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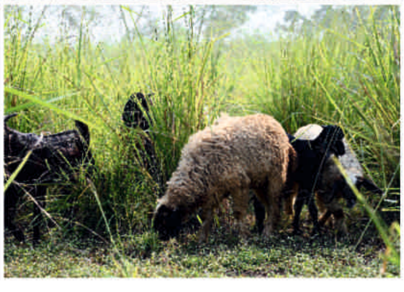
भाकृअनुप-भारतीय चरागाह एवं चारा अनुसंधान संस्थान

ICAR-Indian Grassland and Fodder Research Institute

वार्षिक प्रतिवेदन

Annual Report

2025



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An ISO 9001:2015 Certified Institution

भाकृअनुप-भारतीय चरागाह एवं चारा अनुसंधान संस्थान
झाँसी-284 003 (उत्तर प्रदेश) भारत

ICAR-Indian Grassland and Fodder Research Institute
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From the Director's Desk

Since its inception over sixty years ago, the ICAR–Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, has established itself as a globally recognized premier institution. The institute leads in research, innovation and sustainable solutions to address challenges such as fodder shortages, limited availability of high-quality grass and legume seeds, restoration of degraded lands, year-round fodder supply and development of high-yielding, stress-tolerant fodder crop varieties. It has also played a pivotal role in disseminating knowledge and technologies through training programs and outreach initiatives. Currently, the institute comprises seven specialized divisions focusing on crop improvement, crop production, grassland and silvipasture management, farm machinery and post-harvest technology, seed technology, plant–animal interactions and social sciences. Additionally, IGFRI oversees four regional research stations in diverse agro-climatic zones-Dharwad, Avikanagar, Srinagar and Palampur for further strengthening its research and outreach capabilities.

The year was highly productive, marked by notable advancements in forage crop improvement, genetic resource management and molecular research. A total of 135 forage germplasm samples were collected and oat germplasm evaluation identified 55 lines tolerant to leaf blight. Extensive assessment of 230 cowpea genotypes for agro-morphological and forage quality traits was completed. Three new varieties-berseem, oat and pearl millet were developed, alongside a novel salinity-tolerant oat genetic stock submitted for registration with ICAR-NBPGR, New Delhi. Station trials in berseem, oat, maize, bajra, cowpea, fertile BNH and high-biomass lines facilitated the selection of superior entries, which were submitted for AICRP-FC&U and state varietal trials, with promising lines promoted for all India testing. Three oat varieties (JHO-2015-1, JHO-2012-2 and JHO-2009-1) were proposed for licensing and nucleus seed of berseem, oat and cowpea was produced.

Molecular and breeding advances included genotyping 179 berseem recombinant inbred lines, construction of a 2,741 cM linkage map and advancement of breeding populations in oat, maize, cowpea and interspecific BN hybrids. Maize and cowpea genotypes were screened for biotic stresses, while 91 F6 ISFBN hybrid populations and 23 fodder sorghum genotypes were evaluated for yield, fodder quality and stress tolerance. Waterlogging-tolerant cowpea genotypes were identified and bioinformatics analyses revealed 13 Flowering Locus T genes in cowpea, regulatory networks for apomixis in guinea grass and 46 polymorphic SSR markers across 96 pearl millet inbreds. Gene-specific markers for regrowth and development in pearl millet, including cytokinin-N-glucosyltransferase-1, were also identified. These achievements strengthen IGFRI's efforts to develop high-yielding, stress-tolerant and nutritionally superior forage crops.

Significant progress was made in seed production and resource-efficient forage management, reinforcing the institute's commitment to sustainable livestock systems. Seed standards for five temperate forages-Timothy, Red fescue, White clover, Sainfoin and Persian clover are under development, with dormancy-breaking treatments standardized and validation planned in the third year. Glyphosate tolerant berseem mutant progenies (three lines) were screened at 0.8 kg *a.i.*/ha, showing variable tolerance, although surviving plants produced low seed yield. Innovative resource efficient practices yielded measurable improvements in productivity and sustainability. Application of biochar coated fertilizers derived from invasive weeds enhanced fodder oat dry yield up to 15.6%, improved nutrient uptake and strengthened soil health. Seed inoculation with PGPMs increased green fodder yield up to 26.0 Mg/ha and seed yield up to 846.7 kg/ha even at reduced fertilizer levels. Precision irrigation through drip systems increased fodder yield to 153.6 t/ha, nearly doubled water-use efficiency and reduced fertilizer input by 33%. Complementary strategies including plant based disease management, nanofertilizers, optimized rainfed cropping systems and a drought-tolerant PGPR consortium, further enhanced productivity, resilience and profitability of forage-based systems.

Substantial advancements were also achieved in grassland management, silvipasture and climate-resilient forage systems. Climate modeling identified *Acacia nilotica* as the most resilient species, with biomass carbon stocks reaching 33.45 Mg C/ha. In hortipastoral systems, optimized nutrient and micronutrient management increased fruit yield up to 14.7 t/ha and pasture production to 8.75 t DM/ha. Silvipasture interventions, including 70% lopping and 60% pruning in *Hardwickia binata*, enhanced pasture yield up to 10.11 t/ha. Evaluation of mulberry germplasm revealed wide variability in yield (0.26–7.52 Mg/ha fresh; 0.08–2.31 Mg/ha dry) and crude protein. Low grazing pressure improved pasture productivity by ~29% and nutrient management using silicon and fly ash further increased fodder yield and soil quality. Grassland restoration raised soil organic carbon to 0.68% and supported livestock gains of 50–60 g/day, demonstrating integrated approaches for sustainable productivity, improved soil health and climate resilience.

Considerable advancements were realized in livestock dietary management, nutrition and overall production efficiency. Assessment of green fodder feeding demonstrated that inclusion of fodder sorghum and berseem in crossbred diets significantly increased milk yield by 14.9% and 16.7%, respectively. A total of 195 households managing 3,812 Bundelkhandi goats were registered, strengthening smallholder livestock systems. In Bhadawari buffaloes, average lactation yield reached 1,475 kg over 338 days, with peak daily yield of 8.15 kg and a conception rate of 56.2%. Breeding support included 2,400 frozen semen doses and 3,094 artificial inseminations, reinforcing productivity and genetic improvement in the breeding tract.

The institute's extension and socio-economic research initiatives have fundamentally strengthened the livelihoods of fodder and livestock producers across Uttar Pradesh, Madhya Pradesh, Karnataka, Himachal Pradesh, Jammu & Kashmir, Rajasthan, Maharashtra and the North Eastern states. During the reporting period, the institute conducted 2,081 demonstrations of modern agricultural technologies and improved fodder varieties, complemented by over 20 specialized training programs, *Kisan Melas, Gosthis* and exposure visits, collectively reaching more than 10,000 farmers. It is a pleasure to mention that focused efforts in the North Eastern Hill region, through 140 Frontline Demonstrations benefitting 975 farmers, have reinforced technology adoption, boosted livestock productivity, reduced drudgery and promoted sustainable, inclusive and resilient farm livelihoods in the nation's most remote areas.

Our research and development activities are guided and supported by the Indian Council of Agricultural Research (ICAR) and the Ministry of Agriculture and Farmers' Welfare, Government of India. I sincerely acknowledge the valuable guidance of our advisory bodies-the Research Advisory Council and the Quinquennial Review Team and express my gratitude to the Hon'ble Ministers, the DG of ICAR, DDG (Crop Science) and ADG (Food and Fodder Crops) for their continued support and encouragement.

I commend the dedication of the entire IGFRI team-including the Project Coordinator, AICRP (FCU), Heads of Divisions, Officers-in-Charge of Regional Stations and all scientific, technical and administrative staff-whose efforts have been instrumental in achieving our goals and upholding the standards of this ISO 9001:2015 certified institute. I also appreciate the editorial committee for meticulously compiling this Annual Report, which aptly highlights the institute's achievements.

May 11, 2026 **(Pankaj Kaushal)**

कार्यकारी सारांश

कार्यक्रम 1: चारा फसलों की गुणवत्ता, बहुकटाई, अजैविक दबाव प्रबन्धन एवं जैव-फोर्टिफिकेशन, परम्परागत, अपोमिक्सिस और नये प्रजनन उपकरणों का उपयोग करते हुए अनुवंशिक सुधार

- चार नई किस्में, बरसीम (बुन्देल बरसीम–9), जई (बुन्देल जई 2021–1) बाजरा (बुन्देल बाजरा–1) तथा रिजका आईजीएफआरआई–डीएल–2 (एडब्ल्यूसीएल–2) विकसित की गईं।
- राजस्थान एवं गुजरात से अन्वेषण द्वारा जर्मप्लाज्म के 135 नमूने एकत्रित किए गए तथा 21 जर्मप्लाज्म हिमालय से एकत्रित किए गए।
- पालमपुर स्थित भारतीय हिमालयी चरागाह केन्द्र के अनुसंधान फार्म में हिमालयी क्षेत्र के विभिन्न चारा फसलों के आनुवंशिक संसाधनों के लगभग 456 जर्मप्लाज्म/एक्सेशन संरक्षित किए गये।
- लोबिया की 230 जर्म प्लाज्म के 24 कृषि–आकृतिक एवं 5 चारा गुणवत्ता हेतु उनके गुणों का मूल्यांकन किया गया।
- एक नवीन लवणता सहनशील जई की आनुवंशिक स्टॉक की पहचान कर एनबीपीजीआर, नई दिल्ली में पंजीकरण हेतु प्रस्तुत किया गया।
- बरसीम, जई, मक्का, बाजरा, लोबिया में स्टेशन परीक्षण के पश्चात उर्वर बीएनएच एवं उच्च जैव–भार पंक्तियों का चयन किया गया।
- एक्रिप – चारा फसलें के अंतर्गत परीक्षण हेतु नई प्रविष्टियाँ प्रस्तुत की गईं – बरसीम (02), जई (04), मक्का (03), लोबिया (02), बाजरा (06)।
- जई की राज्य स्तरीय मूल्यांकन परीक्षण (उत्तर प्रदेश राज्य परीक्षण प्रणाली) हेतु तीन नई प्रविष्टियाँ प्रस्तुत की गईं।
- अखिल भारतीय परीक्षण में सात मक्का (01), बाजरा (02), लोबिया (04) प्रविष्टियाँ पदोन्नति की गई।
- जई की तीन किस्में (जेएचओ–2015–1; जेएचओ–2012–2; जेएचओ–2009–1) को लाइसेंसिंग हेतु पीपीवीएफआरए में प्रस्तुत किया गया।
- संस्थान द्वारा विकसित किस्मों बरसीम (72 किग्रा.), जई (270 किग्रा.) तथा लोबिया (30 किग्रा.), का न्यूक्लियस बीज उत्पादन किया गया।
- बरसीम की 179 रिकॉम्बिनेंट इनब्रेड लाइनों (आरआईएल) का जीबीएस तकनीक द्वारा जीनोटाइपिंग किया गया।
- बरसीम का आनुवंशिक लिंकेज मानचित्र विकसित किया गया, जिसकी कुल लंबाई 2,741 cM तथा औसत मार्कर अंतराल 6.6 cM रहा। यह मानचित्र MSTmap सॉफ्टवेयर का उपयोग कर तैयार किया गया।
- प्रजनन आबादियों (Breeding populations) को निम्नानुसार जई (38 आबादियाँ), मक्का में (ISH African Tall × Teosinte संकरण से) एफ$_3$, एफ$_4$ एवं बीसी$_1$ एफ$_4$ पीढ़ियाँ; लोबिया; 124 एफ$_4$ पीढ़ियाँ; (बीएन संकर); 15 अंतःप्रजातीय फर्टाइल संकर (एफ$_6$ पीढ़ी) आगे बढ़ाया गया।
- मक्का की 379 इनब्रेड लाइनों का एस$_4$–एस$_8$ पीढ़ी का चारा गुणों के लिए मूल्यांकन किया गया तथा 20 उच्च जैवभार सिंगल क्रॉस संकरों का साइलेज गुणवत्ता के लिए परीक्षण किया गया।
- मक्का में दो वर्षों के परीक्षण के आधार पर फॉल आर्मीवर्म (FAW) तथा टर्की लीफ ब्लाइट (TLB) के प्रति क्रमशः 2 एवं 3 मध्यम प्रतिरोधी जीनोटाइप्स का चयन किया गया। लोबिया में पीला मोज़ेक वायरस, जड़ सड़न, एफिड तथा पत्ती भक्षक (defoliator) के प्रति क्रमशः 10, 2, 1 एवं 3 मध्यम प्रतिरोधी जीनोटाइप्स की पहचान की गई।
- ISFBN संकरों (*पेनीसीटम ग्लाकम* × *पेनीसीटम परपूरियम*) से (91) पापूलेशन की एफ$_6$ पीढ़ी में उपज एवं चारा गुणवत्ता गुणों के लिए बाह्य आकार

की पहचान किया गया, जिसमें पर्याप्त विविधता देखी गई।

- चारा ज्वार के 23 जीनोटाइप्स (जिनमें 3 चेक किस्में शामिल थीं) को बहुकटाई क्षमता, कम नमी सहनशीलता तथा कम एचसीएन मौजूदगी के लिए पहचान किया गया, जिनमें से 3 जीनोटाइप्स जल तनाव की स्थिति में अच्छा प्रदर्शन करते पाये गये।
- लोबिया के 169 जीनोटाइप्स की स्क्रीनिंग की गई जिसमें से क्रमशः 4 जीनोटाइप्स अंकुरण एवं 20 जीनोटाइप्स पौध अवस्था पर जलभराव तनाव के प्रति सहनशील पहचान की गई।
- लोबिया जीनोम के बायोइन्फॉर्मेटिक्स विश्लेषण में 13 जीनों की Flowering Locus T (FT) तथा संबंधित जीन की पहचान की गई।
- गिनी घास में WGCNA (Weighted Gene Correlation Network Analysis) के अध्ययन से यह ज्ञात हुआ कि अपोमिक्सिस एकल जीन नियंत्रण के बजाय जटिल एवं बहु–स्तरीय नियामक तंत्र द्वारा नियंत्रित होता है।
- बाजरा के 96 इनब्रेड लाइनों के मालीक्यूलर विश्लेषण में 46 एसएसआर मार्कर बहुरूपी (polymorphic) पाए गए, जिनसे 6 स्पष्ट समूह (clusters) पहचाने गए।
- बाजरा में पुनः वृद्धि (regrowth) एवं विकास गुण के लिए जीन–विशिष्ट मार्कर के विकास से संबंधित 10 जीनों की पहचान हुई। इनमें cytokinin-N-glucosyltransferase-1 जीन का सफलतापूर्वक प्रवर्धन (amplification) किया गया, जिसने अभिभावकों के बीच बहुरूपता प्रदर्शित की।
- एफिड (माहू) की जनसंख्या गतिशीलता के अध्ययन से पता चला कि अधिकतम संख्या (125.7) 11वें मानक मौसम सप्ताह, जो मार्च के तीसरे सप्ताह के साथ मेल खाती हैं, में दर्ज की गई। एफिड की संख्या का तापमान के साथ सकारात्मक सहसम्बंध (0.52**) तथा वर्षा के साथ नकारात्मक सहसम्बंध (–0.58*) पाया गया। परीक्षण किए गए पर्यावरण हितैषी उपचारों में *Lecanicillium lecanii* (2ग108 सीएफयू/ग्राम) @ 2 ग्राम/लीटर तथा नीम आधारित फॉर्मुलेशन (3000 पीपीएम) @ 5 मि.ली./ लीटर सबसे अधिक प्रभावी पाए गए।
- Halomix के अनुप्रयोग से 20 जीनोटाइप्स में लवणता तनाव के पुर्नप्राप्ति चरण के दौरान उपज में 12–32% तक वृद्धि देखी गई। संकर बाजरा नेपियर–14 जीनोटाइप ने तटीय एवं इनलैंड परिस्थितियों की लवणता (ईसी 8–10) में उच्च जीवितता तथा मजबूत टिकाऊपन पायी गयी।

कार्यक्रम 2 : उत्पादकता एवं आजीविका विकल्पों में सुधार हेतु चरागाह तथा अन्य संसाधनों के मूल्यांकन और कायाकल्प सहित विभिन्न भू–उपयोग प्रणाली में चारा उत्पादन का विविधीकरण और टिकाऊ सघनीकरण

- झाँसी में मूल्यांकित शहतूत के 73 जननद्रव्य में ताजा पत्ती उत्पादन (0.26–7.52 टन/हे.) तथा सूखा पत्ती उत्पादन (0.08–2.31 टन/हे.) एवं क्रूड प्रोटीन की मात्रा में व्यापक विभिन्नता पायी गयी। वहीं श्रीनगर समशीतोष्ण परिस्थिति में शहतूत जननद्रव्य में ताजा पत्ती उत्पादन (74.42–395.8 ग्रा./पौध) तथा क्रूड प्रोटीन (11.42–16.91 प्रतिशत) दर्ज की गयी। अरडू के जननद्रव्य में झाँसी एवं अविकानगर में पर्याप्त विभिन्नता (पौधे की ऊँचाई एवं कॉलर व्यास) पायी गयी।
- अर्द्वशुष्क क्षेत्र के लिए वन चरागाह पद्धति में पारिस्थितिकी पुनर्स्थापन के अध्ययन में क्षेत्रीय जलवायु मॉडलिंग (2020–2080) से यह पाया गया कि देशी बबूल सबसे अधिक सहनशील है तत्पश्चात पाकर एवं शहतूत है। सूबबूल बढ़ते तापक्रम के प्रति सर्वोत्तम पाया गया। देशी बबूल + धबलू घास मॉडल में कुल जैवभार कार्बन भंडारण एवं कार्बन डाइआक्साइड समतुल्य भंडारण क्रमांश 10.32 से 33.45 टन कार्बन/हे. तथा 37.87 से 122.76 टन/हे. के बीच पाया गया।
- स्थापित उद्यान चरागाह पद्धति में, आंवला आधारित उद्यान चरागाह पद्धति में संस्तुति उर्वरक (30 किग्रा. नत्रजन, 20 किग्रा. फास्फोरस, 20 किग्रा. पोटाश/हे.)

के प्रयोग से अधिक फल उत्पादन (10.96 टन/हे.) एवं चारा (8.75 टन शुष्क भार/हे.) प्राप्त किया गया। अमरूद आधारित उद्यान चरागाह पद्धति में सूक्ष्म पोशक तत्व जिंक सल्फेट + बोरेक्स के उच्च सान्द्रता के प्रयोग से फल लगने एवं धारण क्षमता (ललित 62.8 एवं श्वेता 58.8 प्रतिशत) पाया गया। इसी उपचार के साथ ललित 14.7 एवं श्वेता 13.1 टन/हे.) फल उत्पादन पाया गया। चारा उत्पादन 4.1 से 5.1 टन शुष्क भार/हे. पाया गया।

- अंजन वृक्ष आधारित वन चरागाह प्रणाली में शाखाओं की 60 प्रतिशत कटाई–छंटाई करने से टापफीड (5. 46 टन/हे.), जलाऊ लकड़ी (8.6 टन/हे.) तथा धवलू, अंजन एवं गिनी घास का चारा उत्पादन (10.11 टन/हे.) पाया गया।
- उन्नत चरागाह प्रबंधन में न्यूनतम चराई दबाव (एलजीपी) और मध्यम चराई दबाव (एमजीपी) के अंतर्गत वार्षिक चारा उत्पादन (एपीबी) उच्च चराई दबाव (एचजीपी) की तुलना में क्रमशः लगभग 29 प्रतिशत और 15 प्रतिशत अधिक पाया गया। 0–20 सेमी. मृदा गहराई में जड़ के जैवभार में भी अंतर पाया गया है, (एचजीपी) की तुलना में (एलजीपी 26%), (एमजीपी 13%) अधिक जड़ के जैवभार पायी गयी ।
- चारा घासों के लिए फास्फोरस घोलक प्राकृतिक सिल्कान स्रोतों एवं फास्फोरस घोलक सूक्ष्मजीव के उपचारों से प्रति गमला चारा उत्पादन में महत्वपूर्ण अंतर पाया गया। गिन्नी में सर्वाधिक चारा उत्पादन टी–7 (102.56 ग्रा./गमला) दर्ज किया गया, तत्पश्चात टी–6 एवं टी–5 की महत्व आंकी गयी। जबकि टी–1 में न्यूनतम चारा उत्पादन (16.99 ग्रा./गमला) दर्ज किया गया।
- बेल आधारित उद्यान चरागाह पद्धति में सर्वाधिक चरागाह उत्पादन एकल चरागाह (8.95 टन शुष्क जैवभार/हे.) में दर्ज किया गया, इसके बाद सेन्ट्रल लीडर प्रणाली (8.65 टन शुष्क जैवभार/हे.) रही, जबकि न्यूनतम उत्पादन वी$_2$सी$_4$ (5.43 टन शुष्क जैवभार/हे.) में पाया गया। मृदा में उपलब्ध नत्रजन 152.93–283.92 किग्रा. तथा फॉस्फोरस 8.88–10. 98 किग्रा./हे. के बीच रहा।
- अर्द्वशुष्क क्षेत्र में लोबिया–जई चारा उत्पादन प्रणाली में फ्लाई ऐश के विभिन्न तरीकों में प्रयोग से मृदा गुणवत्ता में अंतर पाया गया। लोबिया आधारित प्रणाली की मिट्‌टी में मृदा कार्बन सूचकांक 1.379–1.592 के बीच रहा। जो फ्लाई ऐश के उपयोग में मृदा सुधार एवं उर्वरता में वृद्धि को दर्शाता है।
- सीएट–जैव विभिन्नता परियोजना के अंतर्गत अंजन, गिन्नी और दीनानाथ घासों को स्थापित करने से जैविक कार्बन में क्रमशः 0.62, 0.63 एवं 0.68 प्रतिशत वृद्धि पायी गयी। सूक्ष्म तत्वों (लोहा, तांबा, जस्ता और मैगनीज) के उपलब्धता में भी वृद्धि पायी गयी।
- ड्रोन एवं रिमोट सेंसिंग आधारित चरागाह स्थापना एवं पुनर्स्थापन के अंतर्गत अंजन गिन्नी और दीनानाथ घासों को स्थापित किया गया। चरागाह में जालौनी भेड़ों को प्रतिदिन 6–7 घंटे चरने एवं उनके शरीर भार का 1 प्रतिशत पुरक आहार देने से भेंड़ों के वजन में 50–60 ग्रा./दिन वृद्धि पायी गयी।
- पाँच प्रमुख चारा आधारित फसल प्रणालियों ज्वार + बरसीम, गिनी घास + बरसीम संकर बाजार नेपियर बरसीम, मक्का + लोबिया तथा संकर बाजरा नेपियर + लोबिया के लिए फसल जल आवश्यकता एवं सिंचाई जल आवश्यकता का आंकलन पेनम, मान्टीथ मॉडल तथा फसल गुणांक आधारित विधियों का उपयोग करके उत्तर प्रदेश के पाँच शहरों मेरठ, कानपुर, झाँसी, लखनऊ और वाराणसी में किया गया।

कार्यक्रम 3 : जलवायु समुत्थानशील चारा उत्पादन हेतु कृषि योग्य एवं गैर कृषि योग्य भूमि के प्राकृतिक संसाधनों एवं मृदा स्वास्थ्य का प्रबन्धन

- आक्रामक खरपतवार (*Parthenium hysterophorus* एवं *Lantana camara* से तैयार) आधारित बायोचार– लेपित उर्वरकों को 75% अनुशंसित उर्वरक मात्रा (आडीएफ) पर प्रयोग करने से चारा जई की उत्पादकता में वृद्धि (शुष्क भार उत्पादन में 15.63% तक), चारा गुणवत्ता एवं पोषक तत्व अवशोषण में सुधार तथा मृदा के भौतिक– रासायनिक एवं जैविक

स्वास्थ्य में उल्लेखनीय सुधार पाया गया। यह उर्वरक उपयोग को कम करते हुए प्रणाली प्रदर्शन सुधारने में सक्षम सिद्ध हुई।

- PGPMs द्वारा उपचारित जई बीज के राइजोस्पेयर माइक्रोबायोम में प्रभावी परिवर्तन हुआ, जिससे जड़ स्राव (root exudates), सूक्ष्मजीवी गतिविधि एवं जीन अभिव्यक्ति में वृद्धि हुई। इसके परिणामस्वरूप कम उर्वरक स्तर (50–75% आडीएफ) पर भी हरा चारा उत्पादन (26.0 टन/हे. तक) तथा बीज उत्पादन (846.7 किग्रा./हे. तक) में वृद्धि हुई। यह पोषक तत्वों की कमी वाली मिट्टी में उत्पादकता बनाए रखने के लिए प्रभावी पाया गया।
- प्राकृतिक सकारात्मक एकीकृत कृषि प्रणाली (IFS) मॉडल के अंतर्गत ड्रैगन फ्रूट–सहजन–(तिल–चना) के साथ वर्षभर चारा उत्पादन प्रणाली (TSH एवं BNH), कृषि–बागवानी घटकों, बायो–फेंसिंग तथा फार्म स्तर पर जैविक इनपुट उत्पादन इकाइयों का एकीकरण किया गया।
- टपक सिंचाई (75% उपलब्ध मृदा नमी) के साथ 100% आरडीएफ से चारा उत्पादन में 153.6 टन/हे. (फ्लड़ सिंचाई की तुलना में 16.8% अधिक) वृद्धि हुई। साथ ही, ड्रिप प्रणाली में 33% उर्वरक बचत के साथ पारंपरिक विधि के बराबर उत्पादन प्राप्त हुआ तथा जल उपयोग दक्षता दोगुनी (45 किग्रा. शुष्क भार/हे. –एमएम तक) हो गई। यह संसाधन उपयोग एवं कुशल चारा उत्पादन के लिए प्रभावी तकनीक सिद्ध हुई।
- चारा ज्वार में जोनेट लीफ स्पॉट रोग के नियंत्रण हेतु पौध–आधारित आवश्यक तेलों एवं स्पाइरुलिना अर्क का जैव–सक्रिय मूल्यांकन के लिए निर्माण किया गया तथा रोगजनक अध्ययन हेतु संक्रमित ज्वार एवं जॉनसन घास के नमूने एकत्र किए गए।
- जियोलाइट एवं हाइड्रॉक्सीएपेटाइट आधारित हाइब्रिड नैनो–उर्वरक विकसित किए गए, जो धीमी गति से पोषक तत्व छोड़ने वाले वाहक के रूप में कार्य करते हैं। इससे पोषक तत्व उपयोग दक्षता, मृदा नमी धारण क्षमता, जई की वृद्धि एवं चारा गुणवत्ता में सुधार हुआ तथा पारंपरिक उर्वरकों की तुलना में उर्वरक मात्रा कम करने में सहायता मिली।
- वर्षा आधारित फसल प्रणालियों में स्वीट कॉर्न–चना प्रणाली सबसे अधिक उत्पादक एवं लाभकारी (3624 किग्रा./हे. चना समतुल्य उत्पादन; आय एवं व्यय अनुपात 1.80) पाई गई। वहीं मूंगफली–चना प्रणाली भूमि विन्यास परीक्षणों में अधिकतम उत्पादकता, शुद्ध लाभ एवं वर्षा जल उपयोग दक्षता में श्रेष्ठ रही। यह वर्षा आधारित परिस्थितियों में उत्तम फसल संयोजन एवं बीबीएफ आधारित प्रबंधन की उपयोगिता को दर्शाता है।
- सूखा सहनशील पीजीपीआर कंसोर्टियम (*Actinobacter sp.* + *Bacillus subtilis* + सहायक जीवाणु) को सबसे प्रभावी पाया गया, जिसने जल तनाव की स्थिति में जई, ज्वार एवं लोबिया में वृद्धि, उत्पादन (24.5 टन/हेक्टेयर हरा चारा तक) तथा शारीरिक सहनशीलता को बनाए रखा।
- त्रिस्तरीय वन चरागाह प्रणाली में झरबेरी, घोट, देशी बबूल एवं अंजन वृक्ष की 70 प्रतिशत कटाई–छंटाई करने से 50 प्रतिशत कटाई–छंटाई की तुलना में अधिक चारा उत्पादन (5.26 टन शुष्कभार/हे.) जलाऊ लकड़ी उत्पादन (5.86 टन/हे.) पाया गया।
- चारा झाड़ी आधारित एली क्रॉपिंग प्रणालियों में, सिंचित परिस्थितियों में सहजन के साथ संकर बाजरा नेपियर तथा वर्षा आधारित परिस्थितियों में सहजन के साथ सिग्नल घास ने अन्य प्रणालियों की तुलना में अधिकतम हरा चारा, सूखा चारा तथा क्रूड प्रोटीन की उपज पायी गयी। चारा फसलों को चारा झाड़ियों के साथ 3 वर्षों तक उगाने से मृदा के जैविक कार्बन तथा उपलब्ध नाइट्रोजन, फॉस्फोरस और पोटाश में सूधार हुआ।

कार्यक्रम 4 : गुणवत्तायुक्त बीज उत्पादन बढ़ाने हेतु बीज विज्ञान एवं तकनीकी को बढ़ावा देना तथा राष्ट्रीय चारा बीज नेटवर्क को मजबूत करना

- पाँच समशीतोष्ण चारा फसलों (टिमोथी, रेड फेस्क्यू, व्हाइट क्लोवर, सेंनफोइन एवं परसियन क्लोवर) के बीज मानकों के विकास हेतु बीज में सुप्तावस्था तोड़ने की विधियाँ मानकीकृत की गईं।

- चार चरणों के चयन के बाद, बरसीम की चयनित उत्परिवर्ती लाइनों (03) की संतति, ग्लाइफोसेट के प्रति (@ 0–8 कि.ग्रा. सक्रिय तत्व/हे.) सहनशील पायी गई। संततियों में सहनशीलता में भिन्नता पाई गई तथा जीवित संततियों में बीज उत्पादन बहुत कम रहा।
- फॉस्फोरस दक्ष लोबिया जीनोटाइप्स (आईसी 202789, आईसी 202790) में जैवभार में केवल 8–16% कमी देखी गई, जबकि अक्षम जीनोटाइप्स में 24–48% कमी रही। कम फॉस्फोरस परिस्थितियों में शाखिय फॉस्फोरस सामग्री एवं नोडुलेशन बनाए रखने की क्षमता के कारण ये जीनोटाइप्स उच्च फास्फोरस उपयोग दक्षता की क्षमता दर्शाते हैं।
- जई की प्रविष्टियाँ (जीईटीओ–1 से जीईटीओ–156) का मूल्यांकन किया गया, जिसमें 154 नमूनों का मॉडलिंग 107/47 calibration/ validation द्वारा विश्लेषण किया गया। रासायनिक विश्लेषण में β-glucan: 1.97–7.83 amylose: 11.9–16.0 protein: 1.4–17.1 starch: 55.1–75.0 phytate: 0. 405–0.991 phenolics: 0.152–0.457 PLSR/mPLS मॉडल ने amylase, protein एवं β-glucan के लिए उच्च सटीकता (उच्च R^2, RPD) प्रदर्शित की, जबकि starch, phytate एवं phenolics के लिए मध्यम स्तर का प्रदर्शन पाया गया।
- सिराट्रो तथा ब्रैकियारिया चारा घासों में किए गए बीज परीक्षण प्रोटोकॉल से यह ज्ञात हुआ कि सिराट्रो के बीजों को सल्फ्यूरिक अम्ल (टी–3) से उपचारित करने पर अंकुरण प्रतिशत तथा सीडलिंग विगर इंडेक्स में उल्लेखनीय वृद्धि दर्ज की गई। न्यूनतम अंकुरण (25.36%) नियंत्रण उपचार में पाया गया। ब्रैकियारिया में भी (टी–3) उपचार के अंतर्गत अधिकतम बीज अंकुरण (29.12%) तथा सीडलिंग विगर इंडेक्स (245.54) दर्ज किया गया, जबकि नियंत्रण में न्यूनतम अंकुरण (12.36%) पाया गया। यह परिणाम चारा घासों में बीज सुप्तावस्था की उपस्थिति को दर्शाता है, क्योंकि अधिकांश परीक्षण किए गए बीजों में बगैर अंकुरित बीजों का प्रतिशत अधिक पाया गया।

कार्यक्रम 5: चारा संसाधनों का पोशण मूल्यांकन एवं कटनोत्तर प्रबंधन तथा टिकाऊ फसल– पशुधन उत्पादन प्रणाली सुधार

- सरसों के सुगन्धित तेल (EO) ने एसपरजीलस फ्लेवस एवं एसपरजीलस पैरासिटीकस के विरुद्ध सर्वाधिक प्रभावी एंटीफंगल गतिविधि दर्शायी। सरसों के सुगन्धित तेल में allylisothiocyanate तथा turmerone + curlone (करकुमा ईसेंसियल आयल) प्रमुख सक्रिय यौगिकों के रूप में पहचाने गए।
- साइलेज की भंडारण क्षमता एवं चारे की सुगंध को प्रभावित करने वाले शीर्ष 10 वाष्पशील कार्बनिक यौगिकों की पहचान की गई।
- चराई व्यवहार अध्ययन में पाया गया कि भेड़ें दिन के अधिकांश समय (सुबह, दोपहर, शाम) मुख्यतः घास को प्राथमिकता देती हैं। बकरियाँ अधिक विभिन्न झाड़ी वनस्पतियों को पसंद करती हैं (सुबह घास, जबकि दोपहर एवं शाम में कांटेदार पौधे एवं झाड़ियाँ)। भेड़ एवं बकरी दोनों प्रजातियों में चराई व्यवहार गुणों का शरद ऋतु में परिवेशीय तापमान के साथ नकारात्मक सहसंबंध पाया गया।
- संकर पशुओं के आहार में चारा ज्वार एवं बरसीम को शामिल करने से दूध उत्पादन में क्रमशः 0.66 ली./दिन (14.89%) तथा 0.95 ली./दिन (16.70%) की उल्लेखनीय वृद्धि हुई।
- बुंदेलखंडी बकरी पालन के अंतर्गत 195 परिवारों का पंजीकरण किया गया, जो कुल 3,812 बकरियों का प्रबंधन कर रहे हैं।
- भदावरी भैंसों में औसत दुग्ध उत्पादनः 1475.4 ± 69.3 किग्रा., दुग्धावधिः 337.8 ± 13.4 दिन, मानक दुग्ध उत्पादनः 1300.9 ± 52.8 किग्रा., शिखर उत्पादनः 8.15 ± 0.11 किग्रा., प्रथम बछड़ा देने की आयु: 50.7 ± 1.24 माह, गर्भाधान दरः 56.2% साथ ही, 2400 वीर्य खुराकें संरक्षित की गईं तथा भदावरी प्रजनन क्षेत्र में 3094 कृत्रिम गर्भाधान किए गए।
- संकर बाजरा नेपियर चारा फसल हार्वेस्टर का एक प्रोटोटाइप विकसित किया गया, जो कठोर तने वाली चारा फसलों की कटाई के लिए उपयुक्त है।

इसकी क्षेत्र क्षमता 0.20–0.25 हे./घंटा तथा कार्य क्षेत्र चौड़ाई 0.80 मीटर है।

- एक्रिप–एफआईएम के अंतर्गत प्रौद्योगिकी एवं कृषि यंत्र प्रदर्शन सह किसान मेला, सौर ऊर्जा संचालित स्प्रेयर सह टिलर का प्रोटोटाइप व्यवहार्यता परीक्षण, तथा चारा बीज कोटिंग मशीन का अग्रिम लाइन प्रदर्शन आयोजित किया गया।

कार्यक्रम 6 : सामाजिक, आर्थिक नीतिगत हस्तान्तरीय अनुसंधान एवं क्षमता निर्माण

- चारा बरसीम की खेती लगभग 230 मिलियन वयस्क पशु इकाईयों को हरा चारा प्रदान करती है, जिसके लिए 1.92 मिलियन हेक्टेयर क्षेत्र एवं प्रतिवर्ष 48,034 टन बीज की आवश्यकता होती है। जबकि 2002–2023 के दौरान देश में संगठित उत्पादन औसतन केवल 13,556 टन रहा, जिससे लगभग 34,478 टन उत्पादन असंगठित क्षेत्र से होने का संकेत मिलता है। आयात में वृद्धि देखी गई, जहाँ मात्रा एवं लागत में क्रमशः 11.1% एवं 2.1% वार्षिक वृद्धि हुई, औसत लागत यूएसडी 1,011.8 प्रति टन रही। नीति विश्लेषण से ज्ञात हुआ कि 15% आयात शुल्क हटाने से कल्याण लाभ की तुलना में सरकारी राजस्व हानि अधिक होगी।
- चारा फसलों हेतु निर्णय समर्थन प्रणाली (डीएसएस) के अंतर्गत आधारभूत सर्वेक्षण प्रारूप तैयार किया गया तथा संबंधित द्वितीयक आंकड़ों को एकत्र, संकलित एवं परिष्कृत किया गया। दो मौजूदा आईजीएफआरआई मोबाइल एप्लिकेशनों के डेटा एकीकरण से एक प्रोटोटाइप विकसित एवं सुदृढ़ किया गया।
- झाँसी के 398 अनुसूचित जाति किसानों के आंकड़ों का Gini decomposition एवं Lorenz वक्र द्वारा विश्लेषण किया गया। लाभार्थियों में Gini सूचकांक कम पाया गया, जो अधिक समान आय वितरण दर्शाता है। फसल कृषि असमानता का प्रमुख स्रोत रही, जबकि पशुधन आय में 1% वृद्धि से असमानता 0.24–0.38% कम हुई, विशेषकर गैर–लाभार्थियों में। तकनीकी सहायता की कमी, छोटे जोत, कम अंकुरण, छुट्टा पशुओं से नुकसान तथा अपर्याप्त सिंचाई, तकनीक अपनाने में प्रमुख बाधाएँ प्रमुखतम रहीं।
- फार्मर फर्स्ट कार्यक्रम के अंतर्गत ढ़िकौली, नयाखेड़ा, गणेशगढ़, रामगढ़ एवं कंचनपुर में किसान–वैज्ञानिक संवाद आयोजित किए गए। उच्च उत्पादन क्षमता वाली मूंग आईपीएम–205–7 (विराट) का 72 किसानों के खेतों में प्रदर्शन लगाया गया जिससे 33% अधिक उत्पादन प्राप्त हुआ। खरीफ सब्जी किस्में (काशी गंगा, काशी श्रेया, काशी क्रांति, काशी निधि) से 26–35% उत्पादन वृद्धि प्राप्त हुआ। उन्नत चारा किस्में (सीएसएच–24, वरदान, जेएचओ–822, एमपीचरी, आईजीएफआरआई–6) से पशु आहार में सुधार, जिसमें सीएसएच–24 से 35% अधिक हरा चारा उत्पादन पाया गया। दो फील्ड दिवस (ढ़िकौली एवं रामगढ़) में 240 किसानों के यहाँ को श्रेष्ठ तकनीकियों का प्रदर्शन किया गया।

Executive Summary

Programme 1: Genetic enhancement of forage crops with emphasis on quality, multicut, stress tolerance & bio-fortification utilizing conventional, apomixes and new breeding tools

- Four varieties were developed, one each of berseem (Bundel Berseem-9), oat (Bundel Jai 2021-1), pearl millet (Bundel Bajra 1) and Lucerne variety IGFR-DL-2 (AWCL-2).
- About 135 forage germplasm samples were collected from Rajasthan and Gujarat exploration and 61 collections from Himachal Pradesh .
- About 456 forage germplasm accessions/ collections of different forage crop genetic resources of the Himalayan region are maintained at the Research Farm of Centre for Indian Himalayan Grasslands, Palampur.
- Oat germplasm were evaluated for fodder traits and 55 lines selected for leaf blight disease resistance.
- Cowpea (230) genotypes were evaluated for 24 agro-morphological and 5 forage quality traits.
- A novel salinity tolerant oat genetic stock was identified and submitted for registration to ICAR-NBPGR, New Delhi.
- Station trials were conducted in berseem, oat, maize, bajra, cowpea, fertile BNH and high biomass lines were selected.
- New entries were submitted for testing in AICRP-FC&U trials in berseem (02), oat (04), maize (03), cowpea (02) and pearl millet (06).
- Three new entries were submitted for testing under state varietal oat evaluation trials (UP state trial system).
- Seven entries were promoted in all India testing in maize (01), pearl millet (02) and cowpea (04).
- Three new proposals were submitted for licensing of oat varieties (JHO-2015-1; JHO-2012-2; and JHO-2009-1) to PPV&FRA.
- Nucleus seed of berseem (72 kg), oat (270 kg) and cowpea (30 kg) varieties developed at IGFRI was produced.
- Recombinant inbred lines (RIL) of berseem (179) were genotyped using the GBS approach.
- Berseem linkage map spanned a total genetic length of 2,741 cM, with an average marker interval of 6.6 cM. Genetic linkage map was constructed using the MST map online software.
- Breeding populations were advanced in oat (38); in maize, the F_3, F_4 and BC_1F_4 progenies of ISH African tall×Teosinte cross; 124 F_4 progenies in cowpea; inter-specific fertile BN hybrids (15 F_6).
- Maize inbreds (379) of S4- S8 generation were evaluated for their *per se* performance for fodder traits; 20 high biomass single cross maize hybrids were evaluated for silage quality.
- In maize, 2 and 3 moderately resistant genotypes to FAW and TLB, respectively, were selected from two years of testing. In cowpea, 10, 2, 1 and 3 moderately resistant genotypes for yellow mosaic virus, root rot, aphid and defoliators, respectively, were identified.
- F_6 populations (91) of ISFBN hybrids (*Pennisetum glaucum* × *P. purpureum*) were phenotyped for yield and fodder quality traits and substantial variability was observed.
- Fodder sorghum genotypes (23) including checks (3) were screened for multicut potential, low moisture tolerance and low HCN content and 3 were found performing well under water stress.
- Four and 20 cowpea genotypes (169) were identified for water logging stress at germination and seedling stage, respectively, from screening 169 genotypes.
- Thirteen *Flowering Locus T* (*FT*) and related genes were identified in bioinformatics analysis of cowpea genome.
- Weighted Gene Correlation Network Analysis in guinea grass revealed that apomixis was governed by a complex, multilayered regulatory framework rather than a single genetic switch.
- In molecular characterization of 96 pearl millet inbreds, 46 SSR markers were found polymorphic and revealed six distinct clusters.
- Development of gene specific marker for

regrowth and development trait in pearl millet led to identification of ten genes associated with it. The cytokinin-N-glucosyltransferase-1 gene was successfully amplified and showed polymorphism between parents.

- Population dynamics of aphid indicated that highest number (125.7) were recorded on 11th MSW which was coinciding on 3rd week of March. Aphid number was positively correlated with temperature (0.52**) and negatively correlated with rainfall (-0.58*). Among eco-friendly approaches tested, *Lecanicillium lecanii* ($2x10^8$ cfu/g) @ 2 g/l and Neem formulation (3000 ppm) @ 5 ml/l were found most effective.
- Application of Halomix in 20 genotypes could increase yield by 12-32% under salinity stress and 12-45% increase during salinity stress recovery phase. BNH-14 showed strong stability and high survival under coastal and inland salinity (EC 8-10).

