



MILLETS

ANNUAL REPORT

2024



ICAR-Indian Institute of Millets Research
Global Centre of Excellence on Millets (Shree Anna)

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Annual Report

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Preface



It is my pleasure to present before you the annual report of the ICAR-Indian Institute of Millets (Shree Anna) Research (IIMR) for the year 2024. The ICAR-IIMR is a global institute working on research and development of millets starting from crop improvement, crop management, basic sciences, training & capacity building, processing and value-addition technologies for profit maximization of millets farmers. The All India Coordinated Research Projects (AICRP on Pearl millet and AICRP on Sorghum & Small millets) involving a network of testing centers across the country and provides effective linkage with seed production and developmental agencies along with IIMR. The Institute pioneered basic and strategic research on millets improvement, production, protection, value-chain model development, capacity building and entrepreneurship development, and has consistently complemented the Government of India's efforts to promote millets in the country.

As part of the upcoming world class research facility under the Global Centre of Excellence on Millets for sharing the best practices of research and development technologies at the international level the Institute acquired latest high-end equipment namely Nanopore - Promethion Genome Sequencer, Digital PCR, Q PCR, Genetic Analyzer for genomics, functional genomics and molecular breeding research; Automatic Dietary Fiber Analyzer, Microwave Digestive System, Microwave Ashing System for nutrient analysis. Advanced microscopy facility is created with fully automated fluorescence Stereomicroscope, Cryo Ultra microtome, Laser microdissection for exploring cellular and molecular functions in plants, insects and microbes. Construction of a state of the art building to house the Global Centre of Excellence has been initiated during the year and is progressing in a rapid pace. Development of Field Research Complex with HPCC Structure has been initiated during the year under Global CoE on millets.

The progress on the research front during the year is quite impressive. One single-cut forage sorghum variety (SPV 2884), a sweet sorghum variety (SPV 2890) and a foxtail millet variety (FXV 647 /CRS FxM-4) have been identified for national release during the year. One sweet sorghum variety - CSV 58SS, a brown midrib variety - CSV 59 BMR, a foxtail millet variety - CFXMV-1 and a barnyard millet variety - CBYMV-1 developed by the Institute have been released and notified in 2024. A total of 49,779 accessions of millets germplasm are being conserved in the millets genebank. A total of 2961 accessions were distributed to the bonafied users across the country for location specific studies and crop improvement programmes. The Institute partnered in a mega characterization of 12,100 finger millet accessions at TNAU, Coimbatore. One sorghum genetic stock was registered with ICAR-NBPGR, New Delhi. New initiatives have been implemented in all the crops, especially for developing heat and drought tolerant genetic material in pearl millet, identification of SNP-trait associations, rapid generation advancement schemes, multi-parent crossing strategies in *rabi* sorghum, utilization of landraces in *kharif* sorghum improvement, prediction of heterosis, metabolomic profiling in all the millets, etc. which have great scope to enhance the genetic gains in these climate-resilient crops as well as understanding the health benefits of millets. Genome sequencing of little millet and kodo millet were taken up and are in different stages of completions. Towards licensing and commercialization of millets technologies, 31 MoAs were signed for seed production of forage cultivars and value-added products. Special

meetings were arranged with Industry to showcase the crop technologies and their promotion. During the year the Institute organized one international training and more than 40 national level trainings on production practices, value chain development, startup ignition etc. for the benefit of various stakeholders from state governments, SAUs, FPOs including farmers from states of Odisha, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Madhya Pradesh and Bihar. More than 1000 farmers from different states visited the Institute and got benefitted by witnessing the latest millets production and processing technologies. IIMR is a must visit place for the agricultural students from different parts of the country and more than 3000 students visited during the year. The institute has published 64 research articles in reputed national and international journals, two books and several other publications.

The Institute successfully organized the 6th edition of International Nutri Cereal Convention (INCC-6.0) which acted as an interphase between researchers, academia, industry, farmers' organizations, financing institutes and policy makers. IIMR also acted as a knowledge partner to different State Governments in successfully implementing the state millets missions.

All the success achieved in the research and development front by the institute was possible due to the constant support and guidance received from the Council. I place on record my sincere thanks and acknowledgements to Dr. Himanshu Pathak, Secretary (DARE) & Director General (ICAR); Dr. T. R. Sharma (Former DDG, Crop Science); D.K. Yadava, Dy. Director General (Crop Science), ICAR; Dr. S.K. Pradhan, ADG (FFC), and several other administrative functionaries at the headquarters for their timely guidance and generous support in implementing the mandate of the institute.

Due credit is to be given to the expert guidance provided by the Chairman and members of various committees, especially those of the Quinquennial Review Team, Research Advisory Committee, Institute Management Committee, and different Institute committees, all the Project Leaders, Scientists and other staff members of this institute for their efforts, support and help. I also appreciate the Principal Investigators and the multi-disciplinary teams of millet scientists at AICRP centres, voluntary centers and private sector participants for their contribution in making the nation-wide millet research network a success. I appreciate the support of different National, International, Non-Governmental, Private organizations and all other stakeholders that have been collaborating with us in our endeavors.

The scientists, technical personnel, administrative, finance and other staff of the institute have put in their best efforts in accomplishing the mandate of the Institute. I extend my appreciation to all of them. My special appreciations to Dr. P.G. Padmaja, Dr. R. Swarna, Dr. K. Hariprasanna, Dr. J. Stanley, Dr. N. Anuradha, Ms. Usha Satija, Mrs. D. Revati and Mr. H.S. Gawali for their efforts in compiling and bringing out this annual report on time.

Hyderabad
10 March, 2025

C Tara Satyavathi
Director

1. Genetic Enhancement for Productivity, Quality, and Stress tolerance

1.1 Genetic Resources Management

- Sorghum: During *rabi* 2023-24, 242 sorghum germplasm accessions were characterized at IIMR, Hyderabad for 22 different morpho-agronomic traits (9 quantitative and 13 qualitative traits).
- Kodo millet: A total of 567 kodo millet accessions were characterized for 13 agro-morphological traits; substantial variability was recorded for all agronomic traits.
- A total of 5864 accessions of different millets germplasm were multiplied during 2023-24, and 2961 accessions were distributed to the bonafied users in 2024.
- A total of 49,779 accessions of millets are being conserved in the millets Genebank at IIMR.
- A mega characterization of 12,100 finger millet accessions was undertaken at TNAU, Coimbatore under CRP-AB for 29 morpho-agronomic descriptors.
- Multi-location (Mandya, Vijayanagaram and Almora) screening of finger millet germplasm was conducted for leaf, stem and neck blast; resistant accessions at different locations were identified.
- One sorghum genetic stock (IIMR 20048/IC651981/INGR24022) was registered with NBPGR, New Delhi for tolerance to stem borer and shootfly.

1.2 Crop Improvement

Pearl millet

- During *kharif* 2024, 21 advanced hybrids were evaluated at Mandor; two hybrids, 843-22A × BL

73 and 291A × BL 73 had the highest grain yield of 4.3 t/ha; R-line BL 73 was developed through shuttle breeding approach.

- Among the 300 lines of diversity panel screened for new virulent Mandor isolate of blast MDR 23, 57 were resistant with a score ≤ 3.0 , which included eight B-lines and 49 R-lines.
- From the 322 progenies involving 51 crosses made between arid lines, established B- and R-lines and landraces, 72 R-lines were advanced.
- A total of 13,464 differentially expressed genes (DEGs) were discovered of which 6932 were down-regulated and 6532 were up-regulated in leaf and root tissues subjected to heat stress.
- A large number of genes encoding ROS scavenging enzymes, WRKY, NAC, enzymes involved in nutrient uptake, protein kinases, photosynthetic enzymes and heat shock proteins (HSPs), and several transcription factors (TFs) were activated under the stress conditions.
- Sixty-eight significant SNPs associated with blast resistance against three different isolates of *M. grisea* were identified.

Forage pearl millet

- Forage lines IIMR FB 88, IIMR FB 81 and IIMR FB 24 were found to be the most stable genotypes with desirable forage yields, while IIMR FB 51, IIMR FB 98 and IIMR FB 90 were found to be good for total green fodder yield.
- Genotypes IIMR FB 17, IIMR FB 38 and IIMR FB 71 showed superior performance for crude protein content and *in vitro* organic matter digestibility.

- Significant SNP-trait associations were detected for forage yield and quality; a number of putative candidate genes were also detected.

Kharif sorghum

- Fourteen medium and two early maturing hybrids out of 164 experimental hybrids recorded >10% yield advantage over respective checks; R lines included derivatives of wild sorghum crosses (11) and local landraces (12).
- Out of 50 mutants of 296B evaluated for shootfly tolerance, four recorded ~30% deadhearts, while all mutants had less incidence compared to 296B.
- SPV 3031, a derivative of elite x guinea-caudatum race recorded significant increase in 100-seed weight and had grain yield on par with the checks.
- Out of 42 landraces evaluated Byhatti local, Balapur local and Bundela were promising for more than one trait.

