. latifolia* and spray/pour Ethrex in each cut. They collect gum dhawra during summer season. Saharia tribe in Sheopur also collects natural exudation from *Acacia catechu* during summer season. For tapping gum-butea, the tribal families in Sheopur and Dewas generally make cuts on the stem bark of *B. monosperma* with the help of axe and collect gum after 3-4 days of knotching.

Interaction meet with the officials of State Forest Department and tribal peoples for ITK. A- Khorhee, Sheopur, B- Ratanpur, Dewas, C- Golai, Khandwa, and D- Chakra, Khandwa

The tribal dominated villages surveyed in Sheopur and Dewas districts enjoy full rights on forest for tapping gums and collection of other NTFPs. In district Khandwa, Forest Department imposed complete ban on gum tapping during 2019 while, collection of other NTFPs are not banned by the department. The officials of Forest Department informed that the tribes of Khandwa district usually set forest on fire during the summer season, which probably increases the gum exudation from *A. latifolia* trees.

Normally tribals of surveyed areas sell collected produce to local traders in original form *i.e.* without any post-harvest value addition. For storage of salai gum, traders of Sheopur and Dewas, make small balls from the salai gum by applying coat of *selkhadi* (chalk) powder. Traders in Dewas informed that the juice exuded from salai gum fetches more price (Rs. 500/L). We noticed that all the traders have employed specific trained women labourers who can segregate and grade the dhawara gum by its appearance and smell.

D. Standardization of gum tapping techniques: To observe gum exudation in *B. monosperma* throughout the year, an experiment has been initiated in the month of December 2021. Every month, three trees are knotched and gum yield is recorded. This study will continue till November 2022. To assess the response of use of ethephon by different seven progenies of *A. pendula*, an experiment has been initiated and gum yield data are recorded. Each progeny has been applied 1170 ppm ethephon as injection at the base of the tree in three replications.

E. Studies on root distribution pattern and above- & below-ground biomass in *Acacia senegal*: During the year 2021, root distribution and biomass studies were undertaken by harvesting 1, 2 and 3 year-old plants of *A. senegal*. The 1, 2 and 3-year-old harvested plants had attained 68.0, 112.5 and 360.0 cm height, respectively. The collar diameter of 1 and 2-year-old plants was 5.38 and 10.23 mm, and GBH of 3-year-old plant was 18.5 cm. The canopy spread in these plants was 195.67 cm^2, 2721.31 cm^2 and 12.40 m^2. In 3-year-old *A. senegal*, the volume of the canopy was 34.70 m^3. The total depth of root system was 76.0, 82.0 and 270.0 cm, and below-ground root bound soil volume was 0.375, 0.672 and 17.300 m^3 in 1, 2 and 3-year-old plants, respectively.

In shoot portion, 3, 6 and 24 primary branches; 2, 8 and 85 secondary branches; and zero, 2 and 193 tertiary branches were recorded in 1, 2 and 3-year-old *A. senegal* plants, respectively. The study recorded 31.68 g, 398.37 g and 9.20 kg fresh weight of main stem; 13.38 g,179.86 g and 6.62 kg weight of primary branches; 2.65 g, 93.31 g and 3.87 kg weight of secondary branches; zero, 41.24 g and 2.25 kg weight of tertiary branches; 9.54 g, 187.50 g and 2.08 kg weight of foliage in 1, 2 and 3-year-old *A. senegal*. The total above-ground weight was 57.25 g, 900.28 g and 24.02 kg in 1, 2 and 3-year-old *A. senegal*. On the other hand, a total of 2, 3 and 25 primary roots; 2, 4 and 64 secondary roots; and 159, zero and 748 feeder roots were recorded in entire root system in 1, 2 and 3-year-old plants. The study recorded 9.90 g, 236.35 g and 1.58 kg fresh weight of main root; 3.97 g, 64.78 g and 1.14 kg weight of primary roots; 1.72 g, 13.21 g and 0.46 kg weight of secondary roots; and 0.86 g, 7.80 g and 0.16 kg weight of tertiary roots in 1, 2 and 3-year-old *A. senegal*. The total below-ground weight was 16.45 g, 322.14 g and 3.34 kg in 1, 2 and 3-year-old *A. senegal*. The root to shoot ratio was 0.287, 0.358 and 0.139 in 1, 2 and 3-year-old plants. Carbon sequestration was 35.100 g/tree, 580.650 g/tree and 12.996 kg/tree in 1, 2 and 3-year-old plants.

ICRISAT, Hyderabad

NRMACAFRISOL201800200114

Transforming rural livelihood through agroforestry based natural resource management in drought prone Bundelkhand region, UP (Sub Project of KISAN MITrA project for Doubling Farmers' Income in Bundelkahand region of Uttar Pradesh)

(Inder Dev, Naresh Kumar and Asha Ram)

Scaling up of agroforestry and water resources

Under the KISAN MITrA (a consortium of ICAR-CAFRI and ICRISAT, Hyderabad) scaling up the initiative, 8 pilot sites covering about 40,000 ha area across the seven districts of Bundelkhand were developed. Reviving and rejuvenating traditional water harvesting structures called *havelis* was given a high priority. Upscaling agroforestry for increasing the vegetation cover, and improving livelihood and nutritional security was also one of the most important objective.

Pilot Villages: Scaling up initiative

District	Block	Villages
Lalitpur	Talbehat	Pura-Khurdh, Birdha, Jhawar
Jhansi	Babina	Imiliya, Rajapur, Amarpur
	Bamour	Singa, Sutta
Jalaun	Mahiva	Noorpur, Naserpur, Hydalpur
Hamirpur	Sumerpur	Saukhar, Nazarpur, Karimati
Mahoba	Kabarai	Chandpura, Nathupura, Baniyatala
Banda	Thindwari	Benda, Amlikaur, Jauharpur
Chitrakoot	Karwi	Rowli-Kalyanpur, Rasin

Increasing water resource availability

The NRM interventions (*haveli* rejuvenation, deepening of ponds, and deepening of drainage network) were undertaken in five districts during the period. A total of 13 such structures have been rejuvenated (Table 2) during 2021. These interventions created a storage capacity of about 0.22 Million Cubic Meter (MCM).

Table 2. Details of major WHS structures

Structure	Latitude	Longitude	Year of construction	Storage capacity created (m^3)
Chitrakoot				
Haveli tank	25.19581	80.7014	2021	30000
Haveli tank	25.19787	80.70116	2021	25000
Haveli tank	25.19874	80.69973	2021	22500
Haveli tank	25.18374	80.69782	2021	45000
Lalitpur				
Farm pond	25.119	78.5388	2019	2000
Haveli tank	25.12028	78.53472	2021	9000
Haveli tank	25.11806	78.5325	2021	15000
Haveli tank	25.11806	78.54056	2021	5000
Pond in Haveli tank	25.11806	78.54056	2021	4050
Jalaun				
Haveli tank	25.68833	80.57626	2021	30000
Bamour				
Deepening of drainage network-Sutta			2021	28000
Mahoba				
Farm pond	25.27507	79.80444	2021	3150
Deepening of Channel			2021	5625
Total Capacity				**224325**

Agroforestry and Haveli System at village Baniyatala in Mahoba

Agroforestry plantation:

Agroforestry intervention

Agroforestry is an important resilience building strategy that works well without compromising on the production and income from the agricultural sector. It provides an opportunity to grow orchard/plantation/forest trees around the field or within fields. A comprehensive agroforestry plan was implemented using teak, *Melia, Acacia senegal*, fruit trees (guava, fig, lemon, acid lime, moringa), ber budding and fodder grasses during 2021**.** A total of about 1.0 lakh agroforestry tree plantation was done in all the locations.

Agroforestry and NRM interventions at Chitrakoot

High density planation of teak at Lalitpur site

Melia in farmer's field at Lalitpur

Productivity enhancement interventions

Farmers' participatory field demonstrations were one of the major activity of the DFI project in which various production technologies of agriculture was validated and demonstrated. During the period about 3000 farmers' participatory field demonstrations were undertaken covering a range of activities. With improved management practices, chickpea yield was found 10-30% higher in all districts. The cultivars such as JG-14, JG-11 were found superior in terms of yields compared to local cultivars. Among the districts, chickpea yield was found highest in Jalaun. Jalaun and Mahoba are the predominant districts for field pea production. The performance of Giriraj and Bharat (mustard crop cultivars) was higher as compared to farmers' varieties.

Field demonstrations in *kharif* season in the pilot villages

Enhancing groundwater recharge and water use efficiency in SAT region through watershed interventions-Parasai-Sindh Watershed, Jhansi

(Inder Dev, R K Tewari and R P Dwivedi)*

**Dr R K Tewari retired on 31.08.2021*

Parasai-Sindh watershed has been developed by ICAR-CAFRI, Jhansi and ICRISAT, Hyderabad in a consortium mode. The agroforestry and Natural Resource Management (NRM) interventions were implemented in Parasai, Chhatpur and Bachhauni villages (25^0 23' 56" to 25^0 27' 9.34" N and 78^0 19' 45.71" to 78^0 22' 42.57" E) in Babina block of Jhansi district. Open shallow dug wells (388 Nos.) were monitored for water table on monthly interval. The average water column during the year was 4.2 m which was much higher than the water column (2.60 m) recorded in untreated watershed. Natural Resource Management interventions in combination with field based interventions helped in ensuring the water availability during *rabi* season.

Agroforestry Interventions

Agroforestry tree plantation in the form of block plantation, bund plantation was done in all the three villages in which 80 (guava), 175 (lime), 200 (teak), 100 (*Melia dubia*) and 400 (*Acacia. Senegal*) were planted in the fields of 25 farmers under various agroforestry systems.

Crop productivity enhancement (as per farmer practice)

The major crops grown in the watershed are greengram, blackgram and groundnut during *kharif* and chickpea, mustard and wheat during *rabi*. 72 crops were taken for groundnut and wheat, whereas, 27 crop samples were taken for greengram, blackgram, chickpea and mustard. The productivity of wheat, mustard and chickpea was significantly higher in treated watershed as compared to base line data. Yield levels of *kharif* crops was not influenced much as *kharif* crops are rain dependent in the entire Bundelkhand region.

Discussion about the various agroforestry, soil and water conservation measures in Parasai-Sindh watershed

Guava (block) and bamboo (field boundary) based agroforestry system at Parasai

Training and Capacity building of farmers

Farmers of the Parasai Sindh watershed were motivated to adopt agroforestry practices at their field by watershed team and scientists of the institute during MGMG programme. Farmers and farm women from watershed area participated in Workshop/field days, *Kisan Mela* and *Gosthis* organized by CAFRI on various occasions from time to time.

ICAR-ICRAF Work Plan

NRMACAFRISOL201800400116

Transforming rural livelihood and check migration through agroforestry in conjunction with natural resource management in Bolangir and Nuapada district of Odisha

(Inder Dev, A K Handa and Asha Ram)

The project entitled, "Transforming rural livelihood and check migration through agroforestry in conjunction with natural resource management in Bolangir and Nuapada district of Odisha" is the sub project of "Enabling small holders in Bolangir and Nuapada districts of Odisha to produce nutritious food through agroforestry systems". The project was sponsored by Dept. of Soil Conservation and Watershed Development, Govt. of Odisha. The main objectives of the project are i) to enhance groundwater recharge through suitable structures to facilitate agroforestry landuse; ii) to improve and optimize crop and livestock productivity to check the migration and iii) to develop model site of learning in Bolangir and Nuapada districts of Odisha. Natural resource management interventions were implemented at village Tara in Bolangir district and village Boirbhadiin Nuapada district of Odisha. Masonry field drainage structures were constructed to dispose of excess runoff and to strengthen earthen field bunding. Tree seedlings of fruits and timber species were planted on bunds.

Agroforestry and NRM interventions at Salandi Agri Voltaic system in Bolangir

Agroforestry and NRM interventions at Tara, Bolangir district

Agroforestry and NRM interventions at Biromal GP in Nuapada district

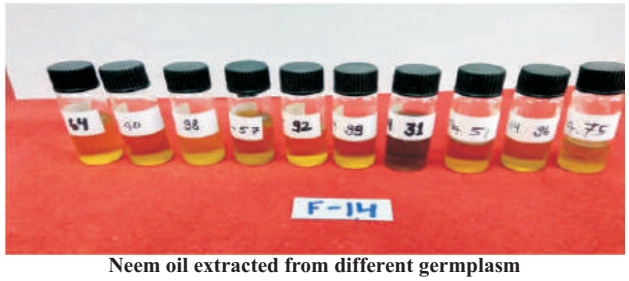
National Rainfed Area Authority (NRAA), Govt. of India, New Delhi

NRMA/CAFRI/SOL/2019/003/00119

Assessment of genetic potential of neem germplasm for higher yield and oil content through molecular markers

(K Rajarajan, H Anuragi and Alka Bharti)

During this period, we estimated the fruit, seed, and kernel yield of 170 germplasm. Plant height and diameter at breast height (DBH) were calculated as individual tree morphological parameters. The 170 genotypes showed a significant variation for yield traits *viz.* fruit weight, seed weight, kernel weight and oil percentage for both the seasons (2020-21). The genotypes VKAF11, VKAF3, VKAF13, VKAF9, VKAF67, VKAF68, VKAF92, VKAF110, VKAF85, VKAF43 and OR05 found to be high seed, kernel and oil percentage than other genotypes during both seasons (2020-21).



Neem oil extracted from different germplasm

ICAR-ICRAF Work Plan

NRMACAFRISOL202000400123

Assessment of area under agroforestry systems/species in agro-climatic zones of India

(A K Handa, Suresh Ramanan S, R H Rizvi and Dr. Archana Verma* (ICAR-CAZRI, Jodhpur)

Selection of Districts and Field Survey

From Rajasthan state, six districts namely- Ajmer, Jodhpur, Nagaur, Pali, Sikar and Rajsamand have been selected for mapping and estimating area under *Prosopis cineraria* (Khejri) and *Azadirachta indica* (Neem) species on farmlands (Fig. 23). These districts have a geographical area of 7382398 ha. Field survey in Nagaur, Sikar, Rajsamand, Jodhpur, Pali, Ajmer district has been completed. GPS points on Khejri and Neem were collected from farmers' field in selected districts of Rajasthan. (Table 3).