Programme 2: Diversification and sustainable intensification of fodder production in different land use systems including assessment and rejuvenation of grasslands and other resources for improving productivity and livelihood options

- Evaluation of 73 mulberry germplasm at Jhansi showed wide variation in fresh (0.26-7.52 Mg/ha) and dry leaf yield (0.08-2.31 Mg/ha) and crude protein content while at Srinagar, fresh leaf yield ranged from 74.4-359.8 g/plant and crude protein ranged from 11.4-16.9% across seasons. *Ailanthus excelsa* germplasm also showed large variability in growth (plant height & collar diameter) at Jhansi and Avikanagar.
- In restoration ecology study in silvipasture system for semiarid region, regional climate modelling (2020–2080) revealed that *Acacia nilotica* was most climate-resilient, followed by *Ficus infectoria* and *Morus alba*, while *Leucaena leucocephala* was most sensitive to warming. Total biomass carbon stock (10.32–33.45 Mg C/ha) and CO_2-equivalent storage (37.87–122.76 Mg/ha) was found highest under *A. nilotica* + *C. fulvus* system.
- In grown up hortipastoral system, higher fruit (10.96 t/ha) and pasture production (8.75 t DM/ha) was recorded with the application of RDF (30 kg N, 20 kg P and 20 kg K/ha). Higher fruit production (14.7 and 13.1 t/ha in Lalit and Shweta, respectively) and fruit retention (62.8% in Lalit and 58.8% in Shweta) was recorded with application of higher concentration of micronutrients $ZnSO_4$ + Borax. Understorey pasture (*C. ciliaris* + *S. hamata*) production ranged from 4.1-5.1 t DM/ha.
- In *Hardwickia binata* based silvipasture systems, pruning of *H. binata* branches at 60% intensity recorded significantly higher top feed (5.46 t/ha), fire wood (8.60 t/ha) and pasture yield of *Chrysopogon fulvus, C. ciliaris* and *Megathyrsus maximus* (10.11 t/ha) as compared to pruning at 30% intensity (3.58, 5.76 and 7.61 t/ha) and found at par with pruning at 45% intensity (5.00, 7.92 and 8.99 t/ha), respectively.
- Under improved pasture management for sustaining soil-pasture-animal productivity, Above ground pasture biomass productivity (APB) under Low (LGP) and Medium (MGP) was ~29 and 15% greater than High Grazing Pressure (HGP), respectively. However, the APB deviated by ~11, 21 and 30% under LGP, MGP and HGP, respectively over ungrazed control. The root biomass at 0-20 cm depth under LGP and MGP was ~26 and 13% greater than HGP, respectively.
- In native soil phosphorus solubilization using natural silicon sources and P solubilizing microbes study, fodder yield per pot varied significantly among treatments for all four grasses. In *M. maximus*, highest fodder yield was recorded under T_7 (100% NPK) (102.56 g pot^{-1}), while in *C. ciliaris*, fodder yield increased progressively across treatments, with T_7 producing the maximum yield (50.54), followed by T_6 (100% NPK + P solubilizing microbes) (46.91) and T_5 (Rice straw + 75% NPK + P solubilizing microbes) (45.63), while T_1 recorded the minimum yield (16.99 g pot^{-1}).
- In bael based hortipasture system, the highest pasture was recorded with sole pasture (8.95) followed by central leader (8.65) and with lowest in V_2C_4 (5.43 t DM/ha). Available N and P ranged from 152.9-283.9 and 8.88-10.98 kg ha^{-1}, respectively, with maximum values observed in V_2C_4 and V_1C_4.

- While using fly ash in agriculture, the soil quality index (SQI) varied noticeably across different fly ash application strategies (AS) in the cowpea-oat fodder production system. In cowpea soils, SQI ranged from 1.379 (AS12) to 1.592 (AS2), showed general improvement under moderate fly ash doses. The highest SQI values were recorded under AS2 (1.592), AS11 (1.577) and AS9 (1.524), suggested that medium to slightly higher application rates enhanced overall soil health and fertility status.
- In the established grassland under CIAT-bioversity Alliance project**,** organic carbon was increased from initial 0.49% to 0.62, 0.63 and 0.68 under *C. ciliaris*, *M. maximus* and *Pennisetum pedicellatum* based pastures and micronutrients (Fe, Cu, Zn and Mn) were also increased in both soil layers.
- Jalauni sheep were allowed to graze in the restored and rejuvenated grassland using remote sensing and drone technologies, consisting of *C. ciliaris, M. maximus* and *P. pedicellatum* during growing season for 6-7 hours daily along with supplemented feed mixture (mustard cake, maize grain, wheat bran, mineral mixture and common salt; 35: 50: 13: 1: 1) @ 1.0% of their body weight. The grazing supported a daily gain of 50-60 g.
- Crop (CWR) and irrigation water requirement (IWR) of five popular fodder based cropping systems *viz*. sorghum + berseem, guinea grass + berseem, BN hybrid + berseem, maize + cowpea and BN hybrid + cowpea in Uttar Pradesh (Meerut, Kanpur, Jhansi, Lucknow and Varanasi) were estimated using penman monteith model and crop coefficient based approaches.

Programme 3: Management of natural resources and soil health of arable and non arable lands for climate resilient sustainable fodder production

- Invasive weed-derived biochar-coated fertilizers (from *Parthenium hysterophorus* and *Lantana camara*) applied at 75% RDF enhanced fodder oat productivity (up to 15.63% dry yield increase), improved fodder quality and nutrient uptake and significantly strengthened soil physico-chemical and biological health, demonstrated a sustainable strategy for reducing fertilizer input while improving system performance.
- Seed inoculation with PGPMs effectively manipulated the oat rhizosphere microbiome, enhanced root exudation profile, microbial activity and gene expression, led to higher green fodder (up to 26.0 Mg ha^{-1}) and seed yield (up to 846.7 kg ha^{-1}) even at reduced fertilizer levels (50-75% RDF), demonstrated a viable strategy for sustaining productivity in nutrient-poor soils while lowering fertilizer dependence.
- Under nature-positive Integrated Farming System (IFS) model, integration of dragon fruit-moringa-(sesame-chickpea) along with round-the-year fodder systems (TSH & BNH), agri-horti components with bio-fencing and on-farm organic input production units was done.
- Drip irrigation at 75% available soil moisture with 100% RDF increased fodder yield (153.6 t/ha; 16.8% over flood irrigation), while 33% fertilizer saving under drip maintained equivalent yields to conventional practice and doubled water use efficiency (up to 45 kg DM/ha-mm), proved its potential for resource-efficient fodder production.
- For zonate leaf spot disease suppression in fodder sorghum, plant-based essential oils and *Spirulina* extracts were prepared for bioactive evaluation, while infected sorghum and Johnson grass samples were collected for pathogen studies.
- Zeolite and hydroxyapatite-based hybrid nanofertilizers were developed as efficient slow-release nutrient carriers, enhanced nutrient use efficiency, soil moisture retention, oat growth and fodder quality, enabled reduced fertilizer application rates compared to conventional fertilizers.
- Among rainfed cropping systems, sweet corn–chickpea was the most productive and profitable system (3624 kg/ha chickpea equivalent yield; B:C 1.80), while groundnut-chickpea excelled under land configuration trials with highest productivity, net returns and rainwater use efficiency, highlighting optimized crop combinations and BBF-based management for enhanced system performance under rainfed conditions.
- A drought-tolerant PGPR consortium (*Actinobacter* sp. + *Bacillus subtilis* + associated bacterium) was identified as most effective in sustaining growth, yield (up to 24.5 t/ha GFY) and physiological resilience across fodder oat, sorghum and cowpea under water stress.

- In three tier silvipasture system, lopping of shrubs (*Ziziphus mauritiana, Z. xylopyrus* and *Acacia catechu*) and *H. binata* at 70% intensity resulted in significantly higher top feed (5.26 t/ha), fire wood (5.86 t/ha) and pasture yield of *Cenchrus ciliaris* (9.67 t/ha) as compared to lopping at 50% intensity (4.21, 4.67 and 8.38 t/ha, respectively).
- Among the fodder shrub based alley cropping systems, moringa with BN hybrid under irrigated and moringa with signal grass under rainfed conditions recorded higher green fodder, dry fodder and crude protein yield as compared to other systems. Growing of fodder crops in conjunction with fodder shrubs for 3 years improved all organic carbon and available N, P and K.

Programme 4: Accelerating seed biology research and technology development for enhanced quality forage seed production and strengthening national forage seed network

- For developing seed standards, dormancy breaking treatments were standardized in five temperate forages *viz*., Timothy, Red fescue, White clover, Sainfoin and Persian clover.
- Seeds of individual progenies of selected berseem mutant lines (03) obtained after four rounds of screening, putatively tolerant to glyphosate, were screened against glyphosate (@ 0.8 kg *a.i.*/ha) along with cultivated varieties as check in pots. Progenies exhibited variable tolerance to glyphosate and survived progenies gave very poor seed yield.
- Phosphorus (P) efficient cowpea genotypes (IC202789 and IC202790) showed minimal reductions in biomass (8-16%) whereas, P inefficient genotypes showed higher reductions (24-48%). By maintaining shoot P content and nodulation under low P condition, P efficient genotypes indicated potential for high P use efficiency.
- Oat entries (GETO-1 to GETO-156) were evaluated and 154 samples were modelled using a 107/47 calibration/validation split. Wet-chemistry range covered β-glucan (1.97-7.83), amylose (11.9-16.0), protein (11.4-17.1), starch (55.1-75.0), phytate (0.405-0.991) and phenolics (0.152-0.457). PLSR/mPLS delivered robust validation performance for amylose, protein and β-glucan (high R^2 and RPD), with moderate screening-level performance for starch, phytate and phenols and predicted distributions aligned closely with reference summaries.
- Seed testing protocols conducted in siratro and *Brachiaria* crops revealed that siratro seeds treated with H_2SO_4 (T_3) recorded significantly higher seed germination and seedling vigour index. The lowest seed germination was recorded in control (25.36%). In *Brachiaria*, T_3 recorded significantly higher seed germination (29.12%) and seedling vigour index (245.54) while lowest seed germination (12.36%) in control which indicated the presence of seed dormancy since majority of the tested seeds recorded higher fresh un-germinated percentage.

Programme 5: Nutritional evaluation and post harvest management of forage resources for sustainable and improved crop-livestock production systems

- *Brassica* essential oil (EO) showed most significant antifungal activity against *Aspergillus flavus* and *A. parasiticus*. The allylisothiocyanate (*Brassica* EO) and turmerone + curlone (*Curcuma* EO) was identified as major compounds.
- Top 10 key VOCs governing silage storability and feed aroma or fragrance were identified.
- While grazing, sheep preferred grasses majority of the day, including morning, afternoon and evening while goats exhibited preference for wider plant species, including grasses in morning and thorny vegetation followed by shrubs during afternoon and evening. Grazing behaviour traits were negatively correlated with ambient temperature during autumn season in both species.
- Inclusion of fodder sorghum and berseem in the diet of crossbreds significantly increased the milk yield (0.66 l/day, 14.89%) and (0.95, 16.70%), respectively.
- A total of 195 households rearing Bundelkhandi goats were registered, collectively managing 3,812 goats.
- In Bhadawari buffaloes, average lactation milk yield, lactation length, standard lactation milk yield and peak yield were 1475.4 ± 69.3 kg, 337.8

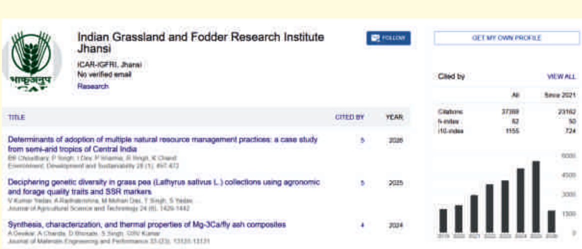
± 13.4 days, 1300.9 ± 52.8 kg and 8.15 ± 0.11 kg, respectively. The average age at first calving was 50.7 ± 1.24 months, with a conception rate of 56.2%. A total of 2400 semen doses were frozen and number of AI in Bhadawari breeding tract was 3094 inseminations.

- A prototype of BN hybrid Forage Harvester was developed for harvesting of hard-stem forage crops, with a field capacity of 0.20-0.25 ha/h and a working width of 0.80 m.
- Technology and Machinery Demonstration Meet cum Farmer's Fair, prototype feasibility testing on solar operated sprayer cum tiller and front-line demonstration on forage seed coating machine was carried out under AICRP-FIM.

Programme 6: Social, economic, policy and translational research and capacity building

- Berseem cultivation supported around 230 million ACUs, required 1.92 million hectares and 48,034 tonnes of seed annually; while domestic organized production averaged only 13,556 tonnes during 2002-2023, suggested a significant production of around 34,478 tonnes through unorganized sector. Imports were increased, with volumes and costs grown at 11.1% and 2.1% annually, at an average cost of USD 1,011.8 per tonne. Policy analysis showed that removing 15% import tariff would cause greater government revenue losses than welfare gains.
- Study on breed-specific heat stress sensitivity in smallholder dairy systems of the Indo-Gangetic Plain found marked differences across breeds. Karan Fries showed highest milk yield (11.17 L/day) but lowest heat tolerance (Threshold Comprehensive Climate Index [CCI] = 24.22), resulted in longer stress period (172 days) and higher annual loss (Rs. 8,937/animal), while Murrah (7.64 L; CCI = 25.93; Rs. 7,363) and Tharparkar (5.69 L; CCI = 26.40; Rs. 4,729) were less productive but more climate-resilient, highlighting a clear productivity-resilience trade-off.
- Under Decision Support System (DSS) for fodder crops, baseline survey schedule was finalized and relevant secondary data were collected, compiled and refined to support database development. A prototype was developed, upgraded and strengthened through integration of datasets from two existing IGFRI mobile applications.
- Data from 398 Scheduled Caste farmers in Jhansi was analysed using Gini decomposition and Lorenz curves to assess the impact of SCSP agricultural interventions on income distribution. Beneficiaries showed a lower Gini index, indicating more equitable income distribution, while crop farming was the main source of inequality; about 1% rise in livestock income reduced inequality by 0.24-0.38%, especially among non-beneficiaries. However, limited technical support, small landholdings, poor germination, stray animal damage and inadequate irrigation were the major limitations in adoption of technologies.
- Under the FFP, three farmer-scientist interaction meetings were held across Dhikoli, Nayakheda, Ganeshgarh, Ramgarh and Kanchanpur. High-yielding greengram IPM-205-7 (Virat) was demonstrated on 72 farmers' fields recorded 33% higher yield. *Kharif* vegetable varieties (Kashi Ganga, Kashi Shreya, Kashi Kranti and Kashi Nidhi) increased yields by 26-35%, diversified farmers' income. Improved fodder varieties like CSH-24, Wardan, JHO-822, MP chari and IGFRI-6 enhanced livestock feed, with CSH-24 yielding 35% more green fodder. Two field days in Dhikoli and Ramgarh showcased best practices to 240 farmers.

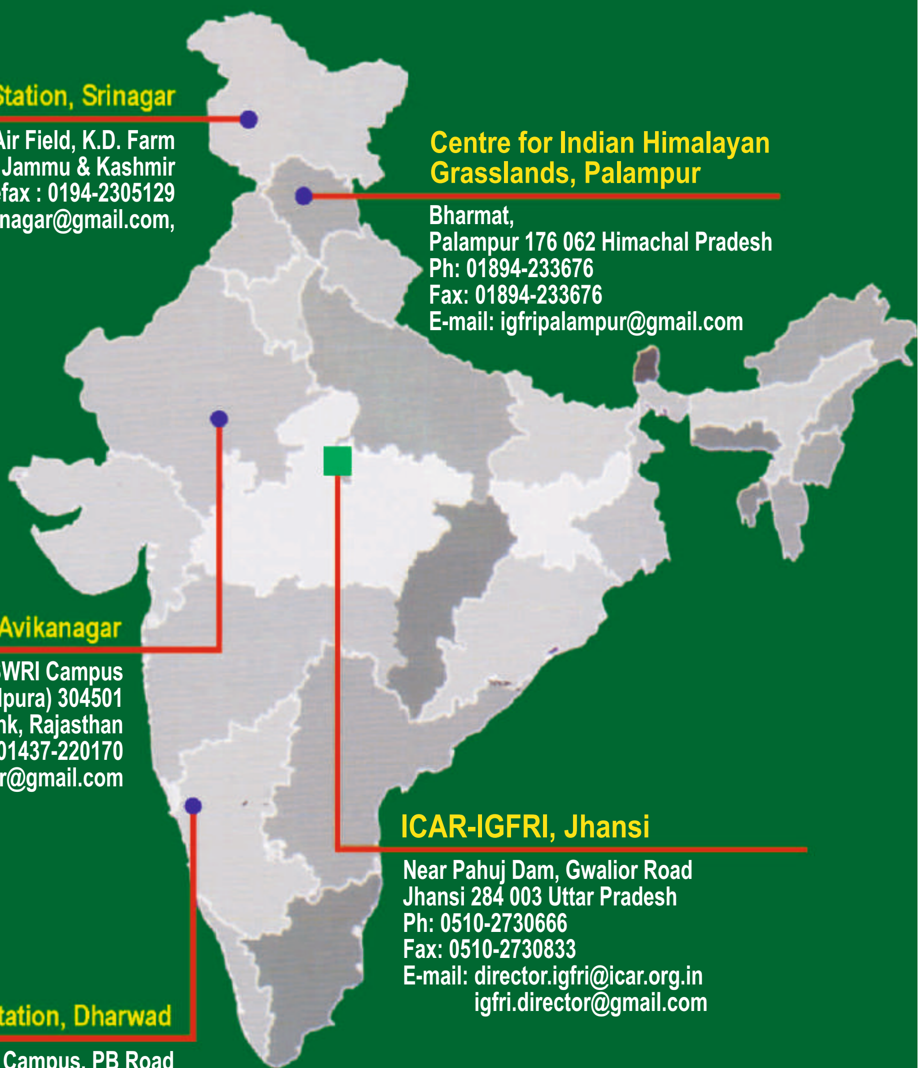
Visibility of the institute: Research citations



During the year 2025, ICAR-IGFRI, Jhansi achieved significant academic visibility at national and international levels. The institute recorded 5,585 citations during 2025, representing a marked increase over the citation count achieved during 2024, thereby reflecting the expanding scientific relevance and scholarly recognition of its research contributions in the domains of grassland and forage science, and sustainable livestock production systems. The cumulative citation profile of the institute reached 37,552 citations, with an overall h-index of 63 and i10-index of 1,162.

ICAR-Indian Grassland and Fodder Research Institute

https://igfri.org.in



Chapter 1

ICAR-IGFRI : An Introduction

Indian Grassland and Fodder Research Institute (IGFRI) was established on 01st November 1962 at Jhansi in Uttar Pradesh to strengthen research and development efforts aimed at meeting the fodder needs of India's vast livestock population. The institute subsequently became a constituent institute of the Indian Council of Agricultural Research (ICAR) on 1st April 1966. To promote coordinated forage research and technology evaluation across different agro-climatic regions of the country, ICAR launched the All India Coordinated Research Project on Forage Crops and Utilization (AICRP-FCU) in 1972 with IGFRI as its headquarters. At present, the project facilitates multi-location testing of forage crop varieties and production technologies through a network of 22 coordinating centres spread across 21 states, most of which are located in State Agricultural Universities under the National Agricultural Research System. IGFRI, functioning under the Crop Science Division of ICAR, comprises seven multidisciplinary divisions: Crop Improvement, Crop Production, Farm Machinery and Post-Harvest Technology, Seed Technology, Social Science, Grassland and Silvipasture Management and Plant-Animal Relationship. The institute is supported by several functional units including PME, HRD, ATIC, ITMU, AKMU and ABIC, along with specialized facilities such as a central library, central research farm, animal complex, central instrumentation laboratory, Mid-Term Storage (MTS) facility and a museum documenting its historical milestones and achievements. Spread over about 373 ha at Jhansi, the institute also operates three regional research stations at Dharwad (Karnataka), Avikanagar (Rajasthan) and Srinagar (Jammu and Kashmir), addressing forage research needs of humid tropical, semi-arid to arid and temperate agro-ecosystems, respectively. In addition, the institute hosts the Centre for Indian Himalayan Grasslands at Palampur in Himachal Pradesh.

For more than six decades, ICAR-IGFRI has served the nation by generating innovative technologies aimed at sustainable fodder production and efficient utilization of grassland resources. The institute conducts both basic and applied research on cultivated and natural forage resources, encompassing fodder crop improvement, intensive fodder production systems, alternative fodder resources, grassland and silvi/horti-pasture management, seed production technologies, farm mechanization, post-harvest conservation and utilization and livestock nutrition. In addition, the institute has developed economic fodder-based feeding systems, reducing enteric methane emissions from livestock through feeding strategies, silage preparation using grasses and agro-industrial wastes. In addition to its conventional role in livestock feed security, the institute is increasingly exploring the wider potential of grasses for emerging applications such as bioenergy and biofuel production, climate-resilient biomass systems, phytoremediation and carbon sequestration. Grasses also serve as valuable genetic resources for gene discovery and functional genomics, particularly for traits related to stress tolerance, biomass productivity and nutrient-use efficiency. Furthermore, several forage grasses are being studied as model systems for understanding and harnessing Apomixis, a unique mode of asexual seed formation which holds tremendous potential for fixing hybrid vigor in crop plants.

The institute plays a key role in mobilizing national and international research collaborations and externally funded projects aimed at addressing the persistent challenges of fodder quantity and quality in India. IGFRI's outreach programmes are extensive and include initiatives such as Model Fodder Villages, *Mera Gaon Mera Gaurav*, National Initiative for Fodder Technologies Adoption, Soil Health Cards, Pradhan Mantri Adarsh Gram Yojana, Saansad Adarsh Gram Yojana, Farmer FIRST, KISAN MITRA, Tribal Sub-Plan, Scheduled Castes Sub-Plan and the NEH programme. These programmes aim to demonstrate improved forage technologies, strengthen farmer capacity and facilitate technology dissemination among stakeholders.

In the area of genetic resource conservation, the institute collected 135 forage germplasm samples from Rajasthan and Gujarat during this year and presently maintains around 11000 forage accessions belonging to more than 70 genera in the Mid-Term Storage (MTS) facility. Through IGFRI and AICRP-FCU efforts, 450+ forage crop varieties covering cereals, legumes and grasses across 22 crops have been identified and notified since inception. Recently, the berseem variety Bundel Berseem-9 (JHB-20-1), a single-cut oat variety JHO 21-1 (Bundel Jai 2021-1) and the pearl millet variety Bundel Bajra-1 for the North-West Zone were released for cultivation. The institute also achieved a global milestone by developing the world's first seed-producing *Cenchrus ciliaris* hybrid (BN hybrid). Additional contributions include development of livestock-based integrated farming system models, silvipasture and hortipasture systems for rainfed ecosystems and several specialized machines such as forage seed coating machines, berseem–chicory seed separators, tractor-operated grass seed harvesters and defluffing machines. Seed standards for five temperate forages namely timothy, red fescue, white clover, sainfoin and Persian clover have also been developed. During the reporting period, 13 technologies developed by the institute were certified by ICAR.

Beyond technology development, IGFRI has prepared comprehensive Fodder Resource Development Plans for 29 states of India. Realizing the importance, many states such as Uttar Pradesh, Assam, Tripura, Goa and Rajasthan have already adopted and implemented, while many other states are in process of implementation. The institute has also secured patents for innovations including a soil core sampler assembly and a tractor-operated grass seed harvesting apparatus, with several others in advanced stages of approval. In recognition of the International Year of Rangelands and Pastoralists 2026, the institute prepared a policy document on "Rangeland and Grassland Conservation and Restoration," emphasizing sustainable management of these vital ecosystems.

Vision

To evolve technologies for maximizing productivity of forages and feeds for livestock in an eco-friendly manner.

Mission

To generate and disseminate technologies for enhanced productivity and quality of forages and livestock in socio-economic and environmental perspectives.

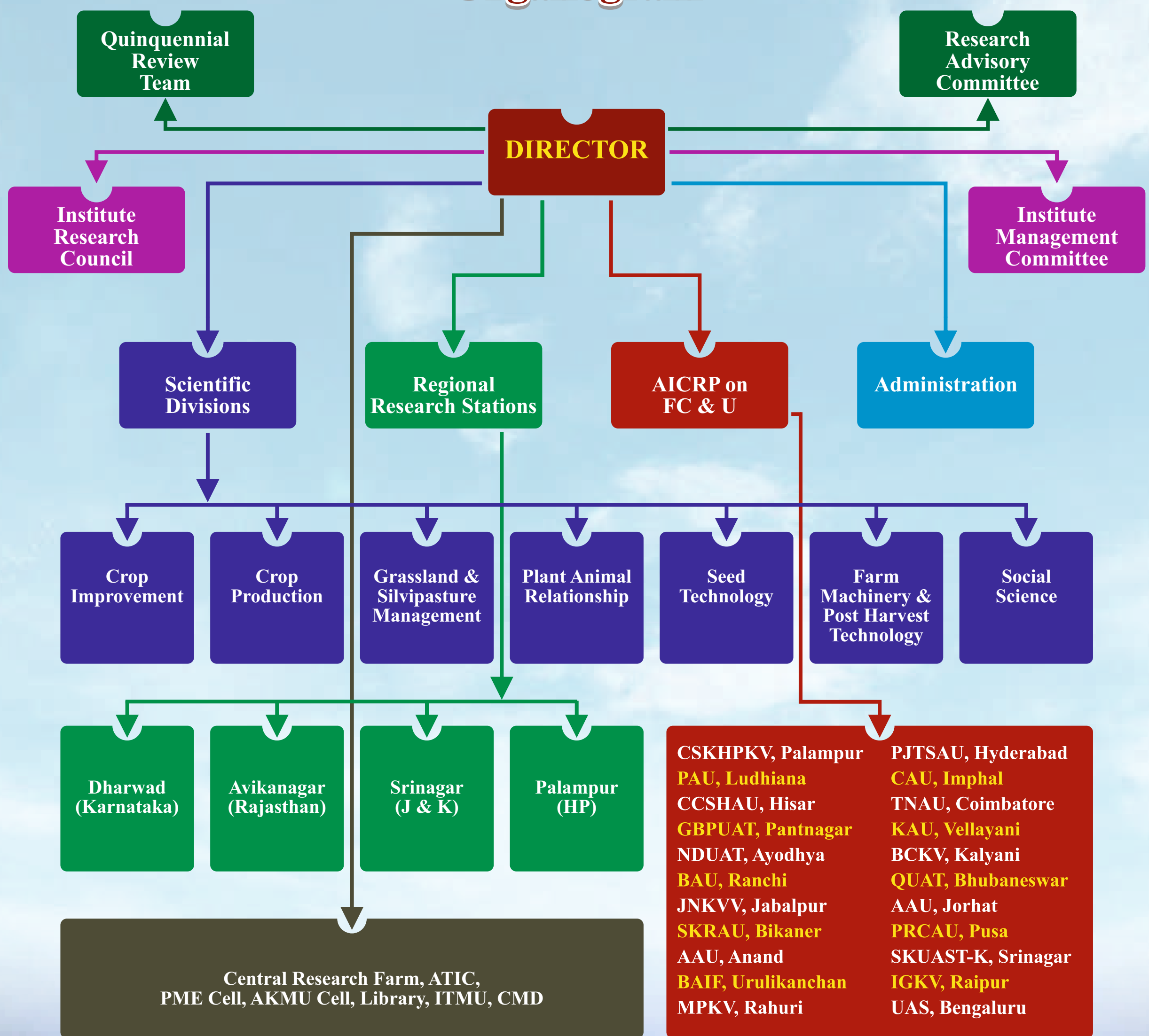
Mandate

1. Basic, strategic and adaptive research on improvement, production and utilization of fodder crops and grasslands
2. Coordination of research on forages and grasslands for enhancing productivity and quality for enhancing livestock productivity
3. Technology dissemination and human resource development

The institute has restructured and prioritised its mandate in view of government agenda (organic and natural farming, waste to wealth, vocal for local), climate change (biotic and abiotic stress, NUE and WUE, more crop per drop) and commercial venture (licensing and commercialization, industrial use). The institute is currently focusing research under following six programmes.

1. Genetic enhancement of forage crops with emphasis on quality, multicut, stress tolerance & bio-fortification utilizing conventional, apomixis and new breeding tools.
2. Diversification and sustainable intensification of fodder production in different land use systems including assessment and rejuvenation of grasslands and other resources for improving productivity and livelihood options.
3. Management of natural resources and soil health of arable and non-arable lands for climate-resilient sustainable fodder production.
4. Accelerating seed biology research and technology development for enhanced quality forage seed production and strengthening the national forage seed network.
5. Nutritional evaluation and post-harvest management of forage resources for sustainable and improved crop-livestock production systems.
6. Social, economic, policy and translational research and capacity building.

Organogram


Quinquennial Review Team
Research Advisory Committee
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Regional Research Stations
AICRP on FC & U
Administration
Crop Improvement
Crop Production
Grassland & Silvipasture Management
Plant Animal Relationship
Seed Technology
Farm Machinery & Post Harvest Technology
Social Science
Dharwad (Karnataka)
Avikanagar (Rajasthan)
Srinagar (J & K)
Palampur (HP)
Central Research Farm, ATIC,
PME Cell, AKMU Cell, Library, ITMU, CMD
CSKHPKV, Palampur
PAU, Ludhiana
CCSHAU, Hisar
GBPUAT, Pantnagar
NDUAT, Ayodhya
BAU, Ranchi
JNKVV, Jabalpur
SKRAU, Bikaner
AAU, Anand
BAIF, Urulikanchan
MPKV, Rahuri
PJTSAU, Hyderabad
CAU, Imphal
TNAU, Coimbatore
KAU, Vellayani
BCKV, Kalyani
QUAT, Bhubaneswar
AAU, Jorhat
PRCAU, Pusa
SKUAST-K, Srinagar
IGKV, Raipur
UAS, Bengaluru


IGFRI
Grassland

Chapter 2

Weather and Crops

India's 2025 monsoon season was marked by early onset, above-average rainfall and multiple extreme weather events, significantly impacting agriculture nationwide. During this year, the all-India annual mean land surface air temperature was 0.28°C higher than the 1991–2020 long-term average. This made 2025 the eighth warmest year since nationwide temperature records began in 1901. The all-India seasonal mean temperature was above the long-term average during the winter (January–February) and pre-monsoon (March–May) seasons, with anomalies of +1.17°C and +0.29°C, respectively. The 2025 annual rainfall over the country as a whole was 1274 mm, which was 110% of the Long Period Average (LPA). Seasonally, winter rainfall was below normal (52% of its LPA), while rainfall during all other three seasons was above normal, with the pre-monsoon, southwest monsoon and post monsoon seasons recording rainfall of 142%, 108% and 111% of LPA, respectively. All-India rainfall in May (126.7 mm) was the highest on record since 1901. Regionally, Northwest India received seasonal rainfall of 127% of its LPA, Central India, South Peninsular India received seasonal rainfall of 115% and 110% of its LPA, respectively, while East & Northeast India received seasonal rainfall of 80% of its LPA.

Weather at Jhansi

2.1 Rainfall pattern

In Jhansi, a total rainfall of 1441 mm was recorded during 2025 (January-December) in 58 rainy days. The rainfall was found to be surplus by 58.0% from LPA of 908.8 mm. In the *rabi* season, 24.6 mm of rainfall occurred, which was lower by 41.3% from LPA (41.9 mm). Rainfall during the *kharif* was 1230.8 mm, which was higher by 34.5% from LPA (806.8 mm). The monthly rainfall pattern indicates that June received a total of 318 mm rainfall, which was 228.9 mm higher than the normal rainfall (89.1 mm) of the same period (Fig. 2.1). Similarly, July (27-30 SMW), with 535.0 mm rainfall, recorded a surplus of 285.4 mm; August (31-34 SMW), with 266.4 mm rainfall, recorded a deficit of 9.3 mm; and September (35-39 SMW), with 101.6 mm rainfall, recorded a deficit of 40.2 mm. The weekly pattern of rainfall also indicated the great variation from its normal values (Fig. 2.2). The SMW of 25-31, 34, 39-41, 43-44 have received higher rainfall than the normal; however, the rest SMW had either received no rainfall or lesser rainfall than the normal. The monsoon rainfall continued up to the first week of November; afterwards, there was no rainfall till the end of the year.

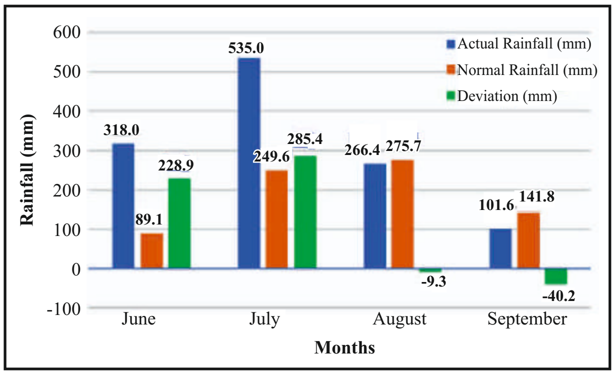

Fig. 2.1. Monthly rainfall and its deviation from normal at Jhansi

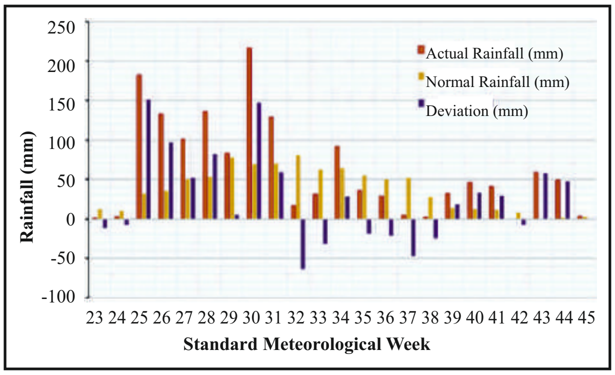

Fig. 2.2. Weekly rainfall during monsoon and its deviation from normal rainfall at Jhansi

2.2 Temperature

The temperature data of year 2025 indicated an annual average maximum temperature (T_{max}) of 32.4°C, which was lower by 0.2°C than the long-term average of 32.6°C. Similarly, average minimum temperature (T_{min}) during 2025 was 16.6°C, which was lower by 1.6°C than the long-term average of 18.2°C. Season-wise, mean maximum (33.2°C) and minimum (14.4°C) temperatures during 1-22 SMW (*Rabi*) were lower by 0.1 and 2.2°C, respectively, from their corresponding normal values (T_{max}=33.3°C and T_{min}=16.6°C). Figures 2.3 and 2.4 depict the temperature anomaly (actual minus normal) pattern. The season started with below-normal conditions during SMW 1–3. A brief warming phase occurred in SMW 4–7, with maximum temperature peaking near +3°C around week 5, while minimum temperature remained near normal. From SMW 10 onward, the minimum temperature declined sharply, reaching around –6°C during SMW 12, 13 and 17, indicating intense cold nights. Maximum temperature showed mixed trends during this period. SMW 18 and 19 recorded negative anomalies in both parameters, highlighting a strong cold spell and notable variability.

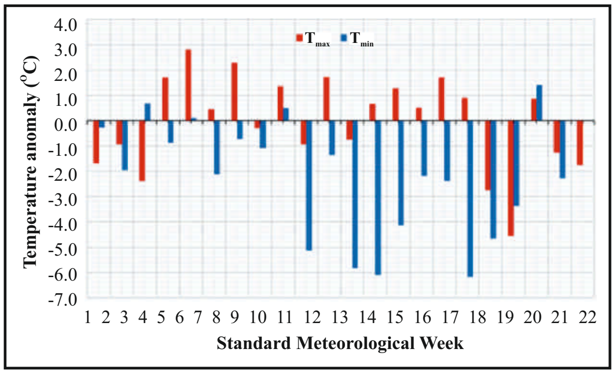

Fig. 2.3. Weekly anomaly pattern of maximum (T_{max}) and minimum (T_{min}) temperature during *rabi*

During *kharif*, early weeks (SMW 23–28) were mostly cooler than normal, with a sharp drop in maximum temperature around SMW 25 and significantly low minimum temperature in SMW 23. A warming phase occurred during SMW 32–39, when maximum temperatures remained consistently above normal, peaking around SMW 37–38, along with near-normal to slightly higher minimum temperatures. From SMW 41 onward, a pronounced cooling trend set in, especially in minimum temperature, which declined sharply during SMW 44–47. Overall, late-season cold conditions were more intense and persistent.

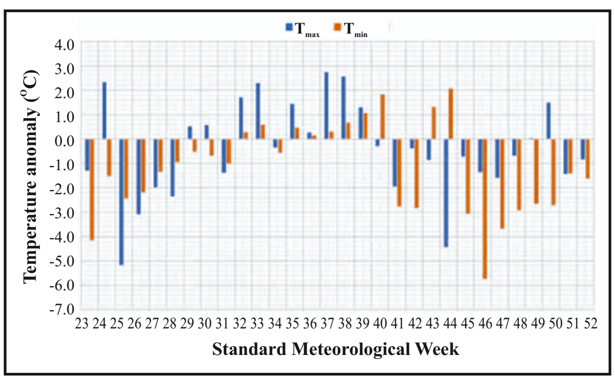

Fig. 2.4. Weekly anomaly pattern of maximum and minimum temperature during *kharif*

2.3 Evaporation

The average annual evaporation rate in 2025 was 4.2 mm/day, 19.2% lower than the long-term average of 5.2 mm/day. Mean *rabi* season (1-22 SMW) evaporation rate (5.3 mm/day) was lower by 16.3% than the normal evaporation rate (6.3 mm/day) (Fig. 2.5). Evaporation rate during *rabi* (1 to 22 SMW) experienced lower evaporation rate in the range of 1.09 to 8.89 mm/day against its normal range (1.69 to12.5 mm/day). Mean evaporation rate during the *kharif* (26-52 SMW) was recorded at 3.0 mm/day, which was 18.6% lower than its long-period average (3.7 mm/day). Evaporation rate during *kharif* experienced a lower evaporation rate in the range of 1.36 to 4.84 mm/day against its normal range (1.70 to 7.50 mm/day). The negative deviations in both seasons indicate that actual evaporation remained below normal levels. The reduction was more pronounced in *rabi* than in *kharif*, suggesting relatively lower atmospheric evaporative demand during the *rabi*.

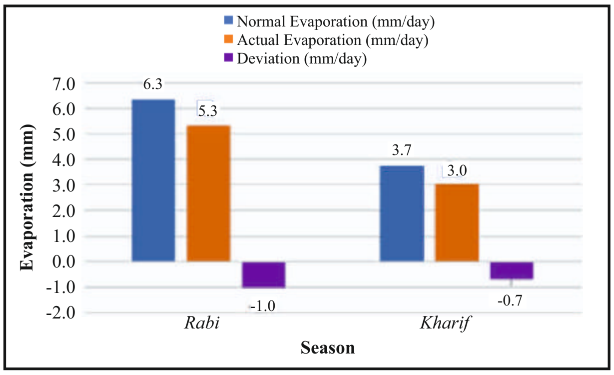

Fig. 2.5. Seasonal actual and normal evaporation along with deviation from its normal values

2.4 Relative humidity pattern

The annual relative humidity (RH) observation during 2025 indicated 80.2% RH1, which was less by 2.9% than the long-term normal corresponding value of 82.5%. Similarly, the average RH2 value during 2025 was 50.5%, which was higher by 18.8% than the corresponding long-term normal average value of 42.5%. During *rabi*, RH1 decreased from 76.0% (normal) to 68.0% (actual), showing a negative deviation of –8.0% (Fig. 2.6). In contrast, RH2 increased from 32.0% to 47.0%, reflecting a positive deviation of +15.0%. In the *kharif*, RH1 remained close to normal, declining slightly from 90.0% to 88.0% (–2.0%). However, RH2 rose from 51.0% (normal) to 61.0% (actual), indicating a +10.0% deviation. Overall, morning humidity (RH1) was lower than normal in both seasons, more prominently in *rabi*, whereas afternoon/evening humidity (RH2) was considerably higher than normal, especially during *rabi*.

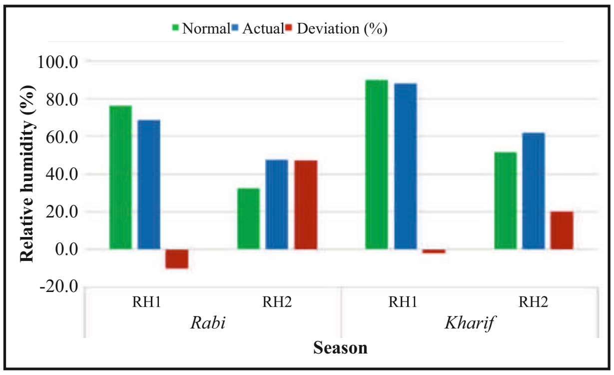

Fig. 2.6. Seasonal actual and normal relative humidity along with deviation (%) from normal

Chapter 3

Research Achievements

3.1 Genetic enhancement of forage crops with emphasis on quality, multicut, stress tolerance and biofortification utilizing conventional, apomixes and new breeding tools

3.1.1 Augmentation, characterization, conservation and documentation of forage genetic resources

(CRSCIGFRISIL20100 101)

Forage germplasm exploration

An exploration for forage germplasm was carried out with ICAR–NBPGR, Jodhpur, under the NEP 2024–25 program during 16 September to 02 October, 2025, to collect targeted species, including *Cenchrus* spp., *Lasiurus*, *Dichanthium*, pearl millet, kalingada and spine gourd from various regions of Rajasthan (Jaisalmer, Jodhpur, Bikaner, Ganganagar and Udaipur) and Gujarat (Aravalli, Banaskantha, Gandhinagar, Mehsana, Patan and Sabarkantha) and approximately 135 samples were collected from the targeted crop species along with a few unidentified species.

Forage crop genetic resources: CIHG, Palampur

About 176 accessions of different forage crops were introduced from RRS Srinagar, which included orchard grass (44), tall fescue (35), sainfoin (18), red clover (28), red fescue (5), brome grass (18), timothy (6), rye grass 15, *Phalaris* (6) and bird's foot trefoil (1). 251 accessions of white clover (*Trifolium repens* L) and 24 collections of unspecified range grasses and other forage crops and 5 fodder tree species. In total, the Centre has 456 forage germplasm accessions/ collections.