Rabi sorghum

- The 8-way cross derivatives S22086RV, S22085RV and S22087RV out of 28 test entries had high grain yield, stover yield and 100-seed weight compared to the 2-way and 4-way cross derivatives.
- In order to generate significant variability in *rabi* sorghum, a comprehensive multi-parent crossing strategy to combine desirable traits from the eight founder lines was proposed.
- Eight BC₂F₄ populations for the traits like stem borer, aphid, shoot bug, rust, drought and stay green in the background of seven popular *rabi* cultivars were generated using a back-cross breeding approach.
- Three RIL populations (F₇) were generated for genetic dissection of *rabi* adaptive traits by using eight *rabi* based founder lines.
- Development of new B lines following *rabi* × *kharif* hybridization, and R lines using early and dwarf progenies is in progress under different generations.

- Six stable restorer lines were identified for Maldandi based cytoplasmic male sterile M31-2A.

Sweet sorghum

- Out of 14 hybrids evaluated for sweet sorghum productivity traits during *kharif* 2024, the hybrid IIMR 35A × ICSV 17335 recorded the highest biomass yield with 33% superiority over check CSH 22SS; same hybrid recorded the highest superiority for fresh stalk yield (62%), juice yield (58%) and ethanol yield (67%).
- Hybrid 2295A × 11NRL recorded the highest stem girth (2.13 cm) while for plant height, the hybrid 356A × RSSV 260 was superior (383 cm).
- Hybrid, Tx 623 A × SPV 2593 recorded highest juice extraction per centage (52.3%) and hybrid 479A × RSSV 558 recorded highest brix (18.1%).
- BMR hybrid IIMR BMR6A × S 21-BC-10 recorded highest green fodder yield with 22% superiority over check CSH 54 BMR and 62% over CSV 43 BMR.

Forage sorghum

- Four out of 257 sorghum × sudangrass derivatives were found to be superior to the check for multi-cut forage traits.
- Fifty-two out of 250 experimental hybrids developed using new parental lines showed better performance over check CSH 24MF; best A and R lines were identified.
- Out of 28 high biomass sweet sorghum × forage type cross derivatives evaluated, IIMR 606, IIMR 613, IIMR 651 and IIMR 609 exceeded the check CSV 35F by more than 25% for green fodder yield.
- For varietal improvement and hybrid male parent development, 37 new sorghum × sudangrass crosses were made in different combinations.

Sorghum Biofortification

- The grain iron content ranged from 19.4 to 39.9 ppm with a mean of 26.1 ppm in the released grain sorghum cultivars, while zinc ranged from 14.0 to 37.7 ppm with a mean of 19.2 ppm.

- A total of seven breeding lines out of 95 recorded grain iron >30 ppm while 23 had >25 ppm grain zinc; 25 lines recorded >10% grain yield advantage over the best check CSV 20.
- Significant location $\times$ genotype ($G \times E$) interaction for grain iron, zinc, and grain yield and related traits was observed in a multi-location evaluation of advance breeding lines; mean grain iron content ranged from 26 to 44 ppm while zinc content ranged from 18 to 36 ppm.

Sorghum DUS testing and PPV&FRA related activities

- Replicated field trials for characterizing the DUS descriptors in three candidate varieties along with reference varieties of sorghum were conducted during *rabi* 2023-24, and five farmer's varieties during *kharif* 2024 seasons as per the PPV&FR Authority guidelines.
- Nine new applications of extant varieties were submitted for PPV&FRA registration during the year.

Finger millet

- Among the 50 white finger millet genotypes evaluated IC0065595, IC0474206 and IC0474233 were promising with grain yield levels of 3.8 t/ha comparable to coloured checks PR 202 and GPU 67.
- Sixteen out of 105 interspecific derivatives from *Eleusine coracana* $\times$ *E. Africana* were identified with >20% grain yield superiority over VL 376 and CFMV 2 during *kharif* 2024.
- Derivatives IIMR/K24/2868, IIMR/K24/2869 and IIMR/K24/2855 recorded mean grain yield of >3.0 t/ha as compared to checks (2.2 to 2.6 t/ha).

Little millet

- Advanced derivatives JK-8 $\times$ IPmr 1075, IIMR-7092 $\times$ 7103-4 and IIMR-7091 $\times$ IIMR-7103-2 out of 73 elite lines, and germplasm selections GPMR-960-2 and GPMR-325 were superior and recorded >10% yield superiority over the best check CLMV 1.

Foxtail millet

- A high yielding, medium duration variety FXV 647 (CRS FxM-4) has been identified for release as CFXMV-2 in the states of Karnataka, Maharashtra and Madhya Pradesh; it is resistant to rust and moderately resistant to brown spot, leaf blast and banded blight, and tolerant to shootfly.
- Twelve out of 57 promising genotypes evaluated over two years recorded >10% grain yield advantage over best check DHFt 109-3; six genotypes had very long panicles (>22 cm) compared to best check.
- Four out of 11 mutants of Suryanandi and 10 out of 30 mutants of SiA 3156 recorded grain yield advantage of >10% over parental lines.
- Mutants IIMR FxM-23323, 23324, 23328, 23308, 23307, 23326, 23313, 23301, 23327, 23305 and 23309 had very long inflorescence (>25 cm) in multi-location trial.

Kodo millet

- Gamma irradiation resulted in pollen sterility and it increased with increasing dose (4%-19%) but spikelet fertility was not affected much in variety TNAU 86.
- Mutants derived out of 300 Gy irradiation had higher grain yield (31-35 g/plant), fodder yield (70 to 94 g/plant) and panicle length (7.5 to 8.4 cm) compared to check.

Barnyard millet

- Diverse lines identified out of 150 accessions (BAR 1221, BAR 1235, BAR 565, BAR 577) were used in crossing programme with cultivar CBYMV-1 to generate variability.
- Out of 562 lines screened, seven were identified with <5% and 45 with 6-10% incidence of leaf spot and leaf blight.
- Four genotypes with high dietary fibre content (9.7% to 10.5%) were identified with good grain and fodder yielding ability out of 136 genotypes evaluated; BAR 1452, IEc 647, BAR 1446 and BAR 1453 had high protein content (13.3% to 14.1%).

Proso millet

- Four out of 10 polymorphic SSR markers were able to distinguish the parental lines (IIMR-PM-59 and IIMR225) and F1s generated.
- From 225 progenies of a cross IIMR Pm59 × IIMR225, 11 were selected for individual traits such as early flowering, early maturity, and high panicle length.
- Using GWAS, 92 significant SNP-trait associations were identified for different traits like plant height, flag leaf length, flag leaf width, protein content and grain yield.

Brown top millet

- Among the 31 genotypes evaluated, adequate range of variation for different agronomic traits was observed; there was no significant association of panicle type with grain yield.
- In the M4 generation, five selections with high grain yield were made; selection 8-3-1 recorded both high grain and fodder yield.
- Cultivar GPUBT-6 had higher canopy temperature depression than HBr-2 indicating better desiccation tolerance due to higher temperature stress; chlorophyll content (SPAD reading) was affected in HBr-2 due to higher temperature compared to GPUBT 6.

1.3. Seed Science

- In kodo millet, spray of boron (B) markedly enhanced the seed yield per plant over control, while zinc (Zn) application alone or in conjunction with B did not result in significant improvement.
- Soil application proved promising in enhancing seed yield over foliar application at panicle initiation (PI), flowering (FL) and PI + FL stage.
- Application of B, Zn and B + Zn had significantly better impact compared to control on seed germination, field emergence and seedling vigour index-2 traits.
- In case of foxtail millet, 1.8 mm round perforation sieve appeared to be optimum for

seed grading during processing to achieve about 98% cumulative seed recovery and higher seed quality.

- Using GWAS in 221 finger millet accessions of Global representation, 1236 significant SNP-trait associations were identified for different seed quality traits.
- Seed treatment with thiamomethoxam 30% FS @ 10 ml/kg + metalaxyl 35% WS @ 6 g/kg of seed recorded relatively lower incidence of all the major pests in pearl millet and sorghum, followed by Arka microbial consortia @ 10 g/kg + azoxystrobin 2.5% @ 4 g/kg of seed in case of pearl millet and Arka microbial consortia @ 10 g/kg + tebuconazole 2% DS @ 6 g/kg of seed in case of sorghum.
- Treatment with thiamomethoxam 30% FS @ 10 ml/kg + azoxystrobin 2.5% @ 4 g/kg of seed recorded highest grain yields in both sorghum and pearl millet.
- Seed treatment with tebuconazole 2% DS @ 6 g/kg seed + tricyclazole 75 WP @ 2 g/kg seed recorded significantly lower incidence of major pests in case of finger millet.

2. Application of Basic and Strategic Sciences in Crop Improvement

2.1 Pre-breeding

- Screening of 30 wild sorghum accessions against shootfly for two years did not result in identification of promising tolerance levels that are repeatable.
- A new set of 18 accessions of wild sorghum were collected from ICRISAT genebank and were multiplied for screening against shootfly.

2.2 Molecular breeding

- *De novo* whole genome sequencing of kodo millet cultivar RK 390-25 was performed through long read sequencing using PacBio Sequel II platform; approximately 0.9 Gb of the genome was assembled.
- Out of 50 genomic SSR markers validated in a set of 48 finger millet genotypes, 34 were

polymorphic with PIC value ranging from 0.56 to 0.85.