Also mapping of agroforestry in two selected districts in agro-climatic zone-15 *i.e.* The Islands Region namely – North & Middle Andaman and South Andaman has been done using Sentinel 2 data (Table 3).

Remote Sensing Data

Resourcesat-2/LISS-4 data for selected districts of Rajasthan has been procured from NRSC, Hyderabad. Total 37 multispectral LISS-4 scenes have been downloaded through 'ftp'. Besides this, Sentinel-2 data for selected districts of Andaman & Nicobar have been freely downloaded from earth explorer website (https://earthexplorer.usgs.gov/).

The Sentinel-2 satellites carry a single multi-spectral instrument (MSI) with 13 spectral channels in the visible/near infrared (VNIR) and short wave infrared spectral range (SWIR).

Table 3. Selected districts from Rajasthan and ACZ-15

State/UT	No. of districts	Name of districts
Rajasthan	06	Ajmer, Jodhpur, Nagaur, Pali, Sikar, Rajsamand
Andaman & Nicobar	02	North and Middle Andaman, South Andaman

Mapping and Estimation of Agroforestry Area

Agroforestry area and selected species (Neem and Khejri) area in six districts namely- Ajmer, Jodhpur, Nagaur, Pali, Sikar and Rajsamand from Rajasthan state has been mapped. Estimated agroforestry area was found highest in Nagaur district (179000 ha) followed by Jodhpur district (132647 ha). Also as a percentage of geographical area, Nagaur has highest area under agroforestry (Table 4a). Agroforestry area was estimated to be about 8.32 percent in six districts of Rajasthan. More than 90 percent accuracy was found in mapping agroforestry in all six districts of Rajasthan. Average of Neem and Khejri species area in selected six districts is respectively 2.04 percent and 1.62 percent. Maps showing agroforestry area in these six districts are depicted in figures 25 (a) to 25 (f). Agroforestry mapping also completed in selected districts of Andaman & Nicobar with average 2.55 percent {Table 4 (b) & Fig. 24}.

Table 4(a). Estimated area under agroforestry in selected six districts of Rajasthan

Rajasthan District Name	Geographical Area (ha)	AF Area (ha)	AF Area (%)	Neem Area (ha)	Neem Area (%)	Khejri Area (ha)	Khejri Area (%)
Ajmer	848734	58550	6.90	21653	2.55	15572	1.83
Pali	1238244	94878	7.66	35995	2.91	23970	1.94
Jodhpur	2269479	132647	5.84	NA		10525.4	0.46
Rajsamnd	469456	46019	9.80	10582	2.25	690	0.15
Nagaur	1779270	179000	10.06	24351	1.37	47031	2.64
Sikar	777215	75135.40	9.67	9234.66	1.19	20983.49	2.70

Table 4(b). Estimated area under agroforestry in selected districts of Andaman & Nicobar

Name of District	Geog. Area (ha)	AF Area (ha)	AF Area (%)
North and Middle Andaman	264037	6320.77	2.39
South Andaman	243563	6643.73	2.73
Total of above two districts	507600	12964.5	2.55 (Average)

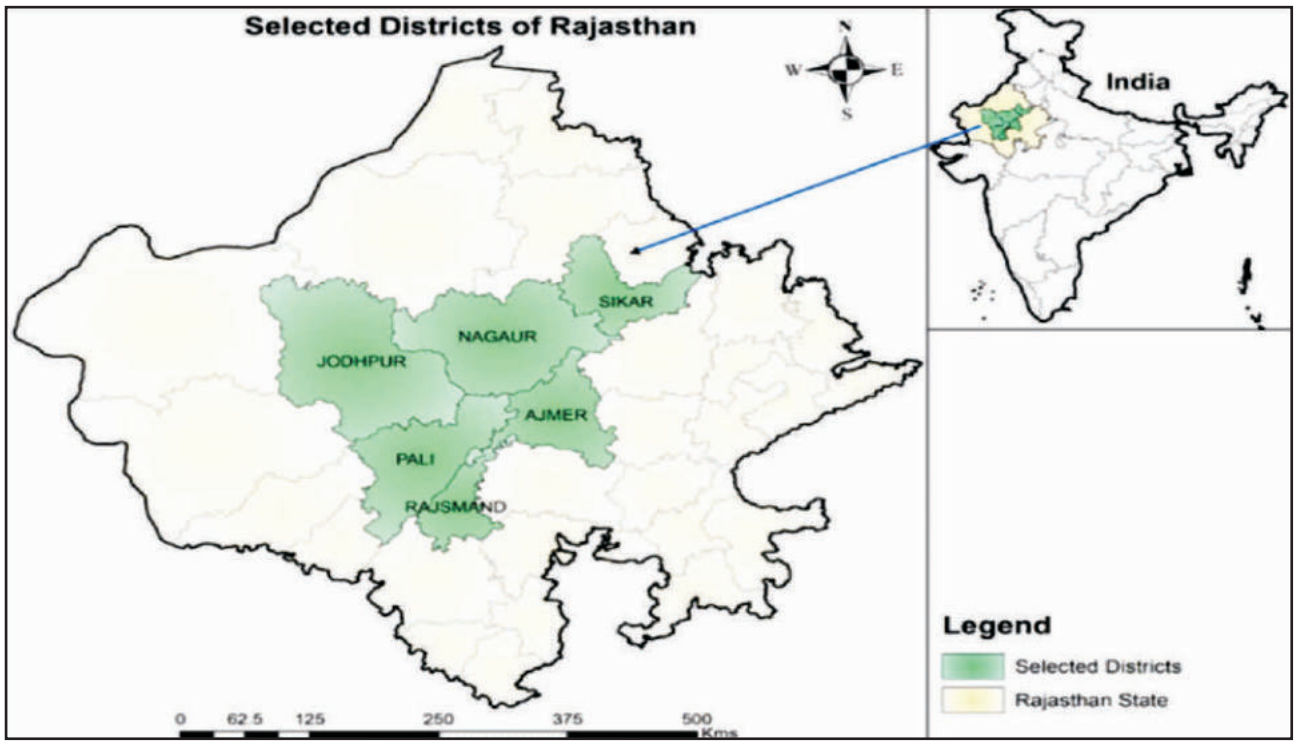


Fig. 24: Selected districts of Rajasthan

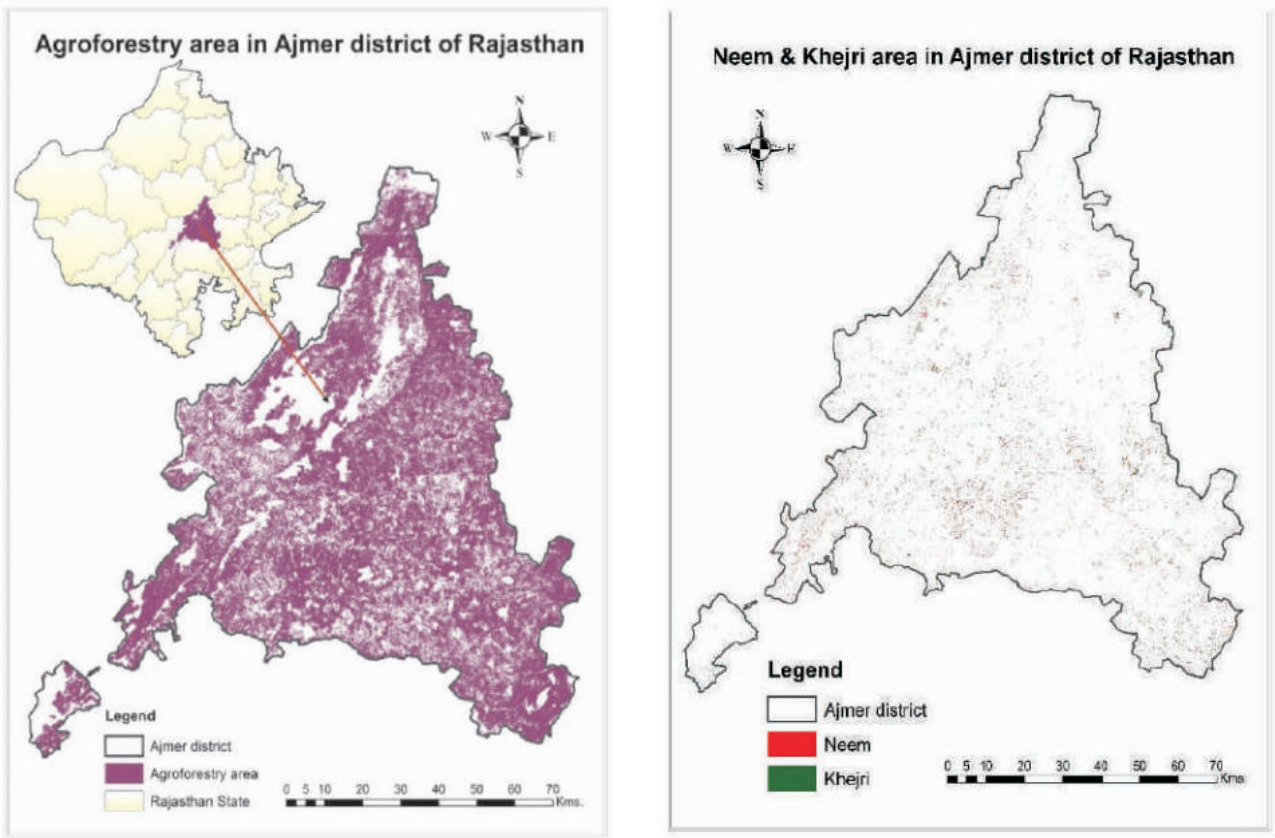


Fig. 25(a): Agroforestry and Species area in Ajmer

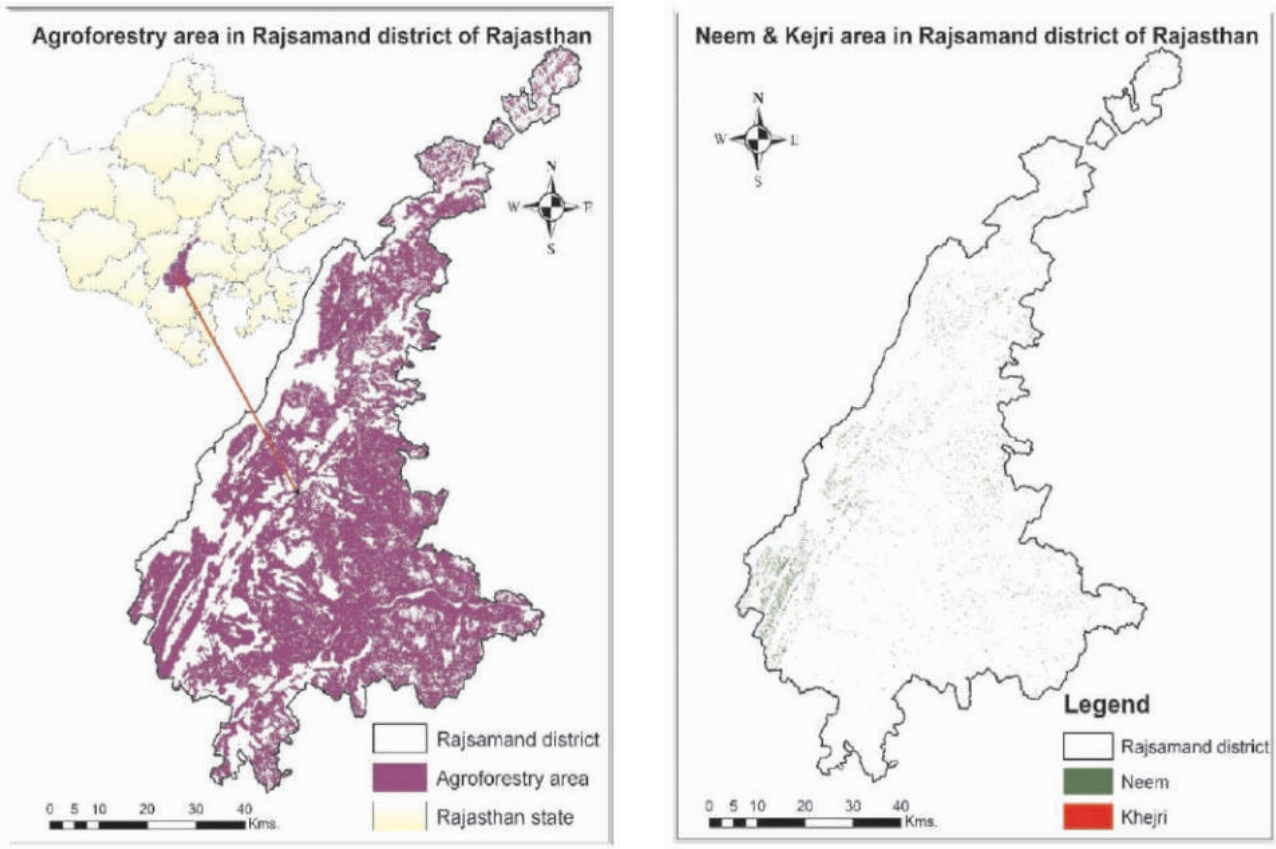
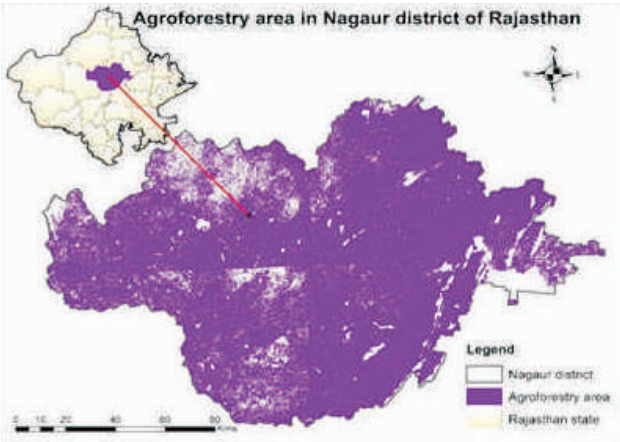