In addition, a 4-day programme on exploration and collection of forage crop germplasm was conducted in different parts of Kangra and Mandi Districts of Himachal Pradesh. A collection of local germplasm (61 collections), rooted slips and seeds of different range grasses and wild crop relatives, used as fodder from these areas was done and the rooted slips were planted in the field. The collected material included *Panicum* species (14), *Themada* sp. (7), brome grass (6), *Chrysopogon* species (4), *Setaria* (3), Deenanath (2) and some identified forage grasses.

3.1.2 Genetic improvement of maize for high biomass and fodder quality

(CRSCIGFRISIL20200105)

Intra and inter- specific hybridization

Twenty-four baby corn and thirty sweet corn hybrids were evaluated and two baby corn and three sweet corn hybrids with high cob and fodder yield were identified (ICAR-IARI, New Delhi). BC_2F_2 progenies (*shrunken*-2 based) of PMIPV-3 and PMIPV-4 were developed (ICAR-IGFRI, Jhansi). The F_3, F_4 and BC_1F_4 progenies of African Tall × Teosinte cross were developed and characterized for tillering and branching trait. Twenty high biomass single cross maize hybrids were evaluated for silage quality. Crude protein ranged from 7.14-10.65%, while NDF, ADF, ADL and total ash varied from 62.14-76.85, 37.34-45.68, 3.12-6.50 and 7.33-12.90%. Silage pH (3.56-4.39) and lactic acid (2.20-3.64%) were in the range of good silage quality.

Development and characterization of inbreds

About 30 S4, 57 S5, 126 S6 and 20 S8 inbreds were developed and146 S5/S6/S8 inbreds were evaluated for their *per se* performance for various fodder traits. About 48 inbreds were characterized using 50 SSR markers. Un-weighted neighbour joining cluster analysis revealed three major clusters (Fig. 3.1.1). The summary statistics of the genotyping assay for 48 inbreds is provided in Table 3.1.1. Screening of maize genotypes under AICRP-FC trials (2 years) identified two genotypes (IGFM-5 & IGFM-11) moderately resistant to fall army worm and three genotypes (IGFM-1, IGFM-8 & IGFM-11) moderately resistant to Turcicum leaf blight.

Trials conducted

Station trials with twenty selected single cross maize hybrids were conducted and four hybrids (SCH-3, SCH-7, SCH-12 and SCH-19) performed better than checks (GFY hybrids: 54.43-56.83 t ha^{-1}; GFY checks: 47.84-52.90 t ha^{-1}). One entry (JHFM-23-3) was promoted from AVT-1 to AVT-2. Three new entries (JHFM-25-1, JHFM-25-2 and JHFM-25-3)

Unweighted Neighbour Joining Dendrogram

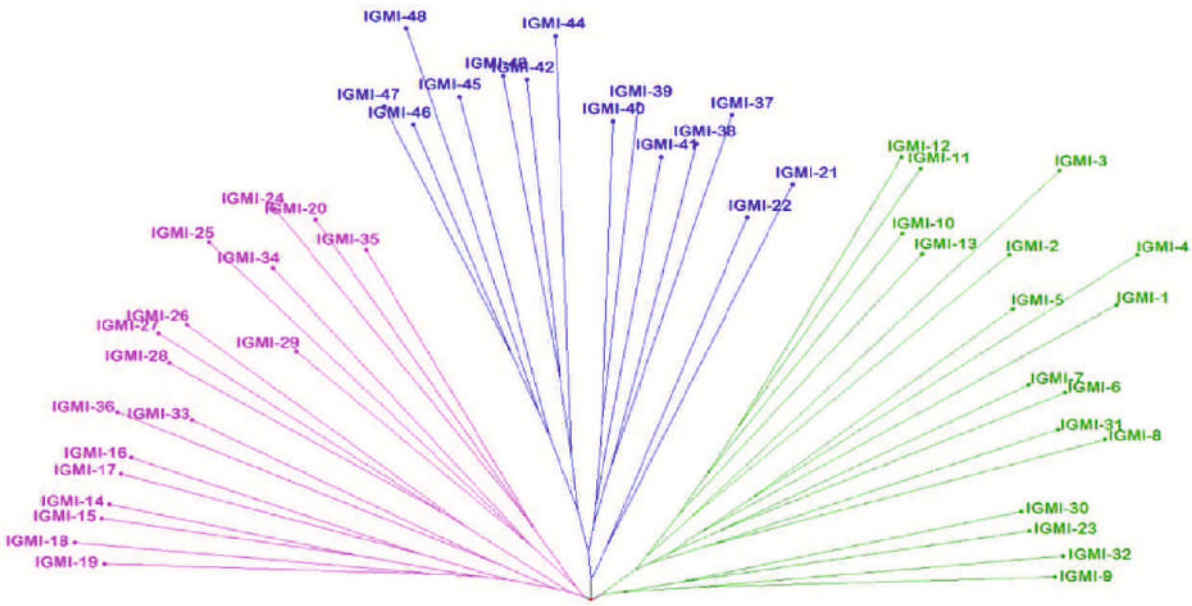

Fig. 3.1.1. Cluster analyses depicting genetic relationships among 48 maize inbreds

Table 3.1.1. Summary statistics of the genotyping assay for 48 maize inbreds using 50 SSR markers

Diversity indices	Major allele freq.	No. of alleles	Gene diversity	Heterozygosity	PIC
Minimum	0.27	2	0.12	0	0.11
Maximum	0.93	5	0.76	1	0.71
Mean	0.56	2.96	0.53	0.37	0.45

were contributed to IVT. Four AICRP trials on fodder maize and four trials of ICAR-IARI, New Delhi were also conducted.

3.1.3 Breeding of pearl millet for deriving multicut and dual-purpose cultivars with high forage yield and quality (CRSCIGFRISIL20200101)

Varietal development

Bundel Bajra-1 is a high-yielding and nutritionally rich fodder pearl millet (*Pennisetum glaucum* L.) variety officially released for cultivation in the North-West Zone of India, covering Punjab, Haryana, Rajasthan, Western Uttar Pradesh and the Tarai region of Uttarakhand. Bundel Bajra-1 produces a green fodder yield of 53.11 t ha^{-1} and dry matter yield of 9.26 t ha^{-1}, along with a crude protein yield of 0.95 t ha^{-1} (Fig. 3.1.2). It possesses a high *in vitro* dry matter digestibility (IVDMD) of 56%.

Fig. 3.1.2. Field view of fodder pearl millet variety– Bundel Bajra-1

Evaluation and molecular diversity analysis of fodder pearl millet inbred lines

About 96 inbreds along with 4 checks were evaluated during *kharif* and summer season for biomass yield and its component traits and physiological traits which included root architectural traits, chlorophyl content and canopy temperature. The inbred lines showed greater variability for the traits such as plant height (113.17-269.00 cm), leaf to stem ratio (0.16-0.80), green forage yield (1.59-36.63 kg/plot), total root length (26.32-481.11 cm) and chlorophyll content (19.67-60.50 SPAD reading). Out of 60 SSR markers screened, 46 were found polymorphic and generated 203 alleles across 96 pearl millet genotypes, with an average of 5.28 alleles per locus.

Developing gene specific marker for regrowth trait in pearl millet

Transcriptome sequencing of Baif Bajra 1 (faster regrowth) and IP8955 (poor regrowth) at 24 h and 48 h after cutting identified numerous differentially expressed genes. Ten growth- and development-related candidate genes were shortlisted for validation and primers were designed for full-length amplification. Among them, cytokinin-N-glucosyltransferase 1 was successfully amplified and exhibited clear polymorphism between the parents.

Fodder pearl millet entry submitted to AICRP trials

Two entries submitted to multicut bajra trial, JHMCB-25-1 and JHMCB-25-4 were promoted from IVT to AVT 1. Four entries JHPM-25-1, JHPM-25-2 and JHPM-25-3 and JHPM-25-4 were submitted for initial varietal trial on *kharif* to AICRP.

3.1.4 Development of genetic and genomic resources for low moisture stress tolerance in berseem (*Trifolium alexandrinum*) (CRSCIGFRISIL20180101)

Release of Berseem variety: Bundel Berseem-9 (JHB-20-1)

Berseem variety Bundel Berseem-9 (JHB-20-1) was developed from the Mescavi ecotype cultivar JHB-17-1 through induced mutation followed by phenotypic recurrent selection. The variety exhibited high fodder productivity, recording a potential green fodder yield of 103.8 t ha^{-1} and a dry matter yield of 17.1 t ha^{-1}. Bundel Berseem-9 (JHB-20-1) was notified for release vide Gazette Notification S.O. 2128(E), dated 13 May 2025 for cultivation in the states of Madhya Pradesh, Maharashtra, Chhattisgarh and Bundelkhand region of Uttar Pradesh.

Station trials

Two station trials were conducted to evaluate advanced berseem breeding lines. In the first station trial, a total of 17 lines were evaluated, while in the second station trial, five lines were tested along with standard check varieties. Among these, the lines STB-13-4, STB-13-5 and STB-13-7 exhibited 10–15% higher green fodder yield (GFY) over the check varieties, indicating their strong potential for multilocation testing and consideration for varietal release. Subsequent evaluation of promising entries during 2024–25 confirmed the stability of their performance. The entries STB-13-7 and STB-13-5 consistently maintained high yield potential, recording 11.6% and 7.7% superiority, respectively, over the check varieties JHB-17-1 and JHB-18-1.

Genotyping of berseem RILs and development of framework linkage map

A total of 179 berseem recombinant inbred lines (RILs), including parental lines, were genotyped using the Genotyping-by-Sequencing (GBS) approach. SNP discovery was performed by aligning sequence reads to the reference genome of *Trifolium pratense* (GCA_020283565.1; 399 Mb). For SNP calling, a minimum coverage threshold of 20 reads per base and an average base quality score ≥20 (Phred score) was applied. A total of 65,534 SNPs were initially identified, of which 411 high-quality SNPs were retained after stringent filtering. These SNPs were grouped into eight linkage groups based on segregation patterns. Genetic distances between markers were calculated using the Kosambi mapping function. The final linkage map spanned a total genetic length of 2,741 cM, with an average marker interval of 6.6 cM. The genetic linkage map was constructed using the MSTmap online software, enabling efficient and accurate framework map development.

Nucleus seed production

Nucleus seed of berseem varieties developed at ICAR–IGFRI was produced in accordance with the projected breeder seed requirements. This ensured the availability of genetically pure and high-quality seed for subsequent multiplication and large-scale dissemination programs.

3.1.5 Identification and characterization of multicut sorghum lines for low HCN and moisture stress tolerance (CRSCIGFRISIL20230101)

Twenty-three fodder sorghum genotypes, including three checks (MP chari, CSV 33 MF and CO-FS29), were screened for multicut potential, low moisture tolerance (skipped irrigation) and low HCN content. The control and moisture stress in field conditions were maintained by irrigation management. The first cut was taken at 55 days after sowing (DAS) and the second and third cuts were taken at 85 and 115 DAS. The plant height at second cut ranged from 130-169, 101-158 and 93-158 cm under control (C), moderate (M) and high-water stress (D) conditions, respectively. After the fresh biomass at first, second and third cut, the second cut had more biomass than the first and third cut and with the increased moisture stress, the fresh biomass decreased (Fig. 3.1.3). Based on the plant height, fresh biomass and HCN contents, SMC-75, IGS-52 and ST-7 genotypes performed well under water stress conditions.

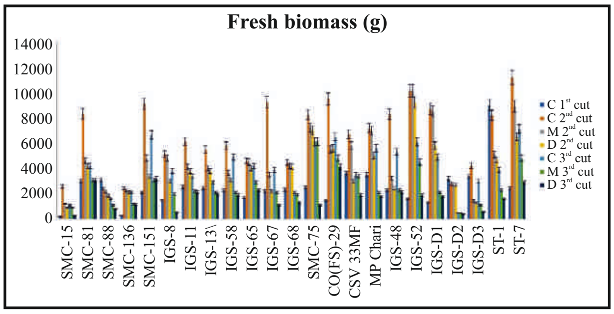

Fig. 3.1.3. Fresh biomass of sorghum genotypes at first, second and third cut under control, moderate and high-water stress conditions

3.1.6 Breeding oat for improved productivity and quality (CRSCIGFRISIL20210104)

Varietal identification

A new single cut oat variety JHO 21-1 (Bundel Jai 2021-1) was notified (Gazette Notification S.O. 6123(E); Dated 31st December, 2025) for south zone (Telangana, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala) with average green fodder yield of 31.80 t ha^{-1}; dry matter yield of 6.18 t ha^{-1}; crude protein of 6.9%.

Novel genetic stock

A novel genetic stock (IG-20-718) (EC-246121) was submitted for registration to ICAR-NBPGR, New Delhi. The genotype IG-20-718 showed high SPAD value, catalase activity (46.02 $\mu g g^{-1}$FW), 1.5 times glutathione S-transferase activity, which made it more tolerant to saline conditions with higher fresh biomass production (438.6 g m^{-1}) under high salinity.

Evaluation of germplasm

A set of 1651 oat germplasm lines were evaluated for fodder traits and lines identified for high green fodder yield and related traits. Genotypes were also screened for leaf blight disease under field conditions. About 55 lines showed very high tolerance and most of the lines were moderately resistant (Fig. 3.1.4).

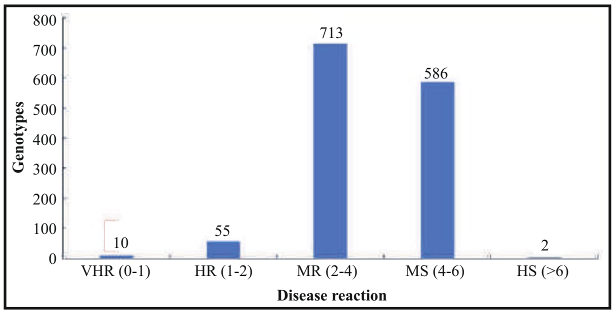

Fig. 3.1.4. Screening of oat genotypes for leaf blight disease under natural field condition

Generation advancement of breeding lines

Thirteen breeding populations were advanced from F3 to F4 generation and another 25 F2 populations were advanced.

Breeder seed production (oat): 723.0 kg.

Trials conducted

Three station (SC/MC/Dual) trials and seven AICRP-FC trials were conducted. From station trials, 12 lines (4 lines from each trial) were selected for single cut, multi cut and dual-purpose trials. Four new entries were submitted for testing for all India testing in AICRP FC. Three new entries were submitted for testing under state varietal evaluation trials (UP state trial system).

Proposals for registration to PPVFRA

Three new proposals were submitted for registration of oat varieties (JHO-2015-1; JHO-2012-2; and JHO-2009-1).

3.1.7 Identification and characterization of cowpea genotypes for phosphorus use efficiency (CRSCIGFRISIL20220102xxxxx)

During the *kharif*-2024 and *rabi*-2025, 12 selected contrasting cowpea genotypes were grown under both sufficient phosphorus (13.2 kg P/ha + RDF) and low phosphorus (7.8 kg P/ha) regimes under pot culture for the study of physio-biochemical basis of PUE in cowpea. After 45 days after sowing, plant growth traits *viz.,* leaf area, plant height and biomass, as well as osmolyte compounds *viz.,* proline and total sugars were measured. P-efficient genotype (IC202789 & IC202790) significantly showed less reduction in growth, plant height and biomass compared to P inefficient genotypes under low P. The osmolyte compounds were increased in P efficient genotypes as compared to sensitive ones under low P stress. Low P showed the negative effect on dry matter

P efficient genotype (IC02789)

P inefficient genotype (IC43062)

Fig. 3.1.5. Phenotypic variation in growth between phosphorus (P)-efficient genotype (IC02789) and P-inefficient genotype (IC43062) under optimum P (+P) and low P (-P) conditions at 25 and 60 days after sowing.

accumulation. The percent reduction in dry biomass was lower (8-16%) in P efficient genotypes, while it ranged from 24-48% in P inefficient genotypes. Smallest reduction was found in IC202781 while highest in EC390281. Shoot P content, averaged over genotypes, decreased by 7-50% at low P. P efficient genotypes (Kashi Shyamal and IC202790) maintained relatively higher shoot P content compared to sensitive ones. Nodule fresh weight, nodule number and leghaemoglobin decreased in all genotypes due to low P, but P efficient genotypes (IC 202791 and IC 202789) maintained relatively higher nodulation than IC 430632 and EC 390281, indicating better tolerance to P deficiency for these genotypes (Fig. 3.1.5).

3.1.8 Genetic improvement of novel fertile Bajra-Napier hybrid for enhanced productivity and quality traits (CRSCIGFRISIL20220101)

Improvement of fodder and seed quality traits in fertile BN hybrid

A set of 15 F_6 interspecific fertile BN hybrids were selected for crossing programme based on the wide variability observed among different agro-morphological traits. These 15 hybrids were crossed in full diallel design, including both one-way and reciprocal crosses. Among these hybrids, several combinations showed high heterosis for seed size.

Phenotyping of F_6 population for yield and fodder quality traits

A total of 118 F_6 interspecific fertile BN hybrids (*Pennisetum glaucum* × *P. purpureum*) were initially screened based on visual observations and agro-morphological characteristics and 91 candidate F_6 lines were evaluated further. The genotypes were planted in a single row of 4 m each with 1 m plant to plant spacing and 1.5 m row to row spacing. Mean data was recorded for 13 agro-morphological and yield traits. The descriptive statistics revealed substantial variability among the genotypes for all 13 agro-morphological and yield related traits. Plant height recorded a mean value of 422.75 cm, ranging from 340.0 to 480.0 cm. Leaf length averaged 117.9 cm with values spanning from 73.0 to 137.0 cm, while leaf width showed a mean of 4.80 cm and varied between 3.5 and 6.3 cm. The number of tillers exhibited pronounced variation, with a mean of 20.85 and a broad range from 6.0 to 70.0. Stem thickness had an average of 19.18 mm, fluctuating between 9.20 and 29.71 mm, whereas internode length recorded a mean of 13.02 cm with limits of 9.00 to 19.60 cm. Green leaf weight per plant showed a mean of 2.2 kg and ranged from 1.0 to 6.7 kg, while green stem weight per plant averaged 9.5 kg and varied from 3.6 to 31.9 kg. Consequently, green fodder yield per plant displayed a mean of 11.7 kg per plant, extending from 4.9 to 38.6 kg and dry matter yield per plant averaged 2.9 kg per plant with a range of 0.9 to 6.9 kg. Spike length recorded a mean of 26.73 cm, varying between 18.0 and 38.0 cm. Thousand-seed weight showed a mean of 1.9 g, with minimum and maximum values of 1.0 g and 3.1 g, respectively. Finally, seed yield per panicle recorded a mean of 6.2 g and exhibited a wide range, varying from 1.3 to 16.5 g.

Station trial

A total of 16 F_6 interspecific fertile BN hybrids were evaluated along with three checks *viz.,* IGFRI-6, CO-6 and BNH-11 for GFY involving three cuts. Results revealed several genotypes with substantial yield superiority over the checks, indicating their potential as high yielding fodder types. Genotype F_6-95 recorded the highest GFY (110.82 t ha^{-1}) along with maximum superiority over the checks IGFRI-6 (81.37%), CO-6 (56.65%) and BNH-11 (41.24%). This was followed by F_6-108 with GFY of 101.72 t ha^{-1}, which also showed substantial yield advantage over IGFRI-6 (66.49%), CO-6 (43.79%) and BNH-11 (29.65%). Genotype F_6-65 produced 86.16 t/ha GFY and expressed consistent superiority over IGFRI-6 (41.01%), CO-6 (21.79%) and BNH-11 (9.81%). Similarly, F_6-51 recorded a GFY of 79.73 t ha^{-1} with moderate but stable superiority over IGFRI-6 (30.49%), CO-6 (12.71%) and BNH-11 (1.62%). Overall, F_6-95, F_6-108, F_6-65 and F_6-51 emerged as superior genotypes for GFY.

3.1.9 Identification of oat (*Avena sativa*) lines for heat stress tolerance (CRSCIGFRISIL20200103)

A total of 20 heat shock proteins (HSPs) reported to be involved in heat tolerance in oat was studied for their gene expression in heat tolerant (HT) and heat sensitive (HS) oat line (one genotype from each category) under heat stress conditions. The plants were grown in pot experiment with normal sowing plants were considered as control and late sowing plants were considered as heat stressed. A total of 12 *HSP* genes showed significant difference in expression between HT and HS lines (Fig. 3.1.6). The gene expression was significantly higher in HT as compared to HS in the studied leaf samples.

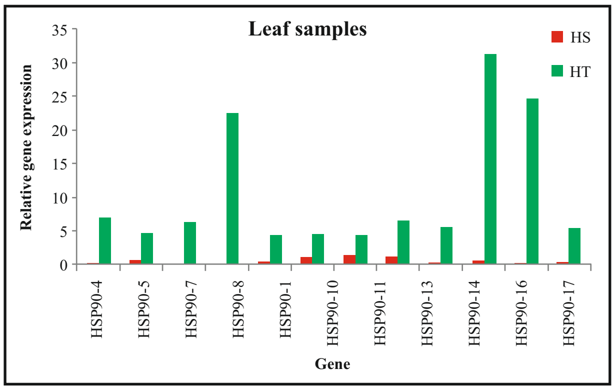

Fig. 3.1.6. Relative gene expression of heat shock proteins between heat tolerant and heat susceptible oat genotypes

- One new entry of lucerne (perennial) - IGFRI-DL4 was contributed for *rabi* 2025-26 during NGM on AICRP FC held during 18th and 19th September 2025 at CAU, Imphal.
- Multi-location trial on lucerne (annual) (2 + 4 checks) was conducted with 6 entries each in Zone-8 (Dharwad, Hukkeri and Bailhongal) and Zone-3 (Bijapur, Bagalkot and Belvatgi) during *rabi* 2024-25. One year MLT data was presented in annual plant scientists' *rabi* meet held in August.

3.1.10 Genomics assisted breeding for zinc and iron biofortification in oat (CRSCIGFRISIL20210102)

Phenotyping of association mapping panel for Zn, Fe and other fodder traits

Wide range of variation was observed for Zn and Fe contents with Zn ranged from 0.53-53.23 ppm & 8.63-79.07 ppm in control & treatment conditions, respectively at Jhansi while at Hisar, it ranged from 0.06-30.77 ppm & 8.28-32.07 ppm in control & treatment conditions, respectively. Similarly, Fe ranged from 1.34-354.84 ppm & 62.76-677.61 ppm in control & treatment conditions, respectively at Jhansi while at Hisar, it ranged from 32.37-846.87 ppm & 15.57-332.16 ppm in control & treatment conditions, respectively.

Development of F_2 mapping population segregating for Zn and Fe

Four mapping populations derived from high Zn and high Fe lines with oat varieties *viz.,* JHO-99-2 and JHO-15-1 were advanced to F_5 generation.

3.1.11 Identification and characterization of genes involved in expression of apomixis component-traits in polyploidy series of guinea grass

(CRSCIGFRISIL20210101)

Weighted gene correlation network analysis (WGCNA)

Transcriptome analysis was conducted for *Megathyrsus maximus*, which was categorized into apomictic, sexual and facultative reproductive stages. All the significant genes were taken to generate the weighted gene correlation network from three reproductive stages. The network illustrated a densely connected module of genes identified from co-expression analysis, highlighting key regulatory hubs involved in reproductive development characterized by tight co-expression among genes controlling meiotic suppression, germline specification, hormonal signalling and flowering-time integration. Nodes represented genes, with highlighted (yellow) nodes indicating apomixis-related genes and edges denoting significant co-expression or interaction relationships. The presence of *MEI2-like, MSP1* and *Argonaute MEL1* points to regulation of meiotic progression and germline specification, while *Flowering Locus T, VRN1, GIGANTEA* and *TWIN SISTER OF FT* indicated strong linkage between reproductive fate and flowering-time pathways (Fig. 3.1.7). WGCNA suggested that apomixis is governed by a complex, multi-layered regulatory framework rather than a single genetic switch.

The magnified inset highlighted the core hub region within the larger network emphasizing coordinated regulation governing meiotic bypass, embryo sac development and parthenogenetic competence in the apomictic pathway.

3.1.12 Genome-wide identification, characterization and expression analysis of *Flowering Locus T* (*FT*) genes controlling floral induction in cowpea

(CRSCIGFRISIL20230102)

Bioinformatics analysis led to identification of 13 *Flowering Locus T* (*FT*) and related genes in cowpea genome. Expression analysis showed higher expression of 2 *FT* genes under flowering condition in cowpea genotype IC372726 (E2) as compared to non-flowering condition in cowpea genotype, BL-2 (L4) at 35 DAS. Further, diurnal expression analysis revealed distinct peak of expression at different time interval of 24 h cycle. *VuFT-1* showed double peak of expression at 9AM and 9PM while *VuFT-2* showed a single peak of expression at 9AM in cowpea genotype IC372726 (E2) under flowering condition (Fig. 3.1.8).

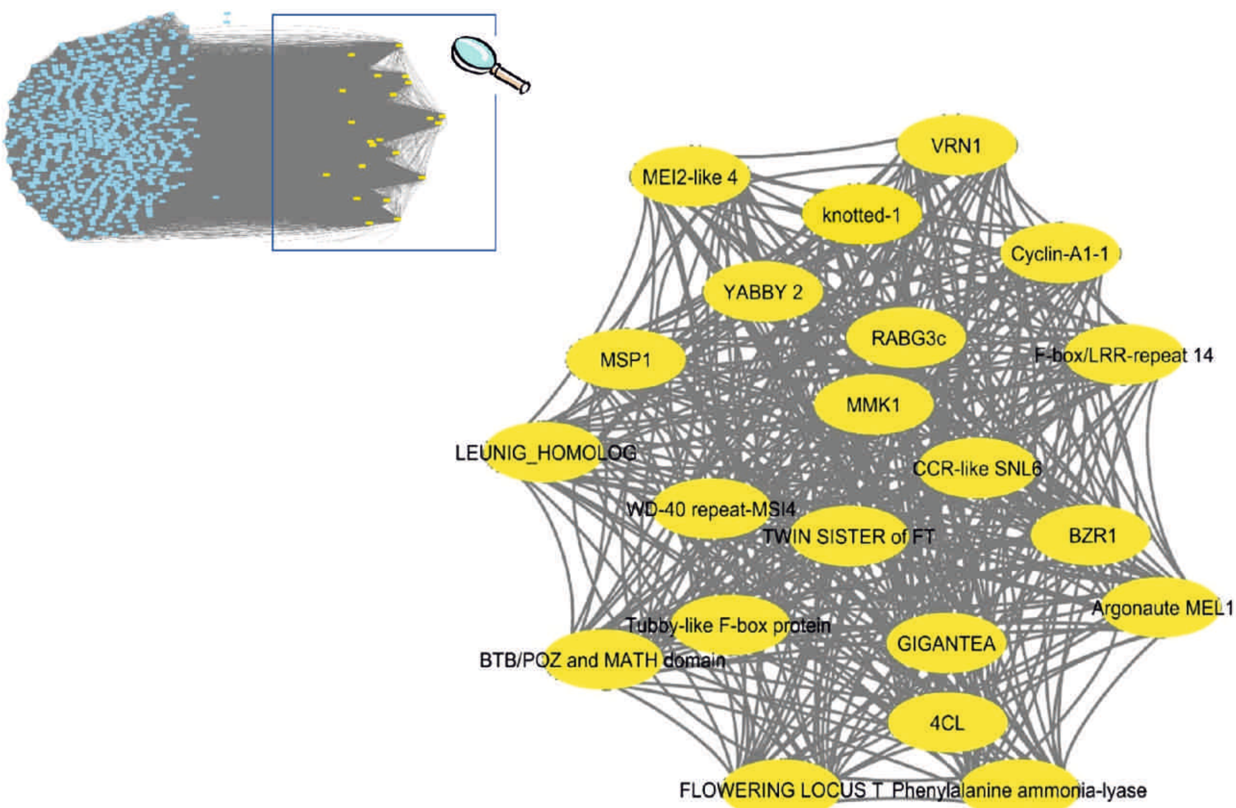

Fig. 3.1.7. Weighted gene correlation interaction network

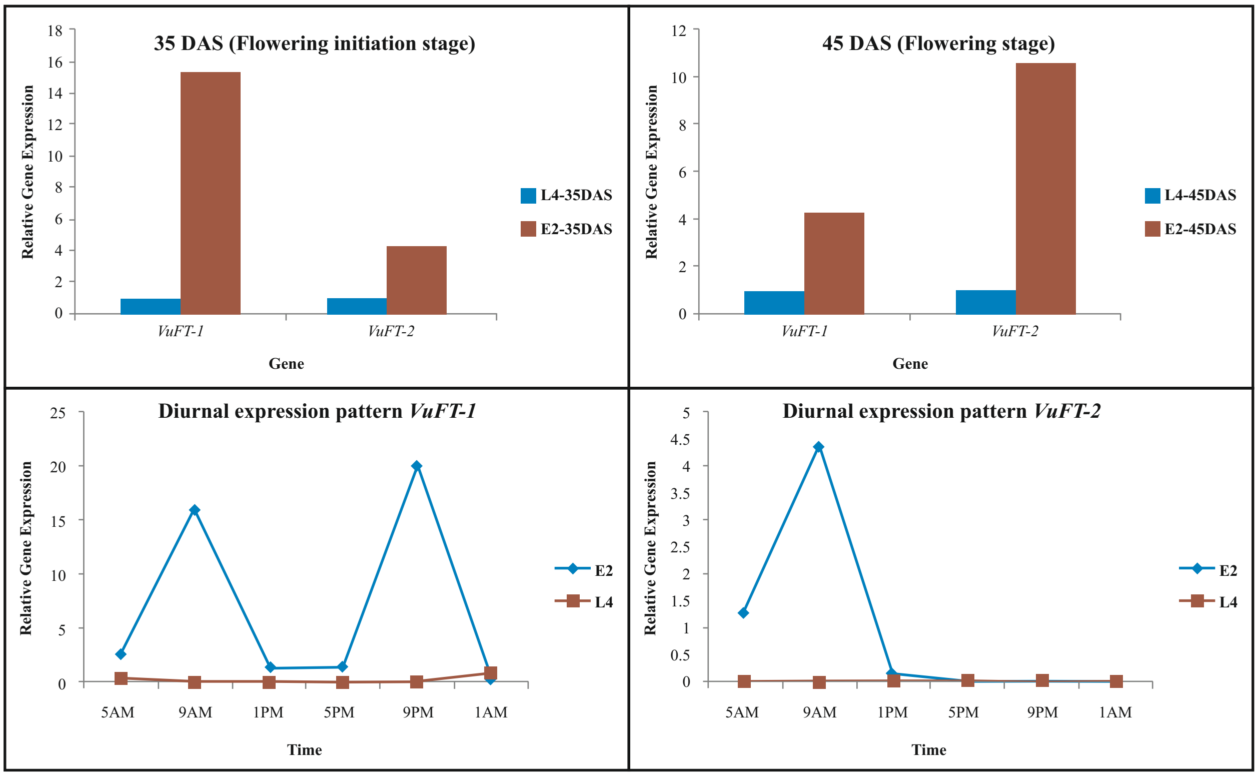

Fig. 3.1.8. Gene expression studies of *VuFT-1* and *VuFT-2* under flowering condition in cowpea

3.1.13 Genetic improvement of temperate forage crops (CRSCIGFRISIL20211002)

Seventeen varieties/germplasm lines of maize were evaluated under irrigated conditions using a Randomised Block Design. Significant variation was observed for the different traits studied. Maximum height was observed in J1007 (256.7 cm), which was at par with KDFM-1. Overall, KDFM-1 excelled all the varieties/ germplasm in productive traits with dry leaf wt./plant (17.31 g), dry stem wt./ plant (24.07 g), green fodder yield (61.9 t/ha) and dry fodder yield (11.4 t/ha).

About 19 varieties of berseem were evaluated under irrigated conditions under Randomized Block Design for fodder quality traits. The maximum crude protein content was observed in BL-44 (19.14%), while as the minimum was observed in JB-5-9 (15.1%). Sixteen varieties/germplasm lines of rye grass were evaluated under a Randomised Block Design. Significant variation was observed for different traits studied. Maximum height was observed in Himpalam-1 (104.67 cm), which was at par with rye grass-3 Imam Sahab (103.67 cm). Tillers /sq.m were maximum in rye drass St. Kralpora (202.00). Maximum Green Fodder Yield (40.83 t/ha) was observed in Himpalam-1, which was at par with rye grass-1 Pahoo (40.40 t/ha) and rye grass-3 Imam Sahab (40.66 t/ha). Maximum dry fodder yield was observed in Himpalam-1 (9.39 t/ha), which was at par with rye grass-1 Pahoo (9.29 t/ha) and rye grass-3 Imam Sahab (9.42 t/ha). Highest fodder yield: Him Palam -1 at par with two of our collections from Imam Sahab and Pahoo.

3.1.14 Evaluation of berseem gene pool for herbicide tolerance (CRSCIGFRISIL20200401)

In this study, our main objective was to search for herbicide resistant lines of berseem against glyphosate. Seeds were collected from individual progenies of the selected mutant lines (03) of berseem, showing low to moderate level of tolerance against glyphosate after four rounds of screening. Seeds of individual progenies of the selected mutant lines (03) were sown in the pot along with the cultivated varieties as check. Glyphosate was sprayed @ 0.8 kg *a.i.*/ha 30 DAS. Like previous rounds of screening, plants showed symptoms of toxicity after 4-5 days of glyphosate spraying, leaves and the region of apical meristem were dried completely by 15-20 days. The growth was extremely retarded almost up to one month. Few seedlings resumed growth from the crown region of the stem through lateral branching. Survived progenies reached till flowering stage and set seeds but seed yield was very poor. The progenies exhibited variable tolerance towards glyphosate.

3.1.15 Breeding lucerne (*Medicago sativa* L.) for high forage yield and nutritional quality for different eco-systems (Phase II)

(CRSCIGFRISIL20200903)

Lucerne variety IGFR-DL-2 (AWCL-2) was a population developed from Anand-2 x Weevlchek. It is a herbaceous perennial and highly nutritious fodder legume grown under irrigated conditions. It grows to a height of 85-90 cm. It has slight deep green, small erect leaves with serrations on margins. It has light to medium dark purple flowers and yellow medium bold seeds. It is propagated through seed. It produced green fodder yield of 85-90 t/ha/year and dry matter yield of 10-15 t/ha. The Crude Protein Yield (CPY) of 2.5-3.0 t/ha and seed yield of 100-150 kg/ha was recorded. It had crude protein content of 16-18% with *in-vitro* dry matter digestibility (IVDMD) of 58-62%. Besides it was had acid detergent fibre (35-40%) and neutral detergent fibre (55-60%) which was desirable indicating digestibility and voluntary intake by animal. It was resistant to rust and leaf miner and moderately resistant to Weevil and *Helicoverpa armigera* (Gazette Notification SO 2128 (E) dt. 13th May, 2025) (Fig. 3.1.9)

Fig. 3.1.9. Growth of IGFRI-DL-2

3.1.16 Combined stress tolerance of water logging and salinity in fodder grasses

(CRSCIGFRISIL20180901)

Application of Halomix in 20 genotypes could increase yield by 12-32% under salinity stress. Whereas Halomix treated plants had 12-45% increase during the salinity stress recovery phase. BNH-14 showed strong stability and high survival under coastal and inland salinity (EC 8-10). *Panicum repens* was identified as tolerant to combined stress. *Coix aquatica* was collected from salinity + water logging lands.

3.1.17 Eco-friendly management of aphids *Aphis craccivora* in cowpea (*Vigna unguiculata*)

(CRSCIGFRISIL20240901)

Population dynamics of aphid (*Aphis craccivora*) population indicated that highest number of aphids 125.66 were recorded on 11st MSW which was coinciding on 3rd week of March .

Correlation studies indicated aphid number was positively correlated with temperature (0.52**) and negatively correlated with rainfall (-0.58*). Among all the eco-friendly approaches tested, *Lecanicillium lecanii* (2x10^{8} cfu/g) @ 2 g/l and Neem formulation (3000 ppm) @ 5 ml/l were found to be most effective. However, standard insecticide Acetamiprid 20 SP @ 1 g/l proved better. Over all the eco-friendly approaches in both the sprays and same trend was reflected in obtaining GFY and DFY.

3.1.18 Studies on fodder production potential of fodder shrub based alley cropping systems in peninsular India

(CRSCIGFRISIL20200902)

On the basis of mean performance of 3 years, the sole bajra napier hybrid recorded higher green fodder yield among all the treatments, however, moringa + bajra napier hybrid recorded the highest crude protein yield of 4.87 tonnes per hectare indicating its superiority in terms of quality fodder production. Similarly, sole grazing guinea recorded higher fodder yield, however the moringa + *Brachiaria* recorded higher crude protein yield and found to be better in crude protein production. The soil fertility status in terms of organic carbon content, available N, P and K content in soil after 3 years, the growing of fodder crops in conjunction with fodder shrubs improved all of them. Further the introduction of fodder shrubs increased these as compared to grasses alone in both irrigated and rainfed ecosystem. The intercropping of moringa+bajra napier hybrid under irrigated ecosystem and moringa+Brachiaria recorded higher monetary returns among the fodder shrub intercropped alley cropping systems under rainfed ecosystem. After the conclusion of the studies in the field, identified 25 progressive farmers were for distribution of planting material of bajra napier hybrid, guinea grass under irrigated ecosystem and signal grass and grazing guinea under rainfed ecosystem along with moringa seeds to demonstrate the salient finding of the above said project.

3.2 Diversification and sustainable intensification of fodder production in different land use systems including assessment and rejuvenation of grasslands and other resources for improving productivity and livelihood options

3.2.1 Study of restoration ecology in silvipasture system for semiarid region (CRSCIGFRISIL20200301)

A regional climate modelling analysis for period 2020-2080 was undertaken to project the effects of climate change based on temperature and precipitation projections from CMIP6 SSP2-4.5 and SSP5-8.5 scenarios. Based on modelling *Acacia nilotica* emerged as the most resilient species, followed by *Ficus infectoria* and *Morus alba* while *Leucaena leucocephala* was the most sensitive to warming with high yield potential. Total biomass carbon stock and carbon dioxide equivalent storage under this system ranged from 10.32 to 33.45 Mg C/ha and 37.87 to 122.76 Mg/ha, respectively. Fine root biomass production (g m^{-3}) and fine root length density (cm cm^{-3}) was also studied and it varied by season, species, distance from tree base and soil depth, following the patterns: Autumn > Spring > Summer; *F. infectoria*>*M. alba*>*A. nilotica*>*L. leucocephala*; 1.0 m > 1.5 m > 0.5 m > 2.0 m > 2.5 m from the tree base; and 0–20 cm > 20–30 cm > 30–60 cm soil depth, respectively. It was noticed that *M. alba* based silvipasture system significantly improved soil structure through enhanced aggregate formation followed by *A. nilotica*, *L. leucocephala* and *F. infectoria* based silvipasture system (Fig. 3.2.1).

Fig. 3.2.1. *F. infectoria* based silvipasture

3.2.2 Evaluation of *Ailanthus excelsa* and *Morus* species germplasm for growth performance, fodder yield and nutritional traits under various agro-climatic zones (CRSCIGFRISIL20200303)

Growth, morphological, leaf yield, leaf nutritional and phenological traits of 75 germplasm collections of *Morus* species were recorded in Jhansi condition. Fresh leaf yield ranged from 0.26 to 7.52 Mg/ha; dry leaf yield from 0.08 to 2.31 Mg/ha; CP% ranged from 9.34-19.9% in summer, 8.33-22.52% in rainy season, 11.03-20.99% in autumn among germplasm (Fig. 3.2.2a) and 15 germplasm under Srinagar, J & K condition wherein fresh leaf yield ranged from 74.42 to 359.8 g/plant and CP ranged from 11.57-16.30% (spring) and 11.42-16.91% (autumn).

In case of *A. excelsa* evaluated at Jhansi, height ranged from 0.33 to 1.92 m and collar diameter from 16.10 to 114.31 cm (Fig. 3.2.2b) and in Avikanagar condition it ranged from 45 to 215 cm and from 1.3 cm to 6.5 cm, respectively.

Fig. 3.2.2a. Field view of *Morus* spp. germplasm

3.2.2b. Field view of *Ailanthus excelsa* germplasm

3.2.3 Sustainable forage production through lopping management in three tier silvipasture systems (CRSCIGFRISIL20220301)

In three tier silvipasture system, planting of *Hardwickia binata* and shrub species in alternate row at 6x6 m spacing recorded maximum understorey pasture yield of *Cenchrus ciliaris* (10.53 t/ha) followed by 6x4 m (9.19 t/ha) and 4x4 m spacing (7.35 t/ha) (Fig. 3.2.3a). Among shrub species, *Ziziphus mauritiana* recorded significantly higher top feed (5.47 t/ha) and fire wood yields (5.97 t/ha) as compared to *Z. xylopyrus* (4.98 and 5.51 t/ha) and *Acacia catechu* (3.75 and 4.31 t/ha) in association with

H. binata, respectively. Lopping of shrubs and *H. binata* at 70% intensity (Fig. 3.2.3b) resulted in significantly higher top feed (5.26 t/ha) and fire wood yields (5.86 t/ha) as compared to lopping at 50% intensity (4.21 and 4.67 t/ha). *Z. mauritiana* recorded maximum carbon stock (50.07 t/ha) followed by *A. catechu* (32.87 t/ha) and *Z. xylopyrus* (29.31 t/ha) in association with *H. binata.* Similarly, lopping of shrubs and *H. binata* at 50% intensity recorded significantly higher carbon stock (43.81 t/ha) as compared to lopping at 70% intensity (31.02 t/ha).

Fig. 3.2.3a. Three-tier silvipasture system
b. Lopping management in three-tier silvipasture

3.2.4 Pruning management for optimizing forage and wood productivity from *H. binata* based silvipasture systems (CRSCIGFRISIL20230304)

In *H. binata* based silvipasture systems (Fig. 3.2.4a), *Chrysopogon fulvus* recorded significantly higher pasture yield (9.45 t/ha) as compared to *Megathyrsus maximus* (8.18 t/ha) and it was found at par with *Cenchrus ciliaris* (9.09 t/ha) in association with *H. binata*. Pruning of *H. binata* branches at 60% intensity resulted in significantly higher pasture yield (10.11 t/ha) as compared to pruning at 30% intensity (7.61 t/ha) and pruning at 45% intensity (8.99 t/ha) (Fig. 3.2.4b), top feed (5.46 t/ha) and fire wood yields (8.60 t/ha) also significantly increased with pruning at 60% intensity of *H. binata* branches than pruning at 30% intensity (3.58 and 5.76 t/ha) and found at par with pruning at 45% intensity (5.00 and 7.92 t/ha), respectively. However, in terms of bole wood volume, pruning at 30% intensity of *H. binata* branches recorded significantly higher bole wood volume (2780 cubic feet/ha) as compared to pruning at 60% intensity (2108 cubic feet/ha) and found at par with pruning at 45% intensity (2451 cubic feet/ha). *H. binata* stored 38.38 tonnes carbon/ha/year. In total carbon stock of *H. binata* contribution of above and below ground carbon stock were around 78% and 22%, respectively. Soil moisture was recorded at 0-15, 15-30 and 30-60 cm depths after monsoon in October and December. Pooled data of two months showed that *C. fulvus* recorded higher moisture content (10.01, 11.26 and 12.28%) as compared to *M. maximus* (8.57, 10.07 and 11.19%) and found at par with *C. ciliaris* (9.47, 10.82 and 11.90%) at 0-15, 15-30 and 30-60 cm soil depth, respectively.