- Correlation between coefficient of marker polymorphism (CMP) among the parental lines using 80 SSR markers with PIC value >0.5 and grain yield heterosis in the respective F1 hybrids revealed a significant, moderate and positive correlation of CMP with mid-parent heterosis for grain yield ($r=0.43^*$) and better parent heterosis ($r=0.51^*$) indicating the potential of these markers in the prediction of grain yield heterosis.

2.3 Biotechnology

- A total of 140 phosphinothricin resistant putative genome edited lines developed through CRISPR-Cas9 technology targeting SERK genes were regenerated out of 4500 Agrobacterium infected shoot tips of sorghum male sterile line 296A.
- Out of these, 41 lines were developed for SbSERK 1 gene, 46 lines for SbSERK 2 gene and 53 for SbSERK 3 gene.
- A total of 79 phosphinothricin resistant putative genome edited lines were regenerated out of 900 shoot tip explants of sorghum genotype C43; in case of pearl millet gene editing is to target lipase gene to control rancidity.

Metabolite profiling of millet grains

- Metabolite profiling of the seeds of all the millets was carried out using an LC-MS/MS based untargeted metabolomics approach; around 1900 metabolites belonging to various classes have been identified.
- Amylose and amylopectin content in the selected progenies of a cross between high popping line from sorghum $\times$ maize cross and another high popping local variety was estimated; 13 lines had amylopectin >70%, while in some lines it was as low as 50%.

2.4 Crop Physiology

- *Rabi* sorghum genotypes under terminal drought stress exhibited accelerated grain

filling which resulted in reduced starch accumulation, grain weight and quality.

- Scanning electron microscopy (SEM) analysis revealed disintegration of starch granules within the endosperm matrix of *rabi* sorghum grains under terminal drought stress.
- Strong correlations between root traits, physiological parameters, and yield components, highlight the critical role of root architecture in drought tolerance.
- A total of 14 sorghum genotypes (2 hybrids (CSH-25, CSH-16); 2 *kharif* varieties (CSV 39, CSV 27); 4 *rabi* varieties (M35-1, CSV 29, SPV 2217, SPV 2758); 1 R line (NR 459-15) and 4 A & B lines (CTD: 151A, 151B, 2219A, 2219B)) were identified as tolerant for high temperature stress based on Canopy Temperature Depression (CTD) reduction.

2.5 Biochemistry & Functional Foods

- Amino acid profiling of finger millet was standardized for determining protein quality of millets.
- Iron bioaccessibility in finger millet was 84.4% for a genotype with 32 ppm iron and 96.4% for a genotype with 15.4 ppm iron. Zinc and calcium were practically completely released into solution under acidic conditions.
- Alcoholic acidity on 7th day of storage in pearl millet flour was found to provide a better differentiation of lines for rancidity development. Alcoholic acidity estimation of 97-R lines and 33-B lines was variable in the range of 0.07 to 0.34 with a mean of 0.15 g sulphuric acid/100g of sample.
- 46 sorghum landraces were analyzed for grain nutritional composition, revealing significant variability in protein, fat, ash, and moisture content. Twelve landraces showed high protein content of >12%.
- Two landraces, KLT 64 and KLT 66, recorded high Zn content of > 40 ppm.
- The tannin content, in sorghum landraces was found to vary widely, ranging from

0.181% CE (KLT 66) to 1.598% CE (KLT 76), as determined by the vanillin-HCl method.

- The amylose content of sorghum landraces varied significantly, with values ranging from 7.03% (KLT 58) to 21.39% (KLT 65).
- Malting significantly improved protein digestibility in barnyard varieties DHBM 93-3 and VL-172. Optimizing malting conditions can further enhance protein digestibility while considering yield, malting loss, and sensory attributes.

3. Host Plant Resistance against Insects and Diseases

3.1 Insect management

Millets

- Fall armyworm (FAW), *Spodoptera frugiperda* preferred sorghum followed by barnyard millet for oviposition when nine millets were tested for oviposition preference.
- Parasitization potential of egg-larval parasitoid, *Chelonus* sp on fall armyworm in millets was studied during *kharif* 2024. Biocontrol potential in terms of per cent parasitization was estimated on the field sampled fall armyworm egg masses and found that per cent parasitization was more in sorghum (55.0) proso millet (52.4), foxtail millet (50.6).

Sorghum

- Nutritional indices of FAW larvae was studied on nine sorghum genotypes. Larvae reared on CSV19SS recorded the highest value of Consumption Index (CI) and Approximate digestibility (AD). The lowest value of CI was on CSV 33M F.
- During *kharif*, 2023, the foliar damage caused by FAW in sorghum ranged from 1.0-3.5 scale with highest incidence in Maharashtra (3.0) and Madhya Pradesh (3.5). During *rabi* 2023-24, FAW damage ranged from 3.0-3.5 scale with maximum damage observed in Telangana, Karnataka (3.5) followed by Maharashtra (3.0).

- Population peak of FAW adult moths was observed during 35 and 47th of 2023; 1 and 4th Standard Metrological Week of 2024 and the pest prefers vegetative stages of crop i.e, upto panicle initiation.
- About 30 sorghum varieties and germplasms were screened against FAW under natural infestation. The entries Hathi kunta, IS 12697, C 43, CSV 21F, IS 12735 and Phule Vasuda were found highly susceptible. The entries, Rampur local, CSV 39, IS 4581 were tolerant to *S. frugiperda* with less than 10% whorl damage.
- Biological management of FAW was evaluated in the field during *rabi* 2023-24. The treatment, consisting release of one card of *Trichogramma chilonis* /acre twice at weekly intervals followed by spray of *M. anisopliae* (NBAIR Ma 35) 0.5% at 20, 35 DAE significantly decreased the whorl damage caused by FAW (11.7%) in comparison to recommended package of practices (36%) and control (55%). There was no significant difference in grain and fodder yield.
- In a screening field trial during *rabi*, 2023-24 at Solapur, CSV 216 R, CSV14, Phule Revati, Phule Anuradha, DSV 4, Katar Khatav & M 35-1 were found promising against shoot fly; genotypes like IS 2205, Y 75, M 35-1 & IS 18551 against stem borer and Y 75, CSV 26, CSV 29R against shoot bug.
- The BC ratio of chemical, biointensive and farmer practice modules were found to be 1:1.80, 1: 1.66 and 1:1.20, respectively.
- Acute and field toxicity studies were conducted against stem borers, shoot bug & their natural enemies. Chlorantraniliprole ($LC_{50} = 1.03$ ppm) and spinetoram was found very effective against third instar larva of *Chilo partellus*. The insecticide, chlorantraniliprole, emamectin benzoate and spinosad were

found effective against, *Sesamia inferens*. Broflanilide was found effective against shootbug in shoot dip bioassay studies. Insecticides like emamectin, flubendiamide, chlorantraniliprole, and spinosad were found safer to *Cotesia* based on selectivity ratio.

- Based on field use environmental impact quotient, insecticides like fipronil, thiacloprid and pymetrozine were found to pose risk to the producer/ farmer. Insecticides like pymetrozine and thiacloprid are toxic and pose risk to the consumer.

Stored grain pests management in millets

- Screening studies were conducted against *Sitophilus oryzae* in five different varieties of each dehulled small millet grains viz., foxtail millet, browntop millet, little millet, kodo millet, barnyard millet and proso millet. The data on grain weight, number of insects, weight of dead insects are being collected at weekly intervals. The progeny emergence was high in proso millet (PM-HP-59 and PM-HP-186) and kodo millet (JK 106) whereas no progeny emergence was observed in brown top and little millet.
- A study conducted to evaluate the effect of packaging material on grain storage of dehulled foxtail millet revealed that either MET PET or MET PET + vacuum as the most efficient method. High insect infestation (*Sitophilus oryzae*, *Tribolium castaneum* and *Corcyra cephalonica*) was found in foxtail millet kept in gunny bags.

3.2 Disease management

Millets

- Identified five resistant donors (IC0479406, ISe1177, IC0479317, IC0479569, and IC0308976) for foxtail millet rust. These lines are better in resistance than the present national check ISe1177, and are top performers on resistance and stability among 179 lines tested across foxtail millet growing locations in India.

- Bengaluru was identified as the best location for screening for rust resistance in foxtail millet.
- Identified a bacterial consortia (SEB15 + FMEB-18 + KMEB-12 + LMEB-23) that showed efficacy for management of banded sheath blight in finger, kodo, and little millets.
- Biomolecule, Benzyl mandelate, isolated from endophytes exhibited higher affinity with the amino acids present in the active site of PR proteins of *M. phaseolina* and *R. solani* in millets, and might have fungicidal efficacy.
- Studied progression of red stripe virus vis-à-vis aphid vector population in *rabi* sorghum and observed that starting from mid-December red stripe continuously increased till mid-February, while vector population reached its peak during 2nd fortnight of January.
- Initiated studies on unraveling multiple virus infection in sorghum and foxtail millet. Next Generation Sequencing (NGS) was carried out for further studies.