Fig. 25(b): Agroforestry and Species area in Rajsamand



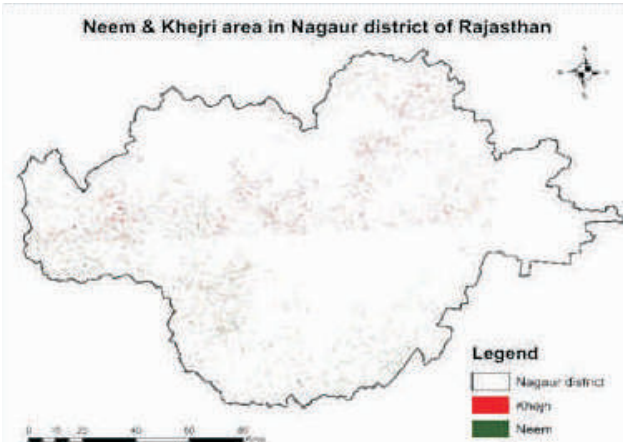
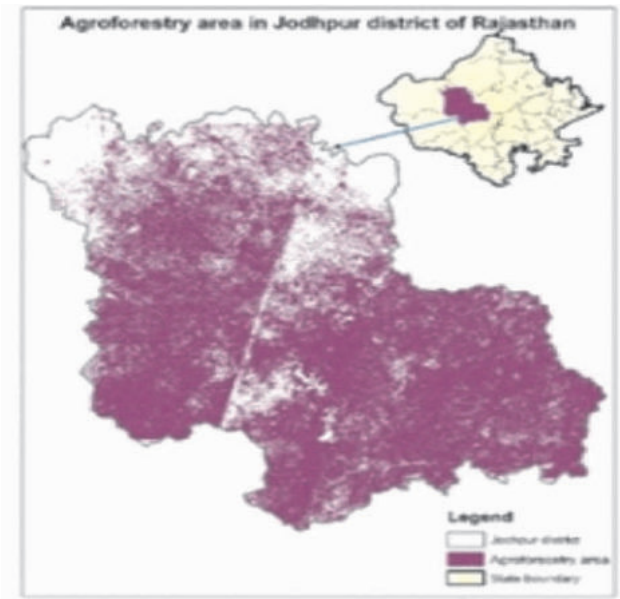


Fig. 25(c): Agroforestry and Species area in Nagaur



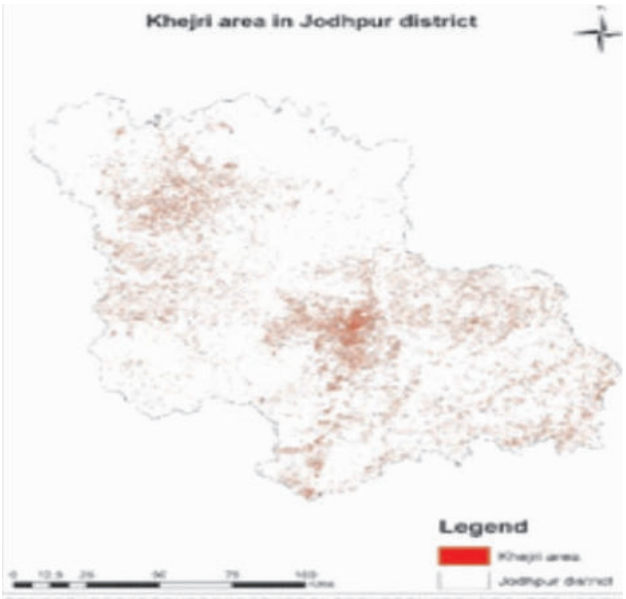
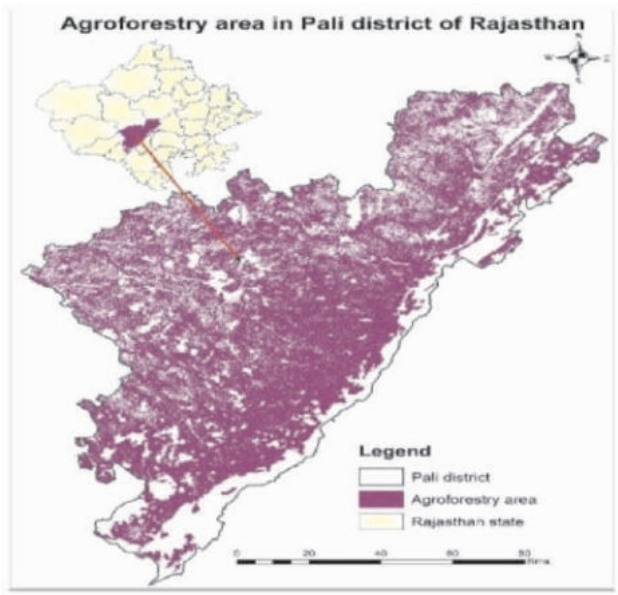


Fig. 25(d): Agroforestry and Species area in Jodhpur



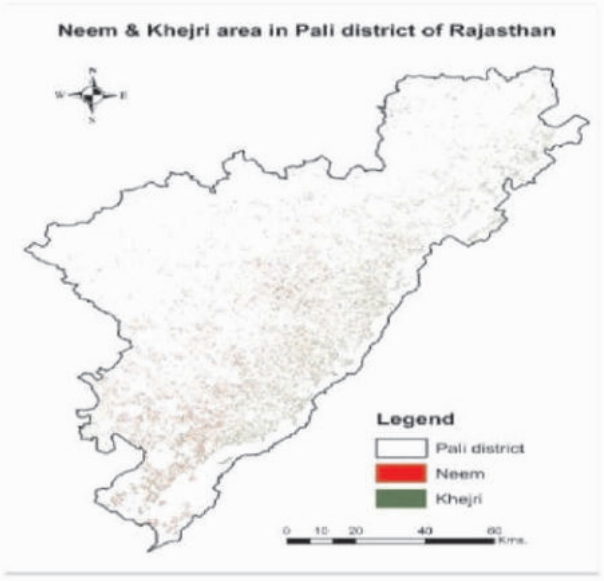


Fig. 25(e): Agroforestry and Species area in Pali

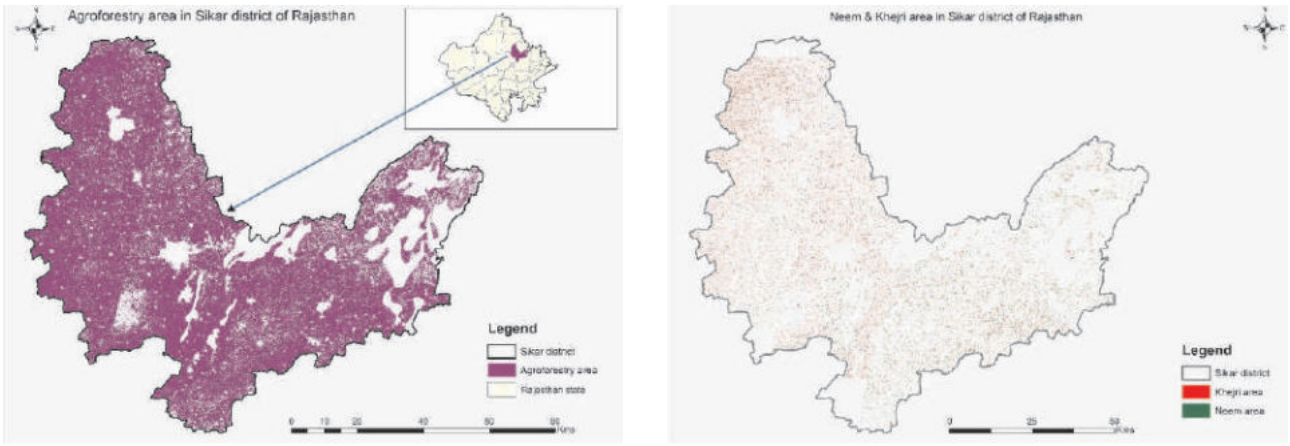
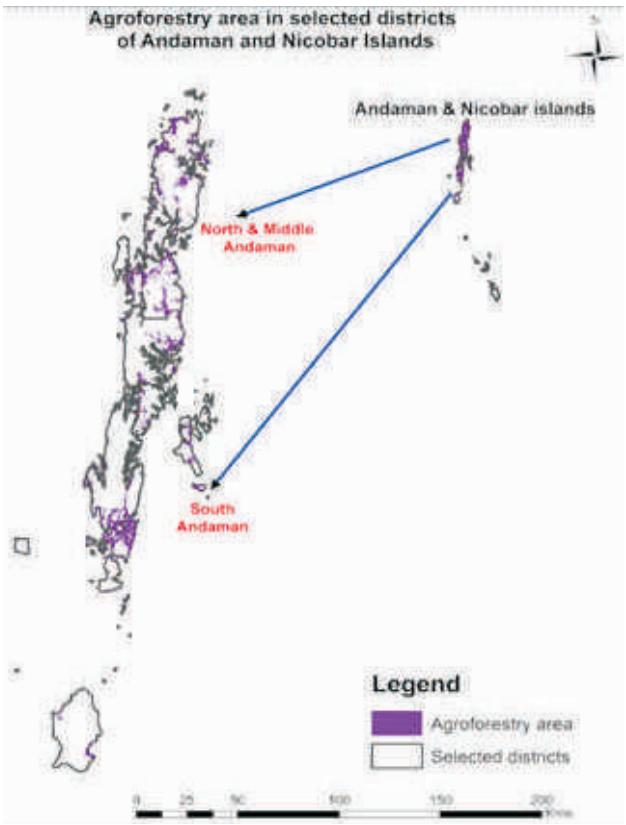


Fig. 25(f): Agroforestry and Species area in Sikar

ACZ-15



Field survey snapshots of Rajasthan

ICAR-ICRAF Work Plan

NRMA/CAFRI/SOL/2020/005/00124

Whole Transcriptome Sequencing of *Pongamia pinnata* for Drought Stress Tolerance

(K Rajarajan, Alka Bharati, Ashajyothi, A K Handa, Suresh Ramanan S and Asha Ram)

The contrasting genotype NRCP9 (tolerant) and NRCP10 (susceptible) was investigated for their transcriptome profiles using RNAseq analysis on a HiSeq-4000 in order to have better understanding the molecular mechanisms of drought tolerance. The results revealed that, compared to the susceptible genotypes the tolerant genotype had more number of DEGs expressed. Between genotypes under stress conditions 128 DEGs were identified. GO and KEGG pathway study identified several molecular mechanisms involved in stress response and their corresponding drought related pathways. The pathways *viz.* metabolic pathway, biosynthesis of secondary metabolites, plant hormone signal transduction, carbon metabolism, MAPK signaling pathway, photosynthesis and carbohydrate metabolism were enriched in NRCP9 genotype as compared with NRCP10 under stress condition. Finally, the identified genes and TFs will serve as useful targets for future research and breeding programme for drought tolerance in Pongamia.

Concerning the meta-analysis on *Pongamia pinnata*, a keyword-based search for literature was carried out in the Web of Science database for the period 1998-2021 [accessed on 1st March 2021]. A total of 695 publications were screen out for analysis following PRISMA Guidelines (preferred reporting items for systematic reviews and meta-

analyses). However, there is growing contributions from China and Malaysia in *Pongamia pinnata* research in the last decades. Production oriented studies at the field level in terms of seed yield as growth is the major research lacunae.

NABARD (U P)

NRMA/CAFRI/SOL/2021/001/00125

Evaluating the performance of strawberry cultivation in Babina block of Jhansi district for crop diversification, and better economic returns at farmer's field

(A Arunachalam, Ashok Yadav and Sushil Kumar)

The project was implemented in the three villages *i.e.* Badora, Maheshgarh and Nahora block of Babina in Jhansi district of Uttar Pradesh. Total 12 farmers were selected and half acre strawberry was grown on each farmers fields leading to 6 acres strawberry cultivation in Babina block. Healthy tissue culture plants of two varieties *i.e.* Winter Dawn and Camarosa were procured and distributed among the farmers. Out of 12 farmers, 10 farmers were successful in strawberry cultivation and it showed better growth performance in Babina block of Jhansi district. The strawberry production led to increase in the farmer's income by 1.2 to 5.7 times as compared to the traditional crops. By using drip irrigation in strawberry, farmers were able to save 75% water compare to traditional crops *i.e.* wheat. This motivated the farmers to take third crop which may increase the crop index of the region. The strawberry produce from farmer's field was given a brand name i.e. "Bundeli Strawberry".

NABARD (U P)

NRMA/CAFRI/SOL/2021/001/00126

Evaluating the performance of strawberry cultivation in Moth block of Jhansi district for crop diversification and better economic returns at farmer's field

(A Arunachalam, Ashok Yadav and Sushil Kumar)

The project was implemented in the three villages *i.e.* Lohagarh, Sakin and Samthar block of Moth in Jhansi district of Uttar Pradesh. Total 13 farmers were selected and half acres strawberry was grown on each farmers fields leading to 6.5 acres strawberry cultivation in Moth block. Healthy tissue culture plants of two varieties *i.e.* Winter Dawn and Camarosa were procured and distributed among the farmers. Out of 13 farmers, 10 farmers were successful in strawberry cultivation and it showed better growth performance in Moth block of Jhansi district. The strawberry production led to increase in the farmer's income by 1.06 to 4.5 times as compared to the traditional crops. The strawberry produce from farmer's field was given a brand name *i.e.* "Bundeli Strawberry".

NRMA/CAFRI/SOL/2021/021/00145

Pilot the solutions of chip-based technology for real-time and RFID-passive monitoring of field genebank and agroforestry species for scaling up

(K Rajarajan and H Anuragi)

This is a jointly implemented pilot project by ICAR-NBPGR-IIHR-CAFRI with ICRAF. In this project, the RFID (Radio-Frequency Identification) tags were installed successfully during September 2021 in three major agroforestry species *viz. Azadirachta indica*, *Pongamia pinnata* and *Acacia nilotica*. In each species, ten RFID tags were installed for individual germplasms. Since the installation, we are regularly updating the growth and tree health information of individual germplasm of these species in the SAMS portal.

RFID tags installed in neem germplasms at CAFRI, Jhansi

Inter-Institutional Collaborative Project

ICAR-IGFRI, JHANSI

Farmer FIRST programme (FFP): Scaling up and integration of fodder technologies in existing farming system for sustainable livestock productivity in Bundelkhand

(Purshottam Sharma, Sunil Seth, S K Mahanta, Harsh Vardhan Singh, Mukesh Choudhary (IGFRI, Jhansi) and R P Dwivedi)

In Farmers' FIRST Programme, various activities of crop improvement, vegetable production and livestock health management were undertaken in selected villages of Bundelkhand region of U.P. Field day on improved variety of wheat was organized. Demonstration of improved varieties of fodder crop were also conducted on *kharif* season.