Fig. 3.2.4a. *H. binata* based silvipasture system

Fig. 3.2.4b. Pruning management in *H. binata* based silvipasture system

3.2.5 Sustaining productivity in grown up hortipastoral system for fruit and forage security with soil and tree management practice (CRSCIGFRISIL20230303)

Evaluation of decomposer accelerator to promote natural farming in Aonla-based horti-pasture system

Seven treatments *viz.,* T_1 (Livestock slurry-Livestock urine 100 l/ha + 100 kg dung/ha), T_2 (Jeevamrit @ 1000 l/ha), T_3 (Ghanjivamrit (@ 2000 kg dry cow dung/ha using 200 litre Jeevamrit), T_4 (Institute decomposer consortium), T_5 (FYM 2 t/ha) T_6 (RDF - 30 kg N, 20 kg P & 20 kg K/ha) and T_7

(control) were applied twice in March and June (2025) to understorey pasture in aonla based hortipasture system (Fig. 3.2.5a). The fruit production (Fig. 3.2.5b) was significantly higher with the treatment of T_6 (10.96 t/ha) followed by T_5 (10.26 t/ha) and T_4 (9.86 t/ha) and minimum with control (8.75 t/ha). The understorey pasture production was significantly higher with treatment T_6 (6. 55 t DM/ha) followed by T_5 (6.0 t DM/ha), T_3 (6.4 tDM/ha) and minimum with control (5.120 t DM/ha). The system productivity was significantly higher (31.6 tDM/ha) with the application of decomposer as compared to control (27.0 t DM/ha).

Fig. 3.2.5a. Aonla based hortipasture system

Fig. 3.2.5b. Aonla fruit production

Improvement of ecosystem productivity in guava based horti-pastoral system with foliar application of micronutrients on fruit tree

In 17 years old guava based hortipasture system (Fig. 3.2.6a) the fruit set and fruit retention were significantly increased (54.9-60.6 & 56.7-60.1%) in *cv.* Lalit and Shweta, respectively with the application of micronutrients as compared to control (47.45 and 48.5%, respectively). Micronutrient application also significantly influenced the fruit yield (Fig. 3.2.6b) as compared to control and it was the highest (14.7 and 13.1 t/ha) in Lalit and Shweta, respectively). The physico-chemical composition was significantly affected with the application of foliar spray of micronutrients as well as with the cultivars. The understorey pasture (*Cenchrus ciliaris*) production ranged from 4.1-5.1 t DM/ha. The system productivity was significantly higher in HPS with *cv.* Lalit (75.8 t DM/ha/y) than Shweta (67.63 t DM/ha/y). The respective increase was 12.08%. In respect of foliar sprays, application of Boron (Borax) (0.5%) + $ZnSO_4$ (0.75%) recorded significantly higher system productivity of guava varieties compared to T_1 and T_5.

Fig. 3.2.6a. Guava based hortipasture system

Fig. 3.2.6b. Guava fruit production

3.2.6 Improved pasture management for sustaining soil-pasture-animal productivity (CRSCIGFRISIL20230302)

The above ground pasture productivity (APB) under low grazing pressure (LGP) and medium grazing pressure (MGP) was ~29 and 15% greater than high grazing pressure (HGP), respectively. However, the APB deviated by ~11, 21 and 30% under LGP, MGP and HGP, respectively over ungrazed control (UGC). At the 0-20 cm depth, the root biomass under LGP and MGP was ~26 and 13% greater than HGP, respectively. Similar trend was true at the 21-40 cm depth. However, the root biomass was ~10, 19 and 28% lower at 0-20 cm depth and 8, 16 and 23% lower at 21-40 cm depth under LGP, MGP and HGP, respectively over UGC. The mean values of $\delta^{13}C$ of vegetation roots were -12.4, -12.5, -12.9 and -13.2%, respectively, for LGP, MGP, HGP and ungrazed control (UGC). The mean values of $\delta^{13}C$ of animal faeces and urine were -19.8 and -20.0%, respectively. At 0-20 cm depth, the large macro aggregate (LMA) mass declined by ~ 18 and 38% under LGP and HGP over UGC, but under MGP, it was similar to UGC. Interestingly, the mass of small macro aggregate (SMA) improved by ~10.5 and 22.5% under LGP and HGP over UGC, whereas that under MGP declined by 8.5% over UGC. The mass of micro aggregate (MI) increased by ~15 and 36% under MGP and HGP than UGC. The mass of SC (silt+clay) increased by ~30 and 86% under LGP and MGP and declined by 24% under HGP over UGC, respectively. At 21-40 cm depth, the LMA mass increased by 47% under MGP and declined by 18% under HGP over UGC. The mass of SMA declined by ~12% under MGP over UGC. The SCagg declined by ~27 and 15% under LGP and HGP over UGC. The SMA could protect ~51-79% of SOC. The LMA, MI and silt clay could protect ~13-36%, 4-8% and 3-9% of SOC, respectively. The mean weight diameter (MWD) under LGP was statistically similar to UGC, but under MGP and HGP, it declined by 9-14% at 0-20 cm depth. The geometric mean diameter (GMD) declined by 11-23% under LGP and HGP over UGC. The MWD and GMD declined by15-26% and 25-29% in grazed plots over UGC at 21-40 cm depth, respectively. In this experiment, advanced nutrient management strategy, such as nitrogen application through drone is adopted for sustainable nutrient management.

Fig. 3.2.7. Drone based nutrient management in pasture system

3.2.7 Solubilization of native soil phosphorus using natural silicon sources and P solubilizing microbes (CRSCIGFRISIL20230301)

Fodder yield per pot varied significantly among treatments (Fig. 3.2.8) for all tested grasses. In *Megathyrsus maximus*, the highest fodder yield was recorded under T_7 (100% NPK application) (102.56 g pot^{-1}), which was statistically at par with T_4(RS+50% NPK + P solubilizing microbes application) (101.26 g pot^{-1}) and significantly higher than the remaining treatments. The lowest yield recorded with T_1 (72.65 g pot^{-1}). In *Cenchrus ciliaris*, fodder yield increased progressively across treatments, with T_7 producing the maximum yield (50.54 g pot^{-1}), followed by T_6 (100% NPK + P solubilizing microbes application) (46.91 g pot^{-1}) and T_5 (RS + 75% NPK + P solubilizing microbes application) (45.63 g pot^{-1}), while control recorded the minimum yield (16.99 g pot^{-1}). Phosphorus use efficiency (PUE) differed significantly among treatments for all grasses. In *M. maximus*, the highest PUE was recorded under T_4 (24.50%), which was significantly superior to all other treatments, followed by T_7 (22.07%) and T_5 (20.88%). Lower PUE values were observed under T_6 (18.75%). A similar pattern was observed in *C. ciliaris*, where T_4 resulted in the maximum PUE (22.36%), followed by T_7 (19.89%) and T_5 (18.69%).

Fig. 3.2.8. Growth of grasses under different P treatments

3.2.8 Recuperated canopy architecture for higher bael (*Aegle marmelos*) productivity and forage security in semi-arid region (CRSCIGFRISIL20200302)

In bael based hortipasture system the highest pasture was recorded with sole pasture (8.95 t DM/ha) followed by central leader (8.65 tDM/ha) and with lowest in NB-9 with untrained system (V_2C_4 -5.43 t DM/ha). Available nitrogen ranged from 152.93 to 283.92 kg ha^{-1}. Available phosphorus varied between

8.88–10.98 kg ha^{-1}, with maximum values observed in V_2C_4 and CISHB-2 with untrained system (V_1C_4). Available potassium varied widely from 126.01 to 258.57 kg ha^{-1}, with highest concentration in V_1C_4. Soil organic carbon content ranged from 0.78 to 0.96% with highest value recorded in V_1C_4, followed by V_2C_4. Soil pH remained near neutral across treatments, ranging from 6.51 to 7.38. Soil biological activity, as indicated by enzyme activities, differed across treatments. Dehydrogenase activity ranged from 43.45 to 68.64 µg TPF g^{-1} h^{-1}, with the highest activity observed in V_1C_4. Alkaline phosphatase activity varied from 97.52 to 127.80 µg g^{-1} h^{-1}, showing maximum values under V_1C_4 and CISHB-2 with untrained sole bael without pasture (V_1C_5). β-glucosidase activity ranged between 10.74 and 17.46 µg PNG g^{-1} h^{-1}, with the highest activity recorded in V_1C_4. Urease activity varied from 116.80 to 140.07 µg NH_4^+ g^{-1} h^{-1}, with the maximum value observed in V_1C_4. Average soil moisture content during November to April ranged from 5.98 to 6.42% at 0–15 cm depth and from 6.57 to 7.10% at 15–30 cm depth. Bulk density ranged from 1.25 to 1.35 g cm^{-3}, with the lowest value observed in V_2C_4 and the highest in CISHB-2 with Open centre/open vase system (V_1C_3) and NB-9 with Open centre/open vase system (V_2C_3). Average leaf area index (LAI) varied from 3.68 to 4.82 m² m^{-2}. The highest LAI was observed under V_2C_4, followed by V_1C_4 and V_1C_5. Average photosynthetically active radiation (PAR) ranged from 144.32 to 289.89 µmol m^{-2} s^{-1}, with the highest PAR recorded in V_1C_3 and V_2C_3. Annual litter biomass production ranged from 14.79 to 28.09 kg tree^{-1} year^{-1}. The highest litter biomass was recorded under V_1C_5, followed by V_1C_4 and NB-9 with untrained sole bael without pasture (V_2C_5). Nitrogen return through litter ranged from 54.28 to 112.17 kg ha^{-1}, phosphorus return from 13.17 to 31.53 kg ha^{-1} and potassium return from 44.05 to 99.11 kg ha^{-1}. The highest nutrient return for all three nutrients was observed under V_1C_4.

3.2.9 Assessment of water requirement for fodder based cropping systems in different parts of Uttar Pradesh (CRSCIGFRISIL20220202)

Crop (CWR) and irrigation water requirement (IWR) of five popular fodder based cropping systems *viz*. sorghum + berseem, guinea grass + berseem, BN hybrid + berseem, maize + cowpea, BN hybrid + cowpea were estimated using Penman Monteith model and crop coefficient based approaches in five cities of Uttar Pradesh (Meerut, Kanpur, Jhansi, Lucknow and Varanasi). It was found that Jhansi consistently showed the highest mean gross IWR across systems (most irrigation-stressed). Varanasi had the lowest mean gross IWR. BN hybrid + berseem was the most water-intensive system overall.

3.2.10 Studies on temperate pasturelands for enhanced forage yield, quality and environmental sustainability (CRSCIGFRISIL20201001)

Temperate grasslands are ecologically fragile ecosystems that play a critical role in supporting livestock-based livelihoods, biodiversity conservation and climate regulation, yet their assessment through conventional field methods is time-consuming and spatially limited. The study was carried out in alpine pastures of Budgam, Kulgam and Shopian districts of Kashmir Himalaya, covering about 22,800 ha with an average elevation of ~2,577 m. Field sampling was conducted at 257 geo-referenced locations during the peak growing season (May–June 2024) to estimate aboveground biomass, supported by laboratory analysis of soil organic carbon and available nitrogen, phosphorus and potassium. Multi-source datasets comprising Landsat-8 derived vegetation and soil indices, MODIS net primary productivity, SRTM-based topographic parameters and NASA POWER climate variables were integrated. Nine machine learning models were evaluated for predicting pasture productivity and carrying capacity, including Random Forest, XGBoost, Cubist, Support Vector Machine, Gaussian Process Regression, KNN, MARS, PLSR and Elastic Net. Model performance was assessed using cross-validation and standard statistical metrics, while interpretability was ensured through SHAP analysis, Sobol global sensitivity analysis and network analysis.

Pasture productivity (Fig. 3.2.9) in the study area ranged from 720 to 4000 g m^{-2} with a mean of about 1530 g m^{-2} and closely followed the spatial pattern of carrying capacity. Among the tested models, Random Forest performed best, achieving high prediction accuracy for aboveground biomass ($R^2 = 0.75$; RMSE ≈ 419 g m^{-2}) and carrying capacity ($R^2 \approx 0.73$). Predicted carrying capacity varied from 0.81 to 3.47 ACU ha^{-1} with a mean of 1.41 ACU ha^{-1}. Interpretability analyses consistently identified available nitrogen, precipitation, elevation, soil organic carbon, phosphorus, net primary productivity and key vegetation indices as the major drivers of pasture productivity. Scenario analysis further indicated that productivity enhancement in degraded alpine pastures required urgent management of soil nutrients, particularly maintaining nitrogen ≥310 kg ha^{-1}, phosphorus ≥9.5 kg ha^{-1}, potassium ≥260 kg ha^{-1} and soil organic carbon ≥0.45 g kg^{-1}, along with appropriate grazing management.

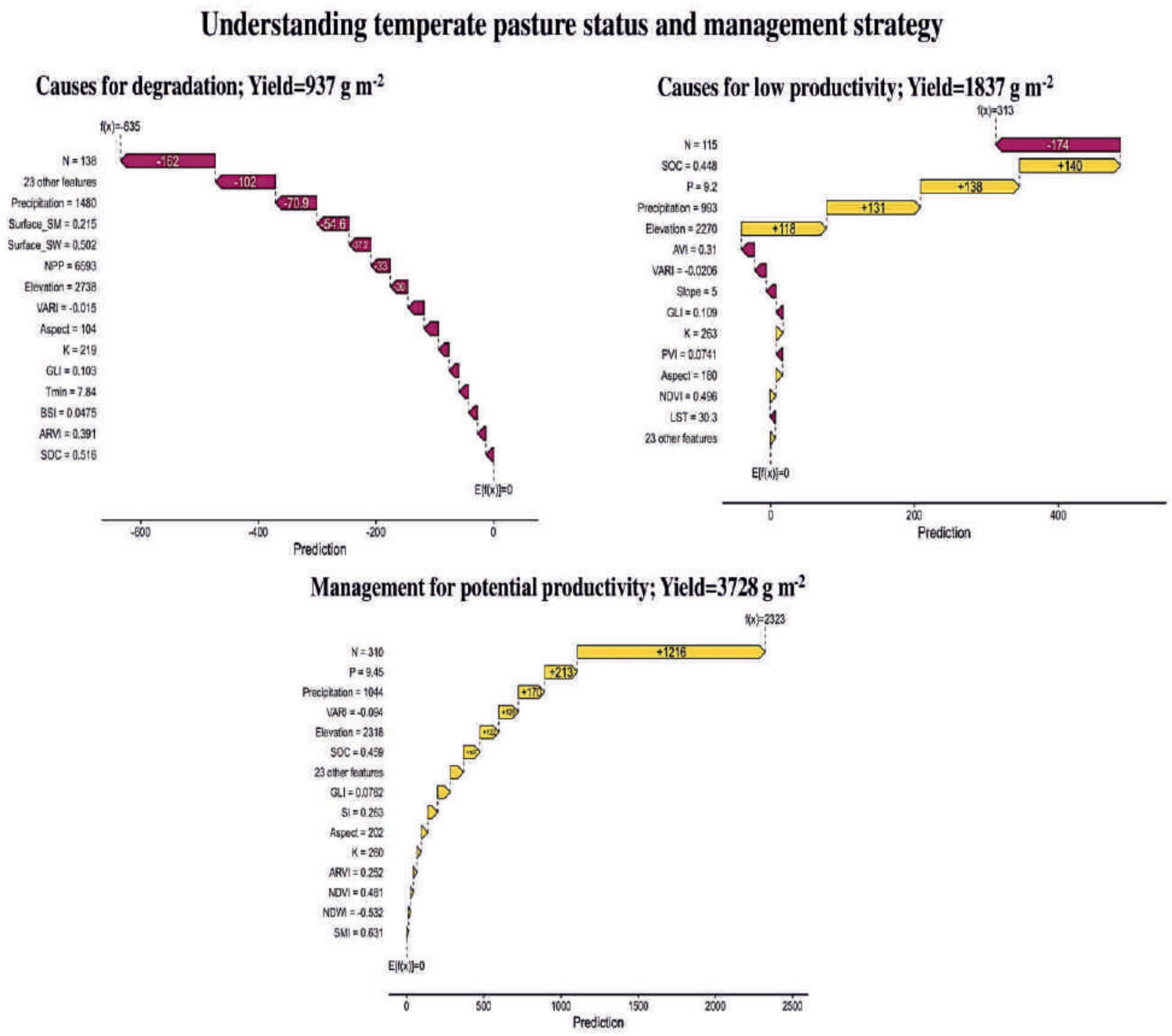

Fig. 3.2.9. SHAP analysis indicating different pasture production scenario in alpine pasture

3.3 Management of natural resources and soil health of arable and non arable lands for climate resilient sustainable fodder production

3.3.1 Harnessing the potential of invasive weed biochar as fertilizer coating material for improving fodder productivity, nutrient use and soil health (CRSCIGFRISIL20240201)

A field experiment was conducted to evaluate the effect of invasive weed biochar-coated fertilizers on plant growth attributes (Fig. 3.3.1a), fodder yield and quality, soil health parameters and nutrient uptake in fodder oat. Results revealed that both *Parthenium hysterophorus* and *Lantana camara* biochars exhibited alkaline pH and high nutrient content. *Lantana camara* biochar showed slightly higher carbon and nutrient levels, whereas *P. hysterophorus* biochar demonstrated superior water-holding capacity and cation exchange potential. Application of *L. camara* and *P. hysterophorus* biochar-coated fertilizers at 75% RDF significantly improved crop growth parameters, dry fodder yield (7.46–15.63%), green fodder yield (3.74–6.93%) (Fig. 3.3.1b), fodder quality (7.58–13.38% crude protein) and nutrient uptake in fodder oat compared to 100% RDF (T_2). Soil physicochemical properties (bulk density, water-holding capacity, soil organic carbon and available N, P and K) and biological properties (microbial population and enzymatic activities) in post-harvest soil were also significantly improved with the application of 75% RDF through invasive weed biochar-coated fertilizers compared to 100% RDF.

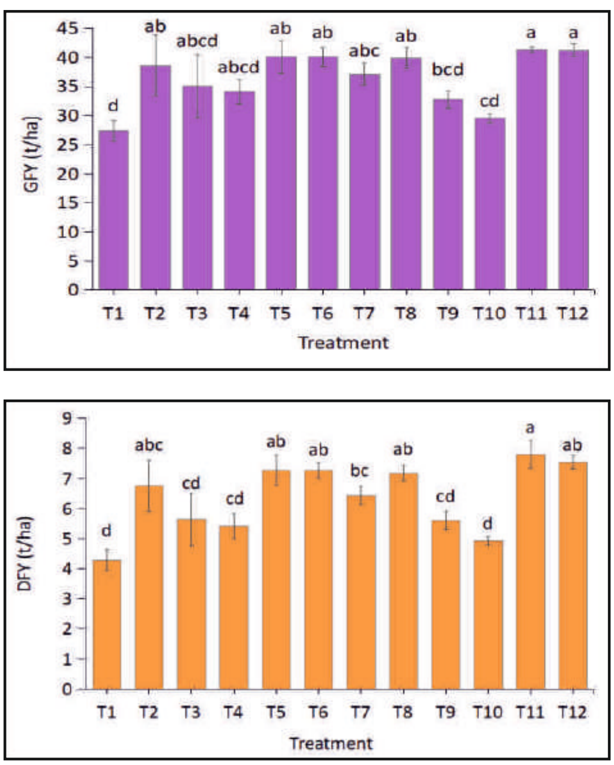

Fig. 3.3.1a. Effect of invasive weed biochar coated fertilizer on green and dry fodder yield of oat

Fig. 3.3.1b. Overview of the experiment

3.3.2 Manipulating the rhizosphere microbiome using plant growth promoting microbes to enhance soil and plant health (CRSCIGFRISIL20210201)

Oat rhizosphere microbiome was manipulated by seed inoculation with plant growth promoting microbes (PGPMs). Three PGPMs with 3 fertilizer doses combinations were used. In field evaluation, all PGPM treatments recorded greater GFY (21.80-26.00 Mg ha^{-1}) and seed yield (796.7-846.7 kg ha^{-1}) compared with 100% RDF (90:40:40 kg N:P:K: ha_{-1}) in the nutrient poor - light textured soil. All PGPMs recorded similar or greater soil microbiological properties (*i.e.* microbial counts, acid and alkaline phosphatase enzyme activities) than 100% RDF. Collected root exudates were analyzed through HPLC and its chromatogram revealed enhancement of the peaks of root exudates in bacteria and fungi inoculated plants. PGPM treatment with 50% RDF and 75% RDF resulted GFY at par with 100% RDF. All inoculants treatments with 50, 75 and 100% RDF recorded at par DFY and seed yield. PGPM treatments recorded enhanced microbial population than uninoculated. Specific compounds exuded in response to PGPM treatments (as shown as additional and enhanced peaks in HPLC/ LC-HRMS chromatograms) were identified through GC-MS/MS as Methyl carbanilate, cis-methyl 11-(3-pentyl-2-oxiranyl) undecanoate, Behenic alcohol, hexadecyloxirane and Octacosonol, which were absent in control.

Metagenomic and metatranscriptomic analysis revealed species diversity and differentially expressed genes in control and treatment samples (Fig. 3.3.2 and Table 3.3.1).

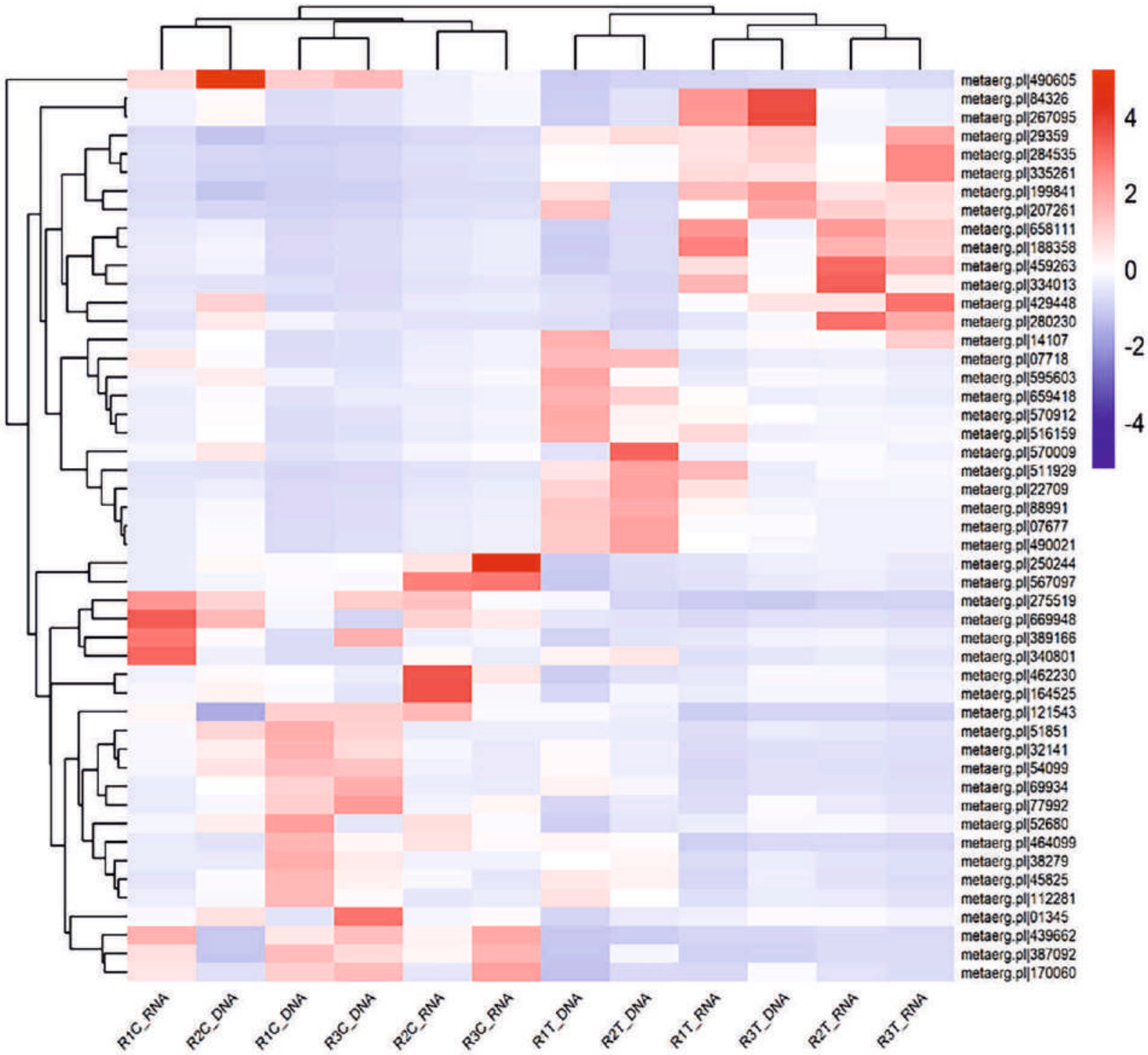

Fig. 3.3.2. Differential analysis of expressed CDS

Table 3.3.1. Results of molecular characterization of control and PGPM treatment samples

Parameter	Control	PGPM treatment
Microbial diversity	Lower	Higher
Beneficial species	Low abundance	High abundance
Active gene expression	Limited	Strong metabolic activity
Functional traits	Weak	Enhanced nutrient cycling and plant signaling

3.3.3 Nature-positive integrated farming system for improving livelihood and ecosystem services (CRSCIGFRISIL20240202)

Activities and achievements included the establishment of an innovative and weather-proof system, having components of dragon fruit + moringa + (sesame-chickpea) in 0.2 acre area of rainfed IFS. This system was conceptualized to save dragon fruits during extreme summer, provide balanced food, fodder and fruits and generate immense profit and employment for the marginal and small farmers. Besides, the tri-specific hybrid based round-the-year fodder production system under the rainfed IFS model, the Bajra Napier hybrid based round-the-year fodder production system under the irrigated IFS model and agri-horti system in the irrigated IFS model were also done and biofencing of the IFS model area through bamboo, karonda, cactus and forestry trees (teak) was ensured. Other achievements included the development of FYM and vermicomposting units, the development of bioformulation (bijamrita, jivamrita, *etc.*) production structures using wood logs, bamboo and polysheets.

3.3.4 Nutrient and water management in BN hybrid through drip irrigation in semi-arid region of India (CRSCIGFRISIL20210203)

The application of the 100% RDF (90:40:40 kg N:P:K: ha_{-1}) recommended dose of fertilizer (RDF) coupled with irrigation at 75% available soil moisture (ASM) recorded the highest green fodder yield (153.6 t/ha), which was 16.8% higher than the farmer's practice (flood irrigation). Notably, one-third reduction in the fertilizer dose under drip irrigation produced a yield equivalent to that of 100% RDF under flood irrigation. However, reducing the fertilizer dose by two-thirds significantly decreased fodder yield, regardless of the irrigation methods. Higher water use efficiency (WUE) was observed under the 50% ASM irrigation level, regardless of fertilizer application. Notably, the highest WUE (45 kg DM/ha-mm) was recorded under T_6 (100% NPK with irrigation at 50% ASM). Flood irrigation significantly reduced WUE, whereas drip irrigation nearly doubled it compared to flood irrigation.

Fig. 3.3.3. BN hybrid under 50% ASM with 100% NPK

3.3.5 Plant-based formulations for zonate leaf spot disease suppression in fodder sorghum (CRSCIGFRISIL20240203)

Essential oils from selected plant materials were successfully extracted using hydro-distillation with a Clevenger apparatus and Spirulina (*Arthrospira platensis*) extracts were prepared using methanol and water through ultrasound-assisted cold percolation, thereby standardized extraction protocols for bioactive formulation development. Zonate leaf spot disease-infected sorghum and Johnson grass samples were systematically collected from eight agro-ecologically diverse locations across India to capture regional variability of the disease. All collected samples were properly catalogued and preserved at −20 °C, establishing a reliable repository for further pathogen studies and evaluation of plant-based disease suppression strategies.

3.3.6 Intensive fodder production through crop diversification and zinc fortification in Kashmir Himalaya (CRSCIGFRISIL20221001)

The intensive cropping system involving maize + cowpea in *kharif* followed by oat + berseem in *rabi* recorded highest GFY of 99.6 t/ha and DMY of 22.8 t/ha averaged over two years. The system recorded 23.38% higher GFY and 19.76 % DMY over maize-oat system (127% higher green fodder over maize only and 170% higher green fodder yield over oat only). Soil + foliar Zn application enhanced total GFY by 11.27% and DMY by 16.5% over control. Zinc application increased Zn content and Zn uptake by 40% and 65% in *rabi* crops and 74% and 99.17% in *kharif* crops, respectively.

Fig. 3.3.5. Impact of crop diversities of Zn application on fodder production

Legume intercropping increased crude protien yield by 29 to 32% over sole oat (*rabi*) and 39 to 41.6% over sole maize (*kharif*). Both legume incorporation and zinc application enhanced over all forage quality (RFV > 105%) and resulted in good quality forage. Cereal + legume intercropping resulted in higher available N, organic carbon and carbon accumulation (33.42 Mg C ha^{-1} as against 30.07 Mg C ha^{-1} in case of maize-oat system). Intercropping also increased carbon accumulation from the initial value of 28 Mg C ha^{-1} in the post-harvest soil. Zn application enhanced soil zinc content from 0.35 ppm to 0.66 ppm (88% increase) increasing it from low to optimum levels in the post-harvest soil. Maize-oat without zinc application resulted in total net returns of Rs. 1,14,016/ha and average B:C ratio of 1.5. Maize + cowpea - oat + berseem cropping system + soil and foliar zinc application resulted in total net returns of Rs. 1,66,333/ha and average B:C ratio of 1.87. The cropping system recorded highest B:C ratio in both *rabi* (1.69) and *kharif* (2.05) seasons (Averaging 1.87).

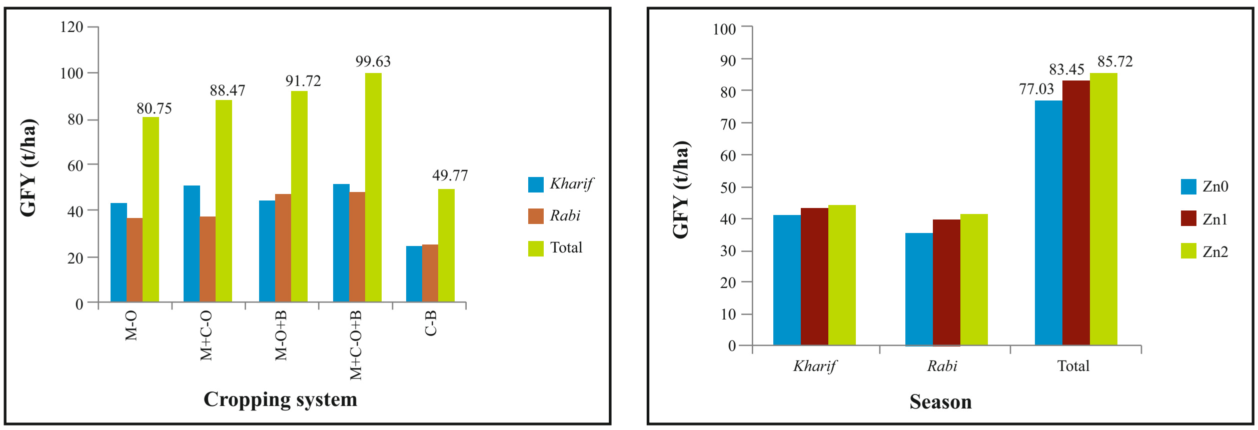

Fig. 3.3.6a. Seasonal and total (*kharif* + *rabi*) GFY as influenced by cropping systems and zinc levels

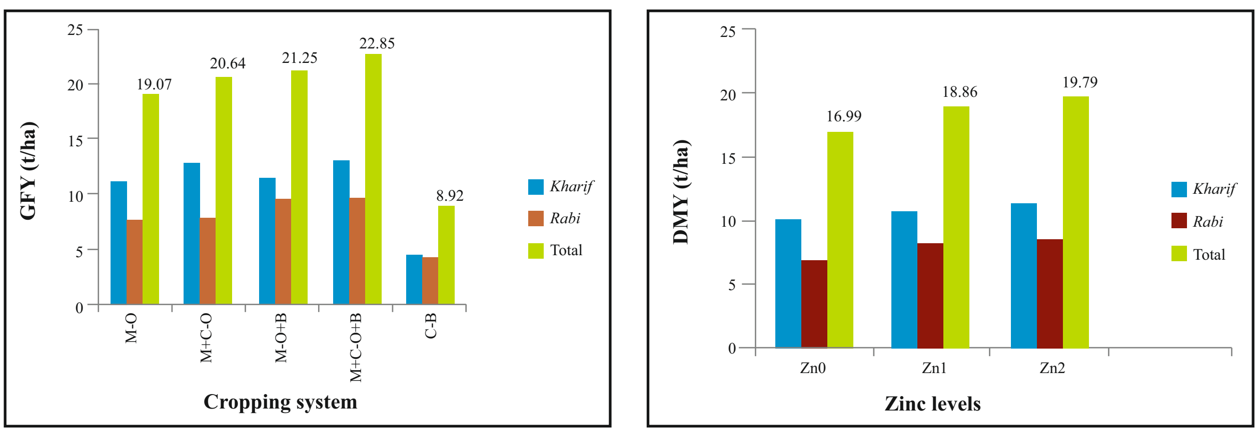

Fig. 3.3.5b. Seasonal and total (*kharif* + *rabi*) DMY as influenced by cropping systems and zinc levels

3.3.7 Agronomical trait(s) improvement in forages using plant-associated microbes from the North Western Himalaya

(CRSCIGFRISIL20221101)

The bacterial and fungal cultures were screened for various agriculturally important traits (zinc solubilization, phosphate solubilization, phytohormone (IAA) production, siderophore production and antagonist activity) using standard methods and assays. Out of 34 bacterial isolates and 5 fungal isolates, 29 bacterial and 4 fungal isolates exhibited zinc solubilization activity. Phosphate-solubilising activity was exhibited by 18 bacterial and 4 fungal isolates. Based on the diverse agriculturally important activities (Zn solubilization, phosphate solubilization, siderophore production and IAA production), the bacterial cultures (B102, B105) and fungal isolate revealed optimal positive activities. The selected bacterial and fungal isolates also exhibited compatibility in growth at 25 ± 5°C. Therefore, the same can be utilized for bioformulations (single or consortia) for agronomical trait improvement in forage crops.

3.4 Accelerating seed biology research and technology development for enhanced quality forage seed production and strengthening national forage seed network

3.4.1 Development of Near-infrared spectroscopy (NIRS) based prediction models for the assessment of seed viability and vigor in tropical grasses (CRSCIGFRISIL20210401)

For oat nutritional-quality model development, near-infrared spectroscopy (NIRS) spectra were generated for 156 oat entries and 154 samples were used for calibration modelling with an independent 107/47 calibration-validation split; spectra were preprocessed using standard normal variate (SNV), detrending, Savitzky-Golay smoothing and derivative transformations and models were developed using partial least squares regression (PLSR) and modified partial least squared (mPLS) against wet-chemistry reference ranged for beta-glucan (1.97-7.83), amylose (11.9-16.0), protein (11.4-17.1), starch (55.1-75.0), phytate (0.405-0.991) and phenolics (0.152-0.457); performance was evaluated using coefficient of determination (R^2), root mean square error (RMSE), mean absolute error (MAE), slope, bias, standard error of prediction (SEP) and ratio of performance to deviation (RPD), delivering strong external validation for amylose (R^2=0.987; RMSE=0.058; RPD 8.878), protein (R^2 =0.990; RMSE=0.082; RPD=9.951) and beta-glucan (R^2=0.972; RMSE=0.107; RPD=6.080), with screening-grade validation for starch (R^2=0.829; RPD=2.446) and phytate (R^2=0.883; RPD=2.959) and comparatively lower performance for phenols (R^2=0.756; RPD=2.045) (Fig. 3.4.1).

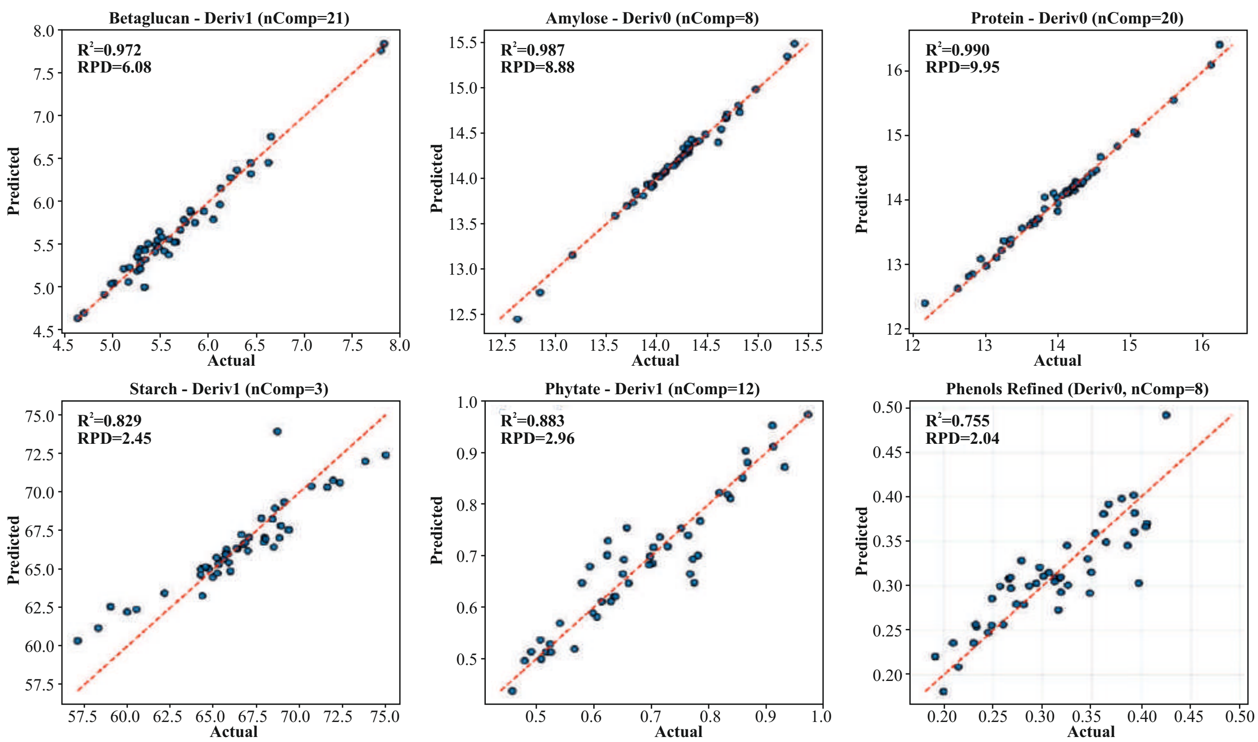

Fig. 3.4.1. Scatter plot between the reference and predicted values

3.4.2 Development of seed standards in temperate forages (CRSCIGFRISIL20230401)

The seed testing protocol and dormancy breaking treatments for five temperate forages namely Timothy, Red fescue, White clover, Sainfoin and Persian clover (Table 3.4.1) and seed standards (Fig. 3.4.2) were developed. Presence of different types of seed dormancy in studied crops ranging from physical, physicochemical and incomplete seed developmental emerging from asynchronous seed maturation were observed. The dormancy breaking treatments were standardized in five temperate forages: In timothy (0.2% KNO_3 for 12 h at 20 °C), red fescue (0.1% KNO_3 for 20 h at 20 °C), sainfoin (Prechill at 6-10 °C for 144 h), white clover (0.2% KNO_3 for 20 h at 15 °C) and Persian clover (Prechill at 6-10 °C for 120 h).

Table 3.4.1. Seed testing protocol for temperate forages

S.No.	Parameter	Timothy	Red fescue	Sainfoin	White clover	Persian clover
1	Germination media	TP (Top of the paper)	TP	TP	TP, BP	TP, BP (Between the paper)
2	Germination temp. °C	20 <==> 30 15 <==> 25	20 <==> 25	20 <==> 30	20	20
3	Dormancy type	Embryonic	Both embryonic and testa induced	Both embryonic and testa induced	Both embryonic and testa induced	Both embryonic and testa induced
5	Hard seeds	Nil	Nil	Yes, 8-15%	Yes. 4-8%	Yes. 3-8%
6	Moisture test	130 °C for 1 h	130 °C for 1 h	130 °C for 1 h	130 °C for 1 h	130 °C for 1 h
7	Others	Fresh ungerminated seed (FUS) reported	Multi seed unit (MSL) reported. Seed blowing required	Seed blowing not required	Seed discoloration	Seed discoloration

Table 3.4.2. Seed Standards for temperate forages

S.No.	Parameter	Timothy	Red fescue	Sainfoin	White clover	Persian clover
1	Pure seed % (minimum)	70	70	98	75	98
2	Inert matter % (maximum)	30	30	2	25	2
3	Other crop seed per kg (maximum)	10	5	5	5	10
4	Weed seed per kg (maximum)	20	10	10	10	20
5	Germination % (minimum)	55	55	55	60	60
6	Moisture % (maximum)	10	10	10	10	10
7	For vapour-proof containers % (maximum)	8	8	8	8	8
8	1000 seed wt (g)	0.40	1.10	15.60	0.60	1.00
9	Working sample (g)	1.00	3.00	40.00	2.00	2.50
10	Submitted sample (g)	10	30	400	20	25
11	Chaffiness	Yes	Yes	Yes	NA	NA

3.4.3 Chemical interventions for enhancing pure germinating seeds in grasses (CRSCIGFRISIL20240401)

Root slips of different grasses namely Dhaman grass (Bundel Dhaman-1), Anjan grass (Bundel Anjan-1, Bundel Anjan-3 and Bundel Anjan-4) and Guinea grass (Bundel Guniea 1, Bundel Guniea 2, Bundel Guinea 4, Dharwad Guinea grass 1) were planted in pots during the month of July, 2025 (Fig. 3.4.2a). Various hormone plus chemical combinations were sprayed twice on the panicles of Anjan and Dhaman grass in an interval of 15 days while only once on the panicles of Guinea grass. Booting stage was preferred for spraying although in some cases early seed head emergence stage was also seen. The panicles of Guinea grass were intentionally covered with muslin cloth after the spray in order to avoid seed loss due to seed shedding while the panicles of Anjan and Dhaman grass were kept open and seeds were collected as the panicles ripened. Observations on seed filling percentage were recorded while seed germination experiments will be carried out after the loss of natural dormancy.