4. Resources Management for Higher Millets Productivity

- Intercropping pearl millet with sorghum and other small millets significantly improved its grain productivity, with the highest increase (92.5%) observed in pearl millet + sorghum intercropping.
- Leaf Color Chart (LCC) values for sorghum, bajra, and ragi crops were developed and submitted to Nitrogen parameters for preparation of LCC.
- Potassium application significantly improved growth, yield attributes, and grain yield of finger millet under moderate and severe stress conditions. Application of 60 kg K/ha recorded maximum yield improvement, with a 17% increase in grain yield under severe stress conditions.

5. Extension research, Economics and Value-addition

5.1 Extension Research

- Determination of yield gap at different levels, data on sorghum yields from farmers of Surat and

nearby districts of Gujarat directly and secondary sources on *kharif* sorghum of last four years (2019-2023) showed that technology gap was of 5.35 q/ha and extension gap was of 8.50 q/ha. The reason for high technology gap was due to difference in local climate coupled with variation of soil fertility status and adoption of management practices by farmers.

- Twelve technology interventions were organized under crop module in nine villages of Nyalkal, Jharasangam and Raikode mandals of Sangareddy district in central Telangana. Four field days, field visits and advisories were provided to 150 farmers regularly through WhatsApp group “Millet farmers (Telugu)” in which IIMR scientists and experts were involved to provide solution to solve farmer’s queries.

Outreach & FPO activities

- To promote millet cultivation, IIMR distributed 10,696 kg of free millet seeds to farmers, Krishi Vigyan Kendra’s (KVKs), Farmer Producer Organizations (FPOs), and various state government departments across more than 10 states as part of the SFAC Millets & SFAC Oilseeds projects.
- IIMR in collaboration with foundations like ICICI, SELCO and through some government schemes like PMFME has established Custom Hiring Centres and Processing facilities at FPO level. Conducted a series of training programs for farmers, FPO staff, students, entrepreneurs aimed at exploring millet-based entrepreneurial opportunities, introducing newly developed millet cultivars, and familiarizing participants with value-added technologies.
- As a Cluster-Based Business Organization (CBBO), ICAR-IIMR successfully facilitated market linkages for Farmer Producer Organizations (FPOs) in the output marketing of various commodities.

5.2 Economics

- Analysed decadal growth and instability of area under bajra between 1966 and 2021. State-wise decadal growth rate of production under bajra reveals that during all decades overall, the country witnessed a growth except in the second decade 1976-86. In case of ragi the area and production

witnessed negative growth trend, however, the yields have shown growth.

- Total Factor Productivity (TFP) of pearl millet in Rajasthan and Maharashtra and for finger millet in Karnataka was worked out by using data from 1991-92 to 2020-21. In all states TFP registered growth, indicates research and extension contributions were the reasons for positive TFP growth.

5.3 Value-addition and Commercialization

- The instant ragi mudde mix combines the health benefits of finger millet (ragi) with the ease of ready-to-use food products. Twelve formulations were developed using cooked ragi flour, offers a balanced combination of nutrition, convenience, and flavour, making it ideal for health-conscious consumers. An instant foxtail millet bisibellebath mix was developed using foxtail millet and red gram dhal in varying proportions, highlights the potential of combining millet and legumes in instant food products to provide convenience, improved nutritional value, and healthier dietary options.
- Anti-oxidant activity of nine millets was evaluated. The antioxidant activity was found to be higher in finger millet followed by brown top, pearl, sorghum, kodo, barnyard, little, foxtail, and proso millet.
- Two millet-based products were developed: a finger millet laddu, enriched with calcium, and a pearl millet-based health mix, rich in iron and zinc.
- Sorghum and ragi starch were extracted using normal soaking method as native starch for overnight for 1kg grain. The mc of the initial sorghum and ragi grains were found to be 4.68% wb and 4.59% wb using Sartorius moisture analyser.

6. Global Centre of Excellence on millets (Shree Anna)

1. Establishing a Medium-term Germplasm Storage Facility to Strengthen Millets GeneBank for Conservation, Trait-specific Characterization and Utilization of Millet Biodiversity for Crop Improvement

- A set of 1000 sorghum germplasm accessions were selected and characterized for genomic experiments.

2. Technology Innovation Centre for Trait, Seed, and Crop Improvement of Millets for Enhancing Yield and Productivity

- Genome-wide Association studies (GWAS) in pearl millet for blast trait revealed important genes such as NLR proteins, WRKY and MYB transcription factors as key regulators for defense response to the blast fungus.
- Whole genome DNA sequencing of the sorghum female shoot fly was completed with >100X genome coverage using the nanopore long-read sequencing approach.
- Sixteen lines were identified with more than 20% grain yield superiority over VL 376 and CFMV 2 from a set of 105 interspecific finger millet derivatives.
- Kodo millet genome of the cultivar RK390-25 has been sequenced de-novo and assembled.
- Suitable sieve size (1.8 mm) was identified for better seed recovery and quality in foxtail millet for grading of seeds during seed processing.

3. Nutri-cereal Analytical, Food Safety and Quality Assurance National Referral Laboratory for Millets

- 1942 plant-specific metabolites across millet crops under different classes of compounds were identified.
- Identified 205 compounds through Secondary metabolite profiling in millets.

4. Centre of Excellence for Millet Value Chain and Business Facilitation for Entrepreneurship, Incubation and Startup Nurturing

- Developed various value-added millet recipes.
- Monthly training programs on Startup ignition and cooking with millets were organized.

5. Establishment of International Knowledge, Skill Development and Capacity Enablement Centre with International Millet Museum & Halls of Residence

- Several infrastructure facilities, including the Global centre of Excellence building and Field research facility are under progress.
- Advanced research equipment is procured to carry out various research experiments in genomics, functional genomics, molecular breeding, biochemistry, value addition and processing programs

6. Global Facility for Millet Pilots on Feed, Fodder, Biofuels, Malting, Brewing and Promotion of Industrial utilization of Millets

- Brewing activity with different millets has been undertaken in collaboration with NSI, Kanpur, and beer production is initiated and under progress on experimental scale.

7. Regional Millet Technology Innovation and Outreach Hubs

- Organized training and awareness programmes on millet value addition and Crop Diversification.
- 35 training programs were conducted with 1680 participants consisting Farmer producer organizations (FPOs), farmers, CEOs and BODs.

About the Institute

The ICAR-Indian Institute of Millets (Shree Anna) Research (IIMR), Hyderabad is the nodal research institute in India for all the research and development needs of millets with its linkages with All India Coordinated Research Projects (AICRP) on Pearl millet and Sorghum & Small millets. The Institute has been instrumental in developing high yielding varieties and hybrids of sorghum, and high yielding varieties of small millets, as well as novel crop production, crop protection, processing and value-added product development technologies. It conducts basic and strategic research, while AICRP on sorghum and small millets with 31 centres across 15 states, and pearl millet with 13 centres located in 10 states undertake applied research and extension work in a network mode.

The Institute takes its origin in 1987 when the National Research Centre on Sorghum (NRCS) was established from the then IARI regional station at Hyderabad, which was later upgraded as Directorate of Sorghum Research (DSR) in 2009, and as the Indian Institute of Millets Research (IIMR) in 2015. During 1991, a research station named Centre on *Rabi* Sorghum (CRS) to support the research activities of *rabi* sorghum was established at Solapur (Maharashtra). Another off-season nursery was established at Warangal (Telangana) in 1995 as a national facility to support AICRP on Sorghum researchers of the country. In 2023, the Institute has been elevated and declared as the Global Centre of Excellence for Millets Research and Development by the Hon'ble Prime Minister of India signifying the role Institute has played in bringing the humble millets to global scenario. A Regional Research Centre for Pearl millet to address exclusively the research needs of pearl millet for the state with largest area under cultivation in Gudamalani, Barmer, Rajasthan has been opened, and the foundation stone for the Centre was laid on 27 September, 2023 by Sh. Jagdeep Dhankhar, Hon'ble Vice President of India.

Vision

- To transform subsistence farming of millets into a globally competitive climate resilient nutri-cereal enterprise through value-addition to meet food, feed, fodder, nutrition, and bio-fuel requirements of the country for equitable prosperity.

Mandate of IIMR

- Basic and strategic research to increase productivity of millets and their diversified utilization for enhancement of profitability.
- Coordination and development of improved crop production and protection technologies of millets.
- Training and consultancy on millet production and utilization.
- Dissemination of technologies and capacity building.