Study of soil-hydrothermal environment under natural vs synthetic mulch

(Nilimesh Mridha (PI), D B Shakyawar, Atul Singha, Manik Bhowmick, Haokhotang Baite, Ashok Yadav (CC-PI) , Vinod Kadam and Manoj Kundu)

The experiment on different mulches *i.e.* Jute, Wool, Plastic and rice straw was laid out under open condition and under protected conditions in mid of November 2021. The coloured capsicum (red, yellow, and green) with three replication of each treatment of mulches were planted under RCBD Layout with plot size of 4 m (width) x 4 m (length) under open conditions and 1 m (width) x 1 m (length) in protected conditions.

Layout of coloured capsicum under different mulches in open and protected conditions

2. Research Achievements

2.6: Other Research Activities

Agroforestry based Integrated Farming System

(Asha Ram, Sudhir Kumar, Inder Dev, Naresh Kumar, R. Vishnu, Sushil Kumar, Lal Chand, Priyanka Singh, Aswathy Chandra kumar and Venkatesh Y N)

Agroforestry based Integrated Farming System (AF-IFS) project was initiated for small and marginal farmers of semi-arid region during year 2016. Various crops *viz.*, wheat, chickpea, field pea (*rabi* season), green manuring (*kharif* season) and sweet corn (*Zaid* season) were grown successfully. From roadside moringa plantation, about 250 kg moringa pods were harvested. The guava production was recorded 23.12 kg/plant and about 900 kg of guava was harvested. Bunds of the field were utilized for pigeon pea and NB hybrid (grass) production. In new initiative, duckery, goatery and poultry have been integrated in Integrated Farming System. Large number of the farmers visited this IFS model. In year 2021, from crop and fruit production about Rs. 100500 gross income has been generated. The project was concluded on IRC 2021 and continues as institute activity under Agroforestry System Research Programme.

Duckery-cum-fishery

Goatery (Barbari and Beetal Breed)

Poultry (Kadaknath Breed)

Developed as learning site for farmers and other stakeholders

Characterization of Chironji accessions

(Ashok Yadav)

Different chironji acessions were characterized for fruit and gum characteristics. Among all, one accession was identified as a high yielding gum type accession in chironji. The nutraceutical analysis revealed that chironji gum has high protein content; beside this it is essential source of amino acid which are essential for human requirement.

Characterization of Manilla Tamarind accessions

(Ashok Yadav)

Survey, collection and identified 14 Manilla tamarind accessions and their characterization was performed on different parameters *i.e.* plant growth, leaves and fruit parameters.

Identified and registered the Ankol accession

(Ashok Yadav, S Kumar, A K Handa and A Arunachalam)

A promising germplasm of Ankol which has Custer bearing habit was identified from Jhansi district of Uttar Pradesh and registered at ICAR-NBPGR New Delhi. (PI).

Development of agroforestry seed museum

(A Arunachalam, A K Handa, Ashok Yadav and Suresh Ramanan S)

Institute took an initiative to establish seed museum of agroforestry exhibiting seeds of trees, grains, crops, flowers, vegetables for the benefit of students and farmers. The contributions for strengthening the seed museum from co-ordinating centre of AICRP on Agroforestry, Kerala Forest Research Institute and Indian Grassland and Fodder Research Institute is highly appreciated.

Developed the "High density Cactus Cafeteria" cum germplasm block

(Ashok Yadav, S Kumar, A K Handa and A Arunachalam)

Opuntiaficus-indica, commonly referred to as prickly pear or nopal cactus, is a dicotyledonous angiosperm plant. It belongs to the Cactaceae family and is characterized by its remarkable adaptation to arid and semi-arid climates in tropical and subtropical regions of the globe. In the last decade, empirical evidence for the nutritional and health benefit potential of this cactus has been provided by academic scientists and private companies. Notably, its rich composition in polyphenols, vitamins, polyunsaturated fatty acids and amino acids, has been highlighted through the use of a large panel of extraction methods. The identified natural cactus compounds and derivatives were shown to be endowed with biologically relevant activities including anti- inflammatory, antioxidant, hypoglycemic, antimicrobial and neuroprotective properties. To utilize its potential under different agroforestry systems especially in the dryland area of the Bundelkhand, ICAR-CAFRI initiated a program on the collection of better cactus germplasm. Accordingly, a cactus cafeteria with 70 germplasms, 62 from ICAR-CAZRI Regional Station, Bhuj, Gujarat and 8 from Jhansi district, has been established at the Experimental Farm of the Institute. In future, these accessions/varieties will be introduced in different agroforestry systems in a phased manner for better income, nutritional and environmental security.

3. AICRP on Agroforestry

All India Coordinated Research Project on Agroforestry

Agroforestry is one of the best practices for diversification of agricultural enterprise and integrate the agricultural enterprises for ensuring better returns and reduced risks associated with variable climate. The All India Coordinated Research Project has contributed tremendously in providing tree-based land use options. The coordinating centres are conducting recurrent surveys to design new technologies based on the requirements of the stakeholders and evaluating different tree species and their germplasm for higher productivity and adaptability.

The All India Coordinated Research Project (AICRP) on Agroforestry was started in 1983 with 20 centres and it has now expanded to 37 centres – 26 in SAUs, 10 in ICAR and 01 in ICFRE Institutes representing all the agro-climatic zones in the country (Figure 26). The Coordinating unit of AICRP-Agroforestry was shifted from ICAR Headquarters to CAFRI, Jhansi w.e.f. 1st April, 1997 with the following specific mandates:

- ✓ Screening and genetic upgrading of selected plant species for their compatibility in different agroforestry systems
- ✓ To optimize tree-intercrop combination for different regions
- ✓ Performance enhancement of the pre-dominant agroforestry systems being already practiced by the farmers
- ✓ To upgrade and refine the existing technologies for higher productivity and sustainability.

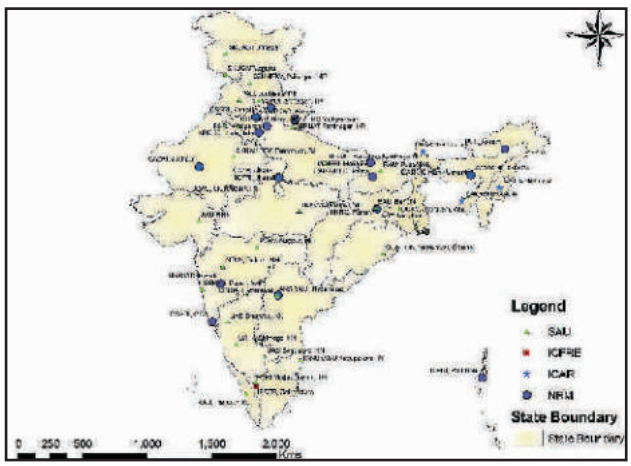


Fig. 26: Showing the distribution of AICRP on Agroforestry Centres across the country

Objectives

- Diagnostic survey and appraisal of existing farming system and agroforestry practices and farmers' preference.
- Collection and evaluation of promising tree species, cultivars of fuel, fodder and small timber for agroforestry interactions.
- Studies on management practices of agroforestry systems such as agrisilviculture, boundary plantation, silvipasture, silvihorticulture, agrisilvihorticulture, multistorey, homestead, *etc.*
- To analyze economical relation of agroforestry systems.
- To explore the role of agroforestry in environment protection.
- To conduct studies on post-harvest technology, fishery, apiculture, lac, etc. in relation to agroforestry systems

Diagnostic and Design survey

The YSPUHF, Solan conducted study on appraisal of existing agroforestry systems in Seraj valley of District Mandi, H.P. and revealed that there were seven different types of agroforestry systems prevalent in the Seraj valley *viz.*, Horti-agriculture (HA), Agri-silvi-horticulture (ASH), Horti-pastoral (HP), Agri-horti-silviculture (AHS), Agri-horticulture (AH), pastoral-silviculture (PS), Agri-silviculture (AS). The GBPUAT, Pantnagar conducted D&D exercise in Kanakpur village Udham Singh Nagar district, and reported poplar farmer prefer agri-silviculture compared to bund/boundary plantation however, in case of eucalyptus, farmers follow bund/boundary plantation compared to agri-silviculture. OUAT, Bhubaneshwar performed D&D exercise in four districts (Khurda & Puri) comprising 4 blocks and 8 villages and reported that many heterogeneous species of trees, shrubs, vegetables and herbaceous plants are grown in random arrangements with dense plant population. Homegardens are predominant form of agroforestry system in that region. The UAHS, Shivamogga centre reported that the choice of the species by farmers would vary with farm size and most of the farmers prefer tree species based on the shade, timber production and standard for paper. More than half of the respondents prefer native tree species for planting in Shivamoga region.

System Research and Tree Germplasm Collection, Evaluation and Improvement works

Name of the centre/State	MPTS working upon	Agroforestry models under trial/ development
Assam Agricultural University- HRS, Kahi-kuchi	*Gmelina arborea,* Bamboo species evaluation	*Gmelina arborea* based Agrisilvicultural system, Jackfruit based Agroforestry system, *Acacia mangium* based Agrisilvicultural system
Professor Jayashankar Telangana State Agricultural University, Hyderabad	*Azadirachta indica*	*Melia dubia* based Agroforestry system, Custard apple based Hortipastoral system, Mango based Agrihorticultural system
Birsa Agricultural University, Ranchi	Multipurpose Tree Species (MPTs)	*Melia azedarach* under Silvi-Pastoral System, Tephrosia hedgerow under Alley cropping based Agrisilviculture system
Bidhan Chandra Krishi Viswavidyalaya, West Bengal - Jhargram	*Acacia auriculiformis Neolamarckia cadamba* Bamboo sp.	*Gmelina arborea* and mango-based Agroforestry system, *Anthocephalus cadamba* and mango Agroforestry system
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli	*Melia dubia*	*Melia dubia* based medicinal Agroforestry system Arecanut based plantation Agroforestry system
Chaudhary Charan Singh Haryana Agricultural University, Hisar	*Populus deltoides Melia composita*	Eucalyptus based Agroforestry system, Poplar based Agroforestry system, Eucalyptus clone-based Agroforestry system
Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur	*Toona ciliata Sapindus mukorossi Leucaena leucocephala*	Harar based silvipastoral system, *Leucaena leucocephala* silvipastoral Agroforestry system
Tamil Nadu Agricultural University, Mettupulayam	*Melia dubia Ceiba pentandra*	Fodder bank *Melia* based medicinal Agroforestry model,
G.B. Pant University of Agriculture and Technology, Pantnagar	94 indigenous and exotic MPTs including 7 species of Bamboo have been maintained at Patharchatta (Old) site and total 54 indigenous and exotic MPTs suitable for agroforestry systems together with 14 species of bamboo have been collected at Haldi (New-AFRC) site.	Shisham based Agroforestry; Turmeric (*Curcumalonga* L.) under 11 different Agroforestry tree species (12 years old)
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur	*Dalbergia sissoo*	Mango based Agri-horticulture system
Kerala Agricultural University, Thrissur	*Tectona grandis*	Boundary plantation of fast-growing fodder trees; Bamboo-based Agroforestry
Mahatma Phule Krishi Vidyapeeth, Rahuri	21-tree germplasm under evaluation	Agri-horticultural system of different fruit tree species, Teak based Agroforestry system
Acharya Narendra Deva University of Agriculture and Technology, Ayodhya	*Dalbergia sissoo*	*Casuarina equsetifolia* and *Psidium guajava* based Agri-silvi-horti system, *Dalbergia sissoo* based Agri-silviculture system
Odisha University of Agriculture and Technology, Bhubaneshwar	*Gmelina arborea*	Silvipastoral system (*Acacia mangium, Acacia auriculiformis, Samaneasaman*) Mango + Pineapple Agrihorticultural system, Agrisilvicultural System (*Acacia mangium, Tectona grandis*)
Punjab Agricultural University, Ludhiana	*Populus deltoides Melia composita*	Poplar based Agroforestry
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, College of Agriculture, Nagpur	*Tectona grandis Melia dubia Bamboosa balcooa*	Citrus based Agroforestry System, Bamboo based Agri-silviculture system, Tectona based system

Dr. Rajendra Prasad Central Agricultural University, Pusa	*Populus deltoides*	*Bombax ceiba* based Agrisilvicultural system,
Sardar Krushinagar Dantiwada Agricultural University, SK Nagar	*Ailanthus excelsa* *Azadirachta indica*	*Ailanthus*-based medicinal plants agroforestry system, Boundary Plantation
Sri Karan Narendra Agriculture University, Regional Research Station, Fatehpur-Shekhawati	*P. cineraria,* *A. nilotica,* *A. tortilis* and *H. binata*	Hardwickia based system, Different Agroforestry systems on biomass and carbon stock in arid zone of Rajasthan
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu (J & K)	-	*Terminalia cehbula* based Silvipastoral System, *Melia composita* based Agroforestry system
Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar	*Salix alba* var. *Caerulea*	Apple based system, Apricot based agroforestry system, Walnut based agroforestry system, Salix based silvi-pastoral system
Tamil Nadu Veterinary and Animal Sciences University, Kattapukkam	*Azadirachta indica* *Gliricidia sepium*	Hortipasture in degraded wastelands, *Psidium guajava* based pasture system, Gliricidia based Silvipastoral system, Cocusnucifera based Hortipastoral system
The University of Agricultural and Horticultural Sciences, Shivamoga	Bamboo spp.	-
University of Agricultural Sciences, Bengaluru	*Simarouba glauca* *Tamarindus indica*	*Melia dubia* based Agroforestry system, Mango based Agroforestry system, Jamun based Agroforestry system and Cashew based Agroforestry system, Mahagony based Agroforestry system
University of Agricultural Sciences, Dharwad	*Pongamia pinnata,* *Tamarindus indica,* Thorn less bamboo	Neem based Agroforestry system, Sapota-timber species-based Agroforestry system
Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan	-	Fruit tree based Agroforestry systems and peach-based Agroforestry system

Subsidiary activity

Quality Planting Materials

More than 90000 seedlings of *Populus deltoides*, *Melia dubia*, *Tectona grandis, Gmelina arborea, Dalbergia sissoo, Azadirachta indica, Melia azedarach, Pongamia pinnata, Toona ciliata, Grewia optiva, Celtis australis, Leucaena leucocephala, Robinia pseudocacia, Salix sp., Sapindus mukorossi, Morus alba* and *Artocarpus heterophyllus* were produced in nurseries and were sold and/or distributed besides different other intercrops.