Fig. 3.4.2a. Different varieties of *Anjan, Dhaman* and Guinea grass in pots

Different stages of reproductive phase like booting, seed head emergence and anthesis in these grasses were studied (Fig. 3.4.2b).

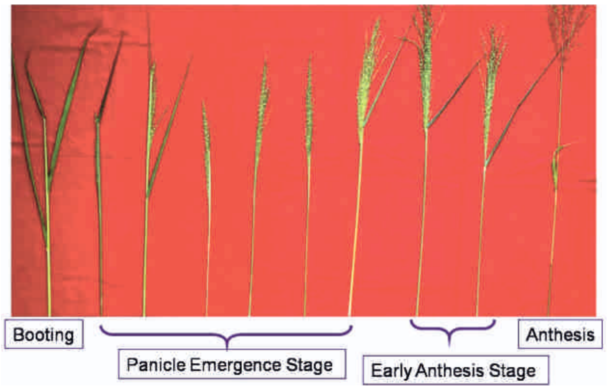

Fig. 3.4.2b. Various stages of reproductive phase in Guinea grass

Maturation of the harvested panicles of guinea grass at anthesis stage by keeping them in100 ppm IAA solution as treatment and water as control (Fig. 3.4.2c) was carried out *in-vitro* and seed filling percentage were recorded.

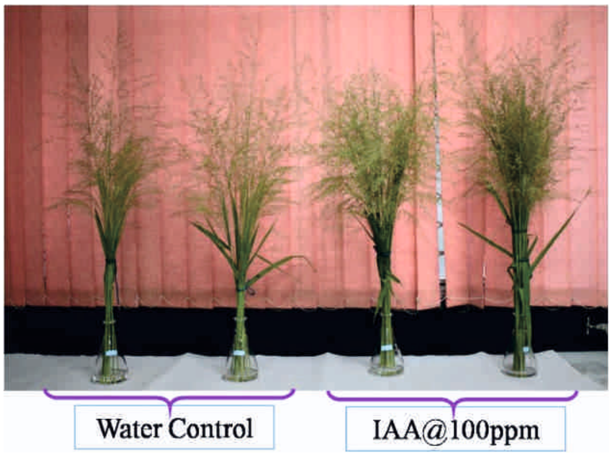

Fig. 3.4.2c. Maturation requirement of Guinea grass

3.4.4 Development of seed standards in forage grasses and legumes (CRSCIGFRISIL20190901)

Influence of different dormancy breaking treatments on seed quality parameters of siratro

Fresh seeds of siratro witnessed the presence of seed dormancy. Hence, the seeds were subjected to different dormancy breaking treatments. The results revealed that the seeds treated with H_2SO_4 (T_3) recorded significantly higher seed germination (42.84%), lower FUS's (51.48%) and higher seedling vigour index (495.29) where as control treatment recorded 32.72%, 64.10% and 377.74, respectively (Table 3.4.3). The abnormal seedlings were significantly higher (5.68%) in T_3 treatment.

Influence of different dormancy breaking treatments on seed quality parameters of *Brachiaria ruziziensis*

With respect to the use of different seed treatments to break the seed dormancy, *Brachiaria* seeds treated with H_2SO_4 (T_3) recorded significantly higher seed germination (29.12%) and seedling vigour index (245.54). The lowest seed germination was recorded in control (12.36%) which indicated the presence of seed dormancy since majority of the tested seeds recorded higher fresh un-germinated percentage (Table 3.4.4).

Table 3.4.3. Influence of dormancy breaking treatments in siratro

Treatments (T)	Germination (%)	Abnormal seedlings (%)	Fresh un-germinated seeds (%)	Seedling vigor index
T_1: TP-Control	32.72	3.18	64.10	377.74
T_2: TP-GA_3 100 ppm	33.41	2.96	63.63	372.50
T_3: TP-H_2SO_4 2 min.	42.84	5.68	51.48	495.29
T_4: TP-KNO_3 (0.2%)	27.54	3.00	69.46	329.04
T_5: BP-Control	25.36	2.50	61.50	268.36
T_6: BP-GA_3 100 ppm	38.20	2.84	58.96	426.20
T_7: BP- H_2SO_4 2 min.	30.16	3.18	66.66	343.79
T_8: BP-KNO_3 (0.2%)	26.66	3.23	70.11	295.91
Mean	23	2	46	264
S.Em (±)	0.82	0.31	1.71	22.52
CD @ 1%	**3.45**	**1.31**	**7.21**	**94.82**

Table 3.4.3. Influence of dormancy breaking treatments in *Brachiaria ruziziensis*

Treatments	Germination (%)	FUG (%)	Dead seed (%)	SVI
T_1: TP-Control	12.36	79.15	8.49	102.40
T_2: TP-GA_3 100 ppm	24.15	73.35	2.50	203.69
T_3: TP-H_2SO_4 2 min.	29.12	60.48	10.40	245.54
T_4: TP-KNO_3 (0.2%)	13.54	78.50	7.96	116.77
T_5: BP-Control	13.70	77.20	9.10	117.77
T_6: BP-GA_3 100 ppm	21.33	74.75	3.92	167.56
T_7: BP- H_2SO_4 2 min.	23.50	62.45	14.05	190.94
T_8: BP-KNO_3 (0.2%)	12.50	77.52	9.98	102.81
Mean	14.25	53.61	8.30	113.00
Sem(±)	0.20	0.69	0.22	1.33
CD @ 1%	**0.85**	**2.31**	**0.92**	**4.59**

3.5 Nutritional evaluation and post-harvest management of forage resources for sustainable and improved crop-livestock production systems

3.5.1. Grazing behaviour of small ruminants on natural pasture during autumn (CRSCIGFRISIL20220703)

A comparison was made between the grazing patterns of Jalauni sheep (n=10) and Bundelkhandi goats (n=10) on natural pastures (Fig. 3.5.1) during the autumn in two separate 0.5-hectare grazing areas at stocking density of twenty animals per hectare and each species of animal was observed for fifteen days. Three hours video footage was captured for each grazing parameter in the morning, afternoon and evening, a daily observation period of nine hours. Goats exhibited a considerably longer average grazing time (30.23 min/h) than sheep (21.30 min/h). In contrast, sheep exhibited longer walking time (7.79 *vs.* 7.64 min/h), standing time (12.64 *vs.* 9.39 min/h) and sitting time (18.27 *vs.* 12.74 min/h) than goats. Furthermore, sheep favoured grasses majority of the day, including the morning, afternoon and evening. Goats, on the other hand, exhibited a preference for a wider variety of plant species, including grasses during morning and thorny vegetation followed by shrubs during afternoon and evening. Moreover, grazing time and grazing intake were negatively correlated with ambient temperature in both species.

Fig. 3.5.1. Goat and sheep grazing in pastures

3.5.2. Phytochemical nanoformulations to control aflatoxins in animal feeds (CRSCIGFRI20220702)

Comparing inhibitions of *Curcuma longa* EO, NSK extract and *Brassica* EO, the order of effectiveness against these two fungi were *Brassica* EO >*Curcuma longa* EO > NSK extract. The results showed that treatments were significant at level 5%. Evaluation of *Brassica* and *Curcuma* essential oils against *Lactobacillus* sp. isolated from silage showed that Curcuma EO (350 ppm) inhibited strains TGF 6 and TGF 21 in broth media by 13.29% and 2.07% and *Brassica* EO (50 ppm) by 19.14% and 8.90%, respectively (Fig. 3.5.2), indicating non-significant inhibition of these beneficial *Lactobacillus* species.

GC/MS analysis of essential oils revealed that *Curcuma* EO contained mainly Turmerone and Curlone (78%) and *Brassica* EO contained mostly allyl isothiocyanate (90.07%). *In-silico* analysis (binding energy) indicated that all the major compounds exhibited higher (less negative) binding energies compared to the standard inhibitor, nystatin. This suggests that the essential oil compounds may act through a mode of action different from that of nystatin, or that their

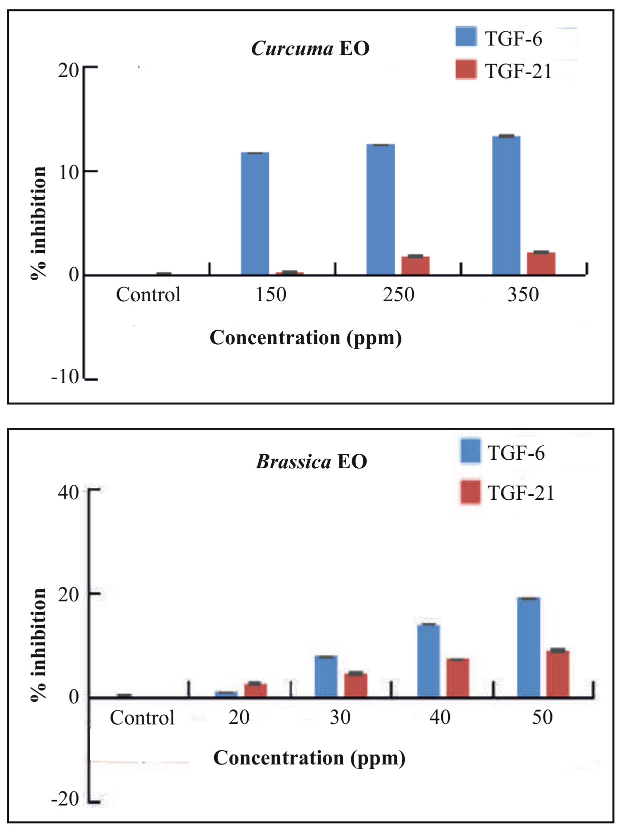

Fig. 3.5.2. Effect of *Curcuma* EO and *Brassica* EO on growth of TGF 6 and TGF 21 *Lactobacillus in vitro*

inhibitory activity could result from synergistic interactions among multiple constituents.

3.5.3. Identification and characterization of volatile metabolites during ensiling (CRSCIGFRISIL20240702)

Oat (JHO 2000-4) silage was prepared to study silage parameters and volatile organic compounds (VOCs) profile. The crude protein in the fresh oat sample was 11.76% and in ensiled it dropped to 10.91%. The pH of silage varied from 3.9 to 4.4 and lactic acid was around 1% which indicated good silage quality for animal feeding. Total of 70 volatile compounds were identified using GCMS. The identified compounds were grouped into 9 chemical classes. Maximum number of compounds belonged to alcohol (12) followed by ester (11), acid and ketone with 8 each, terpenoids, heterocyclic and sulfur containing compounds with 7 each and phenol (6). Only four aldehydes were identified in the oat silage. The variable importance in projection (VIP) scores derived from the PLS-DA model was used to evaluate the relative contribution of each metabolite to the discrimination between storability and aroma or fragrance. Metabolites with VIP>1 were considered significant contributors to group separation. The top 10 key VOCs governing silage storability and feed aroma or fragrance were identified based on their influence on these two characteristics. Dimethyl trisulfide, eugenol, phenol and hexanoic acid were described as antifungal or antioxidant compounds that can enhance silage shelf-life. In contrast, compounds such as ethyl hexanoate, linalool, methyl salicylate, hexanol and geraniol were identified as fresh-scent or fruity-aroma volatiles that can be explored for improving feed flavor or fragrance to increase animal preference and enhance feed intake, particularly in silage.

3.5.4 Evaluation of forage-based ration on lactation performance of dairy animal (CRSCIGFRISIL20240701)

A feeding trial of sorghum fodder (CSH-MF24) was conducted on 12 crossbred lactating cows, randomly divided into two groups of 6 in each for milk yield and parity. The Group I was fed on green fodder along with concentrate and dry roughage as per nutrient requirements, while the Group II was served as a control group, fed on a diet based on concentrate and cereal straw, which was isocaloric and isonitrogenous. Inclusion of fodder sorghum in the diet significantly increased (14.89%) the milk yield (0.66 L/day) as compared to control (group II), after accounting for parity, age at first calving and stage of lactation. Similar to above, inclusion of fodder berseem in the diet of crossbred cows significantly increased (16.70%) the milk yield (0.95 L/day) as compared to control (group II), after accounting for parity, age at first calving and stage of lactation. No significant difference was observed in milk composition between groups in both the trails.

3.5.5 Ensiling of temperate grasses/legumes for increased livestock productivity (CRSCIGFRISIL20211001)

Apple pomace (AP) was evaluated as an additive (10-50%) in apple leaf, grass and legume-based diets for silage preparation (Fig. 3.5.3), silage quality parameters, including pH, lactic acid and nutrient composition, indicated good to medium quality across treatments (Table 3.5.1). Fresh and ensiled diets showed acceptable ranges for crude protein (9.63-13.78%), fiber fractions and energy values (TDN 65.40-76.24%, ME 2.37-2.76 Kcal/g), with AP contributing to improved ensiling. The use of apple pomace and apple leaves as silage additives was evaluated to improve fermentability and nutrient utilization. Different silage formulations comprising grass, legume,

Table 3.5.1. Fermentation quality of silages fed to sheep

Parameters	AFSil1	AFSil2	AFSil3	SEM	Significance
DM%	34.89	41.21	39.60	0.963	0.004
pH	4.22	4.35	4.37	0.023	0.002
LA% fresh	0.66	0.66	0.64	0.005	0.095
LA%DM	1.91	1.61	1.59	0.054	0.009

AL: apple leaves; AP: apple pomace; L: legume; G: grass; AFSil1: AP: G: L: AL (40:40:10:10); AFSil2: AP: G: L: AL (30:40:15:15); AFSil3: AP: G: L: AL (25:40:10:25)

The results demonstrated that inclusion of apple pomace significantly improved silage fermentation, with desirable pH (3.74–4.56) and lactic acid content (2.21–4.86% DM).

Table 3.5.2. Nutrients intake and their digestibility of silages fed to sheep

Parameters	AFSil1	AFSil2	AFSil3	SEM	Significance
Animal wt	23.33	23.45	25.33	0.959	0.485
Nutrients intake					
DMI kg/d	845.44	909.66	1040.74	47.59	0.678
Intake %body wt	3.64	3.92	4.12	0.151	0.250
Intake g/Kg w0.75	79.80	85.85	92.12	3.31	0.481
DCPI intake	34.30	38.25	29.97	1.53	0.221
ME intake	2048.13	2244.62	2592.42		
Digestibility					
DM	62.79	63.84	64.55	1.42	0.346
OM	66.67	66.82	67.92	1.31	0.898
CP	72.53	72.24	70.69	1.33	0.326
NDF	63.33	63.34	64.77	1.39	0.928
ADF	50.44	54.25	50.08	2.17	0.907
Cellulose	64.82	70.62	66.77	1.54	0.726

Fig. 3.5.3. Existing apple forage based temperate grasses/legumes and feeding trial

apple pomace (10–50%) and apple leaves were prepared and assessed for chemical composition and fermentation quality. Selected silages were fed to sheep to study nutrient intake and digestibility (Table 3.5.2).

Apple pomace-based silages exhibited better palatability and higher voluntary intake (3.64–4.12% of body weight) along with improved nutrient digestibility (62.80–64.55%). The study established apple pomace as an effective, low-cost additive for producing high-quality silage from temperate grasses and legumes, while also promoting value-added utilization of horticultural waste in temperate livestock production systems.

3.5.6 Development of drudgery-reducing farm machines and tools for forage and livestock production (CRSCIGFRISIL20190604)

Fabrication of a hard-stem forage harvester

A prototype of the BN hybrid forage harvester (Fig. 3.5.4) was fabricated for harvesting the BN hybrid crop with following technical specifications (Table 3.5.3). It consisted of the main frame, gearbox, power transmission mechanism, rotor and sharpened blades. The whole assembly was rear-mounted on the tractor. It was developed mainly for single-row harvesting. The harvester is suitable specifically for harvesting forage crops of hard-stem.

Table 3.5.3. Technical specifications of the developed prototype

S.No.	Particular	Specification
1.	Swath width	$\geq$80 cm
2.	Height of cut	$\geq$10 cm
3.	Blades	Hardened, rotor type
4.	Power	Tractor PTO
5.	Transmission	Gearbox, universal shaft
6.	Capacity	0.20-0.25 ha/h
7.	Material	Hard metal (MS/CI/SS, *etc.*)
8.	Frame	Using square/ L-sections (hollow/solid)

Fig. 3.5.4. Prototype of the developed BN hybrid forage harvester

3.6 Social, economic, policy and transitional research and capacity building

3.6.1 Development of decision support system for fodder crops

(CRSCIGFRISIL20240501)

Significant progress has been made toward developing a farmer-friendly Decision Support System (DSS) for fodder crops. Under this, the baseline survey schedule was finalized and field activities were initiated during the *rabi* to collect the necessary information. Simultaneously, the collection, compilation and refinement of relevant secondary data for database development were accomplished. An upgradable functional prototype of the fodder DSS (Fig. 3.6.1) was developed. In addition, data from two previously developed IGFRI mobile applications were successfully retrieved and integrated to develop the unified prototype.

3.6.2 Impact of fodder and livestock technologies on livelihood of farmers of SCA schemes of IGFRI

(CRSCIGFRISII 20210502)

Data were collected from 398 Scheduled Caste (SC) farmers in Jhansi district, Uttar Pradesh, to assess the impact of agriculture-based technological interventions under the SCSP on income distribution, using Gini decomposition analysis and Lorenz curves. The results indicated a lower Gini index among beneficiaries, reflecting a more equitable income distribution compared to non-beneficiaries. Crop farming emerged as the primary contributor to overall income inequality in both groups. Importantly, about one percent increase in livestock income reduced income inequality among SC farmers by 0.24–0.38 percent, with a greater impact observed among non-beneficiaries, likely because beneficiaries had already substantially benefitted from livestock-oriented interventions under the programme.

Despite these gains, implementation was constrained by limited technical support, small landholdings, poor seed germination and root slip establishment, damage to crops and saplings by stray animals such as Nilgai and inadequate access to assured irrigation facilities.

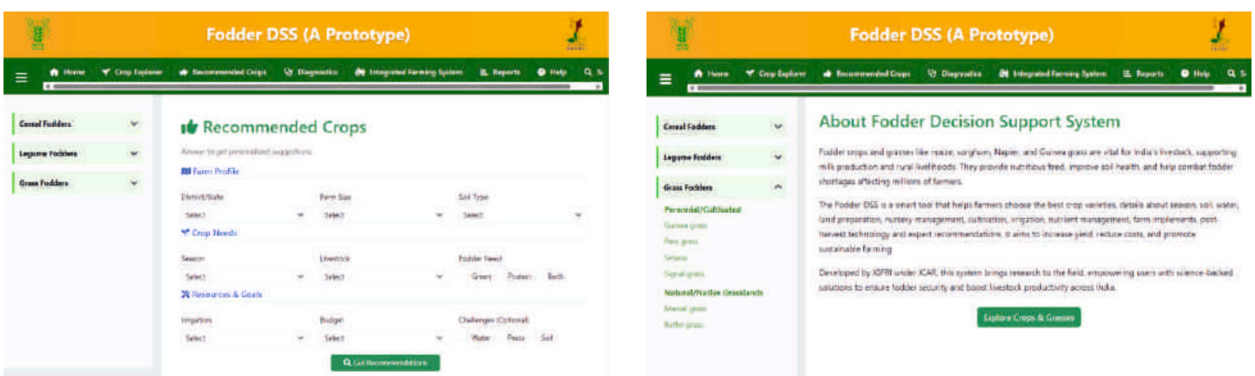

Fig. 3.6.1. Upgradable fodder DSS prototype

3.7 All India Coordinated Research Project on Forage Crops and Utilization

3.7.1 Forage crop improvement

In *Rabi* 2024-25 a total of 24 multi-locational trials comprising test entries and their respective checks were conducted at 35 locations in the country. The annual crops included berseem, fodder oat (single cut, multi cut and dual)), lucerne (annual), whereas Lathyrus, summer bajra (multicut) under the perennial system, Tall fescue and orchard grass were evaluated. A total of 139 entries including 120 annual and 19 perennial along with national and zonal checks were evaluated.

In IVT berseem, five entries with one national (Wardan) and one zonal check (BM 12, PC 91) were evaluated at 20 centers. None of the entries was promoted to AVT-1. In IVT oat single cut, fifteen entries, with one national check (OS-6) and one zonal check (HFO 806, OL-1896, OL-1869-1, OL-1861 and OL-1874-1), were evaluated at 29 locations across the five zones. None of the entries were promoted to AVT-1. In AVT-1 oat single cut, two entries, with one national check (OS-6) and one zonal check (HFO 806 and OL-1869-1) were evaluated at 11 locations across the two zones. None of the entries were promoted to AVT-2. In AVT-2 oat single cut two entries along with one national check (OS-6) and one zonal check (SKO 225 and OL-1869-1) were evaluated at 11 locations across the two zones. Trial was completed and its seed trial was also taken. In IVT oat multicut, twelve entries were evaluated against two national checks RO-19 and UPO-212 and one ZC for respective zone, *viz.,* HFO 915, HFO-707 and JO-05-304 at 17 locations in four zones. Based on superiority three entries were promoted to AVT-1. In AVT-1 oat multi cut, two entries were evaluated against two national checks RO-19 and UPO-212 at five locations in CZ. None of the entries performed superiority over check. In AVT-2 multicut oat (repeat) and seed, nine entries and two national checks RO-19 and UPO-212 were evaluated at six locations in two zones and its seed trial was also taken. In IVT oat dual, nine entries along with one national check (JHO-822) and one zonal check HFO-611 and OL-1876-2 for respective zone was conducted at 14 locations at three zones and four entries were promoted to AVT-1. In AVT-1 oat dual, two entries were evaluated against one national check JHO-822 and one zonal check HFO-611 at five locations in CZ, none of the entries was promoted. In AVT-2 oat dual (repeat) and seed, four entries and two national checks (JHO 822 and UPO-212) were evaluated at nine locations in two zones and its seed trial was also taken. In IVT lucerne, four entries with one national check RL-88 and one respective zonal check TNLC 15 and RBB-07-1 were evaluated at 11 locations in three zones, none of the entries were promoted. In AVT-1 lucerne, four entries with one national check RL-88 and one respective zonal check TNLC 15 and RBB-07-1 were evaluated at 11 locations in three zones. Three entries were promoted to AVT-2. In AVT-1 lucerne (repeat), four entries with one national check RL-88 and one zonal check RBB-07-1 were evaluated at three locations in CZ. Two entries were promoted to AVT-2. In IVT Lathyrus, six entries were tested against the two national checks, Mahateora and Prateek, at seven locations in the country's Lathyrus-growing areas. Four entries were promoted to AVT-1. In AVT-2 Lathyrus, three entries were tested against the two national checks, Mahateora and Prateek, at seven locations nationwide and their seed trial was also established. In IVT multicut summer bajra thirteen entries along with three national checks, *viz.*, ADV 006, BAIF Bajra 1, Moti Bajra and Giant bajra were evaluated at 8 locations across the two zones. Four entries were promoted to AVT-1. In combined AVT-1 + AVT-2 summer bajra (MC) two entries, along with two national checks, were evaluated at 7 locations across the two zones. None of the entry was found superior. In perennial grasses varietal trial of tall fescue grass and orchard grass are in field at different locations.

3.7.2 Forage crop production

Rabi 2024-25

Maximum green and dry matter yield of dual-purpose oat was recorded with 6 t ha^{-1} biogas slurry at Jobner centre. About 25% RDN (30kg ha^{-1}) + 50% N through FYM + biofertilizer + *Jeevamrut,* produced higher GFY, DMY, crude protein and yield of fodder chicory. The seed treatment with *Azotobacter* @ 10 g/kg seed + 75% RDF + Panchagavya @ 3% or 75% RDF + Seaweed extract @ 3% proved better for dual-purpose oats. Oxyfluorfen @100 g *a.i.*/ha + Imazethapyr @15 g *a.i.*/ha after first and second cut to berseem controlled *Cuscuta* infestation and produced maximum green fodder, dry matter yield and net return. Pre-emergence application of Pendimethalin @ 750 g/ha *fb* post-emergence Metsulfuron methyl @ 4 g/ha at 20 DAS was the most economical and recorded higher GFY, DMY and weed control efficiency. Sowing of oat variety JO-5 on 5th November registered significantly maximum green and dry fodder yield and economic parameters in central, northeast and hill zone. Soil application of 5 kg zinc + foliar spray of 0.5% $ZnSO_4$ solution at 40 DAS to oat proved best and recorded higher growth, yield and quality parameters. Application of 100% recommended dose of nutrients (200:40:40) + Sampoorna multi mix (10 g l^{-1}) produced higher green fodder, dry fodder yield, crude protein content and crude protein yield of Bajra Napier hybrid fodder in Kerala. Application of FYM @ 10 t/ha to sorghum- rye grass cropping system (with two rows of Setaria grass on both sides of field boundaries) resulted in significantly higher plant height, green and dry fodder yield of both the crops as well as of the system. At Ayodhya, FYM @ 5 t/ha basal + natural farming with mulch, recorded significantly higher fodder production, crude protein content and crude protein yield as well as economic parameters of sorghum-oat cropping system. In the hill zone, the performance of oat entry HFO-1211 and in central zone entry OL-1964 was superior with significant response up to 120 kg nitrogen/ha. The performance of multicut oat entry OL-1931-2 in Hill zone and OL-1931-2 and PLP-29 in north west zone were superior with significant response up to 140 kg nitrogen/ha. In dual purpose oat, entry OL-1967-1 was superior in north west zone, with significant response up to 140 kg nitrogen/ha. In Lathyrus under north east and central zone, entry JCL-22-1 was superior with significant response up to 80 kg phosphorus /ha.

3.7.3 Forage crop protection

Rabi 2024-25

The occurrence and abundance of major diseases and insect-pests in berseem, lucerne and oats was recorded at six locations. Maximum stem rot incidence in berseem was 48%, leaf blight severity in oats was 52% and incidence of lucerne downy mildew was 37.9%.

Germplasm evaluation against diseases and insect-pests in *rabi* forages: In oat, out of 156 lines tested against different diseases and insect-pest, two lines GETO-35 and 36 were moderately resistant to powdery mildew and 44 lines were moderately resistant to leaf blight. In berseem, out of 21 lines, GETB-3, 13 and 17 were found moderately resistant against stem rot and root rot. In lucerne, out of 8 germplasm tested, all lines were moderately susceptible against downy mildew and aphids. Yield loss due to leaf blight in fodder oat was more than 25% in green fodder. For ecofriendly management of powdery mildew of white clover, three foliar sprays of dashparni @ 2% was most effective.

Kharif 2025

Maximum disease severity of foliar diseases in sorghum was 50%, in bajra leaf blast was 52% and 45% in maize leaf blights. The yield loss due to foliar diseases in fodder sorghum was more than 38%. Foliar spray of Spinotoram 11.70% SC @ 312.5 ml/ ha through drone in fodder maize provided maximum control of FAW (6.51%).

Germplasm evaluation: Out of 67 lines of maize evaluated at five locations for fall armyworm, aphids, maydis leaf blight and turcicum leaf blight, 20 lines exhibited moderately resistant and out of 44 lines of pearl millet evaluated for leaf blast, 10 lines were resistant.

3.7.4 Breeder seed production *rabi* 2024-25 (indent year *rabi* 2025-26)

In *rabi*-2024-25, the indent for breeder seed production was received from DAC, Govt. of India for 56 varieties of 3 forage crops and one grass *viz.,* fodder oat, berseem, lucerne and rye grass The total indent for breeder seed production was 110.4 t. The indent was allocated to twelve SAUS/ICAR/NGO institutes and the overall breeder seed production in forage crops was 96.04 t.

3.8 Externally Funded Projects

3.8.1 Developing hybrid nanofertilizers by using zeolite and hydroxyapatite for sustainable fodder production (DST-SERB)

Hybrid nanofertilizers were prepared to improve the utilization efficiency of nutrients while minimizing losses of nutrients into the environment and providing a range of nutrients in the appropriate proportions. The results indicated the applicability of hybrid nano fertilizers for enhancing plant growth. The prepared hybrid nanofertilizers also improved the soil's moisture content, as observed from the Water Absorption Capacity (WAC), Swelling Ratio (SR) and Water Retention Capacity (WRC) studies (Fig. 3.8.1). Furthermore, hybrid nanofertilizers enhanced nutrient availability in the soil and their delivery to oat plants compared to commercial fertilizers. The findings also revealed that these hybrid nanofertilizers can be applied at lower rates than commercial fertilizers. In conclusion, the studied nano fertilizers act as carriers for nutrients and as mediums for their slow release, thereby improving soil nutrient content, crop nutrient uptake and fodder quality.

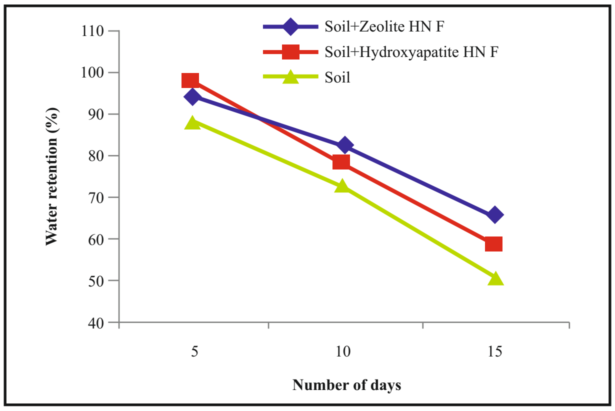

Fig. 3.8.1. WRC of soil with and without hybrid nanofertilizers

3.8.2 All India Coordinated Research Project on Dryland Agriculture (CRSCIGFRISOP20170203)

Seven cropping systems were assessed under rainfed conditions. Among them, the sweet corn–chickpea system recorded the highest system productivity, with a chickpea equivalent yield of 3624 kg/ha, followed by baby corn–taramira (2612 kg/ha) and sorghum (F)–mustard (2399 kg/ha). The mungbean–linseed system exhibited the lowest productivity (1470 kg/ha). Sweet corn– and baby corn–based systems also achieved the highest per day productivity (15.3 and 13.5 kg/ha/day, respectively), attributed to dual outputs of cobs and green fodder within a short crop duration. Economic evaluation revealed that the cost of cultivation varied from Rs. 54,310/ha in the sorghum (F)–mustard system (Fig. 3.8.2) to Rs. 80,890/ha in the sweet corn–chickpea system. Despite the higher investment, the sweet corn–chickpea system realized the maximum net returns (Rs. 1,29,975/ha) along with the highest benefit–cost ratio (1.80).

Fig. 3.8.2. Evaluation of different cropping system under rainfed condition

The performance of four cropping systems was assessed under different land configurations (flat bed, BBF and conservation furrow). Results showed that sowing with the BBF planter enhanced the productivity of *kharif* crops (groundnut, sesame and barnyard millet); however, the performance of fodder sorghum remained comparable across all land configurations. Chickpea yield was not significantly influenced by land configuration. Similarly, system productivity in terms of chickpea equivalent yield was not significantly affected, though it was highest under BBF (2558 kg/ha). Among the cropping systems, the groundnut–chickpea system recorded the highest system productivity (3019 kg/ha), which resulted in higher net returns (₹83,118/ha). However, the maximum benefit–cost ratio was obtained in the sorghum (F)–chickpea system. Likewise, the highest rainwater use efficiency (4.08 kg/ha-mm) was also observed in the groundnut-chickpea system.

3.8.3 AMAAS project: Microbe based drought and nutrient management in forage crops

Three drought tolerant PGPR consortia [C_1-C_3; comprised *Bacillus subtilis* + one unidentified bacterium as common with each of *Pseudomonas putida* (T_1), *Actinobacter* sp. (T_2) and *Achromobacter insolitus* (T_3) were developed based on their compatibility among the selected microbes and were evaluated in forage crops with two control (irrigated-T_4 and drought imposed-T_5) treatments. Most of the biometric traits *viz.*, plant height, root length, stem weight, leaf weight and root weight were reduced under the water stress conditions. The less percent reduction in these traits was recorded in T_2 treatment. Most of the root architectural traits were also recorded higher in T_2 (by consortia-C_2) compared to UIC drought. Consortia 2 (T_2) also recorded significantly higher yield attributes *viz.,* green fodder yield (24.5 t/ha), dry matter yield (5.08 t/ha) and seed yield (569 kg/ha) than T_5 (19.0 t/ha, 3.95 t/ha and 405.5 kg/ha, respectively) and was at par with T_4 (21.2 t/ha, 4.41 t/ha and 631.3 kg/ha, respectively). The percent reduction in gaseous exchange traits such as photosynthesis rate, stomatal conductance and instantaneous water use efficiency were recorded lower in T_2 (C_2 + 50% RDF + drought imposed) in comparison with T_4 (100% irrigated) treatment, while reduction was recorded highest in transpiration rate under T_2 treatment (C_2). Hence, drought tolerant microbial consortia C_2 (*Actinobacter* sp. + *Bacillus subtilis* + one unidentified bacterium) can be recommended for drought stress tolerance in fodder oat.

In fodder cowpea, fodder maize and sorghum under drought stress, the percent reduction in photosynthesis rate and stomatal conductance were recorded lower in T_2 in comparison with T_4 & T_6 (100% irrigated), while reduction was recorded highest in transpiration rate under T_2 treatment. High soil moisture under T_2 treatment indicates the limited transpiration or high WUE. Plant height and plant weight were recorded highest in T_2 treatment in cowpea and sorghum and in T_3 in maize. RWC, MSI and Total chlorophyll content was found relatively higher in all 3 consortia than UIC under drought stress in all fodder crops. Under induced drought, proline content was increased in all fodder crops and highest in T_2 in cowpea and sorghum. Higher TSS was found in T_2 in cowpea and maize which provides the osmotic adjustment under drought stress. Lower MDA was found in all 3 consortium treatments which indicate lower lipid peroxidation under drought stress than uninoculated treatment. High SOD activity was found in T_2 treatment which indicates high free radical scavenging capacity under drought. Hence, drought tolerant microbial consortia T_2 (*Actinobacter* sp. + *Bacillus subtilis* + one unidentified PGPB) can be recommended for drought tolerance in oat, sorghum and cowpea.

3.8.4 Use of fly ash in agriculture for sustainable crop production and environmental protection

The soil quality index (SQI) varied noticeably across different fly ash application strategies (AS) in the cowpea (Fig. 3.8.3a) – oat (Fig. 3.8.3b) fodder production system of semi-arid India. In cowpea soils, SQI ranged from 1.379 (AS12; Ash 20 t/ha (every year) + NPK) to 1.592 (AS2; FYM+NPK), showing a general improvement under moderate fly ash doses. The highest SQI values were recorded under AS2 (1.592), AS11 (Ash 400 t/ha (once) + AS2) (1.577) and AS9 (Ash 100 t/ha (once) + AS2) (1.524), suggesting that medium to slightly higher application rates of fly ash enhanced overall soil health and fertility status. Lower SQI under AS1 (NPK) (1.418) and AS12 (1.379) indicated that both control and excessive fly ash additions were less effective in maintaining soil quality balance. For oat, SQI values ranged from 1.228 (AS12) to 1.504 (AS11), with a similar pattern of improvement under moderate application levels. Treatments AS2 (1.439), AS5 (Ash 40 t/ha (every year) + AS2 (1.400) and AS11 (1.504) showed the best performance, reflecting positive impacts of balanced fly ash application on soil structure, nutrient availability and microbial activity. Overall, the results suggest that moderate fly ash application (AS2–AS11) did not deteriorate the soil quality index in both crops, demonstrating its potential as a soil amendment strategy in semi-arid fodder systems.

Fig. 3.8.3a. Performance of cowpea crop under fly ash influence

Fig. 3.8.3b. Oat crop in fly ash applied soil

3.8.5 CIAT Bioversity International-ICAR-IGFRI collaborative project: Use and conservation of agrobiodiversity for food and nutrition security, increased agricultural sustainability and resilience to climate change in India

Sub-component 1:

Assessment of Biological Nitrification Inhibition (BNI) in range grasses was done. *Sehima nervosum* exhibited the highest BNI activity (62.11%), followed by Guinea grass (59.5%). *Brachiaria* species, already recognized for their BNI potential, showed a retention rate of 57.24%.

Buffel grass genotypes IG99-144, IG96-645, IG97-388 and IG99-132 were found highly resistant to leaf blast disease. Two genotypes IG96-50 and IG-96-358 were also found good for silage preparation due to its high sugar content.

Sub-component 2:

The present investigation demonstrated significant improvements in forage quality, digestibility and methane mitigation potential among the evaluated grass genotypes and formulated diets. Among *Sehima nervosum* genotypes, SN6 emerged as superior with the highest crude protein and comparatively lower fiber fractions, indicating enhanced nutritive value. In *Cenchrus* genotypes, 5/12 and 4/5 showed better relative feed value and energy contents, while 3/14 recorded the highest *in vitro* dry matter digestibility. Among *Guinea* genotypes, Guinea 7 was outstanding with the highest crude protein, lowest ADF and lignin, superior digestibility (62.06%), highest total digestible nutrients (60.11%) and metabolisable energy (2.18 Kcal/g). Importantly, diet formulation studies revealed that barley straw-based diets supplemented with Napier grass and concentrate (50:20:30) significantly reduced methane production while maintaining higher dry matter digestibility, highlighting a promising eco-friendly feeding strategy for sustainable livestock production. Overall, the study successfully identified nutritionally superior genotypes and optimized diet combinations that enhance feed efficiency while reducing enteric methane emissions.

Sub-component 3:

The respondents' observations of the current adequacy of fodder in the Amrit Mahal Kaval grasslands at various seasons was studied. Results of constraints faced by the respondents in adopting improved grazing practices were documented. Among the list of constraints faced for practicing reseeding, lack of money to purchase grass seeds were reported by 79 per cent of the respondents, followed by lack of knowledge about suitable grass species (71.53%) and lack of knowledge regarding the availability of grass seeds.

Socio economic study in two Indian Ethnic grasslands namely Amrit Mahal (Karnataka) and Kangayam (Tamilnadu) showed a positive Policy Support Index 1.995 and 1.939, respectively. This indicated scope to introduce joint management with rotational and controlled grazing to address fodder scarcity.

Sub-component 4:

Grassland productivity was estimated by assimilating satellite, soil and weather data into 9 Machine learning models. The Extreme gradient boosting (XGBoost) model demonstrated high simulation accuracy, according to the findings.

Degraded land restoration through drone based perennial grasses seed pellet enhanced carbon stock and carbon sequestration and it was highest under under *Pennisetum pedicellatum* (PP) based pastures. This enhanced carbon sequestration under PP based system can attract carbon credit of Rs. 42565.

The species-level metagenomic analysis revealed clear differences in microbial community abundance and composition among the three soil treatments. Fallow soil (Fallow) exhibited the highest overall microbial abundance, indicating a richer and possibly more diverse microbial community under undisturbed conditions. In contrast, soils under *Heteropogon* and *Panicum maximum* showed comparatively lower total abundance, suggesting that vegetation type influences microbial population structure through rhizosphere effects and root exudate-mediated selection. Distinct shifts in species composition were observed between fallow and grass-cultivated soils, reflecting plant-driven microbial recruitment and ecological filtering. These findings demonstrated that grassland establishment significantly altered soil microbial communities, potentially affecting nutrient cycling processes, organic matter turnover and overall soil health.

3.8.6 NLM funded project: Grassland restoration and rejuvenation for enhancing grazing resources using remote sensing and drone technologies

Grassland was established in 2023 through drone with seed pellet technology. Jalauni sheep were allowed to graze on pasture consisting of *C. ciliaris, M. maximus* and *P. pedicellatum* during growing season. Sheep were allowed to graze (Fig. 3.8.4) for 6-7 hours daily along with supplemented feed mixture (mustard cake, maize grain, wheat bran, mineral mixture and common salt; 35: 50: 13: 1: 1) @ 1.0% of their body weight. Chemical composition of different grasses indicated that CP and NDF of *C. ciliaris*, *M. maximus* and *P. pedicellatum* were (7.82, 9.32 and 7.66%) and (74.83, 76.77 and 69.74%), respectively. Nutrient utilization study indicated that total DM intake (%BW) by the animals was 3.49% whereas pasture intake was 2.44%. Digestibility of DM, OM, CP and NDF were 63.53, 67.51, 63.08 and 61.98% in sheep, respectively. DCP and TDN intake (g/kg $W^{0.75}$) was 5.82 and 53.86 supporting a daily gain of 50-60 g. Nutrient content in terms of DCP and TDN of the diet based on grazing plus supplementation was 7.32 and 67.79%, respectively. It was found that *M. maximus* recorded highest yield among the three grasses.

Fig. 3.8.4. Sheep grazing in the established grassland

3.8.7 Performance evaluation and improvement of Bhadawari buffaloes

During 2025, the average lactation milk yield, lactation length, standard lactation milk yield and peak yield were 1475.40±69.3 kg, 337.8±13.4 days, 1300.86±52.8 kg and 8.15±0.11 kg, respectively. The milk quality metrics was also impressive with average milk fat at 8.64±0.22%, SNF at 9.46± 0.10%, protein at 3.30±0.03% and lactose at 5.30± 0.07%. The average age at first calving was 50.7± 1.24 months, with a conception rate of 56.2%. Average birth weight of female and male calves was 24.7 and 27.5 kg, respectively, dam's weight at calving was 410.2±11.30 kg. Six breeding bulls were sold to different agencies. A total of 2400 semen doses were frozen from the selected breeding bulls. The number of AI in Bhadawari breeding tract were 3094 inseminations.

3.8.8 Bundelkhandi goats: Conservation and improvement of the breed (CSRCIGFRI20180701)

All India Coordinated Research Project (AICRP), Bundelkhandi goat unit operates across six villages - Bajni, Parasari and Sersa in Datia (Madhya Pradesh) and Palinda, Parwai and Rundkarari in Jhansi district (Uttar Pradesh). Till 2025, 195 households were registered under the project, collectively managing 3,812 goats. Flock sizes varied from 5 to 70. The average body weights of males at birth, 3, 6, 9, 12 months and adult were 2.41±0.12, 9.93±0.32, 14.94±0.31, 18.33±0.45, 21.90±0.65 and 40.02±0.75 kg, respectively. Corresponding weights in females were 2.19±0.09, 9.11±0.31,12.91±0.28, 16.92±0.22, 18.20±0.74 and 31.26±0.20 kg, respectively. The average lactation milk yield was 50.80±4.60 liters, with a lactation length of 109.0±8.60 days. Reproductive performance showed an average kidding percentage of 89.57, with a twinning rate of 22.45% (Fig. 3.8.5).

A total of 21 selected bucks were distributed among the farmers to enhance the breed's genetic potential in the field. To support animal health, the project administered vaccinations against Foot and Mouth Disease (FMD) to 1,445 goats, dewormed 1,680 goats for endoparasites and 210 for ectoparasites and provided treatment to 2,227 animals for various health conditions.