IIMR-Staff Position

As on 31 December, 2024

Category	Sanctioned	In position	Vacant
RMP	1	1	0
Scientific	50	42	8
Technical	44	25	19
Administrative	30	17	13
Supporting Staff	18	06	12
Total	143	91	52

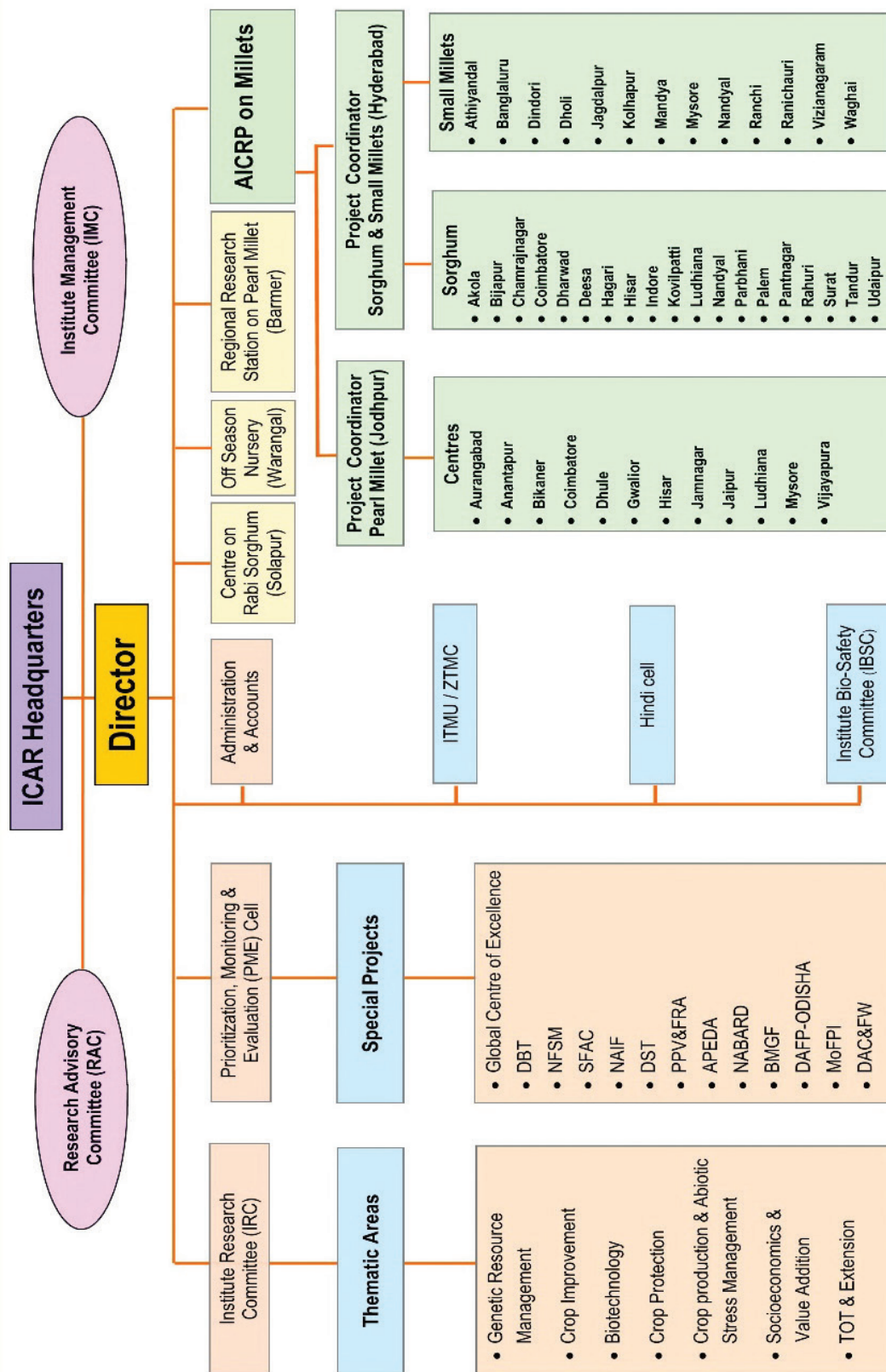
Financial Status - 2023-24

As on 31 March, 2024

Rs. In Lakhs

Scheme	Sanction	Expenditure	Utilization %
ICAR-IIMR-Hyderabad	3065.27	3063.85	99.95%
Global CoE on Millets	8310.80	7050.80	84.84%

Organization set-up of ICAR-Indian Institute of Millets Research Global Centre of Excellence on Millets



1. Genetic enhancement for productivity, quality and stress tolerance

1.1 Genetic Resources Management

IIMR/CI/2021-2026/150: Nutri-cereals Genetic Resources Management (PI: K Venkatesh)

ICAR-Indian Institute of Millets (Shree Anna) Research (IIMR) is one of the National Active Germplasm Sites (NAGS) to act as a national repository for millets germplasm in India. The objectives of the Millets Genebank are collection, augmentation, conservation, characterization, evaluation, distribution, utilization and documentation of millets genetic resources.

Characterization: Two hundred and forty-two

sorghum germplasm accessions were characterized during *rabi* 2023-24 for 22 different morpho-agronomic traits, which included nine quantitative and 13 qualitative traits. The plant height was the most variable trait followed by grain yield per plant, days to maturity, leaf length, etc. (Table 1.1). On an average, plants produced a grain yield (GYP) of 24.67 g/plant. The range of values highlighted the diversity in the set. The wide range of observations across different traits is invaluable for understanding phenotypic differences and could play a key role in breeding efforts to improve traits like yield, height and adaptability.

Table 1.1. Descriptive statistics of sorghum germplasm (242 acc.)

Traits	Mean	SE of Mean	Minimum	Maximum
Total Number of Leaves (TNL)	6.1	0.0	3.5	10.7
Leaf Length (LL, cm)	63.4	0.4	38.6	97.8
Leaf Width (LW, cm)	5.4	0.0	3.6	7.8
Days to Flowering (DF)	62.3	0.3	52.0	81.0
Plant Height (PH, cm)	179.4	1.9	101.0	326.0
Ear Head Length (EHL, cm)	19.2	0.3	7.8	38.5
Ear Head Width (EHW, cm)	4.8	0.0	2.5	8.5
Grain Yield per Plant (GYP, g)	24.7	0.6	2.5	79.9

A total of 567 kodo millet accessions were characterized for 13 agro-morphological traits using an augmented block design. Good variability was observed for different agronomic traits (Table 1.2). The number of basal tillers ranged from 3.4 to 12. The average grain yield per plant was 10.7 g, with high CV (0.5) and standard deviation (6 g), indicating substantial variability (range 1.36 to 43.82 g).

The mean flag leaf blade length was 21.7 cm, with a standard deviation of 5.27 cm and a CV of 0.25. The mean days for 50% flowering was 69, which ranged from 52 to 94 days. Panicle length ranged from 4.1 to 10.5 cm with a mean of 6.0 cm. The mean length of the thumb raceme was 3.7 cm with a range of 1.7 to 8.7 cm, while the mean raceme length was 4.9 cm with a range of 2.54 to 8.22 cm. The number of racemes ranged from 2.4 to 7.8 with a mean of 3.7.

Table 1.2. Descriptive statistics of kodo millet germplasm (567 acc.)

Traits	Mean	SE of Mean	Std. Deviation	Coefficient of variation	Minimum	Maximum
Number of basal tillers	7.2	0.1	1.6	0.2	3.4	12.0
Grain Yield Per Plant (g)	10.7	0.3	6.1	0.6	1.4	43.8
Flag leaf blade length (cm)	21.7	0.3	5.3	0.2	9.5	34.3
Flag leaf blade Width (cm)	0.4	0.0	0.1	0.3	0.2	0.9
Days to fifty % flowering (days)	68.8	0.6	11.5	0.2	52.0	94.0
Plant height (cm)	48.8	1.0	18.7	0.4	18.8	97.6
Peduncle length (cm)	7.2	0.1	1.6	0.2	4.1	12.6
Panicle length (cm)	6.0	0.1	1.0	0.2	4.1	10.5
Panicle Width (cm)	0.3	0.0	0.1	0.3	0.1	0.9
Thumb raceme length (cm)	3.8	0.0	0.9	0.2	1.7	8.8
Raceme length (cm)	4.9	0.0	0.8	0.2	2.5	8.2
Raceme number	3.8	0.1	1.2	0.3	2.4	7.8

Multiplication: A total of 5864 accessions of millets germplasm were multiplied during 2023-24, which included, sorghum (1650), finger millet (257), foxtail millet (1853), kodo millet (1445), little millet (117), proso millet (453) and pearl millet (41).

Conservation: A total of 49,779 accessions of millets are being conserved in the millets genebank, ICAR-IIMR as on 31st December 2024. The maximum accessions conserved are of sorghum with 27,366 acc. followed by finger millet (8,057), pearl millet (4,765) and foxtail millet (4,575).

Distribution: A total of 2961 accessions of different millets were distributed to the bonafied users during 2024, which included sorghum (1001 acc.), kodo millet (829 acc.), proso millet (443 acc.), foxtail millet (324 acc.), barnyard millet (155 acc.), finger millet (80 acc.), little millet (55 acc.), pearl millet (50 acc.) and brown top millet (24 acc.).

Registration with ICAR-NBPGR: One sorghum genetic stock namely, IIMR 20048 (IC651981; INGR24022) was registered during 2024 by ICAR-NBPGR for tolerance to stem borer (9.7% deadhearts at 45 DAE) and tolerance to shootfly (34.8% deadhearts at 28 DAE).