Farmers' Outreach

The AICRP-Agroforestry centres registered a net outreach of agroforestry technologies to benefit over 10500 farmers during 2021-2022. In addition, our centres provide agroforestry/tree-centric agro-advisories to the agroforestry practitioners.

Brainstorming Session on `Har Med Par Ped'

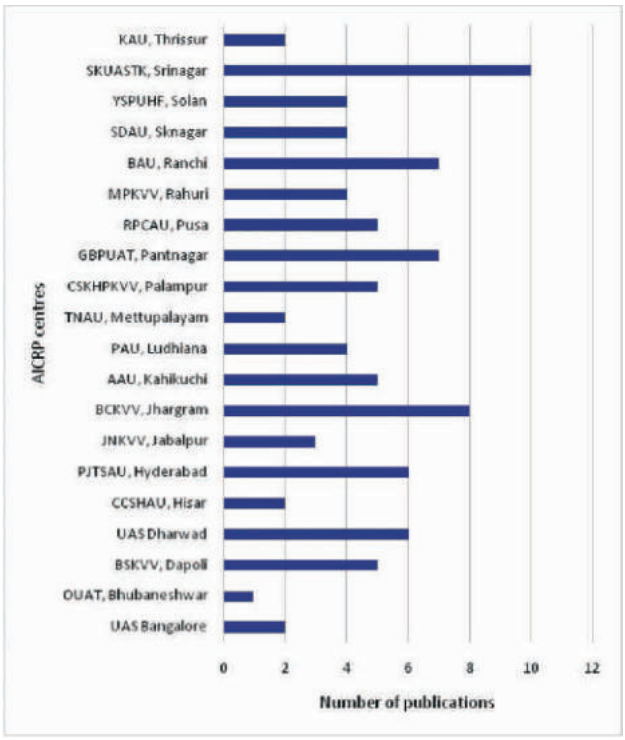
ICAR-Central Agroforestry Research Institute, Jhansi and AICRP-Agroforestry organized a Brainstorming Session on `Har Med Par Ped' on 26th April, 2021 in virtual mode to discuss the constraints and challenges of growing trees on farm bunds and boundaries. Around 80 participants including leading scientists from Indian Council of Agricultural Research and its constituent Research Institutes, faculty/scientists associated with ICAR's All India Coordinated Research Project on Agroforestry, State Agricultural Universities and ICFRE Institutes, representatives from State Forest Department, Industry and Progressive Farmers attended the session.

STC and SCSP Component

The Coordinating centres of the project undertook various activities for the welfare of weaker sections of the society belonging to Schedule Tribe and Schedule Caste categories by providing various inputs in form of seedlings, seeds of intercrop, fertilizers, small equipment for ensuring livelihood opportunities and nutritional security. The centre also conducted capacity building programmes for skill upgradation and knowledge enhancement for adopting different agroforestry-based land use systems.

Agroforestry Photography Competition, 2021

Agroforestry Photography competition was organized for the coordinating centres of AICRP on Agroforestry during April 2021.



Total number of publications from AICRP centres

The AICRP on Agroforestry has been recognised by the PEARL – A foundation for Educational Excellence for the year 2020

4. Awards and Recognitions

Best Agricultural Research Institution Award

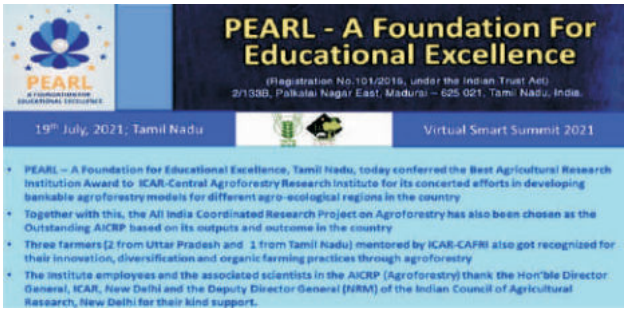
ICAR-CAFRI bagged the Best Agricultural Research Institution Award by PEARL-A Foundation for Education Excellence, Tamil Nadu for efforts in developing bankable agroforestry models for different agro-ecological regions of the country. Apart from this, AICRP on Agroforestry has been awarded with best AICRP award for its significant achievements.

Young Scientist Award

Dr. Sushil Kumar, Scientist (Agronomy) and Dr. Ashok Yadav, Scientist (Fruit Science), Mrs. Ashajyothi, Scientist (Plant Pathology) and Dr. Hirdayesh Anuragi, Scientist (Genetics and Plant Breeding) received PEARL Foundation Best Young Scientist Award during National Conference on "SMART Summit-2020" at Madurai on June 19th 2021.

Awards

- Ashok Yadav, Sushil Kumar, A.K. Handa, Inder Dev, Asha Ram, Badre Alam, Sukumar Taria, K. Rajrajan & A. Arunachalam received third prize for poster entitled "Manilla Tamarind (Mithi Imli)" paristhitiki tantra ki bahali aur poshan suraksha ke liye ek sambhavit phasal" in poster presentation competition during Hindi Saptah from September 14th-20th 2021, organized at ICAR-CAFRI, Jhansi.
- Sushil Kumar, Ashok Yadav, Sukumar Taria, Asha Ram & Hirdayesh Anuragi received third prize for poster entitled "*Melia dubia* aadharit krisihivaniki pranali ke vibhiin antaro ke tehat gehu ka pradasrshan" in poster presentation competition during Hindi Saptah from September 14th-20th 2021, organized at ICAR-CAFRI, Jhansi.
- आशाराम, शुभम चौरे, इन्द्रदेव, नरेश कुमार एवं आशुतोष द्विवेदी (2021). "सागौन आधारित कृषिवानिकी पद्धति में महीन जड़ों का वितरण, उत्पादन और पोषक तत्वों की उपलब्धता" के शोध–पत्र पर संस्थान के हिन्दी सप्ताह (14 से 19 सितम्बर, 2021) के पोस्टर प्रतियोगिता में second prize - Best poster award प्राप्त किया। भा.कृ.अनु.प.–केन्द्रीय कृषिवानिकी अनुसंधान, झाँसी–284003 (उ.प्र.).
- Dr. A. Arunachalam awarded Lifetime Achievement Award for Agroforestry R&D by Society of Biological Sciences and Rural Development, Prayagraj.
- Dr. A. Arunachalam felicitated with the Scientific Tamil Excellency Award 2021 of the Agricultural Scientific Tamil Society (SciTSA), New Delhi; Prominent Alumnus Award 2021 by Ayya Nadar Janaki Ammal College Alumni Association, Sivakasi and Excellence Service Award 2021 during the International Scientist Awards on Engineering, Science and Medicine on 7-8th August, 2021 in Pondicherry by VDGOOD Professional Association.



- Dr. A. Arunachalam notified as the Chairman of the Task Force II on Agroforestry by NITI Aayog, Govt. of India to review and suggest amendment in National Agroforestry Policy.
- Dr. A. Arunachalam was a Member, Research Council of RLBCAU, Jhansi.
- Dr. A. Arunachalam was a Member, UG & PG syllabus Revision Committee, ICFRE, Dehradun.
- Dr. A. Arunachalam was a Member, Board of Trustee & Management Committee, World Education Mission.
- Dr. A. Arunachalam was a Member, Research Advisory Committee, V. Sivaram Research Foundation, Bangalore; PHSS Foundation for Science & Society, Lucknow.
- Dr. A. Arunachalam notified as the Coordinator of the Task Force on Himalayan Agriculture under the NMSHE Program of DST, Govt. of India.
- Dr. A. Arunachalam was a Member of the National Advisory Committee, International Web Conference on Emerging Sustainability Trends in Agriculture, Rural and Environmental Development during 19-20th December, 2021 organized by Society of Biological Sciences and Rural Development, Prayagraj (UP).
- Dr. A. Arunachalam was a Member of the National Steering Committee and Convener of Technical Session Programme Committee, 5th International Agronomy Congress, 23-27 November 2021 organized by the Indian Society of Agronomy, New Delhi in PJTSAU, Hyderabad.
- Dr. A. Arunachalam notified as the Chief Editor of Indian Journal of Agroforestry by the Indian Society of Agroforestry, Jhansi.

5. New Research Projects (2021)

Title of the Project	PI/Co-PI
(A) Agroforestry System Research (ASR) Programme	
Assessment of conservation agroforestry	**Inder Dev**/ Asha Ram
Assessment of *Melia dubia* based agroforestry system under semi-arid conditions	**Naresh Kumar**/ Ashok Yadav & Kamini, IGFRI-Jhansi
Developing multifunctional agroforestry system for nutritional security in semi-arid tropics	**Ashok Yadav**/ A K Handa
Assessment of soil biological and biochemical characters in predominant agroforestry-based land use systems	**Sovan Debnath**/ Suresh Ramanan S
(B) Tree Improvement Research (TIR) Programme	
Evaluation of *Melia dubia* clones	**A K Handa**/ Naresh Kumar
Genetic characterization of neem germplasm for high azadirachtin yield	**K Rajarajan**/ Hirdayesh Anuragi
Collection and evaluation of *Moringa* germplasm for better adaptability and year round fruiting for accelerating agroforestry based nutritional security under semi-arid climate	**Hirdayesh Anuragi**/ K Rajarajan
(C) Carbon & Climate Change Research (CCCR) Programme	
Influence of plant morphological characteristics on soil properties in agroforestry systems	**Rajendra Prasad**/ Badre Alam
Ecophysiological dynamics for assessing climate change mitigation potential of contrasting tree populations of *Pongamia pinnata*	**Badre Alam**/ Rajendra Prasad
Assessment of ecosystem services in silvipastoral system in semi-arid conditions	**Asha Ram**/ Inder Dev
Text mining for assessing research trends and gaps of agroforestry perennials: A Big data analysis approach	**Suresh Ramanan S**/ A Arunachalam
(D) Agroforestry Extension Research (AER) Programme	
Constraints in adoption of agroforestry in Bundelkhand region of central India	**R P Dwivedi**/ Sushil Kumar Yadav & Priyanka Singh
Impact assessment of agroforestry and water conservation interventions on livelihood of farmers in Garhkundar Dabar watershed	**Sushil Kumar**/ Priyanka Singh
Economic impact of ICAR-CAFRI interventions in Parasai-Sindh watershed	**Priyanka Singh**/ R P Dwivedi

All-India Network/Multi-Institutional Projects and Others supported by ICAR

Title of the Project	PI/Co-PIs	Duration	Agency	Budget (Rs. Lakh)
Harvesting, processing and value addition of natural resins and gums	**Rajendra Prasad**/ A K Handa & Badre Alam	2008-March, 2022	ICAR-IINR&G, Ranchi	179.62
National Agriculture Innovation Fund (NAIF) Scheme	**Inder Dev**/ Ashok Yadav, Priyanka Singh & Sovan Debnath	2017-Ongoing	ICAR-NAIF	7.40 annual

All India Coordinated Research Project on Agroforestry

Title of the Project	PI/Co-PIs	Year of Start	Completion	Agency	Budget (Rs. Lakh)
All India Coordinated Research Project on Agroforestry (AICRP-Agroforestry)*	**Dr. A Arunachalam (Project Coordinator)** A K Handa (Nodal Scientist) & Suresh Ramanan S (Associate Scientist)	1997	Ongoing	ICAR, New Delhi	1142.00

*AICRP-Agroforestry Secretariat

Externally Funded Projects

Title of the Project	PI/Co-PIs CC-PI/CC-Co-PI	Duration	Agency	Budget (Rs. Lakh)
Transforming rural livelihood through agroforestry based natural resource management in drought prone Bundelkhand region, UP (Sub Project of KISAN MITrA project for Doubling Farmers' Income in Bundelkhand region of Uttar Pradesh)	**Inder Dev/** Naresh Kumar & Asha Ram	2018- March, 2022	ICRISAT, Hyderabad	182.509
Transforming rural livelihood and checking migration through agroforestry in conjunction with natural resource management in Bolangir and Nuapada districts of Odisha	**Inder Dev/** A K Handa & Asha Ram	2018- March, 2022	ICAR-ICRAF Work Plan	6.78
Assessment of genetic potential of neem germplasm for higher yield and oil content through molecular markers	**K Rajarajan/** H Anuragi & Alka Bharti*	2019- March, 2023	NRAA, Govt. of India, New Delhi	21.95
Assessment of area under agroforestry systems/species in agro-climatic zones of India	**A K Handa/** Suresh Ramanan S & Shiran K (ICAR-CAZRI, Jodhpur)	2020- March, 2022	ICAR-ICRAF Work Plan	61.98
Whole transcriptome sequencing of *Pongamia pinnata* for drought stress tolerance	**K Rajarajan/** Alka Bharti*, Ashajyothi**, Suresh Ramanan S, Asha Ram & A K Handa	2020- Nov. 30, 2021	ICAR-ICRAF Work Plan	4.50
Evaluating the performance of strawberry cultivation in Babina block of Jhansi district for crop diversification and better economic returns at farmer's field	**A Arunachalam/** Ashok Yadav & Sushil Kumar	2021- 2022	NABARD (U P)	24.84
Evaluating the performance of strawberry cultivation in Moth block of Jhansi district for crop diversification and better economic returns at farmer's field	**A Arunachalam/** Ashok Yadav & Sushil Kumar	2021- 2022	NABARD (U P)	24.88
Task Force on Himalayan Agriculture-NMSHE (2nd Phase)-	**A Arunachalam, Project Coordinator** CC-PI: **A K Handa** CC-Co PI: Suresh Ramanan S	October, 2021-March, 2026	DST, New Delhi	952.6
Support Implementation of National Agroforestry Policy by enhancing tree cover & production of wood (FAO-NRAA TCP)	**A Arunachalam, Project Coordinator A K Handa/** R P Dwivedi, Priyanka Singh, Suresh Ramanan S & Ashok Yadav	2021-2022	FAO-India Office	18.37
Pilot the solutions of chip-based technology for real-time and RFID-passive monitoring of field gene bank and agroforestry species for scaling up	**K Rajarajan/** H Anuragi	2022-Ongoing	ICRAF-ICAR Work Plan	4.92

*On study leave w.e.f. 20.06.2021;** On study leave w.e.f. 04.10.2021

Inter-Institutional Collaborative Project

Title of the Project	PI/Co-PIs	Duration	Funding of the Project
Farmer FIRST programme (FFP): Scaling up and integration of fodder technologies in existing farming system for sustainable livestock productivity in Bundelkhand	**Purshottam Sharma/** Sunil Seth, S K Mahanta, Harsh Vardhan Singh, Mukesh Choudhary & R P Dwivedi	2016 - 2022	Inter-Institutional (IGFRI-Jhansi)
Study of soil-hydrothermal environment under natural Vs synthetic mulch	**Nilimesh Mridha/** D B Shakyawar, Atul Singha, Manik Bhowmick, Er. Haokhotang Baite, Ashok Yadav, Manoj Kundu, Dipak Nayak & Vinod Kadam	April 2020-March 2023	Inter-Institutional (NINFET-Kolkata, W.B.)