Fig. 3.8.5. Bundelkhandi goat

3.8.9 AICRP on Farm Implements and Machinery on PFT & FLD

Prototype feasibility testing on solar operated sprayer cum tiller

Prototype Feasibility Testing (PFT) on solar operated sprayer cum tiller was conducted. The sprayer cum tiller consisted of a power source, solar panel, DC motor, spraying unit and rotary tilling and was used for spraying and tilling in forage crops. It was able to reduce the cost of operation and drudgery due to vibrations as compared with engine-operated machine. The observations for the spraying operation showed that the machine had a discharge of 50 litres in 15 minutes using a 50 W DC pump, with a swath width of 2.0 meters and an uniform nozzle output of about 0.47 l/min. It operated at an average speed of 2.4 km/h, giving a theoretical field capacity of 0.80 ha/h and an actual field capacity of 0.75 ha/h (about 2 acres per hour), resulting in a high field efficiency of 93%. For tilling and weeding operations, the machine used a 250 W (0.33 HP) DC motor with a working width of 40 cm and a tilling depth of 5 cm. Its operating speed ranged from 2–3 km/h, producing a theoretical field capacity of 0.10 ha/h and an actual field capacity of 0.09 ha/h, which was significantly higher than manual operations. The machine achieved a field efficiency of 90% and a weeding efficiency of 91%, indicating effective and reliable performance in intercultural and weeding activities.

3.8.10 Network project on ecosystems, agribusiness and institutions component 1: Impact of Agricultural Technology (Crop Science Technologies) Sub title: Analyzing the supply chain and marketing efficiency of fodder seeds in India

Berseem cultivation is critical to support nearly 230 million ACUs, requiring an area coverage of 1.92 million hectares and an annual seed production of about 48,034 tonnes. However, the estimated average seed production between 2002 and 2023 from public and private sectors, assuming a 10:90 share, was only 13,556.2 tonnes, indicating the presence of spurious seed production of approximately 34,478 tonnes. The average cost of berseem seed imports during this period was USD 1,011.8 per tonne (₹101.18 per kg at an exchange rate of 1 USD = INR 85.79). Import quantity and cost showed compound annual growth rates (CAGR) of 11.1% and 2.1%, respectively, reflecting a rising dependence on external sources. Policy simulations suggested that reducing import tariffs from 15% (MFN) to 0% would result in greater government revenue losses (–2106.58 '000 USD) compared to the welfare gains (104.83 '000 USD), making tariff reduction economically unviable. Meanwhile, surveys on the cost of seed production and the functioning of marketing channels are currently in progress to provide further insights into improving seed supply and reducing reliance on imports.

3.8.11 Building resilience model for the vulnerable hotspots to climate change in smallholder dairy production system of Indo-Gangetic plain region of India using GIS and fuzzy cognitive mapping approach

The study assessed breed-specific sensitivity to heat stress in smallholder dairy systems of the Indo-Gangetic Plain, revealing clear differences among Murrah, Karan Fries (KF) and Tharparkar (TP). KF recorded the highest average daily milk yield (11.17 L), followed by Murrah (7.64 L) and TP (5.69 L). However, KF showed lower heat tolerance, with a comprehensive climate index (CCI) threshold of 24.22 compared to Murrah (25.93) and TP (26.40), indicating greater sensitivity to climatic stress. Fixed-effect panel models confirmed significant effects of lactation order, stage of lactation and CCI on milk yield. Early lactation showed positive yield responses, while mid-lactation was most vulnerable, especially in KF. Seasonally, KF experienced the longest stress-induced decline (172 days) and the highest annual economic loss (Rs. 8,937 per animal), compared to Murrah (Rs. 7,363) and TP (Rs. 4,729).

Additionally, in collaboration with ICAR-NDRI, Karnal and ICAR-RCER, Patna, two *Climate-Resilient Dairy Farm Schools* were established in

Karnal (Haryana) and Buxar (Bihar) to promote climate-smart dairy practices and enhance farmers' resilience. Seven farmer–scientist interaction meetings were also held across Kanpur Dehat, Fatehpur, Unnao and Lucknow, focusing on animal health and feeding management to improve productivity and support sustainable dairy farming.

3.8.12 Harnessing genetic diversity in pearl millet and sorghum for identification of trait-specific genotypes and trait mapping for fodder yield and quality component traits

Phenotyping of pearl millet GWAS panel for fodder yield and quality traits

The GWAS panel consisting of 300 genotypes was evaluated for fodder yield and quality component traits such as, plant height, days to 50% flowering, leaf to stem ratio, green forage yield and dry matter, crude protein (%), NDF, ADF, lignin (%), IVDMD and ME during *kharif* 2025. The panel (Fig. 3.8.6) showed significant variations for the traits studied. The phenotypic data along with genotypic data from ICAR-IIMR, Hyderabad will be used for mapping and gene identification for the fodder yield and quality component traits in pearl millet.

Fig. 3.8.6. Pearl millet association panel at institute field

Phenotyping of sorghum genotypes for fodder yield and micronutrients content

Fig. 3.8.7. Sorghum germplasm evaluation for fodder yield and quality traits

About 100 sorghum lines and 5 checks were evaluated (Fig. 3.8.7) for fodder yield-related traits *viz.*, days to 50% flowering, plant height, leaf stem ratio, dry matter yield, *etc.* and micronutrients evaluation are under process (Fe, Zn, Cu, Ca and S) during summer 2025 and *kharif* 2025. The multi season data will be used to identify stable donor lines for fodder yield component traits and micronutrient traits for developing biofortified sorghum cultivars.

3.8.13 ICAR-National Agriculture Innovation Fund (NAIF) component-II establishment of Agri-Business Incubation Centre

About four EDP Training cum Workshop were organized at ABI Centre under National Agriculture Innovation Fund (Component–II) on (i) 'Goat farming: A profitable entrepreneurs for small and large farmers' from 20/01/2025 to 25/1/2025 for 12 trainees; (ii) 'Silage production & marketing to improve farmer's prosperity' from 18/03/2025 to 22/3/2025 for 13 trainees; (iii) 'Empowering agripreneurs through silage innovation' from 04/08/2025 to 09/08/2025 for 10 trainees and (iv) 'Profitable goat farming for aspiring entrepreneurs' from 22/09/2025 to 27/09/2025 for 14 trainees.

3.8.14 Mapping and validation of genomic regions associated with brown midrib mutant in pearl millet

QTL mapping for *bmr* trait in RIL population

The Recombinant Inbred Line (RIL) populations (ICBbmr07 × ICBP19) were phenotyped at two locations *viz.*, ICAR-IGFRI, Jhansi and IGFRI-SRRS, Dharwad during *summer* 2025 and at ICAR-IGFRI, Jhansi during *kharif* 2025. The 208 RIL lines were evaluated for morphological traits and lignin content (%), ADF (%) and NDF (%). The RIL population was genotyped using genotyping-by-sequencing (GBS) with 151 × 2 bp chemistry. A total of 44,402 high-quality SNPs were generated, of which 8,275 polymorphic markers were used to construct the linkage map and grouped into seven linkage groups. Chromosome 2 harbored the highest number of SNP markers (1,527), whereas chromosome 5 had the fewest (768). The total length of the genetic linkage map was 732.45 cM. Using this map, 28 stable QTLs were identified for various traits. Specifically, three QTLs for lignin content were detected on chromosomes 3, 4 and 7. For ADF, two QTLs were identified on chromosome 1, while six QTLs were detected across chromosomes 1, 4 and 7. The distribution of QTLs across the linkage map is illustrated in Fig.3.8.7.

Transcriptome sequencing of *bmr* and non *bmr* genotypes

Transcriptome sequencing of stem and leaf tissues from the parental lines ICBbmr07 and ICBP19 revealed differential expression of key genes involved in the lignin biosynthesis pathway. Two lignin-associated genes-caffeoyl-CoA O-methyltransferase (CCoAOMT) located on chromosome 4 and cinnamoyl-CoA reductase (CCR) located on chromosome 6-were significantly down regulated in the *bmr* parent. These genes were identified as strong candidate genes underlying reduced lignin accumulation in *bmr* plants.

Development of high biomass *bmr* genotypes

Many *bmr* pearl millet composites were developed by crossing S2 generation *bmr* lines developed by crossing ICBbmr07 with TSFB 15-8, Giant bajra, Baif bajra 1, Moti bajra, IGBV9, IGBV24, ICMV05222, ICMV1702 and IP2269.

3.8.15 Novel gene(s) discovery for drought and salinity tolerance using genome wide association analysis and multi-omics studies in Dinanath grass *(Pennisetum pedicellatum)*

For genome wide association studies in Dinanath grass, an exploration was undertaken in the Bastar region of Chhattisgarh for the collection of Dinanath grass germplasm, resulting in the collection of around seventy accessions. In addition, three accessions were collected from Goa, twenty-five from Shivamogga and Davangere districts of Karnataka and ten accessions from Hyderabad. These accessions will be included

3.8.16 Characterization and multiplication of forage crops (CRP-AB)

About 2028 accessions of thirteen perennial/ annual forage crops were sown, germinated/ multiplied or transplanted. Germplasm sets of four crops (dinanath grass; berseem; napier grass; lucerne) were characterised. Seed of *Dichanthium* sp. (217); *Heteropogon (*172); *Cenchrus* species (94); *Bothriochloa* spp. (12); *Medicago* spp. (191) and *Trifolium repens (*218) were deposited in LTS, ICAR-NBPGR, New Delhi. Selected high biomass lines will be submitted for all India testing. Lines with unique traits were identified in *Dichanthium, Heteropogon, Cenchrus* and *Dinanath* grass, red clover which will be submitted for registration. In temperate regions, orchard grass displayed balanced traits, making it a reliable option for temperate forage systems. *Bromus* grass exhibited the tallest plants and highest tillering, indicating excellent biomass potential. Red fescue and red clover were compact and stable, with good regrowth and good for late cutting suitability. Tall fescue showed consistent maturity and superior regrowth among the evaluated lines.

3.8.17 Synthetic seed production in sterile Bajra-Napier hybrid via encapsulation of somatic embryos

An efficient somatic embryogenic plant regeneration protocol for optimizing somatic embryo stage, encapsulating agents and matrix, synthetic seed performance under *in vitro* conditions was evaluated, genetic fidelity was assessed and storage for extended viability successfully was optimized. Overall, this study provided a comprehensive, effective protocol for synthetic seed production and storage of sterile Bajra Napier hybrid, contributing valuable insights for practical propagation and conservation of this important fodder crop.

3.8.18 Enhancing climate resilience and ensuring food security with genome editing tools (ICAR Project)

Two candidate *FT* genes were selected for gene editing by CRISPR/Cas9 tool to enhance biomass

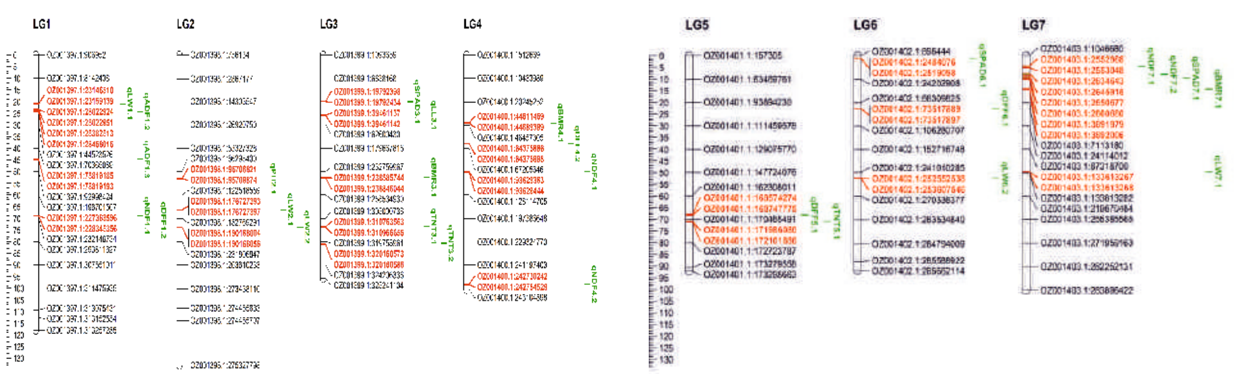

Fig. 3.8.8. Genetic map of chromosomes showing QTL for morphological and lignin component traits in the ICBbmr07 × ICBP19 RILs population

yield in cowpea. A total of four guide RNAs targeting two *FT* genes were designed. Each gene was targeted by 2 guide RNAs. All the four guide RNAs were validated for their cleavage efficiency by *in vitro* analysis. Five CRISPR/Cas9 constructs were developed by golden gate ligation strategy, two constructs target *FT-1*, two constructs target *FT-2* and one construct targets both *FT-1* and *FT-2* genes.

3.8.19 Identification and characterization of candidate genes related to polyploidy and / or apomixis in guinea grass

Based on the assembled transcripts, gene-specific primers were designed to amplify the full-length cDNA of the selected ESTs related to apomixis. The SMART RACE kit was used to clone the 3' and 5' sequences, respectively. The 5' and 3' clones were sequenced and assembled based on overlapping regions resulting in contiguous transcript comprising of 290bp 5' UTR, 1546bp CDS and 100bp 3' UTR with Trinity_331571 transcript was used as reference (Fig. 3.8.8).

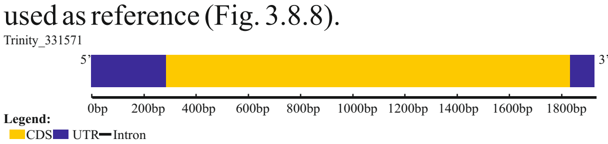

Fig. 3.8.9. Gene structure of the assembled 5' and 3' RACE clones

3.8.20 Utilizing perennial grasses for revolutionizing sustainable bioenergy production under challenging environments

(IGFRI-RIL collaborative project)

The lines of different grasses were tested for germination and their multiplication. Napier, marvel, guinea, switch, cenchrus, BNH, TSH, *Brachiaria* and rhodes grasses were transplanted in replication and successfully established in pots for multiplication and abiotic stress experiments for drought, salinity, alkalinity, acidity and waterlogging. The lines were also multiplied and established in field conditions for initiating crossing programme for high biomass and to generate better hybrids.

The crossing between sexual lines and high biomass guinea grass genotypes is under progress. The high–biomass-yielding guinea grass lines were selected as male parents for the crossing programme. The sexual lines were emasculated following the standard protocol developed at ICAR–IGFRI, Jhansi. Crosses were made between the sexual lines and the apomictic lines and seeds were harvested from the female parents.

Seed multiplication in F_7 lines of fertile seed producing Bajra Napier hybrid is under progress. The F_6 population of fertile seed producing Bajra Napier hybrid was advanced. Wide range of variability was observed for biomass related traits and top 50 variable lines were selected and mass multiplied for abiotic stress screening. Napier grass lines were transplanted in replications for abiotic stress studies. Established the lines of guinea grass by transplanting in pots for drought, salinity, alkalinity, shade, acidity and waterlogged stress conditions. *Brachiaria* grass lines were established by transplanting successfully in pots for water logging experiments.

For standardization of plant regeneration protocol in BN hybrid and *Cenchrus ciliaris*, different explants were cultured on MS media supplemented with growth hormones. In napier, two genotypes showed consistently high callus induction frequencies within one week time on *SIM medium.* Among the *Cenchrus ciliaris* genotypes, IGFRI-01 demonstrated embryogenic callus induction. Genotype IGFRI-02 produced embryogenic callus induction across all tested concentrations, but the callus size was comparatively smaller than that observed in genotype IGFRI-01. In guinea grass, the response of the three genotypes to 2,4-D–induced callus formation on MS medium revealed clear genotype-dependent differences in callus induction efficiency. BG-102 showed the highest callus induction potential, BG-104 displayed moderate responsiveness at lower concentrations, BG-101 showed poor callusing on 2,4-D levels, with callus induction beginning upward.

3.8.21 ICAR-NASF project: Natural grassland ecosystem monitoring system for peninsular and Trans Himalayan India to sustain pastoral communities

The estimation of aboveground biomass (AGB) in Amrit Mahal grassland (AMG) through machine learning, involved remote sensing, topography, soil and climate data. The XGBoost model was very accurate (training: R^2 = 0.704, RMSE = 1.503 Mg ha^{-1}; testing: R^2 = 0.593, RMSE = 1.529 Mg ha^{-1}), showing AGB ranges of 0.33-15.35 Mg ha^{-1}, higher in Mandya and Chikkamangaluru. The positive associations with the soil nitrogen, elevation and relative humidity were observed. The usage of boron, pH, net primary productivity, slope, elevation and nutrients (potassium, iron, phosphorus, nitrogen, organic carbon) were found to have a significant correlation with SHAP analysis, with adequate levels of boron (≥1.25 ppm), iron (>15 ppm) and nutrients (N: 392 kg ha^{-1}, P: 5.1 kg ha^{-1}, K: 297 kg ha^{-1}) recommended to maximize AGB.

Complementarily, the advanced vegetation index (AVI), green leaf index (GLI) and elevation were used to develop a simple index as the "Grassland Ecosystem Monitoring Index" (GEMI) to monitor the semi-arid grasslands at low costs. GEMI had a significant correlation with biomass productivity (r = 0.62), soil erosion (r = 0.54), carbon sequestration (r = 0.57), carrying capacity (r = 0.61) and microbial diversity (r = 0.62), indicating that it accounted variation of about 75% moisture-related ES, > 55% air quality and > 60% for NPP. Monte Carlo and Sobel sensitivity analysis were done to establish the robustness of the developed index; where, GLI was the highest contributor. The tools provided cost-effective strategies that were spatially explicit to manage the sustainable grasslands in India.

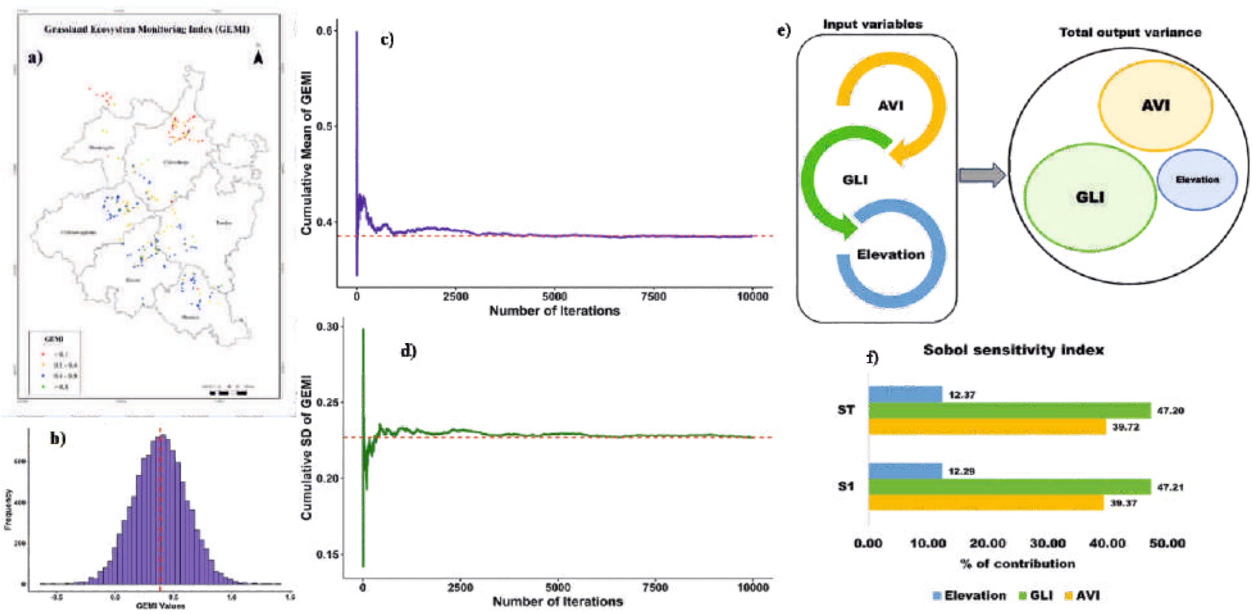

Fig.3.8.10. a) The spatial distribution of Grassland ecosystem monitoring index (GEMI) in a Amrit Mahal grassland of India, b) Monte Carlo histogram presenting probability distribution of GEMI across iterations, c) Monte Carlo simulations convergence test results for c) mean and d) standard deviation of GEMI across iterations, e) Factor prioritization and f) factor fixing of Sobol sensitivity analysis (S1: First order effect and ST: Total effect of different variables on GEMI; AVI: Advanced vegetation index; GLI: green leaf index)

Chapter 4

Forage Seed Production

4.1 Seed production 2024-25

In the *rabi* 2024-25, seed production of different varieties of berseem and oat was done. Out of the total seed production, breeder and truthfully labeled seed production of oat and berseem together was 24038 kg and 7506 kg, respectively. In the *kharif* 2025, seed production of different varieties of fodder cowpea, cluster bean, pearl millet and maize was carried out. Out of the total seed production, breeder seed production of fodder cowpea, cluster bean, pearl millet and maize was 1065 kg while truthfully labeled of fodder maize was 20 kg. In range grasses, 1016.50 kg TFL seed was produced.

4.1.1 Variety-wise seed production of fodder crops

Rabi 2024-25

Crop	Variety	Breeder seed (kg)	Truthfully labeled seed (kg)	Total (kg)
Oat	Kent	7350	735	8085
	JHO-822	9395	5555	14950
	JHO-851	770	480	1250
	JHO-2009-1	1890	315	2205
	JHO-2000-4	1785	140	1925
	JHO 2015-1	570	30	600
	JHO 2012-2	50	-	50
	Total	**21810**	**7255**	**29065**
Berseem	Wardan	750	80	830
	BB-2	200	56	256
	BB-3	230	25	255
	JHB-17-1	8	-	8
	JHB-17-2	135	-	135
	JHB-18-1	350	40	390
	JHB-18-2	80	-	80
	JBSC-1	450	50	500
	JHB-20-1	25	-	25
	Total	**2228**	**251**	**2479**
Total seed production		**24038**	**7506**	**31544**

Kharif 2025

Crop	Variety	Breeder seed (kg)	Truthfully labeled seed (kg)	Total (kg)
Fodder cowpea	BL1	138	-	138
	BL2	114	-	114
	BL4	216	-	216
	EC-4216	215	-	215
	Total	**468**	**-**	**468**
Maize	African tall	150	20	170
Pearl millet	AVKB-19	282	-	282
Clusterbean	Bundel Guar-1	165	-	165
Total seed production		**1065**	**20**	**1085**

4.1.2 Grasses and legumes seed production

Grasses name	Variety	Breeder seed (kg)	Truthfully labeled (kg)
Dinanath grass	Bundel Dinanath-2	-	70.0
Guinea grass	Non-specific	-	100.0
Clitoria	Non-specific	-	45.0
Dhaman grass	Bundel Dhaman-1	-	3.0
	Non-specific	-	738.5
Anjan grass	Bundel Anjan-1	-	60.0
Total seed production (range grasses)			**1016.5**

4.2 Seed sale (2025)

4.2.1 Total seed sale

In the year 2025, total sale of breeder and TFL seed of various fodder crops was 18,502 kg and 4989 kg, respectively. Total seed sale of TFL seeds of fodder shrubs and range grasses was 6.25 kg and 1538.85 kg, respectively. Root slips of various perennial grasses like BN hybrid, Guinea grass, cactus cladodes of spineless cactus were also sold.

Variety-wise seed sale (kg) in cultivated fodder crops (IGFRI, Jhansi)

Crop	Variety	Breeder seed (kg)	Truthfully labeled (kg)	Total (kg)
Oat	JHO-822	8090	3280	11370
	Kent	5475	83	5558
	JHO-2009-1	1550	-	1550
	JHO-2000-4	1525	350	1875
	Total	**16640**	**3713**	**20353**
Berseem	Wardan	642	220	862
	BB-2	15	44	59
	BB-3	-	53	53
	JBSC-1	463	161	624
	JHB 17-2 (BB-5)	75	-	75
	JHB 18-1 (BB-7)	405	4	409
	Total	**1600**	**482**	**2082**
Sorghum	MP chari	168.0	643.25	811.25
	Total	**168.0**	**643.25**	**811.25**
Cowpea	BL-2	-	02	02
	BL-4	-	02	02
	Kohinoor	-	102	102
	EC4216	-	20	20
	Total	**-**	**126**	**126**
Maize	African tall	94	25.25	119.25
	Total	94	25.25	119.25
Total seed sale (Fodder crops)		**18502**	**4989.50**	**23491.50**

Subabool	K-636	-	1.0	1.0
	S-24	-	1.5	1.5
	Non specific		0.25	0.25
	Total		**2.75**	**2.75**
Moringa	PKM-1	-	3.75	3.75
	Total	**-**	**3.75**	**3.75**
Total seed sale (Fodder shrubs)			**6.50**	**6.50**
Deenanath grass	BD-2 (Husk)	-	382.25	382.25
	Naked	3.0	-	3.0
	Total	**3.0**	**382.25**	**385.25**
Guinea grass	Non specific	-	1156.60	1156.60
	Total	**-**	**1156.60**	**1156.60**
Total seed sale (Range grasses)		**3.0**	**1538.85**	**1541.85**

Tropical grasses & non conventional crops

Crop	TFL (kg)
Bothriochloa	0.25
Dhaman grass	17.0
Clitoria ternatea	3.5
Dashrath grass	0.75
Rhodes grass	1.15
Sehima nervosum	0.5
Azolla pinnata	120.0
Total	**143.15**

Planting material (in numbers)

Crop	Quantity
BN hybrid (IGFRI-6, CoBN-3, PBN-342)	523727
Cactus cladodes	21180
Guinea grass root slips	500
Anjan grass root slips	500
Dhaman grass root slips	500
Fodder sugarcane root slips	50
Total	**546457**

Seeds sale (Regional Research Station, Avikanagar)

Particulars	Breeder seed	TFL seed	Total
Quantity (kg)	2842	773	3615
Value (Rs. in lakhs)	3.24	4.56	7.80

Seeds sale (Regional Research Station, Dharwad)

Crop	Seed sold (kg)	Amount (Rs.)	Stem cutting/ slips sold (No.)	Amount (Rs.)
Perennial fodder sorghum (CoFS-29)	904.80	352225	-	-
Guinea grass	487.9	319855	-	-
Hedge lucerne	0.6	360	-	-
Fodder cowpea	180.5	25392	-	-
Stylosanthes sp.	28.0	14800	-	-
Rhodes grass	11.0	8250	-	-
Brachiaria ruziziensis	12.0	7200	-	-
Dinanath grass	10.0	4000	-	-
Horse gram	311.0	24880	-	-
BN hybrid *cv.* DNH 6	-	-	52282	76921

BN hybrid *cv.* CoBN-5	-	-	47463	71813
BN hybrid *cv.* DNH 15	-	-	2000	2000
BN hybrid *cv.* Super Napier	-	-	400566	1063898
BN hybrid *cv.* Red Napier	-	-	25563	35014
Guinea grass	-	-	254843	224463
Rhodes grass	-	-	102750	77875
Brachiaria sp.	-	-	184750	138500
Others	-	158893	-	-
Total	**1945.8**	**915855**	**1070217**	**1690484**
Total amount (Rs.)	**915855 + 1690484 = 2606339**			

Seeds/planting material sale (Regional Research Station, Srinagar)

Crop	Variety	Breeder seed (kg)	Truthfully labeled seed (kg)	Total (kg)
Tall fescue	EC-178182	-	72	72
Orchard grass	Curie	-	15	15
Perennial rye grass	PPRG-2	-	50	50

Sale of planting material

Crop		Number of rooted slips
Phalaris aquatica	Non descriptive	100000
Tall fescue	Non descriptive	150000
Orchard grass	Non descriptive	100000

Seeds/planting material sale (Centre for Indian Himalayan Grasslands, Palampur)

Crop	Variety	Truthfully labeled seed (kg)	Breeder seed (kg)	Total (kg)	Amount (Rs.)
Tall fescue	Non descriptive	5.0	-	5.0	6500
Finger millet	VL-352	100.0	-	100.0	7000
Rye grass	Non descriptive	45.0	-	45.0	58500
Setaria	Non descriptive	10.0	-	10.0	13000
Oat	JHO-99-1	300.0	-	300.0	21000
White clover	Local collection	10.0	-	10.0	25000
Total		**470.0**	**-**	**470.0**	**131000**

Crop	Variety	Rooted slips/cuttings (No.)	Amount (Rs.)
Paspalum	Local collection	59850	179550
Brachiaria	Non descriptive	27650	82950
Setaria	Non descriptive	125650	376950
BN hybrid	NB-37	123850	371550
Guinea grass	Non descriptive	1150	3450
Tall fescue	Non descriptive	20000	60000
Orchard grass	Non descriptive	20000	60000
Total		**378150**	**1134450**

Chapter 5

Outreach Programmes

5.1 Scheduled Castes Sub-Plan (SCSP)

The activities under SCSP in 2025 focused on promoting fodder-livestock technologies across Uttar Pradesh, Madhya Pradesh, Karnataka, Himachal Pradesh and Jammu & Kashmir. In Jhansi and Datia, the SCSP team, along with the SS Division, carried out 2081 demonstrations of modern equipment. Inputs like sprayers (100), chaff cutters (5), vermi units (10), seed drills (1) and storage bins (100) were also distributed. Fodder varieties such as MP chari, BN hybrid, cowpea, cactus, oat, berseem and wheat were promoted, alongside livestock demonstrations (5) of Bhadawari buffaloes. Further, five training programmes and farmer meetings were organized to improve the knowledge and skills of the farmers.

Fig. 5.1. SCSP activities in UP and MP

Scheduled Sub-Plan (SCSP) – Jammu, Palampur & Dharwad

At ICAR–IGFRI, Srinagar, targeted interventions improved livestock productivity in Jammu. Three awareness programmes trained 200 farmers on feed, forage and animal health. Demonstrations with quality berseem seed increased fodder yield by 20% and milk output by 10-12%. Integrated support-calcium supplements, deworming, vermicompost and balanced nutrition-enhanced animal health and soil fertility.

Programme Highlights

1. One-day training on feed and forage technologies (Feb. 4, Bishnah) with 100 participants.
2. One-day training on livestock productivity (Feb. 6, Kotli Charkhein) with 50 participants.
3. Vermicompost demonstration (Feb. 21, Bishnah) benefitting 50 farmers.

Fig. 5.2. SCSP activities in Jammu and Kashmir

In Palampur, four awareness-cum-training programmes under SCSP benefitted 379 farmers. These included millet promotion (100 farmers) and fodder production systems (102 farmers) at Hamirpur, with Padma Shri Dr. P.L. Gautam as Chief Guest. A third programme on fodder and grassland management reached 131 farmers in Mandi, followed by a Kisan Mela on 1st November 2025 attended by 45 farmers, with Dr. S.K. Yadav as Chief Guest. Farmers received planting material of perennial grasses (*Setaria, Brachiaria,* Napier, *Paspalum*), seeds of rye grass, oats, finger millet and minor farm tools.

Training emphasized fodder technologies, post-harvest management and livestock productivity through grassland rejuvenation.

Fig. 5.3. SCSP activities in Himachal Pradesh

In Dharwad, three SCSP training programmes in Kalaburgi, Kolar and Chamarajanagar trained 300 farmers on improved fodder production. Sessions covered crop selection, nutrient and water management, harvesting and sustainable systems for year-round fodder production. Farmers received planting material of Bajra–Napier hybrid, Guinea grass and perennial sorghum. Mechanization support included 70 nipping machines in Kalaburgi and 54 cycle weeders in Kolar to reduce drudgery and improve efficiency. These interventions enhanced technical skills, ensured adoption of fodder technologies and strengthened livestock-based livelihoods among Scheduled Caste households.

Fig. 5.4. SCSP activities in Karnataka

5.2 Tribal Sub Plan (TSP)

TSP interventions were implemented across districts in Maharashtra, Rajasthan, J&K, Ladakh, Madhya Pradesh and Himachal Pradesh.

Rajasthan (Dausa): Seven input distribution and three training programmes benefitted 1,053 farmers. Inputs included 1,050 kg ZnSO4, 1,560 kg mineral bricks, 1,430 kg calcium supplements and improved fodder varieties (CSV-33MF sorghum, IGFRI-6 BN hybrid, AVKB-19 pearl millet, Bundel Guar-1, BL-43 berseem).

Jammu & Kashmir & Ladakh: ICAR–IGFRI Srinagar, with local partners, trained 238 farmers through four programmes on forage production and grassland restoration. Ten hectares of degraded grassland were rejuvenated using 1.5 lakh rooted slips, calcium supplements and deworming medicines, strengthening fodder supply and livestock health.

Madhya Pradesh (Barwani & Sheopur): KVK Barwani distributed 680 kg fodder sorghum and mungbean seed, 325 poultry chicks (Narmada Nidhi & Kadknath) and farm tools to 70 farmers. Six trainings for 176 farmers covered crop, fodder, livestock and poultry management. An exposure visit to IISR Indore was arranged. In Sheopur, 120 farmers attended training, receiving 98 battery sprayers and fodder bulletins.

Maharashtra (Nandurbar): Training and input distribution supported fodder-based livestock improvement. Inputs included 55 knapsack sprayers, wheel hoes, hand cultivators, mineral mixtures and fodder seeds (COFS-29, Guinea grass) for 100 farmers.

Himachal Pradesh (Chamba & Kangra): Four training programmes benefitted 161 farmers. Planting material of perennial grasses (Setaria, *Brachiaria*, Napier, rye grass, oats, clover) and drudgery-reducing tools were distributed, with emphasis on fodder technologies and grassland rejuvenation.

5.3 North Eastern Hill (NEH) Plan –2025

The institute collaborated with CAU Imphal, ICAR-KVK Phek, ICAR-NRC on Mithun and KVK Mamit to promote fodder and livestock interventions across districts in Manipur, Tripura, Assam, Mizoram and Nagaland. About 975 farmers, extension workers and officials benefitted through 140 Front Line Demonstrations (FLDs) on maize, sorghum, oat, BN

Fig. 5.5. TSP activities in Rajasthan, J&K, Maharashtra, Madhya Pradesh and Himachal Pradesh

hybrid, fodder units and horti-pastoral systems. Technical bulletins and literature on seed production, crop cultivation, fertilizers and farm tools were distributed, supporting sustainable region-specific practices.

5.4 Farmer's FIRST Programme (FFP)

Three farmer–scientist meetings in five villages demonstrated high-yielding greengram (IPM-205-7) on 72 farms, achieving 33% higher yield. Kharif vegetable varieties (Kashi Ganga, Shreya, Kranti, Nidhi) improved yields by 26–35%. Improved fodder varieties (berseem, oat, sorghum, Bajra–Napier hybrid) were promoted, with sorghum CSH-24 yielding 35% more green fodder. Two field days on wheat and Bajra–Napier hybrid engaged 240 farmers. Adoption of improved practices boosted incomes, with farmer Sh. Prabhu Dayal Rajput honored as Best Farmer by NAARM and IGFRI.

5.5 Agricultural Technology Information Centre (ATIC)

ATIC at IGFRI supplied seeds, literature and value-added products worth ₹7,720 in 2025. It engaged 9,540 visitors (farmers, students, organizations), handled 280 farmer and stakeholder calls and organized seven training programmes benefitting 438 farmers.

5.6 *Kisan Goshtis* organized

Several farmer meetings and field days were conducted under SCSP and Farmer FIRST projects. Key events included Wheat Field Day at Dhikoli (120 farmers) and Bajra–Napier grass Field Day at Ramgarh (100 farmers). Input distribution programmes under SCSP benefitted 115 farmers in May, while a large-scale "Viksit Krishi Sankalp Abhiyan" reached 405 villages across Jhansi, Lalitpur and Jalaun, distributing 12,000 leaflets. Additionally, farmer interactions with FAO experts were held in Thakurpura and Kakraua villages, engaging 140 farmers. Overall, these goshtis strengthened awareness of improved fodder, crop technologies and input support.

5.7 *Kisan Melas* organized and participated

The institute actively participated in major agricultural fairs and exhibitions across India. These included the Farmers Fair and Agriculture Exhibition at RLBCAU Jhansi, NAAS Congress at Pantnagar, Agro-Industrial Exhibition at Gwalior, IFSC Conference at Meerut and Technology & Machinery Demonstration Meet at IGFRI Jhansi. Foundation Day celebrations at CAFRI and IGFRI also featured farmer participation. Across these events, about 1,550 leaflets were distributed to disseminate improved technologies.

5.8 Visits to IGFRI

A total of 116 visits were recorded, involving 2,562 farmers, officers and NGOs, along with 6,978 students and teachers. Around 3,000 leaflets were distributed during these visits, ensuring wide outreach of IGFRI's technologies.

5.9 Revenue generation

Through the Agricultural Technology Information Centre (ATIC), sales of seeds, rooted slips, publications and value-added products (Azolla, bio-fertilizer, vermicompost) generated ₹7,720 during 2025.

Chapter 6

Training and Capacity Building

The HRD unit plays a vital role in strengthening human resources and institutional capabilities through well-structured training, capacity-building programmes and collaborative initiatives. It undertakes a range of sponsored projects and institutional programmes designed to enhance technical knowledge, professional competencies and practical skills in its core mandate areas. These initiatives aim to build a strong foundation for research, innovation and technology dissemination among scientists, students, extension personnel and other stakeholders involved in the agricultural sector.

A key focus of the unit is the continuous capacity building and skill enhancement of its internal staff members. Through regular training programmes, workshops, exposure visits and knowledge-sharing sessions, the unit ensures that its personnel remain updated with emerging technologies, modern research methodologies and best management practices. This contributes significantly to improving organizational efficiency, productivity and overall effectiveness in delivering institutional objectives.

The unit also facilitates and coordinates the development of Memorandum of Understanding (MoUs) and other collaborative agreements with national and regional institutions. These collaborations promote joint research activities, academic cooperation, knowledge exchange, capacity-building programmes and entrepreneurship development initiatives. By fostering such partnerships, the unit helps create a strong network of institutions working collectively towards agricultural development, innovation and rural transformation.

In this regard, the unit actively promotes academic and research collaborations with several prominent ICAR institutes and other research and development organizations, including Rani Lakshmi Bai Central Agricultural University, Bundelkhand University, Sher-e-Kashmir University of Agricultural Sciences and Technology and Sardar Vallabhbhai Patel University of Agriculture and Technology. These partnerships enable the exchange of expertise, sharing of research infrastructure, joint supervision of student research and implementation of multidisciplinary projects that address region-specific agricultural challenges.

Furthermore, the unit provides the necessary facilities, technical guidance and institutional support for organizing a wide range of academic and professional development activities. These include short-term training programmes, skill development workshops, internships, Rural Agricultural Work Experience (RAWE) programmes, dissertation and thesis research support and Entrepreneurship Development Programmes (EDPs). Such initiatives are designed to provide students and young professionals with practical exposure, hands-on training and real-world experience in agricultural research, technology transfer, agribusiness management and rural development.

Through these comprehensive efforts, the unit contributes significantly to strengthening the capacity of students, researchers, extension workers, entrepreneurs and farming communities. Ultimately, these activities support the broader goals of agricultural innovation, human resource development and sustainable rural development.

6.1. Capacity building and skill improvement thrust to IGFRI personnel

Under the capacity building mode of activities, 08 Scientists and 03 Administrative staff received various specialized training organized by different national institutes and agencies on a wide spectrum of topics including finance management. Human resource development programs covered both genders in institute building.

Table 6.1 Capacity building of the staff

Scientific category

S.No.	Name	Period	Institute	Training programme
1.	Dr. Bishwa Bhaskar Choudhary	01- 21 Jan., 2025	University of Agricultural Sciences, Bangalore, Karnataka	Emerging employment in agriculture, sericulture, horticulture, fisheries, animal husbandry, dairy & allied sectors for economic development of India
2.	Dr. Surinder Paul	10-11 Mar., 2025	ICAR-IARI, New Delhi	Virome profiling in plants: Advanced methods for discovery and analysis
3.	Dr. Pooja Tamboli	20-26 Mar., 2025	Vital Biotech, Kota, Rajasthan	Cutting edge innovation in veterinary science for a sustainable future
4. 5. 6. 7.	Dr. Avijit Ghosh Dr. Samir Barman Dr. Bishwa Bhaskar Choudhary Dr. Rajesh Kumar Singhal	16 Jul.- 5 Aug., 2025	ICAR-NIASM, Baramati	Advanced statistical and machine learning techniques for data analysis using open-source software for abiotic stress management in agriculture
8.	Dr. Vinod Kumar	26-28 Nov., 2025	ICAR-NAARM, Hyderabad	Generative AI tools for agriculture

Administrative category

S.No.	Name	Period	Institute	Name of training programme attended
1.	Mr. Shubham Yadav Mr. Shubham Tripathi Mr. Pranjal Panwar Mr. Akash Prakash Verma Mr. Satyam Agarwal Mr. Siddharth Pratap Singh Mr. Sohail Khan	20-24 Jan., 2025	ICAR-IARI, New Delhi	Orientation training program for the assistant recruited under direct recruitment quota through assistant grade examination 2022
2.	Mr. Prashant Saxena	08-24 Dec., 2025	ICAR-NIASM, Baramati, Pune	Pre-examination training for limited departmental competitive examination for the post of assistant in ICAR system
3. 4.	Mr. Shubham Tripathi Mr. Shubham Yadav	22-23 Dec., 2025	ISTM, New Delhi	Pay fixation

6.2. Capacity building for forage resource development

Five sponsored training and three institutional capacity building programmes were organized in areas related to fodder production, conservation and utilization. The details are as in Table 6.2 and 6.3.

Table 6.2. Sponsored capacity building programmes

S.No.	Training programme	Sponsor	No. of participants	Duration
1	Improved fodder production and utilization technologies	UP Government	23	03 Jan., 2025
2	Fodder seed production, processing and storage	NDDB, Anand, Gujarat	25	17- 21 Feb., 2025
3	Fodder production, conservation and utilization	ATMA, Dausa, Rajasthan	40	03-07 Mar., 2025
4	Fodder production, conservation and utilization	NABARD, Surendranagar, Gujarat	25	18-20 Mar., 2025
5	Fodder production, conservation and use for animal husbandry in Bihar	ATMA, Rohtas, Bihar	20	17-23 Dec., 2025

Table 6.3. Institutional capacity building programmes

S.No.	Training Programme	Project	No. of participants	Duration
1	Fodder production, conservation and utilization techniques	SCSP	90	11-13 Feb., 2025
2	Bajra-Napier hybrid field day	FFP	120	02 Mar., 2025
3	Wheat field day	FFP	120	23 Mar., 2025

6.3. Students dissertations/internship/RAWE

Human Resources Development Unit facilitated 05 M.Sc. students for dissertation, in addition unit facilitated 02 Ph.D. students for dissertation.