CRP-AB: Consortia Research Platform on Agrobiodiversity (PI: K Venkatesh)

Characterization: A mega characterization of 12,100 accessions of finger millet was conducted at TNAU, Coimbatore research facility (Fig.1.1). The accessions involved both indigenous and exotic collections, representing the entire finger millet collection from the

National Genebank. A total of 29 descriptor traits were recorded, focusing on vegetative traits during 2023-24 and reproductive traits in 2024-25.

Multi-location screening of finger millet germplasm

Multi-location (Mandya, Vijayanagaram and Almora) screening of finger millet germplasm for leaf, stem and neck blast was conducted along with two resistant checks (GE 4449 and KMR 204) and two susceptible checks (KMR 301 and Uduru Mallige) in an Augmented Block Design (Fig. 1.2). Data were recorded for days to 50% flowering, number of fingers, number of productive tillers, plant height, grain yield (kg/ha) and fodder yield (kg/ha). At Almora centre, the accession IC0402458 was found resistant for leaf blast (grade 3) while the accessions IC0261985, IC0283858, IC0344986, IC0393019, IC0393019, IC0393058, IC0403309 and IC0403406 were resistant for finger blast (<5%), and the accessions IC0344986, IC0344955, IC0403283, IC0403318, IC0403406, IC0402671, IC0403071 and IC0403017 were resistant to neck blast.



Fig. 1.1. Field view of mega finger millet germplasm characterization

At Vizianagaram, a total of 212 accessions recorded a leaf blast grade of 1 which is resistant reaction while 459 accessions recorded a neck blast score of 0% and a total of 474 accessions recorded a resistant reaction of 0% finger blast. At Mandya, a total of 75 accessions recorded highly resistant leaf blast score (1 grade) while 331 accessions recorded resistant reaction (<3 grade). In case of neck blast, 70 accessions recorded highly resistant reaction (<1%) and in case of finger blast, 136 accessions recorded highly resistant reaction (<1%).



Fig. 1.2. Field view of blast symptoms on finger millet germplasm screened for blast

1.2. Crop Improvement

1. Pearl millet

IIMR/CI/2021-2026/141: Genetic enhancement of pearl millet for yield and adaptation to arid regions (PI: P Sanjana)

Creation of new variability for arid zone: From the 322 progenies involving 51 crosses made between arid lines, established B- and R-lines and landraces, 72 R-lines were advanced. These involved 59 elite × arid adapted and 13 landrace introgressed progenies. From the arid R-population, 47 R-lines were derived and advanced with SSD method.

Promising hybrids for arid regions: A total of 21 advanced hybrids based on eight A-lines and 15 R-lines selected from *kharif* 2023 initial hybrid trials at IIMR, were evaluated in advanced hybrid trial at Mandor during *kharif* 2024 season. Of them, grain yield ranged from 1.7 to 4.3 t/ha. Two hybrids, 843-22A × BL 73 and 291A × BL 73 had the highest grain yield of 4.3 t/ha. The common R-line BL 73 was developed through shuttle breeding approach. Of these two hybrids 843-22A × BL 73 flowered in 45 days and suitable for arid adaptation (Table 1.3).

Table 1.3. Mean performance of top ten best performing hybrids evaluated at Mandor, Rajasthan, *kharif* season, 2024

Hybrid	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	Grain yield (t/ha)	No. of productive tillers
843-22A x BL73	45	183	19.3	2.7	4.3	1.1
291A x BL73	52	198	20.5	2.7	4.3	1.0
264A x BL86	50	187	22.3	2.6	3.9	1.1
221A x BL88	49	178	21.0	2.5	3.6	1.0
291A x BL72	53	200	21.5	2.8	3.4	1.1
264A x BL72	50	169	19.3	2.6	3.4	1.0
262A x BL88	49	183	21.5	2.8	3.3	1.1
274A x BL67	50	180	22.3	2.6	3.0	1.1
843-22A x 129R	46	188	19.5	2.8	2.9	1.1
260A x BL73	53	190	21.5	2.4	2.9	1.1
Mean	50	182	20.6	2.7	2.8	1.1
LSD (5%)	3.5	19	4.0	0.5	1.9	0.1
P<0.05	0.00	0.02	0.3	0.5	0.02	0.6

Inbred lines with resistance to blast: The diversity panel of 300 inbred lines were screened for new virulent Mandor isolate of blast MDR 23 under controlled

conditions at ICRISAT following completely randomized design (CRD) with two replicates; one pot/replicate and 12 seedlings/pot. The data on foliar blast severity

in each line was recorded after 6 days of inoculation using 1–9 progressive scale. The lines exhibiting blast score ≤ 3.0 were categorized as Resistant (R), 3.1–5.0 as Moderately Resistant (MR), 5.1–7.0 as Susceptible (S), and >7.0 as Highly Susceptible (HS). Among the 300 lines, 57 were resistant with a score ≤ 3.0 (Fig. 1.3). This included 8 B-lines and 49 R-lines.

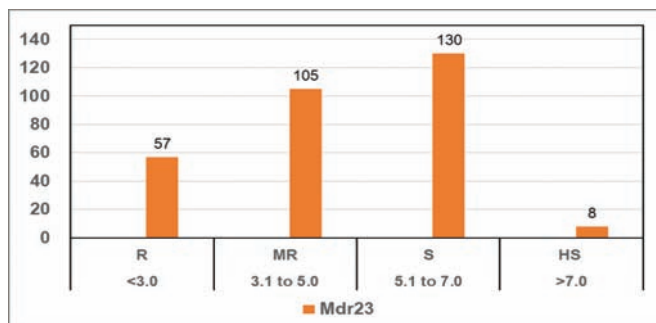


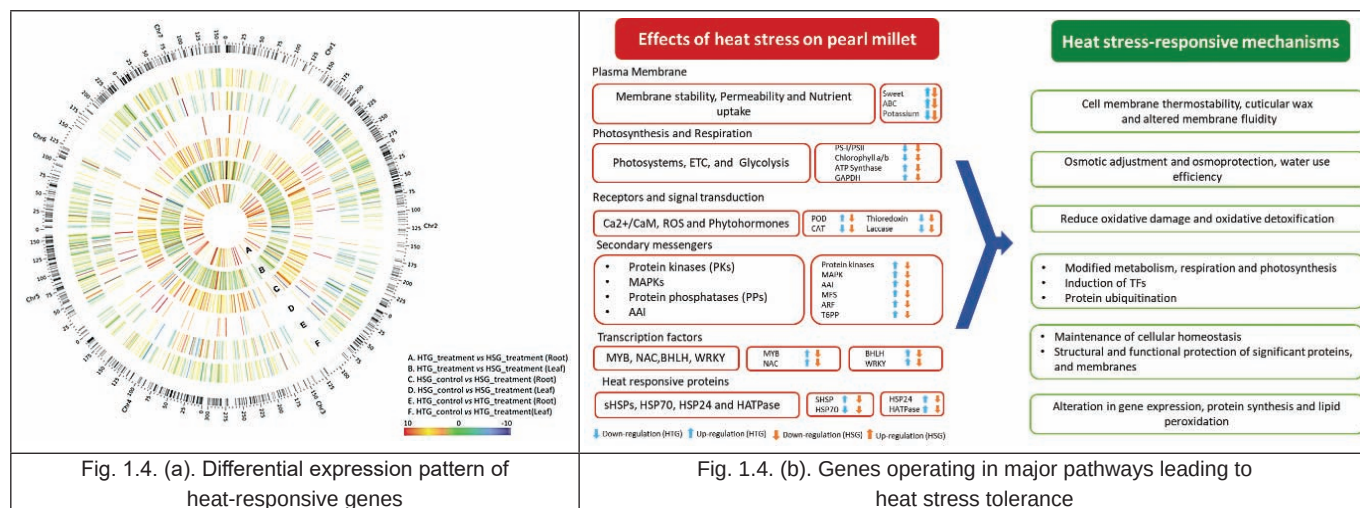
Fig. 1.3. Blast resistance pattern in the 300 pearl millet inbred lines

IIMR/CI/2023-28: Development of breeding resources and technologies through genomic approaches in pearl millet (PI: T Nepolean)

Identification of key genes and molecular pathways regulating heat stress tolerance

Pearl millet is mostly grown in harsh environments, making it an ideal crop to study heat tolerance mechanisms at the molecular level. Despite having a better-inbuilt tolerance to high temperatures than other crops, heat stress negatively affects the crop, posing a threat to productivity gain. To understand the heat-responsive genes, the leaf and root samples of two pearl millet inbreds, EGTB 1034 (heat tolerant)

and EGTB 1091 (heat sensitive), were subjected to heat-treated conditions and generated genome-wide transcriptomes. A total of 13,464 differentially expressed genes (DEGs) were discovered of which 6932 were down-regulated and 6532 were up-regulated in leaf and root tissues. The pairwise analysis of the tissue-based transcriptome data of the two contrasting genotypes demonstrated distinctive genotype and tissue-specific expression of genes (Fig. 1.4). The root exhibited a higher number of DEGs compared to the leaf, emphasizing different adaptive strategies of pearl millet. A large number of genes encoding ROS scavenging enzymes, WRKY, NAC, enzymes involved in nutrient uptake, protein kinases, photosynthetic enzymes, and heat shock proteins (HSPs) and several transcription factors (TFs) were activated in the stress conditions. Ribosomal proteins emerged as pivotal hub genes, highly interactive with key genes expressed and involved in heat stress response. The synthesis of secondary metabolites and metabolic pathways of pearl millet were significantly enriched under heat stress. Comparative synteny analysis of HSPs and TFs in the foxtail millet genome demonstrated greater collinearity with pearl millet compared to proso millet, rice, sorghum and maize. In this study, 1906 unannotated DEGs were identified, providing insight into novel participants in the molecular response to heat stress. The identified genes hold promise for expediting varietal development for heat tolerance in pearl millet and similar crops, fostering resilience and enhancing grain yield in heat-prone environments.