Research Projects concluded in 2021

S.No.	Title of the Project	PI/Co-PI
A	**SYSTEM RESEARCH PROGRAMME**	
1	Nutrient management in ber based agri-horti. system	**Sudhir Kumar; Dr. Ashok Yadav** nominated as PI w.e.f. 25.5.2021 to 15.10.2021 /Rajendra Prasad, Inder Dev &Y N Venkatesh
2	Performance of pomegranate integrated with lemongrass under organic regime	**Sudhir Kumar; Dr. Ashok Yadav** nominated as PI w.e.f. 25.5.2021 to 15.10.2021 /Rajendra Prasad & Y N Venkatesh
3	Structural and functional analysis of short rotation tree based agroforestry system	**Naresh Kumar**/Asha Ram, Inder Dev, Priyanka Singh & Kamini (ICAR-IGFRI, Jhansi)
B	**NATURAL RESOURCE & ENVIRONMENT MANAGEMENT PROGRAMME**	
1	Agroforestry based conservation agriculture for sustainable landuse and improved productivity	**Inder Dev**/Asha Ram, Naresh Kumar, Lal Chand, Sushil Kumar, Priyanka Singh & Y N Venkatesh
2	Agroforestry based Integrated Farming System for small and marginal farmers in semi-arid region	**Asha Ram**/Sudhir Kumar, Naresh Kumar, R. Vishnu, Sushil Kumar, Lal Chand, Priyanka Singh, Aswathy Chandrakumar & Y N Venkatesh
3	Impact of watershed and agroforestry interventions on hydrology and nutrient loss at Garhkundar-Dabar watershed in Bundelkhand region of Central India	**Inder Dev**/Asha Ram & R K Tewari
4	Relevance of soil and water conservation measures in enhancing productivity and sustainability of silvipastoral system in semi-arid conditions	**Asha Ram**/Naresh Kumar & Inder Dev
5	Biomass modelling and area estimation in *Tectona grandis* based agroforestry systems in Central India	**R H Rizvi**/Asha Ram & R Vishnu
6	Temporal evaluation of cropping systems under *Melia dubia* based agroforestry system	**Sushil Kumar**/Asha Ram, Naresh Kumar, Sukumar Taria, Rajendra Prasad & Priyanka Singh
7	Standardization of nursery practices for the production of quality planting material of Indian Sandalwood (*Santalum album* L.)	**R Vishnu**/Naresh Kumar, Rajendra Prasad, K Rajarajan & Sukumar Taria
C	**Tree Improvement, Post-Harvest & Value Addition Programme**	
1	Comparative studies on seedling and clonal plants of *Pongamia pinnata* with special reference to their adaptability to rainfed dry agroclimate	**Badre Alam**/A K Handa, Sukumar Taria, Hirdayesh Anuragi & Alka Bharti

2	Evaluation and characterisation of different *Leucaena* germplasm at CAFRI	**K Rajarajan**/A K Handa, R Vishnu, A K Singh, (IGFRI) & Maneet Rana (IGFRI)
3	TBOs based Agroforestry models	**R Vishnu**/Inder Dev
4	Functional genomics for early drought tolerance in *Pongamia pinnata* genotypes	**K Rajarajan**/Lal Chand, A Rathakrishnan,(IGFRI), Sukumar, Taria, Hirdayesh Anuragi & Alka Bharti
5	Collection, evaluation and hybridization of Moringa germplasms	**Hirdayesh Anuragi**/Lal Chand,Sukumar taria, K Rajarajan, Alka Bharati & Y N Venkatesh
D	**HRD, Technology Transfer & Refinement Programme**	
1	Socio-economic, energetic and environmental impact assessment of watershed and agroforestry interventions at Garhkundar-Dabar watershed in Tikamgarh district of Madhya Pradesh	**R P Dwivedi**/R K Tewari, R H Rizvi, Priyanka Singh & Mrs. Aswathy Chandrakumar

6. Participation in Workshop/Webinars/Meetings/Symposia

Duration	Event	Organizer	Participants
16th January, 2021	One-day seminar on Tree Borne Oilseeds (TBO mini mission under National Food Security Mission)	Organized by Agricultural Department, Jhansi at Pt. Deendayal Auditorium, Jhansi	Dr. Hirdayesh Anuragi
27th January, 2021	NBA-UNDP Webinar series on Biodiversity and Biological diversity Act 2002: Access and Benefit Sharing-Processes and Outcomes		Dr. R Vishnu
9th -11th February, 2021	National web conference on Sustaining Pulse Production for Self Sufficiency and Nutritional Security (Pulse WebCon 2021)"	Organized by ICAR-IIPR, Kanpur and ICAR, New Delhi	Dr. Hirdayesh Anuragi
17th February, 2021	Targeting Sustainability of Forests through Certification and NCCF Standards	Organized by The India International Centre (IIC), Delhi	Dr. R Vishnu
21st March, 2021	Virtual webinar on the occasion of International Day of Forests and World	ICAR-CAFRI, Jhansi in association AIRPAF on Agroforestry	All scientists of ICAR-CAFRI
5th April, 2021	Webinar on Linkages of Joint Forest Management Committees (JFMCs) with Institutions of Community Participation & Panchayati Raj Institutions	TERI, New Delhi	Suresh Ramanan S
22nd April, 2021	Environmental Education in India	ICAR, New Delhi	Suresh Ramanan S
4th & 5th June, 2021	National E-Seminar on "Ecosystem Restoration" on the eve of "World Environment Day" (WED2021)	Organized by GITAM, Visakhapatnam in association with Society for Science of Climate Change and Sustainable Environment, New Delhi, India	Dr. Hirdayesh Anuragi, Dr. Ashok Yadav
19th June, 2021	National Conference on SMART Summit -2021	PEARL Foundation, Madurai (Virtual Mode)	Dr. Sushil Kumar, Dr. Hirdayesh Anuragi, Dr. Ashok Yadav, Mrs. Ashajyothi
22nd-24th June, 2021	International Conference on Forest Education	FAO, FAO-India Office, New Delhi	Suresh Ramanan S
29th-30th June, 2021	Virtual workshop "Statistical and Economical Analysis of Data through Packages"	Sher-e-Kashmir University of Agricultural Sciences, Jammu	Suresh Ramanan S
1st July, 2021	Azadi Ka Amrit Mahotsav-One District One Focus Produce webinar on Banana processing and value addition	IIFPT, Thanjavur	Suresh Ramanan S
15th July, 2021	Policies for Agroecology event from the Agroecology Transformative Partnership Platform (TPP)	ICRAF, New Delhi	Suresh Ramanan S

16th July, 2021	Webinar on Advances in Teak Cultivation: Genetic Resources and Technologies	IFGTB, Coimbatore	Suresh Ramanan S
29th July, 2021	Webinar on Checking Plagiarism	AKMU, CAFRI, Jhansi	All CAFRI Scientists
29th July, 2021	Live event on "Status of Research on Moringa oleifera: Breeding, Genomics & Nutrition"	World Agroforestry (CIFOR-ICRAF)	Dr. Hirdayesh Anuragi
3rd August, 2021	Online lecture on "Processing and Value Addition of Natural Resins & Gums"	IINRG Ranchi as part of India @75 Azadi ka Amrut Mahotsav	Dr. Rajendra Prasad, Dr. Ashok Shukla and Shri. Prashant Singh
19th August, 2021	Live webinar on "Tools and Methods for CRISPR-Cas9 Functional Genomics and Precise Gene Editing"	Thermo Fisher Scientific	Dr. Hirdayesh Anuragi
27th August, 2021	National Stakeholder Consultation Workshop on Development of Roadmap for Institutional and Policy Mainstreaming of Sustainable Land and Ecosystem Management in India	ICFRE, Dehradun	Suresh Ramanan S
8th September, 2021	Virtual National Level Stakeholder Consultation for a new global initiative of one CGIAR on Nexus Gains: Realizing Multiple Benefits across Water - Energy - Food - Forest - Biodiversity Systems	CGIAR	Suresh Ramanan S
29th September, 2021	Invited Lecture on Agroforestry for Sustainable Development in the Inter-disciplinary Refresher Course on Science and Technology during 28th September to 11th October, 2021.	Mizoram University-HRDC, Aizwal	Dr. A Arunachalam
3rd -10th October, 2021	Workshop on hands on online training on CRISPR/Cas9 mediated gene editing in plants	SERB sponsored organized by Department of Plant Science, University of Hyderabad, Hyderabad	Dr. Hirdayesh Anuragi
4th-24th October, 2021	Invited Lecture on Methodologies and practices for climate change resilience in the 21-days online Scientific Training on Agricultural Research Methodologies, Practices and their Management	Samagra Vikas Welfare Society and CAU, Pasighat, Arunachal Pradesh	Dr. A Arunachalam
26th October, 2021	International webinar on fighting the hunger using smart technology	ICAR-IIOPR, Pedavegi, Andhra Pradesh	Dr. Hirdayesh Anuragi
27th-29th October, 2021	29th Annual Conference on "Public Policies and Agricultural Transformation in India"	Agricultural Economics Research Association, India	Dr. Priyanka Singh
9th-10th November, 2021	Online 13th Annual workshop of Network Project on "Harvesting, Processing and Value Addition of Natural Resins and Gums (NP-HPVA of NRGS)"	ICAR-IINRG, Ranchi, Jharkhand	Dr. Rajendra Prasad, Dr. Badre Alam, Dr. A K Handa, Dr. Ashok Sukla and Shri Prashant Singh
23rd-27th November, 2021	Fifth International Agronomy Congress on "Agri Innovations to Combat Food and Nutrition Challenges"	PJTSAU, Hyderabad, India	Dr. Asha Ram and Dr. Sushil Kumar
26th November, 2021	International Webinar on Fighting the Hunger using Smart Technology	ICAR-IIOPR, Pedavegi, Andhra Pradesh	Dr. Hirdayesh Anuragi

6th-18th December, 2021	Advanced Course (Asia & North Africa) on Conservation Agriculture: Gateway for Sustainable Intensification of Smallholder Systems	CIMMYT in collaboration with ICAR-CSSRI, Karnal and BISA, Ludhiana at ICAR-CSSRI, Karnal	Dr. Asha Ram
19th-20th December, 2021	Invited Panel Lecture on 'Agroforestry and Humans' on 19 December, 2021; International Web-Conference on Emerging Sustainability Trends in Agricultural, Rural and Environmental Development	Organized by Society of Biological Sciences and Rural Development, Prayagraj, Uttar Pradesh	Dr. A Arunachalam
30th December, 2021	National Workshop on Bamboo	NITI Ayog, GoI, New Delhi	Dr. A K Handa

7. Important Events/Meetings/Days Observed

Days Observed

Celebration of 34th Foundation Day of ICAR-CAFRI

ICAR-Central Agroforestry Research Institute celebrated its 34th Foundation Day along with the Foundation Day of Indian Society of Agroforestry (ISAF) on 18th June, 2021. Foundation Day address was delivered by Dr. Trilochan Mohapatra, Secretary DARE & DG ICAR. Deputy Director General, Natural Resource Management Division, ICAR and ADG (Agronomy, Agroforestry and Climate Change), ICAR were also present in the meeting. Institute publications and media materials were released by DG ICAR, followed by virtual inauguration of the new training hostel. On the occasion, ISAF conferred Lifetime Achievement Awards to Dr. Trilochan Mohapatra, Dr. Ravi Prabhu, Dr. P S Pathak and Dr. P K Koshla.

National Science Day on 28.02.2021.

International Women's Day on 08.03.2021

World Sparrow Day

ICAR-CAFRI virtually celebrated World Sparrow Day on 20th March, 2021 under the chairmanship of Dr. A. Arunachalam, Director. Dr. Sanjay Shukla, Add. Principal Chief Conservator Of Forest, M.P was the Chief Guest and Dr. Ashwarya Maheshwar, Assitt. Professor, Banda Agricultural University, Banda was the Guest of Honour. About 80 participants participated in the programme.

World Forest Day & Tree Day

ICAR-CAFRI virtually observed International Forest Day and World Tree Day on 21st March, 2021 under the guidance of Dr. A. Arunachalam, Director. Dr. B.P. Bhatt, Ex. Director, ICAR Research Complex for the Eastern Region, Patna and Dr. C.G. Kushalpa, Dean, Forest college, Ponampet, Karnataka were the keynote speaker of the function.