6.4. Memorandum of Understanding (MoUs)

- MoU between ICAR-IGFRI, Jhansi & KVK, Badwani, M.P. for upliftment of tribal's in Badwani district, M.P.
- MoU between ICAR-IGFRI, Jhansi & Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U.P. for promotion of students' training, quality postgraduate research and collaborative research.
- MoU between ICAR-IGFRI, Jhansi & Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, U.P. to promote academic collaboration and strengthen research activities.
- MoU between ICAR-IGFRI, Jhansi and M/s Exceed digital, Jhansi for advancement of forage production, conservation, utilization and other allied technologies.

6.5. Academic collaboration

Team HRD is facilitating the academic collaboration with institutions like RLBCAU, BU Jhansi, SRGI, Jhansi *etc.* A total of 30 scientists of ICAR-IGFRI, Jhansi are engaged in teaching courses at RLBCAU, Jhansi.

Table 6.4 : Training and exposure visits

S.No.	Date	Department	No. of visitors	Category
1	03-01-2025	Agriculture Department, Lalitpur, U.P.	23	Government employees
2	18-01-2025	KVK, Basti, U.P.	35	Farmers
3	29-01-2025	Government Inter College, Burhpura, U.P.	39	Students
4	29-01-2025	Government Inter College, Moth, U.P.	65	Students
5	04-02-2025	Agriculture Department, Damoh, M.P.	38	Farmers
6	06-02-2025	Agriculture Department, Narmadapuram, M.P.	18	Farmers

7	07-02-2025	Kendriya Vidyalaya, Gwalior, M.P.	192	Students
8	11-02-2025	SCSP Farmers Goshthi, Jhansi, U.P.	30	Farmers
9	11-02-2025	Government Inter College, Jhansi, U.P,	300	Students
10	12-02-2025	Government Inter College, Jhansi, U.P.	300	Students
11	12-02-2025	BUA&T, Banda, U.P.	86	Students
12	12-02-2025	SCSP Farmers Goshthi, Jhansi, U.P.	30	Farmers
13	13-02-2025	Agricultural Department, Newari, M.P.	12	Government employees
14	13-02-2025	SCSP Farmers Goshthi, Datia, M.P.	30	Farmers
15	18-02-2025	Manav Jagran Sewa Sansthan, Jhansi, U.P.	50	Farmers
16	07-03-2025	KPS College, Lalitpur, U.P.	32	Students
17	12-03-2025	ATMA, Damoh, M.P.	24	Farmers
18	18-03-2025	Yuva Kaushal Kisan Mandal, Jhansi, U.P.	27	Farmers
19	18-03-2025	SCSP Farmers visit for TMDM, Jhansi, U.P.	250	Farmers
20	20-03-2025	ATMA, Vidisha, M.P.	74	Farmers
21	25-03-2025	Chandrashekhar Azad University of Agriculture & Technology, Kanpur, U.P.	145	Students
22	29-03-2025	ATMA, Mahoba, U.P.	52	Farmers
23	01-04-2025	Dy. Directorate of Farmers Welfare and Agriculture Development, Chhatarpur, MP	9	Farmers
24	30-04-2025	FFP Farmers Goshthi, Jhansi, U.P.	5	Farmers
25	01-05-2025	FFP Farmers Goshthi, Jhansi, U.P.	7	Farmers
26	05-05-2025	Kundal Academy of Development, Administration and Management, Sangli, Maharashtra	40	Students
27	09-05-2025	Akhil Bhartiya Vidhyarthi Parishad, Jhansi, U.P.	2	Students
28	14-05-2025	SCSP Farmers Goshthi, Jhansi, U.P.	60	Farmers
29	15-05-2025	SCSP Farmers Goshthi, Jhansi, U.P.	55	Farmers
30	05-06-2025	Agriculture Department, Vidisha, M.P.	1	Government employees
31	17-06-2025	Agriculture Department, Tamil Nadu	25	Government employees
32	18-06-2025	Chandrashekhar Azad University of Agriculture & Technology, Kanpur, U.P.	31	Students
33	26-06-2025	Catholic Seva Samaj, Jhansi, U.P.	63	Farmers
34	01-07-2025	SCSP Farmers Goshthi, Jhansi, U.P.	128	Farmers
35	17-07-2025	Telangana Forest Academy, Telangana	36	Forest rangers
36	02-08-2025	Farmers Goshthi on "Pradhan Mantri Kisan Samman Nidhi", Jhansi, U.P.	105	Farmers
37	28-08-2025	SCSP Farmers Goshthi, Jhansi, U.P.	25	Farmers
38	29-08-2025	G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand	49	Students

39	29-08-2025	Farmers Goshthi, Morena, M.P.	23	Farmers
40	29-08-2025	SCSP Farmers Goshthi, Datia, M.P.	28	Farmers
41	09-09-2025	SCSP Farmers Goshthi, Jhansi, U.P.	59	Farmers
42	10-09-2025	SCSP Farmers Goshthi, Datia, M.P.	50	Farmers
43	22-09-2025	Agriculture Department, Guna, M.P.	44	Farmers
44	09-10-2025	Bull distribution under SCSP , Jhansi, U.P.	10	Farmers
45	11-10-2025	Farmers Goshthi on "Pradhan Mantri Dhan Dhanya Krishi Yojna" Jhansi, U.P.	212	Farmers
46	15-10-2025	KVK, Datia, M.P.	40	Farmers
47	27-10-2025	KVK, Shivpuri, M.P.	41	Farmers
48	28-10-2025	FFP Farmers Goshthi, Jhansi, U.P.	20	Farmers
49	31-10-2025	FFP Farmers Goshthi, Jhansi, U.P.	12	Farmers
50	31-10-2025	SCSP Farmers Goshthi, Jhansi, U.P.	22	Farmers
51	01-11-2025	Farmers Goshthi on 64^{th} Foundation Day Programme, Jhansi, U.P.	15	Farmers
52	04-11-2025	Farmers Goshthi, Jhansi, U.P.	25	Farmers
53	04-11-2025	Agriculture Department, Guna, M.P.	19	Farmers
54	06-11-2025	Agriculture Department, Firozabad, U.P.	37	Farmers
55	07-11-2025	PM Shri Government Inter College, Katera, Jhansi, U.P.	440	Students
56	08-11-2025	ATMA, Rajasthan	46	Farmers
57	10-11-2025	Farmers Goshthi, Jhansi, U.P.	15	Farmers
58	10-11-2025	Input dealers from Lalitpur, U.P.	58	Farmers
59	11-11-2025	ATMA, Panna, M.P.	20	Farmers
60	14-11-2025	Farmers Goshthi, Jhansi, U.P.	15	Farmers
61	17-11-2025	Government Inter College, Kulpahar, U.P.	271	Students
62	17-11-2025	Agriculture Department, Shivpuri, M.P.	31	Farmers
63	18-11-2025	Government High School, Bilgaon, Hamirpur, U.P.	25	Students
64	18-11-2025	Government Women Inter College, Hamirpur, U.P.	68	Students
65	18-11-2025	Government High School, Dulara, Hamirpur, U.P.	86	Students
66	18-11-2025	ATMA, Guna, M.P.	15	Farmers
67	19-11-2025	Farmers Goshthi on "Pradhan Mantri Kisan Samman Nidhi", Jhansi & Datia	200	Farmers
68	20-11-2025	FFP Farmers Goshthi, Jhansi, U.P.	30	Farmers
69	21-11-2025	Farmers Goshthi, Jhansi, U.P.	80	Farmers
70	21-11-2025	PM Shri Government Middle School, Shivpuri, M.P.	57	Students
71	21-11-2025	Kasturba Gandhi Governmental Girls High School, Hamirpur, U.P.	56	Students

72	24-11-2025	ATMA, Gwalior, M.P.	11	Farmers
73	26-11-2025	PM Shri Government Inter College, Mauranipur, U.P.	105	Students
74	26-11-2025	Government Inter College, Lalitpur, U.P.	255	Students
75	27-11-2025	Navodaya Vidyalaya, Dhamsa, Pratapgarh, U.P.	65	Students
76	27-11-2025	Government High School, Gundela, Hamirpur, U.P.	67	Students
77	28-11-2025	Government High School, Dawani, Lalitpur, U.P.	170	Students
78	28-11-2025	Government High School, Virdha, Lalitpur, U.P.	243	Students
79	28-11-2025	Government High School, Newari, M.P.	82	Students
80	29-11-2025	Government Inter College, Jalaun, U.P.	86	Students
81	02-12-2025	ATMA, Damoh, M.P.	23	Farmers
82	02-12-2025	Government High School, Hansarkala, Lalitpur, U.P.	248	Students
83	03-12-2025	Rani Lakshmibai Public School, Datia, M.P.	32	Students
84	03-12-2025	ATMA, Rajasthan	42	Farmers
85	03-12-2025	Government High School, Ajitapur, Jalaun, U.P.	33	Students
86	03-12-2025	Government High School, Damras, Jalaun, U.P.	65	Students
87	03-12-2025	Government High School, Entoo, Jalaun, U.P.	20	Students
88	03-12-2025	Government High School, Margaya, Jalaun, U.P.	50	Students
89	04-12-2025	Agriculture Ministry, Rewa, M.P.	21	Farmers
90	05-12-2025	Government Higher Secondary School, Machawali, Shivpuri, M.P.	76	Students
91	05-12-2025	Government High School, Rawat, Hamirpur, U.P.	67	Students
92	06-12-2025	Pandit Dindayal Upadhayay Model Inter College, Kaithi, Hamirpur, U.P.	234	Students
93	08-12-2025	Government High School, Thora, Lalitpur, U.P.	150	Students
94	08-12-2025	Government High School, Dongarakala, Lalitpur, U.P.	127	Students
95	08-12-2025	Government High School, Didoniya, Lalitpur, U.P.	141	Students
96	08-12-2025	Government High School, Dailwara, Lalitpur, U.P.	118	Students

97	09-12-2025	Government High School, Jakhora, Lalitpur, U.P.	517	Students
98	09-12-2025	Government High School, Veer, Lalitpur, U.P.	77	Students
99	09-12-2025	Government High School, Kushmar, Lalitpur, U.P.	43	Students
100	09-12-2025	Government High School, Mahroni, Lalitpur, U.P.	89	Students
101	10-12-2025	Government High School, Kalyanpur, Lalitpur, U.P.	188	Students
102	10-12-2025	Government High School, Andher, Lalitpur, U.P.	89	Students
103	10-12-2025	Government High School, Vastravan, Lalitpur, U.P.	78	Students
104	10-12-2025	Government Senior Secondary School, Kumheri, Lalitpur, U.P.	72	Students
105	10-12-2025	Government Inter College, Jakhora, Lalitpur, U.P.	570	Students
106	10-12-2025	Government Inter College, Mainwara, Lalitpur, U.P.	153	Students
107	11-12-2025	SCSP Bhadawari Project, Jhansi, U.P.	45	Farmers
108	12-12-2025	Government High School, Patha, Lalitpur, U.P.	40	Students
109	12-12-2025	Government High School, Ramghadha, Lalitpur, U.P.	75	Students
110	12-12-2025	Government High School, Simiriya, Lalitpur, U.P.	115	Students
111	14-12-2025	ATMA, Datia, M.P.	40	Farmers
112	16-12-2025	ATMA, Orai, U.P.	37	Farmers
113	18-12-2025	College of Forestry. Dr. PDKV, Akola, Maharashtra	53	Students
114	23-12-2025	Swaliman High School, Mathurapura, Jhansi, U.P.	13	Students
115	23-12-2025	Government High School, Babina, Jhansi, U.P.	25	Students
116	23-12-2025	Block Resource Office, Bangra, Jhansi, U.P.	63	Students

Chapter 7

Success Stories

Restoration of temperate grasslands in Aru Valley, Jammu & Kashmir

In the high-altitude temperate landscapes of Aru Valley in Anantnag district of Jammu & Kashmir, grasslands are central to the livestock-based livelihoods of Gujjar, Bakarwal and Chopan pastoral communities. However, a short growing season (May–October), severe winters, low soil fertility and increasing weed invasion had led to rapid pasture degradation, forage scarcity and mounting pressure on fragile native alpine meadows.

To restore these vital ecosystems, the ICAR–Indian Grassland and Fodder Research Institute (IGFRI), Regional Research Station, Srinagar, initiated a collaborative long-term temperate grassland restoration programme (2019–2025) at the Fodder Seed Production Station in Aru Valley (2540 m amsl). The intervention focused on creating awareness among local farmers about grassland restoration (Fig 7.1), emphasizing scientific pasture rejuvenation through the sowing of improved temperate grasses, introduction of legumes to enhance soil fertility and systematic weed management practices.

Over six years, more than 10 hectares of degraded pastureland were successfully rehabilitated. The restored grass-legume systems improved forage and seed availability, strengthened livestock nutrition, enhanced pasture productivity & carrying capacity and reduced dependence on vulnerable native pastures. Additionally, the programme boosted regional fodder seed production and facilitated the dissemination of quality seed to farmers and line departments. This science-based, community- aligned initiative demonstrated a replicable and sustainable model for revitalizing temperate and sub-alpine grasslands under changing climatic conditions.

Fig. 7.1. Creating awareness among local farmers for restoration of grassland

Table 7.1. Effect of grassland restoration programme in Aru Valley, Anantnag

Indicator	Pre-intervention	Post-intervention
Herbage yield	4-5 t/ha	7-8 t/ha
Palatable species cover	<40%	>75%
Soil organic carbon	0.4-0.6%	0.9-1.1%
Forage species diversity	Fair	Significantly improved (>40 species)
Seed production	Nil in case of Tall	450 kg in Tall fescue, 300 kg in Bromus and 500 kg in Fescue/Bromus/Lolium/Rye grass

Seeding success through FFP: The inspiring journey of Shri Purushottam Rajpoot

Under the Farmers FIRST Programme (FFP) of ICAR-Indian Grassland and Fodder Research Institute- Jhansi, Shri Purushottam Rajpoot of Village Ramgarh, Block Babina, District Jhansi, Uttar Pradesh, has emerged as a shining example of how scientific interventions can transform rural livelihood of farmers. A 45-year-old farmer with 20 years of farming experience and a 5-acre landholding, Shri Rajpoot became associated with FFP in 2022. Through the programme, he received improved seeds of high-yielding fodder crops such as berseem, oat and sorghum, along with rooted slips of BN hybrid grass. He also underwent hands-on training in dairy and goat farming, which strengthened his technical knowledge and confidence in adopting improved livestock management practices.

The introduction of quality forages significantly reduced his daily drudgery in sourcing green fodder by nearly one hour, ensuring regular availability of nutritious feed for his livestocks. By adopting the improved package of practices promoted under FFP, he recorded a 17% increase in milk yield from his buffaloes, leading to enhanced household income and nutritional security. Diversification into goat farming provided an additional and stable income source. Cultivation of BN hybrid grass (Fig. 7.2a) further created entrepreneurial opportunities, as he began producing and selling rooted slips to other farmers and *Gaushalas*. With institutional guidance, he also established a milk collection centre in his village, benefiting fellow dairy farmers (Fig. 7.2b).

Today, Shri Rajpoot serves as a local technology disseminator. He has supplied 2,000 rooted slips to Catholic Samaj Seva Sansthan and another 2,000 to neighboring farmers, while nearly 100 farmers have visited his fields-reflecting FFP's tangible impact on sustainable agriculture and community development.

Fig. 7.2(a) BN Hybrid grass and (b) Milk collection center at Shri Rajpoot's farm

Chapter 8

List of Publications

Research Papers

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गौरेन्द्र गुप्ता, अवनींद्र कुमार सिंह, सीताराम कांटवा, सुरेंद्र कुमार मीणा, रवि प्रकाश सैनी, देवेंद्र प्रताप, साधना पांडेय, बिश्व भास्कर चौधरी, पंकज कौशल। पूर्वोत्तर राज्य उप–परियोजनांतर्गत मक्का, जई, राइसबीन एवं संकर बाजरा नेपियर की खेती तकनीकः भा.कृ.अनु.प.– भारतीय चरागाह एवं चारा अनुसंधान संस्थान, झाँसी.

Chapter 9

Approved Ongoing Projects

Programme 1: Genetic enhancement of forage crops with emphasis on quality, multicut, stress tolerance & bio-fortification utilizing conventional, apomixes and new breeding tools

Project Code	Title	PI & Co-PIs	Duration
CRSCIGFRISIL 20230102	Genome-wide identification, characterization and expression analysis of flowering locus T (FT) genes controlling floral induction in cowpea	*PI: P. Priyadarshini Co-PIs: K.K. Dwivedi, B. K. Mehta and S.K. Meena*	2023-2026
CRSCIGFRISIL 20200105	Genetic improvement of maize for high biomass and fodder quality	*PI: B.K. Mehta, Co-PIs: P. Shashikumara, K.K. Dwivedi and Firoz Hossain, IARI, New Delhi*	2020-2025
CRSCIGFRISIL 20200103	Identification of oat (*Avena sativa*) lines for heat stress tolerance	*PI: Parichita Priyadarshini Co-PIs: P. Shashikumara, M. Tomar*	2020-2025
CRSCIGFRISIL 20200101	Breeding of pearl millet for deriving multi-cut and dual purpose genotypes with high forage yield and quality	*PI: P. Shashikumara Co-PIs: B. K. Mehta and K. K. Dwivedi*	2020-2025
CRSCIGFRISIL 20210103	Developing erect type and multi-cut fodder cowpea with enhanced nutritional quality	*PI: B.K. Mehta; Co: PIs: S. K. Meena and K. Sridhar*	2021-2026
CRSCIGFRISIL 20230101	Identification and characterization of multicut sorghum lines for low HCN and moisture stress tolerance	*PI: R.K. Singhal Co-PIs - S. Ahmed, Maneet Rana and Subhash Chand*	2023-2026
CRSCIGFRISIL 20220102	Identification and characterization of cowpea genotypes for phosphorus use efficiency	*PI: S.K. Meena, Co-PIs: B.K. Mehta, Maneet Rana and Mahendra Prasad*	2023-2026
CRSCIGFRISIL 20220101	Genetic improvement of novel fertile Bajra-Napier hybrid for enhanced productivity and quality traits	*PI: Maneet Rana Co-PIs: Shashikumara P., S. Ahmad , R. K. Singhal, Gaurendra Gupta and Sangeeta Singh*	2022-2027
CRSCIGFRISIL 20210102	Genomics assisted breeding for zinc and iron bio-fortification in oat	*PI: Maneet Rana Co-PIs: K.K. Dwivedi, S. Ahmed, R.K. Singhal, Surinder Paul and (Satpal, Agronomist and Vinod Kumar, Biochemist, HAU, Hisar)*	2021-2024
CRSCIGFRISIL 20200101	Identification and characterization of genes involved in expression of apomixes component traits and polyploidy series in guinea grass (*Panicum maximum* Jacq.)	*PI: K. K. Dwivedi CO-PIs: Maneet Rana and Tejveer Singh*	2021-2025
CRSCIGFRISIL 20210104	Breeding oat for improved productivity and quality	*PI: Shahid Ahmed Co-PIs: Maneet Rana, R.K. Singhal, Sultan Singh, Subhash Chand and Parichita Priyadarshini*	2021-2026

CRSCIGFRISIL 20200102	Augmentation, characterisation, conservation and documentation of forage genetic resources	*PI: Shahid Ahmed; Co-PIs: R.K. Singhal, E. Antony, S.S. Bhat, P. Shashikumara and B.K. Mehta*	2020-2025
CRSCIGFRISIL 20180901	Combined stress tolerance of water logging and salinity in fodder grasses	*PI: Edna Antony Co-PIs: Vinod Kumar, Kuligod, UAS Dharwad, Doddamani, UAS Dharwad and M. Akbar, UAS Dharwad*	2018-2023
CRSCIGFRISIL 20200903	Breeding Lucerne (*Medicago sativa* L.) for high forage yield and nutritional quality for different ecosystems (phase II)	*PI: K. Sridhar Co-PIs: E. Antony, N.S .Kulkarni, R.P. Nagar, Sultan Singh, Suheel Ahmad, Shahid Ahmed and Ramyashree Devi (study leave)*	2020-2025
CRSCIGFRISIL 20211002	Genetic improvement of temperate forage crops	*PI: S.S. Bhat Co-PIs: Suheel Ahmad, Tejveer Singh, Shahid Ahmed and P. Koli*	2021-2026
CRSCIGFRISIL 20251001	Harnessing temperate fodder germplasm resources for conservation and sustainable utilization	*PI: Asif Mohd Iqbal Co-PIs: Suheel Ahmad and Sheeraz Saleem Bhat*	2025-2027
CRSCIGFRISIL 20250101	Development of tailor-made berseem for traditional and emerging cultivation areas	*PI: Tejveer Singh Co-PIs: S.R. Kantwa, Ravi P. Saini, Surendra K. Meena and Sangeeta Singh*	2025-2030
CRSCIGFRISIL 20250102	Novel gene discovery in fodder grasses and legumes: comparative analysis of disease resistance (R) genes, defense response (DR) genes, susceptibility (S) genes and abiotic stress responses in cultivated vs wild gene pools	*PI: Sangeeta Singh Co-PI: V.C. Tyagi*	2025-2028
CRSCIGFRISIL 20250103	Forage genetic resources management	*PI: V.C. Tyagi Co-PI: Tejveer Singh*	2025-2030
CRSCIGFRISIL 20240901	Eco-friendly management of aphids Aphis craccivora in cowpea *Vigna unguiculata* (L.) walp	*PI: N.S. Kulkarni, Co-PI: K. Sridhar*	2025-2028
CRSCIGFRISIL 20240401	Chemical interventions for increasing percentage pure of germinating seeds in grasses.	*PI: R.P. Saini Co-PIs: S.K. Meena, K.K. Dwivedi and Awnindra Kr. Singh*	2025-2028

Programme 2: Diversification and sustainable intensification of fodder production in different land use systems including assessment and rejuvenation of grasslands and other resources for improving productivity and livelihood options

Project Code	Title	PI & Co-PIs	Duration
CRSCIGFRISIL 20250301	Forage GIS: A geospatial framework for area and yield mapping	*PI: Amit Kumar Singh Co: PIs- Avijit Ghosh, Samir Barman and Ajay N. Satpute*	2025-2027

CRSCIGFRISIL 20200302	Recuperated canopy architecture for higher bael (Aegle marmelos) productivity and forage security in semi-arid region	*PI: A.K. Shukla Co-PIs: Sunil Kumar, Avijit Ghosh, Amit Kumar Singh and M.M. Das*	2020-2025
CRSCIGFRISIL 20230303	Sustaining productivity in grown up hortipastoral system for fruit and forage security with soil & tree management practices	*PI: Sunil Kumar Co-PIs: Amit Kumar SIngh, Avijit Ghosh, S.R. Kantwa and Srinivasan. R.*	2023-2027
CRSCIGFRISIL 20230304	Pruning management for optimizing forage and wood productivity from *Hardwickia binata* based silvopasture systems	*PI: S.N. Ram Co-PIs: Kamini, A. Ghosh and A.K. Shukla*	2023-2026
CRSCIGFRISIL 20200303	Evaluation of *Ailanthus excelsa* and Morus species germplasm for growth performance, fodder yield and nutritional traits under various agro climatic-zones	*PI: Kamini Co-PIs: A.K. Handa (CAFRI), S.S. Bhat (Palampur), Maneet Rana and R.P. Nagar (Avikanagar)*	2020-2025
CRSCIGFRISIL 20230301	Solubilization of native soil phosphorus using natural silicon sources and P solubilizing microbes	*PI: Avijit Ghosh Co-PIs: Amit Kumar Singh, Srinivasan R and Mukesh Choudhary*	2023-2026
CRSCIGFRISIL 20230302	Improved pasture management for sustaining soil-pasture-animal productivity	*PI: Avijit Ghosh Co-PIs: Amit K. Singh, Srinivasan R, Sultan Singh, S.N. Ram, R.V. Kumar and Sunil Kumar*	2023-2028
CRSCIGFRISIL 20200301	Study of restoration ecology in silvipasture system for semiarid region	*PI: R.V. Kumar, Co-PIs: Sunil Kumar, Amit K. Singh, Kamini and A.Ghosh*	2020-2025
CRSCIGFRISIL 20201001	Studies on temperate pasturelands for enhanced forage yield, quality and environmental sustainability	*PI: Suheel Ahmad, Co-PIs: S.S. Bhat, A. Ghosh, N. Biradar, N.H. Mir and Ms. Atufa Regu*	2020-2025
CRSCIGFRISIL 20220201	Studies on natural farming practices in forage crops	*PI: S.R. Kantwa Co-PIs: D.R. Palsaniya, S.K. Mahawer, R. Srinivasan Mahendra Prasad, H.S. Meena and N.H. Mir*	2022-2027
CRSCIGFRISIL 20220202	Assessment of water requirement for fodder based cropping systems in different parts of Uttar Pradesh	*PI: J.B. Singh Co-PIs: Amit Kumar Singh, S.R. Kantwa*	2022-2025
CRSCIGFRISIL 20241001	Sustainable livelihood security and grassland dependency on Chopan pastoralists in north western Himalayan region	*PI: Atufa Regu Co-PIs: Suheel Ahmad, S.S. Bhat, N H Mir and B.B.Choudhary*	2025-2030

Programem 3: Management of natural resources and soil health of arable and non arable lands for climate resilient sustainable fodder production

Project Code	Title	PI & Co-PIs	Duration
CRSCIGFRISIL 20190201	Livestock based integrated farming systems for sustaining livelihood of Bundelkhand farmers	*PI: D.R. Palsaniya Co-PIs: M.M. Das, R.K. Patel, Gaurendra Gupta, Samir Barman and Mahendra Prasad*	2019-2024
CRSCIGFRISIL 20190202	Precision nitrogen management in forage crops	*PI: Mukesh Choudhary*	2019-2024
CRSCIGFRISIL 20210203	Nutrient and water management in BN hybrid through drip irrigation in semi-arid region of India	*PI: Mukesh Choudhary Co-PI: Samir Barman*	2021-2025
CRSCIGFRISIL 20210201	Manipulating the rhizosphere microbiome using plant growth promoting microbes to enhance soil and plant health	*PI: Srinivasan R. Co-PIs: Mahendra Prasad, R.P. Saini, Mukesh Choudhary and Anup Kumar*	2021-2026
CRSCIGFRISIL 20210202	Development of microbial inoculants to enhance ensiling	*PI: Srinivasan R. Co-PIs: Sultan Singh and K.K. Singh*	2021-2024
CRSCIGFRISIL 20200201	Development of decision support system for fodder crops with a special reference to climate change	*PI: S.K. Rai Co-PIs: R.K. Singhal, B.K. Mehta, Mahendra Prasad and Sangeeta Lenka (IISS Bhopal)*	2020-2025
CRSCIGFRISIL 20220301	Sustainable forage production from different densities of shrubs and tree through lopping management in three tier silvopasture systems	*PI: S.N. Ram Co-PIs: R.V. Kumar, M.M. Das, Avijit Ghosh and Kamini*	2022-2026
CRSCIGFRISIL 20200902	Studies on fodder production potential of fodder shrub based Alley cropping systems in Peninsular India	*PI: B.G. Shivakumar Co-PI: N.S. Kulkarni*	2020-2024
CRSCIGFRISIL 20221001	Intensive fodder production through crop diversification and zinc fortification in Kashmir Himalaya	*PI: N.H. Mir, Co-PIs: Suheel Ahmad and S.S. Bhat*	2022-2025
CRSCIGFRISIL 20221101	Agronomical trait(s) improvement in forages using plant associated microbes from the North-Western Himalaya	*PI: Surinder Paul Co-PIs: One scientist from CSIR-IHBT, Palampur*	2021-2025
CRSCIGFRISIL 20240201	Harnessing the potential of invasive weed biochar as fertilizer coating material for improving fodder productivity, nutrient use and soil health	*PI: Mahendra Prasad Co-PIs: D.R. Palsaniya and S.K. Mahawer*	2024-2027
CRSCIGFRISIL 20240202	Nature positive integrated farming system for improving livelihood and ecosystem services in Bundelkhand region	*PI: Gaurendra Gupta Co-PIs: D.R. Palsaniya, S.R. Kantwa, Mahendra Prasad, Sunil Kumar and P. Sharma*	2025-2030

CRSCIGFRISIL 20240203	Plant-based formulations for zonate leaf spot disease suppression in fodder sorghum.	*PI: Sonu Kumar Mahawer Co-PIs: Anup Kumar and Srinivasan R.*	2025-2028

Programme 4: Accelerating seed biology research and technology development for enhanced quality forage seed production and strengthening national forage seed network

Project Code	Title	PI & Co-PIs	Duration
CRSCIGFRISIL 20230401	Development of seed standards in temperate forages	*PI: Sunil Swami Co-PIs: Vijay Kumar Yadav, Awnindra Kumar Singh and Suheel Ahmad*	2023-2026
CRSCIGFRISIL 20210401	Development of Near-infrared spectroscopy (NIRS) based prediction models for the assessment of seed viability and vigour in tropical grasses	*PI: Maharishi Tomar Co-PIs: V. K. Yadav and Prabha Singh*	2021- 2026
CRSCIGFRISIL 20250401	Assessment, implications and management of seed dormancy in grasses and legumes	*PI: Nakul Gupta Co-PIs: S.K. Meena and Awnindra Kumar Singh*	2025-2028
CRSCIGFRISIL 20240801	Standardization of agro-techniques for seed production of *Cenchrus* species in various seasons under semi-arid climate of Rajasthan	*PI: H.S. Meena, Co-PI: R.P. Nagar*	2025-2029
CRSCIGFRISIL 20190901	Development of seed standards in forage grasses and legumes	*PI: Vinod Kumar, Co-PI: RP Nagar and Sunil Swami*	2022-2025

Programme 5: Nutritional evaluation and post harvest management of forage resources for sustainable and improved crop-livestock production systems

Project Code	Title	PI & Co-PIs	Duration
CRSCIGFRISIL 20230701	Feeding efficiency improvement through micro climatic stress amelioration for bovines	*PI: P Sharma Co-PIs: K.K. Singh, Pooja Tamboli and Amit Kumar Patil*	2023-2026
CRSCIGFRISIL 20220702	Phytochemical nano-formulations to control aflatoxins in animal feeds	*PI: Anup Kumar Co-PIs: Srinivasan R., S.K. Mahawer and P. Koli*	2022-2027
CRSCIGFRISIL 20220702	Foraging Behaviour of Small Ruminants under Natural Grassland in Bundelkhand region	*PI: Pooja Tamboli Co-PIs: Anup Kumar, K.K. Singh and M.M. Das*	2022-2026
CRSCIGFRISIL 20220701	Ensiled TMR (Total Mix Ration) for livestock production	*PI: M.M. Das Co-PIs: Sultan Singh, Anup Kumar, K.K. Singh and Pooja Tamboli*	2022-2025
CRSCIGFRISIL 20190602	Development of forage based feed for commercial goat farming	*PI: P.N. Dwivedi Co-PIs: P.K. Pathak, S.K. Singh and B.P. Kushwaha*	2019-2025
CRSCIGFRISIL 20240701	Evaluation of forage based ration on lactation performance of dairy animal	*PI: P.N. Dwivedi Co-PIs: K.K. Singh, P. Sharma, B.B. Choudhary and R.K. Agrawal*	2024-2029

CRSCIGFRISIL 20240702	Identification and characterization of volatile metabolites during ensiling	*PI: P. Koli Co-PIs: Sultan Singh, Sonu Kumar Mahawer and Prashant Kaushik (ICAR-IARI)*	2024-2027
CRSCIGFRISIL 20240601	Development of drudgery reducing farm machines and tools for forage and livestock production	*PI: Amit Kumar Patil Co-PIs: S.K. Singh, Ajay N. Satpute, P. Sharma and S.R. Kantwa*	2024-2028
CRSCIGFRISIL 20211001	Ensiling of temperate grasses/legumes for increased livestock productivity	*PI: S. Ahmed Co-PIs: S.S. Bhat, Sultan Singh, K.K. Singh, R. Srinivasan and N.H. Mir*	2021-2024
CRSCIGFRISIL 20250601	Micro-catchment based soil and water conservation measures for range grasses	*PI: Ajay N. Satpute Co-PIs: Amit Kumar Singh and Mukesh Choudhary*	2025-2029

Programme 6: Social, economic, policy and translational research and capacity building

Project Code	Title	PI & Co-PIs	Duration
CRSCIGFRISIL 20210502	Impact of fodder and livestock technologies on livelihood of farmers of SCA schemes of IGFRI Sub project I: Impact of fodder and livestock technologies on livelihood of farmers of SCSP	*Coordinator: Sadhana Pandey PI: B.B. Choudhary, Co-PIs: Gaurendra Gupta, B.G. Shivakumar, S.S. Bhat, Avinash Chandra, Shailendra Sinha, Nazim Hamid Mir and Atufa Regu*	2021-2026
CRSCIGFRISIL 20250501	Participatory varietal selection (PVS) for enhancing productivity and acceptability of fodder crops	*PI: Ashok Rai Co-PIs: Sadhna Pandey, Bishwa Bhaskar Choudhary and Samir Barman*	2026-2029
CRSCIGFRISIL 20200401	Evaluation of berseem gene pool for herbicide tolerance	*PI: R.P. Saini Co-PIs: Tejveer Singh, Prabha Singh and V. K. Yadav*	2020-2024
CRSCIGFRISIL 20240501	Development of decision support system for fodder crops	*PI: Samir Barman Co-PIs: Sadhna Pandey, Gaurendra Gupta, P. Sharma, B.B. Choudhary and Ashok Rai*	2025-2028

Externally funded projects

1.	RRS, Srinagar	Development of climate resilient and sustainable agri-based systems for better food, feed nutritional livelihood security options to and farming community of cold arid regions-Ladakh	2023-24 to 2025-26 (3 years)	Rs. 271.92 lacs (only Field Assistant is being provided)	DST (NMSHE)	(NDRI Karnal lead centre), Sheeraz Bhatt, and Suheel Ahmad

2.	CP Division	AMAAS project: Development of microbial consortia for enhancing drought tolerance and efficient nutrient management in forage crops	2017- Contd. nature	12.25 lacs (2023-24)	ICAR-NBAIM, Mau	*R. Srinivasan, S.K. Meena*
3.	CP Division	Developing hybrid nanofertilizers by using zeolite and hydroxyapatite for sustainable fodder production	2023-26	51.51 lacs	SERB, DST	*Mahendra Prasad*
4.	CP Division	Optimizing growth and yield of Cactus Pear as a 4F crop (Food, fodder, fertilizer and fuel): Exploring the effects of plant density and fertilizer application	2023-26	US$ 8500 (2023-24)	ICARDA	*D.R. Palsaniya, Mukesh Choudhary and M.M. Das*
5.	CP Division	AICRP on Dryland Agriculture (Voluntary Centre)	2018 - contd. nature	1.30 lacs (2023-24)	ICAR-CRIDA, Hyderabad	*S.R. Kantwa, Mukesh Choudhary and R.K. Agrawal*
6.	SS Division	Scaling up and integration of fodder technologies in existing farming system for sustainable livestock productivity and livelihood security in Bundelkhand region	2016- contd. nature	10.0 lacs	Farmer FIRST Programme	*Purushottam Sharma, Sunil Kumar, S.K. Singh, Mukesh Choudhary and B.B. Choudhry*
7.	SS Division	Building resilience model for the vulnerable hotspots to climate change in smallholder dairy production system of Indo-Gangetic Plain Region of India using GIS and Fuzzy cognitive mapping approach	2024-2027	9.03690 lakhs (2025-2026)	ICAR-NASF	*B.B. Choudhary, P. Sharma, Samir Barman, and Sadhna Pandey*
8.	SS Division	Network project on ecosystems, agribusiness and institutions Component 1: Impact of agricultural technology (Crop Science Technologies) Subtitle : Impact analysis of grassland and fodder technologies	2021-2026	9 lakhs (2025-26)	ICAR-NIAP, New Delhi	*B.B. Choudhary, P. Sharma, Gaurendra Gupta and Avijit Ghosh*
9.	FM&PHT	AICRP (FIM)	Continue nature	9,25,000	AICRP (FIM), ICAR-CIAE, Bhopal	*P.K. Pathak, Amit Kumar Patil and S.K. Singh*
10.	CI Division	Enhancing climate resilience and ensuring food security with genome editing tools	2023-26	144.0 lakhs	ICAR	*Parichita Priyadarshini, K.K. Dwivedi, Maneet Rana and Ravi Prakash Saini*
11.	CI Division	Identification and characterization of candidate genes related to polyploidy and /or apomixes in guinea grass	March-2024-Feb. 2027	35.00 lakhs	DST-SERB	*K.K. Dwivedi and Maneet Rana*

12.	CI Division	Mapping and validation of genomic regions associated with brown midrib mutant in pearl millet	27 June 2023 to 26 June 2026	36.83 lakhs	SERB	*Shashikumara P., B.K. Mehta and Anup Kumar*
13.	ST Division	Quality seed production of forage crops	Continue nature	10.00 lakhs	AICRP on Seed Crops	*Awnindra Kr. Singh*
14.	CI Division	Characterization and multiplication of forage crops	2022-2026	20.0 lakhs	ICAR-NBPGR. New Delhi	*Shahid Ahmed, Tejveer Singh, B.K. Mehta, Maneet Rana, P. Shashikumara, Rajesh Kumar Singhal, Suheel Ahmed and S.S. Bhat*
15.	GSM Division	NTPC: Fly ash use in agriculture for sustainable crop production and environmental protection	2021-2031	177 lakhs	NTPC	*Avijit Ghosh, R.V. Kumar, A.K. Singh, Sunil Kumar and Kamini*
16.	GSM Division	RKVY-ICAR: Agri-Drone Project	2022-Cont..	36 lakhs	RKVY	*Amit Kumar Singh, Avijit Ghosh and Gaurendra Gupta*
17.	GSM Division	NASF: Natural grassland ecosystem monitoring system for peninsular and trans Himalayan India to sustain pastoral communities. (CCRI, Goa, IASRI, New Delhi, G.B. Pant Institute, Leh are collaborative partners)	2024-2027	106 lakhs	NASF	*Avijit Ghosh, Amit K. Singh, J.P. Singh (Retd.), A.K. Shukla, Nagratna Biradar and Ajay N. Satpute*
18.	PAR Division	Performance recording and improvement of Bhadawari buffaloes	2021-Cont.			*B.P. Kushwaha*
19.	PAR Division	AICRP on Goat Improvement Bundelkhandi Goat Unit	2018-Cont.			*B.P. Kushwaha and Pooja Tamboli*
20.	NLM Project	Development of effective mass propagation techniques for rapid multiplication and easy transportation of quality planting material in Bajra Napier hybrid.	2023-2026	Total: Rs. 179.39 lakhs Rs. 51.83 lakhs at Dharwad	NLM	*V.K. Yadav, Vinod Kumar and Edna Antony*
21.	GSM Division	NLM: Grassland restoration and rejuvenation for enhancing grazing resources using remote sensing and drone technologies	2023-2026	117 lakhs	NLM	*Amit K. Singh, Avijit Ghosh, Amit K. Patil, R.V. Kumar and S.K. Singh*

22.	NLM Project	Genetic improvement of forage crops for sustainable livestock production. Sub-projects	April 2023 to March 2026	376.84 Lakh	NLM	*Sultan Singh, P. Shashikumara, Maneet Rana, B.K. Mehta, Shahid Ahmed, R.K. Singhal, Anup Kumar, Deepak Upadhyay, Prabha Singh, R.P. Saini and V.K. Yadav*
		Genetic improvement of pearl millet for high biomass, multicut and forage nutritional quality				*P. Shahsikumara, B.K. Mehta, Anup Kumar and Shahid Ahmed*
		Utilizing genetic and genomic approaches for development of seed producing Bajra x Napier Hybrid for enhanced productivity and ensiling traits				*Maneet Rana, P. Shashikumara, R.K. Singhal and Shahid Ahmed*
		Development of dual-purpose maize hybrids with enhanced fodder yield and feed quality using marker-assisted selection				*B.K. Mehta, P. Shashikumara, Anup Kumar and Shahid Ahmed*
		Genetic dissection of genomic regions associated with plant growth habit, multicut nature and forage nutritional quality in cowpea				*B.K. Mehta, P. Shashikumara and Anup Kumar*
		Genetic enhancement of oat for multi-purpose potential under marginal and challenged environments				*Shahid Ahmed, Maneet Rana, R.K. Singhal and Anup Kumar*
		Designing water use efficient stay green with multiple foliar disease resistance fodder sorghum ideo types for changing climates				*R.K. Singhal and Shahid Ahmed*
23.	ICAR-IGFRI-CIAT-Bioversity	Use and conservation of agrobiodiversity for food and nutrition security, increased agricultural sustainability and resilience to climate change in India	2021-2025	77.61 lakhs	ICAR-IGFRI-CIAT-Bioversity	*V.K. Yadav, Shahid Ahmed, K.K. Dwivedi R. Srinivasan Tejveer Singh, Sultan Singh, Anup Kumar, N. Biradar, P. Sharma, B.B. Choudhary J.P. Singh, Amit K. Singh and A. Ghosh*

24.	Global COE on Millets Research Collabo-ration Pro-gramme	Harnessing genetic diversity in pearl millet and sorghum for identification of trait specific gentoypes and trait mapping for fodder yield and quality component traits	2023-2024 to 2025-2026	50.00 lakhs	ICAR-IIMR, Hyderabad	*R.V. Kumar, P. Shashikumara, Subhash Chand, R.K. Singhal, Gaurendra Gupta and K.K. Singh*
25.	National Agri-cultural Science Fund (NASF)	Novel gene(s) discovery for drought and salinity tolerance using genome wide association analysis and multi-omics studies in Dinanath grass (*Pennisetum pedicellatum*)	01.11.2025 to 31.10.2028	96.47 lakh	NASF	*Shashikumara P., Brijesh Kumar Mehta, Maneet Rana and R.K. Singhal*
26.	Spon-sored Research & Extension Programme (SREP 2025-26)	Integrated forage production and conservation strategies for fodder security in North Western Himalayan region	02.12. 2025 to 01.12.2027	12.00 lakhs	JKST&IC	*Nazim Hamid Mir, Suheel Ahmad and Asif Mohd Iqbal*

Chapter 10

Events and Meetings

10.1 Technology and Machinery Demonstration Meet cum Farmer's Fair

Under the AICRP–FIM project, one-day "*Technology and Machinery Demonstration Meet-cum-Farmer's Fair"* was successfully organized on 18th March 2025. The event witnessed enthusiastic participation of over 450 farmers. More than 20 institutions, including KVKs, agri-startups, private companies, Farmer Producer Organizations (FPOs), line departments of UP state and tractor manufacturers, showcased their innovative technologies, advanced farm machinery and services aimed at promoting farm mechanization and improving agricultural productivity. The program was inaugurated by the Chief Guest, Dr. Arvind Kumar Shukla, Hon'ble Vice Chancellor of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior. The event was graced by the Chairman, Dr. Pankaj Kaushal, Director of ICAR-Indian Grassland and Fodder Research Institute, Jhansi and the Guest of Honor, Prof. (Dr.) Rajendra Sahu from Atal Bihari Vajpayee Indian Institute of Information Technology and Management, Gwalior. Following the inaugural session, a farmer–scientist–entrepreneur interaction and discussion session was organized. During this session, various issues, field-level challenges and queries raised by farmers and other stakeholders were addressed by experts, facilitating knowledge exchange and strengthening linkages among researchers, entrepreneurs and the farming community.