Novel SNPs linked to blast resistance genes in pearl millet

With a focus on understanding the genetic factors behind blast resistance, a genome-wide association study (GWAS) was carried out using 281 diverse pearl millet inbreds. The GWAS panel was tested for resistance against three different isolates of *M. grisea* sourced from Delhi, Gujarat and Rajasthan, uncovering a notable variability with 16.7% of the inbreds exhibiting high levels of resistance. The analysis employed BLINK and MLM models on transformed means, identifying 68 significant SNPs associated with resistance, particularly concentrated on chromosomes 1, 2, and 6 (Fig.1.5). These chromosomal regions contain genes that play a role in defence mechanisms, encompassing immune

responses, stress tolerance, signal transduction, transcription regulation, and pathogen defence. Key genes, including 14-3-3-like proteins (RGA2, RGA4), hypersensitive-induced response proteins, NHL3, NBS-LRR, LRR-RLK, LRRNT_2, and various transcription factors such as AP2/ERF and WRKY, were found to be essential in stress-responsive pathways. The investigation of transporter proteins, redox processes, and structural proteins revealed further mechanisms that contribute to blast resistance. This research provides critical insights into the intricate genetic framework of blast resistance in pearl millet, laying a strong groundwork for marker-assisted breeding and gene-editing initiatives.

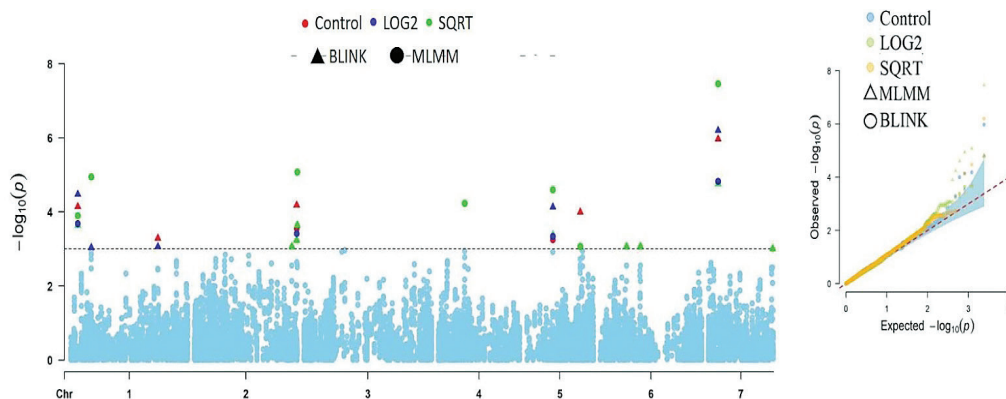
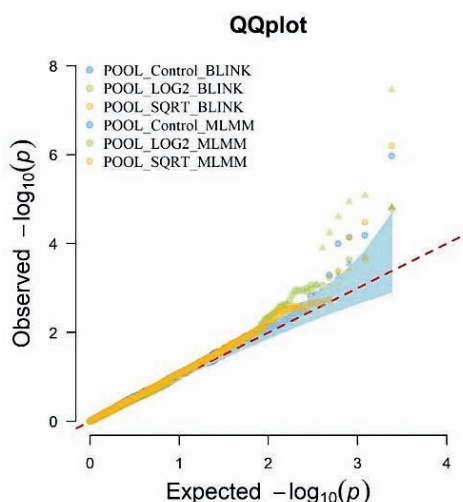


Fig. 1.5. Significant SNPs identified for three blast isolates using transformed data sets and two GWAS models



BMGF project: Application of next generation breeding, genotyping and digitization approaches for improving the genetic gain in Indian staple crops (PI: T Nepolean)

Optimising the rapid breeding cycle pipelines to speed up the genetic gain

A new line development programme has been created to speed up genetic gain in pearl millet. The programme involves selecting parents based on their breeding values and crossing the elite lines to initiate the line development programme (Fig. 1.6). The progenies were advanced through a single-seed-descent approach, and the best progenies were selected at F_3 - F_4 instead of waiting for F_7 - F_8 . The selection was done by genotyping the progenies at F_3 - F_4 using a cost-effective 4K mid-density SNP panel and predicting their breeding values through gBLUP model. Progenies with high breeding values were used to generate experimental hybrids and simultaneously recycled to initiate new breeding cycles. The generated hybrids were tested in sparse design with partial reps at six locations, and analyses of the

results are under progress. The pipeline mentioned above will help to achieve a rapid rate of genetic gain in pearl millet hybrid programmes.

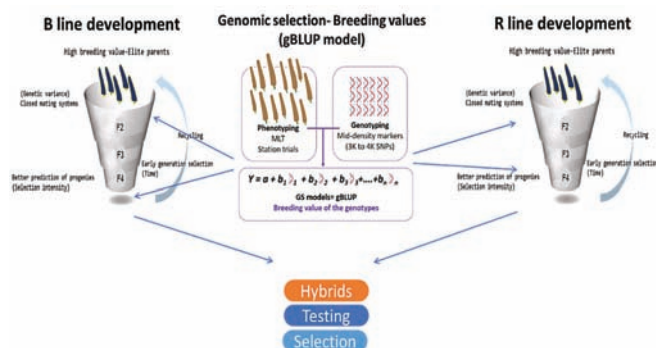


Fig. 1.6. Optimised breeding cycle, designed to accelerate higher rate of genetic gain in pearl millet

IIMR/CI/2018-23/120: Forage pearl millet improvement for high biomass (PI: Avinash Singode)

Stable entries identified for high forage yield

Phenotypic stability analysis was conducted using an advanced parametric stability model to identify stable genotypes with consistent forage performance across

environments out of 87 genotypes tested. Comparing parametric models (Eberhart & Russell, AMMI and WAASB) (Fig. 1.7), the most common stable genotypes with desirable forage yields were IIMR FB 88, IIMR FB 81 and IIMR FB 24 (Table 1.4). These genotypes exhibited stability for multiple traits, including green and dry fodder yields, making them ideal genotypes for cultivar development programmes. By comparing the overall mean of the genotypes over seasons for fodder yield and quality traits genotypes IIMR FB 51, IIMR FB 98 and IIMR FB 90 were found to be good for total green fodder yield along with desirable performance in related traits. The genotypes IIMR FB 17, IIMR FB 38 and IIMR FB 71 showed superior performance for forage quality traits, particularly in crude protein and *in vitro* organic matter digestibility. IIMR FB 17 and IIMR FB 38 showed superiority in both forage yield and quality traits, making them valuable for breeding programmes aimed at enhancing both productivity and nutritional value.

Table 1.4. Selection of desired stable genotypes based on multiple stability analysis

Traits	Common Genotypes at least in two models
Leaf length	IIMRFB47
Leaf width	IIMRFB83
Number of leaves	IIMRFB88, IIMRFB18, IIMRFB44
Internode length first cut	IIMRFB47, IIMRFB42, IIMRFB52
Stem thickness first cut	IIMRFB63, IIMRFB59, IIMRFB39, IIMRFB48, Wonder leaf
Plant height first cut	IIMRFB70, IIMRFB47, IIMRFB38
Number of tillers first cut	IIMRFB102
Number of new tillers	IIMRFB15
Number of tillers regrowth	IIMRFB28, IIMRFB19, IIMRFB102
Leaf stem ratio	IIMRFB10, IIMRFB30, IIMRFB43, IIMRFB10, IIMRFB81
Green fodder yield first cut	IIMRFB90, IIMRFB88
Dry fodder yield first cut	IIMRFB88, IIMRFB24
Green fodder yield second cut	IIMRVS79, IIMRFB49, IIMRFB43, IIMRFB81, IIMRFB83
Dry fodder yield second cut	IIMRFB7, IIMRFB49, IIMRFB79, IIMRFB81
Total green fodder yield	IIMRFB51, IIMRFB55, IIMRFB24, IIMRFB73
Total dry fodder yield	IIMRFB98, IIMRFB73, IIMRFB24

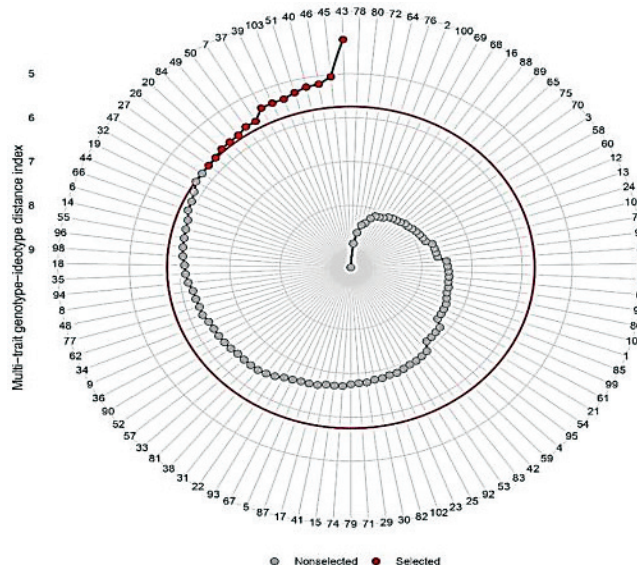


Fig. 1.7. Genotypes selected based on MGIDI index and strength and weakness view of MGIDI

GWAS for forage yield and quality

A genome-wide association study (GWAS) was conducted to investigate the genetic basis of forage yield and quality traits in pearl millet. Using high-density single nucleotide polymorphism (SNP) markers, GWAS was performed to identify significant marker-trait associations for key forage-related characteristics. Initially, 1,492,759 raw SNPs were identified. After rigorous filtering, a high-quality collection of 19,234 filtered SNPs were obtained for further investigation.