World Water Day

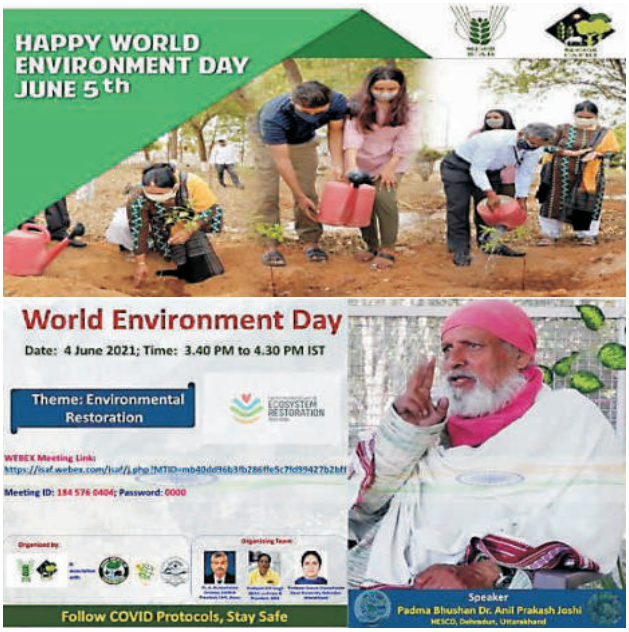
World Water Day was organized by ICAR-CAFRI on 22nd March, 2021 in Parasai village of Babina block in Jhansi on the global theme "Valuing Water". About 200 farmers participated in the programme.

International Day of Biological diversity

Indian Society of Agroforestry in association with Doon University and the Society for Science of Climate Change and Sustainable Environment celebrated International Day of Biological Diversity on 22nd May, 2021.

World Environment Day

On the occasion of World Environment Day on 5th June, 2021, public lecture was virtually delivered by Padma Bhushan Dr. Anil Prakash Joshi on the theme "Environmental Restoration".



International Day of Yoga

Following the COVID-19 protocols, ICAR-CAFRI observed International Day of Yoga on 21st June, 2021 on the theme "Yoga for Wellness".

Constitution Day

Constitution Day was observed on 26th November, 2021. The institute staffs read the Preamble of the Constitution of the at the Institute premises.

Republic Day and Independence Day

ICAR-CAFRI celebrated the Republic Day (26th January, 2021) and Independence Day (15th August, 2021) in the institute premises. Director of the institute unfurled and hoisted the flag on both the occasions. Various cultural activities and sport events were organized for the staff and their family members.

Events Organized

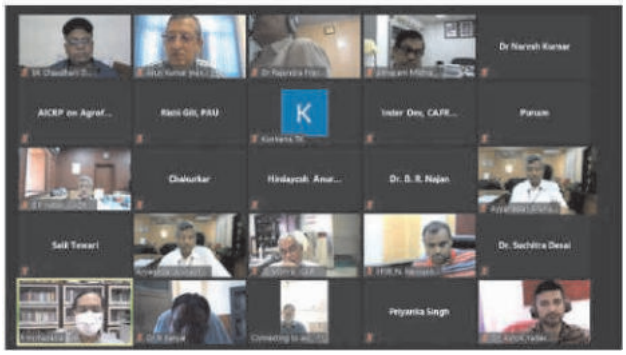
ICAR-CAFRI organized a virtual brainstorming session on "*Har Med Par Ped*" on 4th June, 2021 to discuss the scope and challenges of growing trees on farm bunds and boundaries. DG, ICAR chaired the session and several dignitaries across the country participated in the event.

- Public lecture on Animal Health and Productivity on 11th June, 2021 (Speaker: Dr. A.K. Srivastava, Member, ASRB, Govt. of India, New Delhi).

- Public lecture by Dr. Abdesh Kumar Gangwar, Coordinator RCE and Former Senior Programme Director CCE on "Towards a Sustainable Climate Smart and Disaster Resilient Community" on the eve of Day to Combat Desertification and Drought on 17th June, 2021.

Annual IRC Meeting

The annual IRC meeting of Institute was conducted on 11th - 12th October, 2021. All scientists of the institute participated and 14 new research proposals were approved by the house after thorough discussion.



Swachh Bharat Abhiyan

ICAR-CAFRI observed Swachhta Pakhwada from 16th-30th December, 2021. During this period, awareness campaign and both on-campus as well as off-campus cleanliness activities were conducted involving the staffs of the institute.

New in Campus

- Establishment of ***Navagraha Vatika*** at ICAR-CAFRI on 15th November, 2021

- Establishment of ***Star Tree Plantation*** at ICAR-CAFRI on 22nd November, 2021

- Establishment of ***Rashi Vatika*** at ICAR-CAFRI on 10th November, 2021

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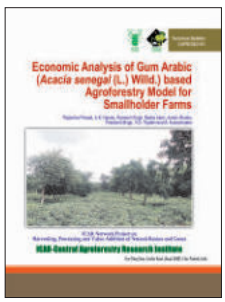
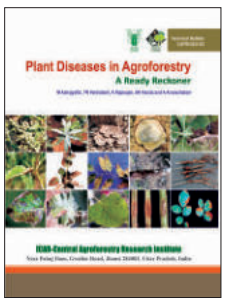
(F) Blog

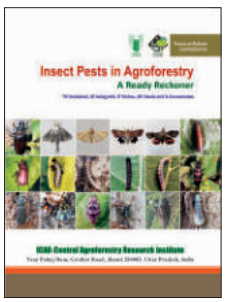
Trees for the SDGs: Woody perennials building resilience in urban and rural landscapes – THE GFAR BLOG (https://blog.gfar.net/2021/11/12/trees-for-the-sdgs-woody-perennials-building-resilience-in-urban-and-rural-landscapes/) – Written by A. Arunachalam and Suresh Ramanan S.

(G) Book Review

Ramanan, S S and Arunachalam, A, 2021. A look over on the scented tree of India (*Santalum album*). *Journal of Threatened Taxa,* 13(12): 19884-19886. https://doi.org/10.11609/jott.7614.13.13.19884-19886







9. Trainings and Capacity Building

A. Participation in Trainings

Event	Duration	Organizer	Participants
Online training programme on "Accrual Accounting"	12th-14th January,2021	ICAR- NRRI, Cuttack	Sh. Birendra Singh
DST sponsored national online training programme on "Integrated Nutrient Management and Budgeting through Advanced Models to Improve Crop Productivity"	18th-22nd January, 2021	ICAR-IISWC, Regional Station, Ooty, Tamil Nadu	Dr. R Vishnu
Online training programme on "Documentation procedures for NABL accreditation for PTLs and PRLs"	9th - 10th February, 2021	NIPHM, Hyderabad	Dr. K Rajarajan
DST sponsored online training for scientists/ technologist in environmental science working in government sector on "Biodiversity Conservation"	22nd - 26th February, 2021	Wildlife Institute of India, Dehradun	Dr. R. Vishnu and Mr. Venkatesh Y N
Online training on "Role of PT and ILC in maintaining accreditation as per the ISO 17025:2017"	2nd March, 2021	NIPHM, Hyderabad	Mrs. Ashajyothi
Online training programme on "Agroforestry for Environmental Sustainability and Climate Resilience"	10th -12th May, 2021	ICAR-CAFRI and MANGE, Hyderabad	Dr. H Anuragi and Suresh Ramanan S
NAARM MDP training on "Biodiversity and Environmental Laws relevant to Agricultural Researchers"	7th - 9th June, 2021	ICAR-NAARM, Hyderabad	Dr. K Rajarajan and Suresh Ramanan S
Online training programme on "Appropriate sampling technique including sample preparation and preservation for soil, water, plant and air samples for various analysis"	2nd-7th August, 2021	ICAR-IARI, New Delhi	Dr. Ajay Kumar Pandey
Online training programme on "Budget Utilisation Procedure" for administrative and finance officers of ICAR	09th - 11th August, 2021	ICAR-NAARM, Hyderabad	Sh. Birendra Singh and Sh. J J Singh
Online training programme on "Species Distribution Modelling"	12th, 17th & 19th August, 2021	NASA's Applied Remote Sensing	Suresh Ramanan S
Online training programme for vigilance officer of ICAR	16th -18th August, 2021	ICAR- NAARM, Hyderabad	Dr. A K Handa
Online training programme on Data Analysis in Social Sciences Research	4th -8th October, 2021	ICAR-NAARM, Hyderabad	Dr. Priyanka Singh
Online training programme on "Statistical Techniques for Data Analysis in Agriculture"	4th -13th October, 2021	ICAR-IASRI, New Delhi	Suresh Ramanan S
Online training/workshop on "Analysis of Multi-Location Experiments"	28th October - 1st November, 2021	ICAR-NAARM, Hyderabad	Dr. Hirdayesh Anuragi
Advance course on conservation agriculture-Gateway for sustainable intensification of small holder system sponsored by CIMMYT	6th - 8th December, 2021	ICAR-CSSRI, Karnal	Dr. Asha Ram
Online training programme on "Statistical Designs and Analytical Methods for Multifactor Experiments"	8th - 17th December, 2021	ICAR-CMFRI, Kochi	Dr. Priyanka Singh
Online training programme on "SNP Mining, GWAS and Genomic Selection"	16th - 21tst December, 2021	ICAR- IASRI, New Delhi	Dr. Hirdayesh Anuragi

B. Trainings organized for Various Categories of Employees

Event	Duration	Venue	Participants
"Business Opportunities in Agroforestry" for agripreneurs under AC&ABC scheme	2nd - 4th March, 2021	CAFRI-MANAGE joint Online Training Programme	45
Agroforestry for Environmental Sustainability and Climate Resilience	10th -12th May, 2021	CAFRI-MANAGE joint Online Training Programme	75
Training programme on Agroforestry for Forest Officers, Forest Department, Chhattisgarh	11th August, 2021	ICAR-CAFRI, Jhansi	25
Training programme on "Ber Budding"	01st -03rd September, 2021	Parasai village Jhansi	35
Training programme on "Krishivaniki Aadharit Naveen Taknikiyan"	28th -30th September, 2021	ICAR-CAFRI, Jhansi	45
Three days hands on training on DNA extraction and PCR techniques in Plant Biotechnology	3rd -5th December, 2021	ICAR-CAFRI, Jhansi	22

C. HRD funds Allocation and Utilization

Year	Allocation	Utilization
2021-22	0.14	0.14

10. Scheduled Caste Sub Plan (SCSP) Programme

ICAR-CAFRI is implementing SCSP scheme with the main objective to improve the socio-economic conditions of the SC community. Under this scheme, various training/capacity building programmes are being organized for scheduled caste farmer, farm women, widows and handicaps. The scheme includes the enhancement of incomes of the target group for the development of assets such as those related to agricultural sector.

During this period four programmes were organized in which different equipments/tools were distributed to the farmers/farm women. Four trainings (01 day each) and Agroforestry Awareness programmes were organized for the benefit of SC community.

Table 5. Details of the training cum distribution camps organized during 2021

Name of Village	Number of Farmers	Date	Items
Simardha Pal Colony, Jhansi	35	30/09/2021	Sewing machine
Simardha & Jhansi Local	55	10/10/2021	Sewing machine
Bachhauni, Rajapur, Jhansi	13	23/12/2021	Spray Pump
Nathupura, Baniyatala and Chandrapura of district Mahoba	111	24/12/2021	Spray Pump
Rasin and Raulikalyanpur of district Chitrakoot, (U.P.)	230	29.12.2021	Spray Pump

Dr. S.K. Chaudhari distributing sewing machine to SCSP beneficiaries at CAFRI, Jhansi

Training-cum-distribution camp Nathupura in Mahoba district

Training cum distribution camp at Rasin and Raulikalyanpur in Chitrakoot district

Distribution of brush cutter at Rasin in Chitrakoot district

11. Consultancy Services

Impact Assessment of Soil and Moisture Conservation works on Economic, Social and Environmental aspects in Bundelkhand and Chirtakoot circle of Forest Department

Compensatory Afforestation Fund Management and Planning Authority (CAMPA) is a National Advisory Council under the chairmanship of the Union Minister of Environment & Forests for monitoring, technical assistance and evaluation of compensatory afforestation activities. It meant to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses. Soil and water conservation and afforestation are the important activities to enhance the forest cover in all climatic conditions in general and arid and semi-arid conditions in particular. These activities not only protect and promote the vegetation cover in the forest but also contribute to benefit the residents of forest fringe areas. Since public resources are limited, therefore, Government of India has decided to implement such programs which not only helps in conservation of land, water and plant resources but also ensures the livelihood security of farm households.

Various soil and water conservation measures has been undertaken by the Department of Forest, Bundelkhand Forest Circle, Government of Uttar Pradesh in the seven districts of Bundelkhand region of Uttar Pradesh. To evaluate/assess the socio-economic and environmental impact of these interventions on rural livelihood, Department of Forest, Bundelkhand Forest Circle has commissioned ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi. The study was limited to only impact evaluation, rather than process evaluation. Impact evaluation, measures the impacts of the program on intended stakeholders in comparison to suitable counterfactuals. The scope of the project was limited to impact assessment of soil and water conservation measures and plantation work and documentation of these impacts in the form of report.

The study was carried out with following specific objectives:

1. To assess the project interventions on ground water level, water availability for wild life, vegetation, domestic use, irrigation and livestock in treated and fringe area of forests;
2. To assess the impact of soil and water conservation measures on floral and faunal biodiversity in treated area of forest;
3. To assess the impact on crop productivity in fringe area of forests;
4. To assess the impact on conservation of natural resources.
5. To assess the availability of forage resources for livestock and wild animals; and
6. To estimate the impact on livelihood security and socio-economic conditions of the people in forests fringe.

The field enquiry/survey was conducted during the, July 2021 to September, 2021.

The team visited selected sites in all seven forest divisions of the region. The basic information about forest, soil and water conservation measures and plantation works carried out under the project were collected from forest department. The primary data on the forest diversity was collected from visited sites. The socio-economic data were collected through focused group discussion and personal interviews with the residents of forest fringe areas. All the ranges of forest divisions were visited for this evaluation. Team found that almost all the water harvesting structures were found with stored water. Storing of water increases the opportunity time for infiltration and ultimately helps in recharging of groundwater. Availability of soil moisture for longer time helped in natural regeneration and increased

vegetation cover in the treated areas. The rain water harvesting structures have now developed as a habitat for aquatic life especially lentic and lotic ecosystem such as algae, rooted and floating leaved plants, invertebrates such as crabs, shrimps, etc, amphibians like frog and reptiles like water snakes. Due to water harvesting structures, soil loss, runoff loss and nutrient loss reduced drastically in the treated area. Man-animal conflict decreased in forest fringe area as wild animals were getting the drinking water in the treated area.