Releasing publications at the meet

10.2 Innovators / Industry meet 2025

IGFRI-RRS Dharwad organized one day Innovators/ Industry Meet- 2025 on 25.03.2025 in supervision of ITMU of institute. Prof. Basavaprabhu Jirli, Director, Centre for Multidisciplinary Development Research, Dharwad graced the occasion as the Chief Guest and emphasized the importance of Public Private Partnership to reduce the gap between the research Institutions and end user. He also stressed that cultural and social factors strongly influence technologies spread and their adoption. Dr. Praveen Malik, CEO, Agrinnovate, New Delhi joined meet online, highlighted the importance of commercialization of technologies, as it provides innovators and industry stakeholders with a basket of technologies suited to different agro-climatic zones across the country. Dr. Shiv Datt, Principal Scientist, IPTM unit, ICAR, New Delhi addressed the inaugural session and explained the role of IPTM and ITMU's in mass scale popularization and commercialization of developed technologies by institutions.

Glimpses of innovators/industry meet

10.3 National Group Meet *Kharif* of Forage Crops and Utilization

National Group Meet *Kharif* 2025 of AICRP on Forage Crops was organized during 22-23rd April, 2025 at University of Agricultural Sciences (UAS), Dharwad. The event was jointly organized by

IGFRI- Regional Research Station (Dharwad) and UAS, Dharwad. Dr. D.K. Yadava, Deputy Director General (Crop Science), ICAR, New Delhi, inaugurated the program. In keynote address, he emphasized the urgent need to develop climate resilient forage varieties in view of the growing challenges posed by climate change. Stressing innovation in fodder crop breeding, he called upon the scientific community to focus on developing stay-green varieties capable of performing better under stress conditions. Dr. Yadava also urged for the commercialization of technologies developed by the public institutions through licensing and registration under the Protection of Plant Varieties and Farmers' Rights Authority (PPVFRA). Furthermore, he encouraged the adoption and strengthening of Gaushalas by making them fodder self-sufficient through the adoption of improved forage varieties and technologies. Dr. P. L. Patil, Hon'ble Vice Chancellor of University of Agricultural Sciences, Dharwad, underscored the importance of integrating the forage technologies developed by IGFRI, into the package of practices released by state governments for large scale adoption. He noted that such integration would enhance accessibility and ensure that these technological advancements effectively reach to local farmers.

Glimpses of NGM

10.4 *Viksit Krishi Sankalp Abhiyan* (Pre-*Kharif* Season) 2025

Viksit Krishi Sankalp Abhiyan was conducted during 29th May to 12th June, 2025. A total of 48 scientists from ICAR-IGFRI, Jhansi were involved, with 135 teams covering three districts in the Bundelkhand region (Jhansi, Lalitpur and Jalaun). The teams visited 405 villages, interacting with approximately 47,718 farmers, including 41,037 men and 6,681 women and sensitized them with almost all aspects of farming with emphasis on forage production, conservation and livestock rearing. On average, 27 village interface meetings were held daily, benefitting around 3,000 to 4,000 farmers in a day. During the campaign, multiple key issues emerged from farmer interactions which were answered. These included frequent crop losses, particularly in pulses and oilseeds, due to erratic weather conditions, damage from stray and wild animals; the harmful practice of crop residue burning, and water scarcity for irrigation. Farmers also reported a lack of awareness about quality fodder seeds, along with inadequate veterinary and animal healthcare services.

Scientists interacting with farmers

10.5 International Yoga Day

The international Yoga day-2025 was celebrated on 21st June 2025 at ICAR-IGFRI, Jhansi and its Regional Research Stations (Dharwad, Avikanagar, Srinagar and Palampur). An enthusiastic participation was observed from staff of the institute and regional stations. The event was celebrated to propagate the benefits of Yoga practices for well being of human being.

IGFRI RRS Srinagar

CIHG, Palampur

10.6 Participation in *Krishi Mela* 2025 at Palampur

A team of scientists participated in the Destination Himachal, during 2-4th July, 2025 and demonstrated seeds and live samples of different fodder crops suitable for the region, production technologies, grassland management and others activities. Distinguished dignitaries, including Sh. Shiv Pratap Shukla, Honorable Governor, Himachal Pradesh, Dr. Rajeev Bhardwaj, Hon'ble Member of Parliament, Kangra, among others, visited the ICAR-IGFRI-CIHG stall. More than 1000 beneficiaries including students, farmers and NGO representatives visited the stall and learned regarding importance of green fodder feeding and forage production.

Scientists interacting with farmers at *Krishi Mela*

10.7 Krishi Mela 2025 at Dharwad

The team of Scientists participated in the *Krishi Mela* of UAS, Dharwad during 3rd week of September 2025. Fodder stall was erected and information of fodder technologies was displayed for visiting farmers.

IGFRI-SRRS, staff at *Krishi Mela*, UAS Dharwad

10.8 एक दिवसीय हिंदी कार्यशाला एवं पखवाड़ा का आयोजन

विगत वर्ष संस्थान में ''अधिक से अधिक कार्य हिंदी में करने'' के उद्देश्य से तीन एक दिवसीय हिंदी कार्यशाला (22 जुलाई, 15 सितम्बर एवं 3 दिसम्बर, 2025) तथा हिंदी पखवाड़ा (14–29 सितम्बर, 2025) का आयोजन किया गया। हिंदी पखवाड़े के अंतर्गत प्रारूप एवं टिप्पणी लेखन, निबन्ध, अनुवाद, भाषण प्रतियोगिता इत्यादि आयोजित की गई। विजयी प्रतिभागियों को पुरस्कृत किया गया एवं सामाजिक विज्ञान विभाग को वर्ष पर्यन्त हिंदी में अधिक कार्य करने के लिये चल बैजन्ती शील्ड प्रदान किया गया। हिंदी पखवाड़ा का आयोजन दक्षिण क्षेत्रीय अनुसंधान केन्द्र, धारवाड़ में भी आयोजित किया गया।

एक दिवसीय हिंदी कार्यशाला

चल बैजन्ती शील्ड प्रदान करते संस्थान निदेशक

दक्षिण क्षेत्रीय अनुसंधान केन्द्र, धारवाड़ में हिंदी पखवाड़ा का आयोजन

10.9 Swachhtha Hi Seva Celebrations

The Swachhta Hi Seva (SHS) 2025 campaign was observed in the Institute from 17th September to 2nd October, 2025 under the aegis of Swachh Bharat Abhiyan. This year's theme, *"Swachhotsav,"* emphasized cleanliness, community participation and sustainable sanitation practices. A detailed, date wise action plan as suggested by the Council was prepared and systematically executed. The campaign witnessed enthusiastic participation from staff, faculty members, students, contractual employees and their families. Major Activities included; Human Chain Formation: to raise awareness and reinforce the collective commitment toward cleanliness and environmental sustainability. In 'Clean & Green Utsav' staff members actively participated in cleaning and maintaining common utility areas and their individual work spaces, in 'Ek Din – Ek Ghanta – Ek Saath' offices and laboratories were cleaned as part of the defined collective activity encouraging everyone to dedicate one hour together toward cleanliness, 'Waste-to-Art Activities' where staff children and contractual employees creatively developed useful and decorative items from waste materials, promoting the concept of recycling and sustainable resource utilization and in 'Health and Safety Measures' health services and facilities were reviewed to align with hygiene and sanitation objectives. Personal Protective Equipment (PPE) kits and other safety gear were distributed to cleaning staff and selected farm staff to ensure their safety and to commemorate the campaign activities. On the closing day Sh. Apoorva Gupta, Managing Director and Sh. Prashant Singh, General Manager, Dainik Jagran were invited to deliver talks on strategies to strengthen social welfare linkages and enhance media outreach. Swachchatha Pakhwada (14th Sept.-01st Oct., 2025 and 16th–31st Dec. 2025) was also organized at RRS, Dharwad.

Swachchatha Abhiyan activities at IGFRI & SRRS, Dharwad

10.10 Vigilance Awareness Week

The ICAR–Indian Grassland and Fodder Research Institute observed Vigilance Awareness Week from 27th Oct. to 3rd Nov. 2025 in accordance with the guidelines issued by the Central Vigilance Commission (CVC). The theme declared by the

Vigilance week- oath and Prize distribution

CVC for the year was ‘Vigilance – Our Shared Responsibility’. To promote awareness about the importance of integrity, transparency and vigilance in public life, institute organized various activities throughout the week. These included debates, discussions, essay writing competitions and painting competitions for staff members and their wards. The Vigilance Awareness Week was also observed at the Institute's regional research stations, for wider outreach and public awareness, posters and banners highlighting the theme and significance of vigilance were displayed at prominent locations across the Institute premises.

10.11 Institute Foundation Day

The ICAR-Indian Grassland and Fodder Research Institute, Jhansi celebrated its 64th Foundation Day (1st November, 2025) with wholehearted commitment and a series of impactful events. Dr. D.K. Yadava, Deputy Director General (Crop Science), ICAR, New Delhi graced the occasion as Chief Guest and Dr. K. Ramesh, IFS, Chief Conservator of Forest, Forest Department, Gujarat as Special Guest.

Dr. D.K. Yadava highlighted the Institute's significant contributions in fodder research and development, including preparation of state-specific Fodder Development Plans and development and release of more than 450 fodder and grass varieties in collaboration with AICRP on Forage Crops. He appreciated the institute's efforts in narrowing green fodder deficit in the country from 36% to 11% and emphasized for national and international collaborations in grassland research.

Dr. K. Ramesh delivered Dr. P.M. Dabadghao Memorial Lecture on “Unique Grassland Management,” with special reference to grassland management practices in Gujarat, particularly the Banni Grassland. Publications were also released on this occasion and progressive farmers and entrepreneurs engaged in fodder resource development activities were felicitated. The event was attended by officials, farmers, retired employees and staff members.

10.12 World Soil Day

World Soil Day was organized on 5th December, 2025 on the theme “Healthy Soils for Healthy

Distribution of soil health card to farmers

Cities”. The programme was attended by 25 farmers from adopted villages under different projects. Experts emphasized soil health management with integrated nutrient management as well as agricultural practices. Farmers were also provided with Soil Health Cards for effective utilization to sustain productivity.

10.13 Launching of Collaborative R&D Project between IGFRI and RIL

Dr. M.L. Jat, Secretary, DARE, Government of India and Director General, Indian Council of Agricultural Research (ICAR), New Delhi in the presence of DDG (Crop Science), ICAR, Dr. D.K. Yadava and Director, ICAR-IGFRI, Dr. Pankaj Kaushal launched the establishment of Centre of Excellence for Research on Bioenergy Grasses at ICAR-IGFRI, Jhansi and also laid foundation stone of ‘Plant Phenomics Facility’ on 19th August 2025 in collaboration with Reliance Industries at ICAR-IGFRI, Jhansi. The officials from Reliance Industries, Shri Vamsee Krishna Jasti, Senior Vice President & Head Energy Plantation- R&D and Dr. Manish Roorkiwal, Head - Energy Plantation - R&D also graced the occasion.

Launching of collaborative R&D project

Chapter 11

Awards and Recognitions

Professional Society Awards

- Dr. Pankaj Kaushal was awarded **UPAAS Fellow 2024** by Uttar Pradesh Academy of Agricultural Sciences, Lucknow.

- Dr. Sultan Singh awarded **UPAAS Fellow 2024** by Uttar Pradesh Academy of Agricultural Sciences, Lucknow.

- Dr. D.R. Palsaniya was conferred as **Fellow** of the Indian Society of Agronomy–2024.
- Dr. Sunil Kumar was conferred as **Fellow** of the Indian Academy of Horticultural Sciences (Fruit Science) – 2025
- Dr. Mukesh Choudhary received **Dr. P.S. Deshmukh Young Agronomist Award** for excellence in agronomic research-2023, Indian Society of Agronomy, New Delhi.

- Dr. Pooja Tamboli received the **Young Scientist Award** of Indian Veterinary Association.

Academic Awards

- Dr. Avijit Ghosh received the **Top Agri-Food Pioneer Award** from the World Food Prize Foundation in 2025.

Conference Awards

- Dr. Suheel Ahmad received the **Excellence in Research Award** at the International Conference on "Global Research Initiatives for Agriculture, Science and Technology (GRIAST-2025)", Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, 20–22 January 2025.
- Dr. Mukesh Choudhary received the **Best Oral Presentation Award** at the International Conference on "Rainfed agriculture: Building pathways for resilience & sustainable livelihoods" held at ICAR–Central Research Institute for Dryland Agriculture, Hyderabad, 29–31 January 2025.
- Dr. Mukesh Choudhary received the **Best Oral Presentation Award** at the 1st International Farming Systems Conference on "Transforming Food, Land and Water Systems under Global Climate Change" held at ICAR–Indian Institute of Farming Systems Research, Meerut, 07–09 March 2025.
- Dr. Pooja Tamboli received the **Best Poster Presentation Award** at the 4th International conference on "Recent advances in agriculture, food security, veterinary & allied sciences for livelihood and environmental sustainability" held during 25–27 April 2025 at University of Agricultural Sciences Raichur, Karnataka.
- Dr. Pooja Tamboli received the **Young Women Scientist Award** at the 4th International conference on "Recent advances in agriculture, food Security, veterinary & allied sciences for livelihood and environmental sustainability" 25–27 April 2025, at University of Agricultural Sciences Raichur.
- Dr. Pooja Tamboli received the **Dr. Nagendra Sharma Award of Excellence in Veterinary**

Sciences & Livestock Research–2025 on the occasion of World Veterinary Day (26 April 2025), organized by Pashudhan Praharee and AGROVET.

- Dr. Pooja Tamboli received the **One World–One Health Excellence Award–2025** on the occasion of World Zoonoses Day (06 July 2025), organized by Pashudhan Praharee, Veterinary Association of India and AGROVET.
- Dr. Pooja Tamboli received the **Best Oral Presentation Award** at the National Conference on "Scientific innovations in agriculture, humanities and allied sciences for better public health and environment," 19–20 September 2025 at Madhav University, Abu Road, Rajasthan.
- Dr. Pooja Tamboli was awarded the **Best Veterinary Scientist Award** at National Conference on "Scientific Innovations in Agriculture, Humanities and Allied Sciences for Better Public Health and Environment," 19–20 September 2025.
- M.M. Das, S. Singh, P. Koli, K.K. Singh and P. Tamboli were awarded **Best Paper Award** for the paper "Ensiling characteristics of total mixed ration prepared with guinea grass and its effect on nutritional value and growth performance in Jalauni lambs", ANSICON-2025, Acharya Narendra Deva University of Agriculture & Technology, Ayodhya, UP, 19–21 Nov. 2025.
- Dr. Suheel Ahmad received the **Best Oral Presentation Award** at the National Conference on "Agroforestry Assisted Natural Farming for Restoration of Agroecosystems", Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Benhama, Ganderbal, Jammu and Kashmir, 20–21 November 2025.
- Dr. Atufa Regu received the **Best Oral Presentation Award** at the International Conference on "Sustainable Innovations in Agriculture, Veterinary and Allied Sciences" held at University of Agricultural Sciences Raichur, Karnataka, 29–31 December 2025.
- Dr. Suheel Ahmad received the **Sheikh Nooruddin Noorani Award of Excellence** at the International Conference on "Sustainable Innovations in Agriculture, Veterinary and Allied Sciences" held at University of Agricultural Sciences Raichur, Karnataka, 29–31 December 2025.
- Dr. Pushpendra Koli received the **Scientist of the Year Award** at the International Conference on "Innovations in Horticulture, Agriculture, Veterinary, Fisheries and Allied Sciences for Sustainable Development & Environment (IHASE-2025)", Goa College of Agriculture, Goa.

Technologies certified by ICAR in 2025

1. *Cenchrus ciliaris, Heteropogon contortus, Sehima nervosum* accelerate recarbonization of soil (RECSOIL): Evolution and proof of concept from Carbon Isotope ($\delta^{13}C$) signature.
2. Characterization of range grasses to improve fodder security and carbon sequestration in degraded lands of semi-arid conditions.
3. Diversification and intensification of cropping systems through inclusion of single-cut berseem as a catch crop.
4. Doubling cropping intensity in rainfed areas through fodder sorghum + cowpea–mustard system.
5. Enhanced forage production from *Hardwickia binata*-based silvipasture system under moisture conservation practices in semi-arid conditions.
6. Fruit tree-based hortipasture system for enhancing productivity in semi-arid region
7. GRASS (Grassland Restoration for Accelerated Soil and Fodder Security) for degraded community pasturelands restoration in Bundelkhand region using *Cenchrus ciliaris, Megathyrsus maximus* and *Stylosanthes seabrana*.
8. High-value crop-based IFS model for peri-urban small farmers of Bundelkhand region.
9. Hortipasture technology (apple and almond based) for augmentation of forage resources and other ecosystem services.
10. Labelling and certification standards for Tall Fescue, Orchard Grass, Bromus Grass, Red Clover and Rye Grass.
11. Nutrigel for improving nutrient and water use efficiency
12. Standardization of deficit irrigation and management strategies to conserve energy, reduce greenhouse gas emissions and improve profitability of fodder maize seed production in semi-arid India.
13. Weed dynamics and crop productivity in *Sesbania* alley-based rainfed food–fodder systems under conservation agricultural practices.

Chapter 12

Administration and Accounts

Budget

	Budget allocated (Rs. in Lakhs)	Expenditure (Rs. in Lakhs)
ICAR-IGFRI*	5306.50	5306.06
AICRP (FC&U)*	1346.71	1346.68
Total	6653.21	6652.74

*Including salary & pension

Staff strength as on 31.12.2025

Cadre	Sanctioned	In position	Vacant
Research Management	01	01	-
Scientist	121	68	53
Technical	75	51	24
Administrative	73	38	35
Multi Tasking Staff	55	25	30
Total	325	183	142

Departmental Promotion in respect of Scientific, Technical, Administrative and Skilled Supporting Staff during the period 01.01.2025 to 31.12.2025

Sl.No.	Name of Officer	Nature of Promotion	Date of Council OO
1	Dr. Mahendra Prasad Scientist (Soil Science)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 8000/- (Revised Research Pay Level-12) w.e.f. 01.01.2024 To be designated as Senior Scientist	07.05.2025
2	Dr. Amit Kumar Singh Scientist (Agril. Meteorology)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 8000/- (Revised Research Pay Level-12) w.e.f. 01.07.2024 To be designated as Senior Scientist	07.05.2025
3	Sh. Amit Kumar Patil Scientist (Farm Mach. & Power) (Transferred)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 02.07.2023	07.05.2025
4	Dr. Pooja Tamboli Scientist (Livestock Production & Management)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 07.01.2024	07.05.2025
5	Ms. Bhargavi H.A. Scientist (Genetics & Plant Breeding) (Transferred)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 02.07.2023	07.05.2025

6	Dr. Indu Scientist (Genetics & Plant Breeding) (Transferred)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 30.12.2022	07.05.2025
7	Dr. Subhash Chand Scientist (Genetics & Plant Breeding)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 07.02.2023	07.05.2025
8.	Dr. Bishwa Bhaskar Choudhary Scientist (Agril. Economics)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 07.01.2024	22.05.2025
9.	Dr. Maneet Rana Scientist (Agril. Biotechnology)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 8000/- (Revised Research Pay Level-12) w.e.f. 01.07.2024 To be designated as Senior Scientist	22.05.2025
10.	Dr. Parichita Priyadarshini Scientist (Agril. Biotechnolgoy)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 29.08.2023	22.05.2025
11	Dr. Surendra Kumar Meena Scientist (Plant Physiology)	Promotion to the next higher grade Rs. 15600-39100 + RGP of Rs. 8000/- (Revised Research Pay Level-12) w.e.f. 01.07.2024 To be designated as Senior Scientist	22.05.2025
12.	Sh. Surinder Paul Scientist (Agril. Biotechnology)	Promoted to the next higher grade Rs. 15600-39100 + RGP of Rs. 7000/- (Revised Research Pay Level-11) w.e.f. 02.07.2023	22.05.2025
Sl.No.	**Administrative**	**Nature of promotion category**	**Office order**
1.	Sh. Rakesh Kumar Chhipa	Promoted to AAO from Assistant	01.02.2025
2.	Sh. Prashant Saxena	Promoted to UDC from LDC	27.06.2025

New appointment /Joining

1	Sh. Sushil Kumar, SAO	01.01.2025
2	Sh. Kiran Singh Meena, Assistant	27.01.2025
3	Sh. Abhishek Kumar Gupta, Technical Officer-1	28.02.2025
4	Sh. Amod Kumar, Technical Officer-1	28.04.2025
5	Dr. Nakul Gupta, Senior Scientist	01.05.2025
6	Dr. Sangeeta Singh, Senior Scientist	13.06.2025
7	Dr. Ashok Rai, Senior Scientist	19.06.2025
8	Dr. Asif Mohd. Iqbal, Senior Scientist	11.06.2025
9	Sh. Nitin Kumar, Assistant	27.08.2025
10	Sh. Neeraj Tahiliani, Comptroller	24.09.2025
11	Dr. Sunil Kumar VP, Scientist	27.10.2025
12	Dr. Jitendra Suman, Scientist	27.10.2025

13.	Dr. Aravind T., Scientist	05.12.2025
14.	Dr. Megaladevi P., Scientist	05.12.2025

Retired/Transferred

S.No.	Name of employee	Retired/ Transferred	Date
1	Dr. Maharishi Tomar, Scientist (Agril. Biochemistry)	Transferred	28.04.2025
2	Sh. Amit Kumar Patil, Scientist	Transferred	30.09.2025
3	Dr. Sudesh Radotra, Principal Scientist & OIC, RRS, Palampur	Retired	31.01.2025
4	Sh. Vijay Kumar Paliwal, Assistant Administrative Officer	Retired	31.01.2025
5	Sh. Shripat, Multi Tasking Staff	Retired	31.01.2025
6	Sh. Shriprakash, Multi Tasking Staff	Retired	31.01.2025
7	Dr. J.B. Singh, Principal Scientist (Agril. Meteorology)	Retired	31.03.2025
8	Dr. J.P. Singh, Principal Scientist (Geography)	Retired	31.03.2025
9	Sh. Bhagwat Narayan Kushwaha, Technical Officer-1	Retired	31.05.2025
10	Sh. Gulab Singh, Multi Tasking Staff	Retired	31.05.2025
11	Sh. Ratiram, Multi Tasking Staff	Retired	31.05.2025
12	Sh. Ningappa V. Bailur, Multi Tasking Staff	Retired	31.05.2025
13	Sh. Mathura Singh, Technical Officer-2	Retired	30.06.2025
14	Sh. Syed Zulfikar Ali, Technical Officer-4	Retired	31.08.2025
15	Sh. V.K Tiwari, Assistant Administrative Officer	Retired	30.09.2025
16	Sh. Satya Naresh Singh, Technical Officer-5	Retired	31.10.2025
17	Sh. Rajesh Kumar Sharma, Technical Officer-5	Retired	31.12.2025
18	Sh. Om Prakash, Multi Tasking Staff	Retired	31.12.2025

Chapter 13

Distinguished Visitors

Shri Rajiv Ranjan Singh (Lalan Singh)
Union Cabinet Minister for Panchayati Raj, Fisheries, Animal Husbandry & Dairying (Govt. of India), New Delhi

Shri Shyam Bihari Gupta
Hon'ble Chairman, Gau Seva Aayog, Uttar Pradesh, Lucknow

Dr. A.K. Singh
Vice Chancellor, Rani Lakshmi Bai Central Agricultural University, Jhansi

Dr. M.B. Chetti
Vice Chancellor, Sanskriti University, Mathura

Dr. P.L. Gautam
Former Chairperson, Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

Dr. Sunil Kumar
Director, ICAR-Indian Institute of Farming Systems Research, Meerut

Dr. C.L. Mehta
Director, ICAR-Central Institute of Agricultural Engineering, Bhopal

Dr. Yashpal Sharma
Director, ICAR-Central Institute For Research On Buffaloes, Hisar

Dr. Sanjay Kumar
Director, ICAR-National Institute of Seed Science & Technology, Mau

Mr. H. Ginzalala
MLA, Champhai, Mizoram

Dr. D.K. Agrawal
Registrar General, Protection of Plant Varieties and Farmers' Rights Authority, New Delhi

Mr. Apoorva Gupta
Managing Director, Dainik Jagran Group, Jhansi

Prof. Shailendra Goyal
Professor, Delhi University, New Delhi

Prof. S.P. Singh Baghel
Union Minister of State for Fisheries, Animal Husbandry, Dairying and Panchayati Raj (Govt. of India), New Delhi

Dr. M.L. Jat
Secretary, Department of Agricultural Research and Education and Director General, Indian Council of Agricultural Research, New Delhi

Dr. D.K. Yadava
Deputy Director General (Crop Science), Indian Council of Agricultural Research, New Delhi

Dr. B.M. Prasanna
Distinguished Scientist and Regional Director for Asia, International Maize and Wheat Improvement Center, New Delhi

Dr. Ch. Srinivasa Rao
Director, ICAR-Indian Agricultural Research Institute, New Delhi

Dr. K. Ramesh
Chief Conservator of Forest, Gujarat Forest Department, Ahmedabad

Dr. Alok Kumar Srivastava
Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Mau

Dr. V.N. Waghmare
Director, ICAR-Central Institute for Cotton Research, Nagpur

Dr. N.K. Bajpai
Director Extension, Banda University of Agriculture and Technology, Banda

Shri Altaf Ahmad Kaloo
Member of Legislative Assembly, Anantnag, Union Territory of Jammu and Kashmir

Dr. S.K. Dhyani
Former Director, ICAR-Central Agroforestry Research Institute, Jhansi

Dr. Maroof Ahmad
Deputy Director (Research), Sheep Husbandry Department, Union Territory of Jammu and Kashmir

Dr. Kamna Barkataki
Director, Central Poultry Development Organization (Northern region), Chandigarh

Chapter 14

List of Personnel

DIRECTOR

Dr. Pankaj Kaushal	Director	

SCIENTIFIC

Division of Crop Improvement

Dr. Shahid Ahmed	Principal Scientist (Plant Breeding) & Head	
Dr. K.K. Dwivedi	Principal Scientist (Biotechnology)	
Dr. Tejveer Singh	Senior Scientist (Genetics)	
Dr. Maneet Rana	Senior Scientist (Agricultural Biotechnology)	
Dr. (Mrs.) Sangeeta Singh	Senior Scientist (Genetics & Plant Breeding)	w.e.f. 13.06.2025
Dr. Rajesh Kumar Singhal	Scientist (Plant Physiology)	
Dr. Brijesh Kumar Mehta	Scientist (Genetics & Plant Breeding)	
Dr. Shashikumara P.	Scientist (Genetics & Plant Breeding)	
Dr. (Mrs.) Parichita Priyadarshini	Scientist (Ag. Biotechnology)	
Dr. Subhash Chand	Scientist (Genetics & Plant Breeding)	
Sh. Vikas Chandra Tyagi	Scientist (Economic Botany & PGR)	
Dr. Aravind T.	Scientist (Plant Pathology)	w.e.f. 07.07.2025
Dr. Sunilkumar V.P.	Scientist (Genetics & Plant Breeding)	w.e.f. 27.10.2025
Dr. (Ms.) Megaladevi P.	Scientist (Agril. Entomology)	w.e.f. 05.12.2025

Division of Crop Production

Dr. D.R. Palsaniya	Principal Scientist (Agronomy) & Head	
Dr. J.B. Singh	Principal Scientist (Ag. Meteorology)	Retired on 31.03.2025
Dr. Sita Ram Kantwa	Principal Scientist (Agronomy)	
Dr. Srinivasan R.	Principal Scientist (Microbiology)	
Dr. Mukesh Choudhary	Scientist (Agronomy)	
Dr. Mahendra Prasad	Scientist (Soil Science)	
Dr. Sonu Kumar Mahawer	Scientist (Agricultural Chemicals)	
Dr. Gaurendra Gupta	Scientist (Agronomy)	

Division of Grassland and Silvipasture Management

Dr. A.K. Shukla	Principal Scientist (Fruit Science) & Head	
Dr. J.P. Singh	Principal Scientist (Geography)	Retired on 31.03.2025
Dr. Shiv Nath Ram	Principal Scientist (Agronomy)	
Dr. Sunil Kumar	Principal Scientist (Horticulture)	
Dr. Amit Kumar Singh	Senior Scientist (Soil Science)	w.e.f. 02.06.2025
Dr. (Ms.) Kamini	Scientist (Agroforestry)	
Dr. Avijit Ghosh	Scientist (Soil Science)	

Division of Plant Animal Relationship

Dr. Purushottam Sharma	Principal Scientist (LPM) & Head	
Dr. K.K. Singh	Principal Scientist (Animal Nutrition)	
Dr. M.M. Das	Principal Scientist (Animal Nutrition)	
Dr. Sultan Singh	Principal Scientist (Animal Nutrition)	
Dr. P.N. Dwivedi	Principal Scientist (Animal Nutrition)	
Dr. A.K. Singh	Senior Scientist (Plant Breeding)	
Dr. Pushpendra Koli	Scientist (Agricultural Chemicals)	
Dr. Anup Kumar	Scientist (Agricultural Chemicals)	
Dr. (Mrs.) Pooja Tamboli	Scientist (LPM)	

Division of Seed Technology

Dr. Awnindra Kumar Singh	Principal Scientist (Plant Breeding) & Head	
Dr. Nakul Gupta	Senior Scientist (Seed Science & Technology)	w.e.f. 01.05.2025
Dr. Swami Sunil Ramling	Scientist (Seed Science & Technology)	Upto 24.08.2025
Dr. Maharishi Tomar	Scientist (Plant Biochemistry)	Upto 28.04.2025
Dr. Ravi Prakash Saini	Scientist (Agricultural Biotechnology)	
Dr. Surendra Kumar Meena	Senior Scientist (Plant Physiology)	
Dr. (Mrs.) Prabha Singh	Scientist (Plant Physiology)	Upto 18.07.2025
Dr. Ramappa S.	Scientist (Seed Science & Technology)	w.e.f. 27.10.2025

Division of Farm Machinery and Post Harvest Technology

Dr. Sanjay Kumar Singh	Principal Scientist (APE) & Head	
Dr. P.K. Pathak	Principal Scientist (ASPE)	
Er. Bholuram Gurjar	Scientist (Farm Machinery & Power)	On Study leave
Sh. Amit Kumar Patil	Scientist (Farm Machinery & Power)	Upto 30.09.2025
Dr. Satpute Ajay Narayanrao	Scientist (Land & Water Management Engineering)	

Division of Social Science

Dr. (Mrs.) Sadhna Pandey	Principal Scientist (Home Science) & Head	
Dr. Ashok Rai	Senior Scientist (Agril. Extension)	w.e.f. 19.06.2025
Dr. Bishwa Bhaskar Choudhary	Scientist (Agril. Economics)	
Dr. Samir Barman	Scientist (Agril. Statistics)	
Dr. Jitendra Suman	Scientist (Agril. Economics)	w.e.f. 27.10.2025

AICRP (Forage Crops & Utilization)

Dr. V.K. Yadav	Principal Scientist (Genetics & Cytogenetics) & Project Coordinator	
Dr. R.K. Agrawal	Principal Scientist (Agronomy)	
Dr. R.V. Kumar	Principal Scientist (Plant Breeding)	

Regional Research Station, Avikanagar (Rajasthan)

Dr. R.P. Nagar	Principal Scientist (Seed Science & Technology) & Officer-in-charge	
Dr. Hari Singh Meena	Scientist (Agronomy)	

Regional Research Station, Dharwad (Karnataka)

Dr. K. Sridhar	Principal Scientist (Plant Breeding) & Officer-in-charge	
Dr. (Mrs.) N. Biradar	Principal Scientist (Agricultural Extension)	
Dr. B.G. Shivakumar	Principal Scientist (Agronomy)	
Dr. Vinod Kumar	Principal Scientist (Seed Technology)	
Dr. N.S. Kulkarni	Principal Scientist (Agril. Entomology)	
Dr. (Mrs.) Edna Antony	Senior Scientist (Plant Physiology)	
Ms. Ramyashree Devi G.S.	Scientist (Plant Pathology)	

Regional Research Station, Srinagar (J & K)

Dr. Suheel Ahmad Dand	Senior Scientist (Forestry) & Officer-in-charge	
Dr. Asif Mohd. Iqbal	Senior Scientist (Genetics and Plant Breeding)	
Sh. Nazim Hamid Mir	Scientist (Agronomy)	
Ms. Atufa Regu	Scientist (Agril. Extension)	

CIHG, Palampur

Dr. S. Radotra	Principal Scientist (LPM)	Retired 31.01.2025
Dr. Sheeraj Saleem Bhat	Senior Scientist (Forestry) & Officer-in-charge	
Dr. Surinder Paul	Scientist (Plant Biotechnology)	

TECHNICAL

Sh. P.K. Tyagi	Chief Technical Officer	
Sh. A.K. Saxena	Chief Technical Officer	
Sh. Avinash Chandra	Chief Technical Officer	
Sh. V.D. Chhabra	Chief Technical Officer	
Sh. H.K. Agrawal	Chief Technical Officer	
Ms. Seema Khatri	Chief Technical Officer	
Sh. Kailash Prakash Rao	Chief Technical Officer	
Sh. Ram Asrey	Chief Technical Officer	
Sh. P.C. Gahlot	Assistant Chief Technical Officer	
Sh. Mohd. Irfan	Assistant Chief Technical Officer	
Sh. C.B. Tripathi	Assistant Chief Technical Officer	
Sh. S.M. Singh	Assistant Chief Technical Officer	
Dr. H.C. Pandey	Assistant Chief Technical Officer	
Sh. Neeraj K. Dubey	Assistant Chief Technical Officer	
Sh. Raj Kapoor Singh	Assistant Senior Technical Officer	
Sh. Shailendra Sinha	Senior Technical Officer	
Dr. Anjaly M.V.	Senior Technical Officer	
Sh. Dheeraj K. Dhingra	Senior Technical Officer	
Sh. Devendra Pratap	Senior Technical Officer	
Sh. Satya Naresh Singh	Technical Officer	Retired 31.10.2025
Sh. Rajesh K. Sharma	Technical Officer	Retired 31.12.2025
Sh. Harish Chandra	Technical Officer	

Sh. Prem Swaroop	Technical Officer	
Sh. D.K. Niranjan	Technical Officer	
Sh. Haider Ali	Technical Officer	
Sh. S.V. Shinde	Technical Officer	
Sh. Pawan Kumar	Technical Officer	
Dr. R.S. Patel	Technical Officer	
Sh. Gopal Lal Meena	Technical Officer	
Sh. V.K. Gupta	Technical Officer	
Sh. Veeranna Rudrappa Kadakol	Technical Officer	
Sh. Syed Zulfikar Ali	Technical Officer (Driver)	Retired 31.07.2025
Sh. M.K. Tripathi	Technical Officer (Driver)	
Sh. Sudhir Ramteke	Technical Assistant	
Sh. Deepak Choudhary	Senior Technical Assistant	
Sh. Arun Prajapati	Senior Technical Assistant	
Sh. Uttam Singh Verma	Senior Technical Assistant	
Sh. Mathura Prasad	Senior Technician	Retired on 30.06.2025
Sh. Bhagwat Narayan Kushwaha	Technician	Retired on 31.05.2025
Sh. Ajay Kumar	Technician	
Sh. Suraj Kumar	Technician	
Sh. Surendra Rajpoot	Technician	
Ms. Shivani Prakash	Technician	
Sh. Anand Raj	Technician	
Sh. Rambhoo Kumar	Technician	
Sh. Priyanshu Anand	Technician	
Sh. Akhilesh Kumar	Technician	
Sh. Ravi Shankar Kumar	Technician	
Sh. Sundram Kumar	Technician	
Sh. Arun Kumar	Technician	
Sh. Nitesh Kumar Ravi	Technician	
Sh. Amod Kumar	Technician	w.e.f. 28.04.2025
Sh. Abhishek Kumar Gupta	Technician	w.e.f. 28.02.2025
ADMINISTRATIVE		
Sh. Kumar Vivek	Chief Administrative Officer	
Sh. Neeraj Tahiliani	Comptroller	w.e.f. 24.09.2025
Sh. Ravi Bhadra	Senior Finance & Accounts Officer	
Sh. Sushil Kumar	Senior Administrative Officer	w.e.f. 01.01.2025
Sh. Vijay Kumar Paliwal	Assistant Administrative Officer	Retired on 31.01.2025
Sh. Vijay Kumar Tiwari	Assistant Administrative Officer	Retired on 30.09.2025
Sh. Yashpal Singh	Assistant Administrative Officer	
Sh. Sanjay Kumar Rajak	Assistant Administrative Officer	

Sh. Dinesh Kumar Namdev	Assistant Administrative Officer	
Sh. Ravinder Singh Negi	Assistant Administrative Officer	
Mrs. Shobita Pillai	Assistant Administrative Officer	
Sh. Amit Kumar Singh	Assistant Administrative Officer	
Sh. Rakesh Kumar Chhipa	Assistant Administrative Officer	w.e.f. 01.02.2025
Sh. Pithani Satya Naveen	Assistant Finance & Accounts Officer	
Sh. Prem Chand	Principal Private Secretary	
Sh. Kriparam	Personal Secretary	
Mrs. Kumud Bhatia	Personal Secretary	
Mrs. Kirti Chaturvedi	Personal Secretary	
Sh. Sanjay Kumar	Assistant	
Sh. Siddhartha Pratap Singh	Assistant	
Sh. Shubham Yadav	Assistant	
Sh. Pranjal Panwar	Assistant	
Sh. Akash Prakash Verma	Assistant	
Sh. Satyam Agrawal	Assistant	
Sh Sohail Khan	Assistant	
Sh. Shubham Tripathi	Assistant	
Sh. Karan Singh Meena	Assistant	
Sh. Nitin Kumar	Assistant	
Sh. Aneel Kumar	Upper Division Clerk (Deputation)	
Mrs. Neha	Upper Division Clerk	
Sh. Rajkumar	Upper Division Clerk	
Sh. Uma Shankar	Upper Division Clerk	
Sh. Prashant Saxena	Upper Division Clerk	
Sh. Jitendra Kushwaha	Lower Division Clerk	
Sh. Bharat Singh	Lower Division Clerk	
Mrs. Priyanka Prajapati	Lower Division Clerk	
Mrs. Sanjana Yadav	Lower Division Clerk	
Sh. Brij Bihari	Lower Division Clerk	
Mrs. Girja	Lower Division Clerk	

भा.कृ.अनु.प.-भा.च.चा.अनु.सं. समाचार-पत्रों में/ICAR-IGFRI in Newspapers

जागरण

किसान दिवस : प्राकृतिक खेती से खुलेगी किसानों की तरक्की की राह

जीरो बजट खेती को अपनाने की दी गई सलाह, समारोह में सम्मानित किए गए किसान

कृषि गोष्ठी में कचीर के किसानों को दीं विभिन्न कृषि उपयोगी जानकारी

बुन्देलखण्डी बकरी को नई नस्ल के रूप में मिली मान्यता

झाँसी : कृषि संकल्प अभियान के शुभारम्भ पर विचार रखते कुलपति।

कृषि संकल्प का शुभारम्भ

मशरूम उत्पादन कर किसान बदल सकते हैं गाँव की तस्वीर

ग्राम खड़उवा, पसैया और पूलगहना में विकसित कृषि संकल्प अभियान का हुआ आयोजन

500 किसानों ने लिया सक्रिय भाग, मृदा स्वास्थ्य प्रबंधन पर मिली अहम जानकारी

14 देशों से आए ... ने ग्रासलैण्ड में चा... का लिया प्रशि...

समय जगत

पशुपालन में लागत कम करने एवं अधिक आय का सशक्त आधार है हरा चारा

चरागाह संस्थान का प्रशिक्षण बदलेगा किसानों की तकदीर

झाँसी में किसानों को मिलेगा उन्नत तकनीक का प्रशिक्षण

स्वदेश

भारत को कृषि में आत्मनिर्भर बनाने हेतु विकसित कृषि संकल्प अभियान का शुभारम्भ

रिलायन्स ने ग्रासलैण्ड से 100 करोड़ में खरीदी तकनीक

ग्रासलैण्ड • घास से बनाई ... अनुप्रयोगों के लिए

झाँसी : प्रशिक्षण प्राप्त करते किसान।

किसानों को मशीनों के उपयोग का प्रशिक्षण दिया

अमर उजाला

कृषि वैज्ञानिकों ने किसानों को दिए जलवायु परिवर्तन के प्रभाव से निपटने के टिप्स

झाँसी : किसानों से संवाद करते कृषि वैज्ञानिक।

चारा आधारित वृक्ष कार्बन डाइऑक्साइड लेकर देते हैं ऑक्सिजन

• ग्रासलैण्ड में हुये शोध से तथ्य हुये उजागर

दैनिक भास्कर

13 जून, 2025

विकसित कृषि संकल्प अभियान के तहत किसान गोष्ठी का आयोजन

किसानों को बाँटे गए मृदा स्वास्थ्य कार्ड

• वैज्ञानिकों ने दिए नई तकनीक से खेती करने के टिप्स

ग्रासलैंड संस्थान में हिंदी कार्यशाला सम्पन्न

मृदा स्वास्थ्य कार्ड देते प्रदेश के अपर कृषि निदेशक एमपी सिंह ने इस...

तकनीक : डेढ़ हेक्टेयर खेती से दो लाख की आमदनी

किसानों को बकरी पालन का दिया प्रशिक्षण

झाँसी : भारतीय कृषि अनुसन्धान परिषद, भारतीय चरागाह व चारा अनुसन्धान में बकरी पालन में छोटे व बड़े किसानों के लिए कार्यशाला का आयोजन किया गया। इसके समापन पर कार्यवाहक निदेशक डॉ. विजय कुमार यादव ने प्रशिक्षणार्थियों को प्रमाण-पत्र वितरित किए। इस दौरान डॉ. पुरुषोत्तम शर्मा, डॉ. प्रभाकान्त पाठक आदि ने विचार व्यक्त किया। ऋचा दुबे

ग्रासलैण्ड में हिन्दी दिवस पर हुई कार्यशाला

कार्यशाला का शुभारम्भ करते अतिथि व अन्य।

Swachh Bharat Abhiyan

स्वच्छ भारत

चारा-आत्मनिर्भरता को अग्रसर...
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भाकृअनुप
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हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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