Team: A. Arunachalam, Inder Dev, Naresh Kumar, Asha Ram, Sushil Kumar, Vishnu R., Priyanka Singh, Rajendra Singh and Shishupal Singh

12. Distinguished Visitors

- Hon'ble DDG (NRM) ICAR, Dr. S.K. Chaudhari visited ICAR-CAFRI during 10th-11th October, 2021and guided the research programme.





- Hon'ble DDG (Crop Science), ICAR Dr. T.R. Sharma visited CAFRI on 01st November, 2021.
- Dr. G.R. Rao, Director, TERI, Jabalpur.
- Dr. N.P. Melkania, Dean, Gautam Buddha University, Greater Noida, Uttar Pradesh.
- Dr. G. Babu, Asst. Director In-charge, Central Ayurveda Research Institute, Jhansi.
- Dr. J.P. Mishra, Principal Scientist NRM Division, ICAR, New Delhi.
- Dr. B.P. Bhatt, Principal Scientist NRM Division, ICAR, New Delhi.
- Shri Joginder Kumar, DIG, Jhansi Region visited on 12th August, 2021.

13. Digital Reforms

Official website, payment gateway, social media platforms and mobile *app* of ICAR-CAFRI, Jhansi

ICAR-CAFRI, Jhansi has upgraded its official website to a dynamic, responsive and secured version (https://cafri.icar.gov.in) using latest tools. A number of official social media platforms *viz.* Facebook, Twitter, LinkedIn, YouTube, Instagram, *etc.*, and '*FarmTree*' bilingual mobile app have been created for effective outreach to its stakeholders. Further, the Payment Gateways (QR code-based UPI pay and SBIePay) and Sale counter have been created and updated on its website for easier access and better utilization. Intranet facility is being created for central access of the laboratory equipments and consumables.

14. Personnel Information

Dr. A. Arunachalam, Director		
Scientific		
1.	Dr. Rajendra Prasad, Principal Scientist (Soil Science)	
2.	Dr. A K Handa, Principal Scientist (Forestry/ Agroforestry)	
3.	Dr. R P Dwivedi, Principal Scientist (Agriculture Extension)	
4.	Dr. Inder Dev, Principal Scientist (Agronomy)	
5.	Dr. Badre Alam, Principal Scientist (Plant Physiology)	
6.	Dr. Naresh Kumar, Principal Scientist (Agroforestry)	
7.	Dr. K Rajarajan, Scientist, Senior Scientist (Genetics & Plant Breeding)	
8.	Dr. Asha Ram, Scientist, Senior Scale (Agronomy)	
9.	Dr. Sushil Kumar, Scientist, Senior Scale (Agronomy)	
10.	Dr. Sovan Debnath, Scientist, Senior Scale (Soil Science)	(Joined on 07/10/2021)
11.	Dr. Hirdayesh Anuragi, Scientist (Genetics & Plant Breeding)	
12.	Sh. Sukumar Taria, Scientist (Pl. Physiology)	(on Study Leave) w.e.f. 26/12/2020
13.	Mrs. Alka Bharati, Scientist (Agril. Biotech.)	(on Study Leave) w.e.f. 20/06/2021
14.	Sh. Y N Venkatesh, Scientist (Agril. Ento.)	(on Study Leave) w.e.f. 04/10/2021
15.	Dr. Ashok Yadav, Scientist (Fruit Scientist)	
16.	Sh. Suresh Ramanan S, Scientist (Agroforestry)	
17.	Dr. (Ms.) Priyanka Singh, Scientist (Agricultural Economics)	
18.	Mrs. M Ashajyothi, Scientist (Plant Patho.)	(on Study Leave) w.e.f. 04/10/2021
Technical		
1.	Dr. Rajeev Tiwari, Chief Technical Officer	
2.	Dr. C K Bajpai, Chief Technical Officer	
3.	Dr. A Datta, Chief Technical Officer	
4.	Sh. Sunil Kumar, Chief Technical Officer	
5.	Sh. Rajendra Singh, Chief Technical Officer	
6.	Sh. Rajesh Srivastava, Assit. Chief Technical Officer (Art & Photo)	
7.	Sh. R K Singh, Assit. Chief Technical Officer	
8.	Sh. S P Singh, Sr. Technical Officer	
9.	Sh. Ram Bahadur, Sr. Technical Officer	
10.	Dr. Ajay Kumar Pandey, Sr. Technical Officer	
11.	Mrs. Shelja Tamrakar, Sr. Technical Assistant (Library)	
12.	Sh. Prince, Technical Officer, Mechanic	
13.	Sh. Het Ram, Technical Officer (Driver)	
14.	Sh. Kashi Ram, Sr. Technical Assistant (Driver)	
Administration		
1.	Sh. J L Sharma, Sr. A O	
2.	Sh. Pavan Kumar Pandey, FAO	(Joined on 11/11/2021)
3.	Sh. Birendra Singh, AAO	

4. Sh. Mahendra Kumar, AAO
5. Sh. Hoob Lal, Private Secretary
6. Sh. Om Prakash, Private Secretary
7. Sh. Deepak Vij, Personal Assistant
8. Mrs. Kirti Chaturvedi, Personal Assistant
9. Sh. Tridev Chaturvedi, Personal Assistant
10. Sh. Jai Janardan Singh, Assistant
11. Mrs. Kaushalya Devi, Sr. Clerk
Skilled Supporting Staff
1. Sh. Jagdish Singh
2. Sh. Ram Din
3. Sh. Pramod Kumar
4. Sh. Munna Lal
Transfer
1. Dr. R H Rizvi, Pr. Scientist (Computer Application) has been transferred on12/01/2021
2. Dr. R. Vishnu, Scientist (Agroforestry) has been relieved on 06/10/2021 to Kerala Agricultural University, Thrissur
3. Mrs. Aswathy Chandrakumar, Scientist (Agricultural Extension) has been transferred on 31/01/2021
Promotion
• Dr. Ajay Kumar Pandey, Technical Officer promoted to the post of Sr. Technical Officer w.e.f. 19/02/2021
• Sh. J L Sharma, AO promoted to the post of Sr. A O w.e.f. 29/06/2021
• Sh. Mahendra Kumar, Assistant promoted to the post of AAO w.e.f. 29/06/2021
• Sh. Hoob Lal, P A promoted to the post of Private Secretary w.e.f. 01/07/2021
• Sh. Om Prakash, promoted to the post of Private Secretary w.e.f. 05/07/2021
• Sh. Deepak Vij, promoted to the post of Personal Assistant w.e.f. 01/07/2021
• Sh. Tridev Chaturvedi, promoted to the post of Personal Assistant w.e.f. 01/07/2021
• Sh. Prince, Technical Assistant, Mechanic promoted to the post of Technical Officer w.e.f. 29/06/2021
Retirement
1. Dr. R K Tewari, Pr. Scientist (Horticulture/ Fruit Science) voluntarily retired on 31/08/2021
2. Sh. J L Sharma, Sr. A O retired on 31/12/2021
3. Sh. A K Chaturvedi, Private Secretary retired on 30/06/2021
4. Sh. Vir Singh Pal, Assistant retired on 31/12/2021
Obituary
Dr. Sudhir Kumar, Pr. Scientist (Horticulture/ Fruit Science) passed away on 07/05/2021

Annexure-I

Research Advisory Committee (RAC) (2021-2023)

Dr. P Kaushal, Chairman Vice Chancellor Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP)	**Dr. N B Singh** Formar Dean, CAU, Barapani
Dr. K T Parthiban Dean, Forest College and Research Institute, TNAU, Mettupalayam	**Dr. K Sammi Reddy** ICAR-CRIDA, Hyderabad
Dr. A K Shukla ICAR-IISS, Bhopal (MP)	**Dr. N. Narasimha** Former Head (Extension), UASB, Bangalore (KA)
Dr. S Bhaskar Assistant Director General (Agron./AF & CC) NRM Division, ICAR, Krishi Anushandhan Bhawan-II, New Delhi- 110 012	**Dr. Inder Dev** Pr. Scientist & Member Secretary, ICAR- CAFRI, Jhansi (U.P.)
Sh. Ashok Rajput Village- Nandsiya, Mooth, Post- Karjanva, Jhansi (U.P.)	**Sh. Pradeep Saravgi** House No. 165, Purani Nazai Jhansi (U.P.)

Annexure-II

Institute Management Committee (IMC) (2018-2021)

Dr. A. Arunachalam Director ICAR-CAFRI, Jhansi (U.P.)	**Dr. C.B. Pandey** Principal Scientist, ICAR-CAZRI, Jodhpur (Rajasthan)
Dr. K.P. Mohapatra Principal Scientist, ICAR-RC-NEHR, Barapani	**Dr. Harsh Mehta** Principal Scientist, ICAR- IISWC, Dehradun (Uttrakhand)
Dr. Jagdish Tamak HOD Plantations, ITC Limited, Paperboard and Specialty Paper Division, 106, Sardar Patel Road, Secunderabad - 500 003 (Telengana)	**Dr. Inder Dev** Principal Scientist, ICAR-CAFRI, Jhansi (Uttar Pradesh)
The Assistant Director General (A,AF&CC) NRM Division, Indian Council of Agricultural Research, Krishi Anushandhan Bhawan-II New Delhi - 110 012	**Sh. Ashok Rajput** Village- Nandsiya, Moth, Post- Karjanva, Jhansi (Uttar Pradesh)
Director Statistics and Crop Insurance, Government of Uttar Pradesh, Krishi Bhawan, Madan Mohan Malviya Marg, Lucknow (Uttar Pradesh)	**Sh. Pradeep Saravgi** House No. 165, Purani Nazai, Jhansi (Uttar Pradesh)
Dean Krishi Vidyalaya, Raj Mata Vijyaraje Scindiya Krishi Vishwa Vidyalaya, Gwalior (Madhya Pradesh)	**Director Extension Services** Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)
Finance & Account Officer ICAR- Indian Grassland and Fodder Research Institute, Jhansi (Uttar Pradesh)	**Dr. Inder Dev** H O & Member Secretary, ICAR-CAFRI, Jhansi (U.P.)

Annexure-III

Institute Joint Staff Council (IJSC)
(2019-2022)

Chairman : Dr. A. Arunachalam, Director				
Category	**Staff Side**		**Office Side**	
Administration	**Sh. Birendra Singh** AAO	**Member, CJSC**	**Dr. A.K. Handa** Pr. Scientist	Member
	Sh. Tridev Chaturvedi Stenographer	**Secretary, IJSC**	**Dr. Rajendra Prasad** Pr. Scientist	Member
Technical	**Smt. Shelja Tamrakar** Sr. Technical Assistant	Member	**Dr. Inder Dev** Pr. Scientist	Member
	Sh. Kashi Ram Tech. Asstt. (Driver)	Member	**Dr. C.K. Bajpai** CTO	Member
Supporting	**Sh. Pramod Kumar** SSS	Member	**A.O./H.O.**	**Member Secretary**
	Sh. Munna Lal SSS	Member	**Sh. P.K. Pandey** FAO	Member

Annexure-IV

Farm Calendar-2022

S.No.	Month	Activity
1.	January	1. Need-based cultural operations in *rabi* season crops/germplasm blocks/seed orchards
		2. Preparation of tentative list of input requirements
		3. Preparation of tentative list of farm produce with periodicity
		4. Price fixation of farm produce (tentative)
		5. Interaction meeting with scientists and stakeholders
2.	February	1. Need-based cultural operations in *rabi* season crops
		2. Auction of farm produces (Ber fruits *etc.*)
		3. Initiation of demo agroforestry model with flower plants/crops
		4. Deepening of existing water resources/excavation of new ponds
		5. Observing open day on the occasion of Basant Panchami
3.	March	1. Need-based work in *rabi* season crops
		2. Initiation of the certification process for model nursery
		3. Initiation of composting pits
4.	April	1. Auction of summer season guava fruits
		2. Harvesting/threshing/winnowing operations of *rabi* season crops
		3. Interaction meeting with scientists and stakeholders
		4. Maintenance of biological units such as organic manure unit/vermicompost/FYM *etc.*
		5. Observing open day on the occasion of Baishakhi
5.	May	1. Storage/price-fixing /sale of *rabi* season crops
		2. Pruning operations in tree plants/ber
		3. Need-based irrigation in established plants/germplasm blocks/seed orchards
		4. Inputs purchasing for *kharif* season crops
		5. Initiation of field preparation for *kharif* season crops
		6. Monitoring and maintenance of farm implements for *kharif* sowing
		7. Visit by dignitaries and farmers
		8. Interaction meet with farm incharges of neighboring institutes
		9. Disiltaion of ponds
		10. Sale/auction of lemongrass
		11. Insurance renewal of motorcycle (UP 93 V7891)
		12. Initiation of Annual Rate Contract (ARC) for farm works
6.	June	1. Need-based irrigation in established plants/germplasm blocks/seed orchards
		2. Field preparation for *kharif* season crops
		3. Sowing of *kharif* season crops
		4. Field day *kharif* season
		5. Maintenance of drainage channels
		6. Sale/auction of fuelwood/pruned material
		7. Finalization of Annual Rate Contract (ARC) for farm works

7.	July	1. Sowing of *kharif* season crops
		2. Irrigation schedule
		3. Interaction meeting with scientists and stakeholder
		4. Implementation of Annual Rate Contract (ARC) for farm works
8.	August	1. Need-based cultural operations in *kharif* season crops
		2. Inputs purchasing for *rabi* season crops
		3. Monitoring of water source and water bodies for water storage capacity
9.	September	1. Need-based cultural operations in *kharif* season crops
		2. Land preparation and sowing of *rabi* season crops (rapeseed & mustard)
		3. Harvesting/threshing/winnowing of *kharif* season crops
		4. Monitoring and maintenance of farm implements for *rabi* season sowing
10.	October	1. Harvesting/threshing/winnowing of *kharif* season crops
		2. Storage/price fixation/sale of *kharif* season crops
		3. Land preparation and sowing of *rabi* season crop (gram)
		4. Field day *rabi* season
		5. Interaction meeting with scientists and stakeholder
		6. Sale/auction of lemongrass
		7. Insurance renewal of Tractors (UP 93 AG0342; UP 93 AG 0227; UP 93 AG 0336)
11.	November	1. Auction of bael, aonla and guava fruits
		2. Sowing of *rabi* season crops
		3. Pruning of MPTs
12.	December	1. Need-based cultural operations in *rabi* season crops
		2. Annual store verification

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