The BLINK model outperformed other GWAS models in identifying marker-trait associations, demonstrating its efficiency in detecting significant loci. Using this model, 119 significant associations were identified for traits, such as leaf length, leaf width, number of tillers at the first cut, number of new tillers, green fodder yield at the second cut, total green fodder yield, total dry fodder yield, acid detergent fibre, hemicellulose, acid detergent lignin, cellulose, digestible energy, metabolizable energy and *in vitro* organic matter digestibility. Across all 14 traits, the Manhattan plots revealed significant SNP associations, with several markers surpassing the threshold of $\text{Log}_{10}(P) > 5$, indicating strong genetic influences contributing to the observed trait variations (Fig. 1.8). A number of putative candidate genes were detected based on annotation with pearl millet genome wide predicted protein databases and rice orthologous genes databases (Table 1.5).

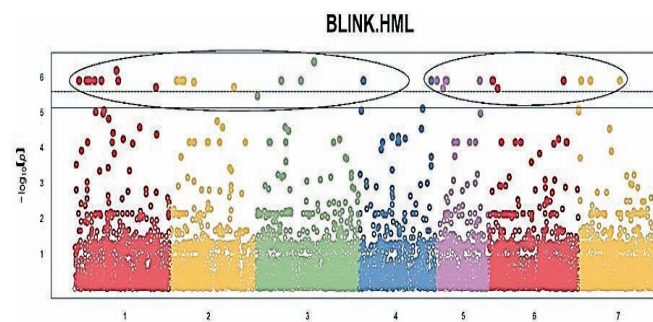


Fig. 1.8. Manhattan plot for hemicellulose content

Table 1.5. Putative candidate genes for fodder yield and quality traits

Trait	SNP	Chr	Gene	Gene Annotation with Rice	Function
TGFY	274148:69:-	3	Pgl_GLEAN_10011133	Phytochrome C	Environmental stressors, including flowering time, drought tolerance, and nutrient metabolism
TDFY	816036:106:+	7	Pgl_GLEAN_10027602	START domain containing protein	Transcriptional activity
ADF	434639:21:+	4	Pgl_GLEAN_10012899	Jacalin-like lectin domain containing protein	Plant defence
ADL	287221:72:-	3	Pgl_GLEAN_10025349	Cytochrome P450	Broad-spectrum resistance
CL	434639:21:+	4	Pgl_GLEAN_10012900	Phosphoglycerate kinase	Disease resistance
ME	227361:53:+	2	Pgl_GLEAN_10018961	Expansin precursor	Developmental and physiological processes
IVOMD	223619:135:-	2	Pgl_GLEAN_10003913	Superoxide dismutase	Common stress-response pathways

(TGFY: total green fodder yield, TDFY: total dry fodder yield, ADF: acid detergent fibre, ADL: acid detergent lignin, CL: Cellulose, ME: metabolizable energy, IVOMD: *in vitro* organic matter digestibility)

II. Sorghum

a) Kharif sorghum

IIMR/CI/2021-2026/139: Breeding for genetically diverse kharif sorghum genotypes with improved grain yield, quality and resistance to important biotic stresses (PI: C Aruna)

Performance of hybrids in station trials

One hundred and sixty-four experimental hybrids based on 23 MS and 47 R lines were sown in four trials each in a RCBD with three replications along with

the checks, CSH 25, CSH 30 and CSH 41. Data were recorded on days to flower, plant height, grain yield, panicle length and grain mold score. Sixteen hybrids were early maturing in around 100 days. Fourteen medium and two early maturing hybrids recorded >10% yield advantage and 16 hybrids recorded >10% yield advantage over respective checks (Table 1.6). R lines include derivatives of wild sorghum crosses (11) and local land races (12). Fourteen hybrids recorded grain mold score of 3.0-4.0; 17 hybrids recorded > 3.2 g per 100-seed.

Table 1.6. Performance of promising sorghum hybrids during kharif

S. No.	Hybrid/Check	DTF	Grain yield (kg/ha)	Adv. over CSH 41/42 (%)	Plant height (cm)	100-Seed weight (g)	GMS (1-9)
1	4918A × CB33	71	6298	15.8	172	2.65	4.75
2	400A × ISC320-5-2	18	5946	29.1	148	1.75	3.0
3	415A × Vidisha6-1	88	5860	10.3	311	2.3	5.5
4	2911A × NR4118	75	5936	10.4	169	2.8	3.0
5	415A × ISC304-3-e	71	5820	7.0	180	2.25	4.5
6	151A × NR8518	69	5740	6.0	152	2.05	4.0
7	AK14A × NR8018	63	5180	28.5	156	3.05	3.0
	CSH 41 (Check)	68	5440	-	179	2.2	4.5
	CSH 42 (Check)	61	4031	-	156	2.3	6.0
	CV (%)	4.08	25.5	-	4.08	24.3	17.7
	CD (0.05)	5.87	1665	-	5.87	-	1.60

Breeding for shoot fly resistance

Evaluation of 296B mutant derivatives: 50 mutants of 296B were evaluated in replicated trials using artificial fish meal technique for shoot fly traits such as deadheart (DH) percentage, eggs, seedling height, etc. All mutants had less DH compared to parent, 296B. Four mutants with ~30% DH may be targeted for use in breeding (Fig.1.9).

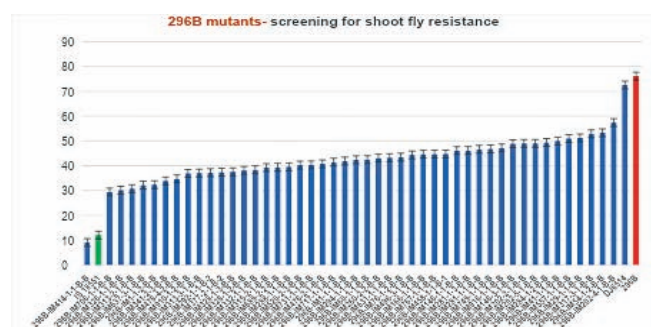


Fig. 1.9. Performance of 296B mutant lines for shoot fly resistance

Another set of 80 advanced breeding lines (derivatives of 296B and RS29 with IS 18551 and other resistant lines

from minicore) were evaluated for shootfly resistance (SFR). New lines showed significant improvement in their SFR compared to 296B, 27B and other varieties (Fig.1.10). Entries with less than 20% DH may be further tested for their SFR and yield attributes.



Fig. 1.10. Performance of advance breeding lines for shoot fly resistance

Evaluation of local landraces for yield, biochemical traits and tolerance to biotic stresses

Forty-two local land races from seven states were evaluated in a RCBD with three replications. The lines include genotypes with white, red and yellow grain

colour. The lines were evaluated for agronomy, pest resistance and quality traits. Some lines like Byhatti

local, Balapur local and Bundela were promising for more than one trait (Table 1.7).

Table 1.7. Performance of local land races for agronomy, resistance and quality traits

Trait	Minimum	Maximum	Mean	CD (5%)	CSV 20	Promising lines
Days to flower	60	85	74.3	7.37	70	Byhatti local (Kar), Palem local 4 (Tel), Palem local 3
Plant height (cm)	150.5	332.5	295.6	52.3	283.5	Short: Macia, Byhatti local Tall: Gird 3 (MP), Gird 31 (MP), Porbandar local (Mah)
Panicle length (cm)	9.6	32.3	21.0	6.76	24.3	Palem local 4 (Tel), Chinnavellaicholam (TN), Black jowar (AP), GGUB 59 (MP)
Grain yield/pl (g)	9.0	47.0	24.1	17.3	33.5	Balapur local (Mah), <u>Bundela</u> (MP)
100-seed wt (g)	1.28	3.0	2.17	0.9	2.25	Balapur local, Kalagunda local (Kar), GGUB 59 (MP)
GMS (1-9 scale)	3.0	8.0	5.84	0.5	6.00	Porbandar local, Balapur local, Palem local, Seethamma Jonna, Black jowar, GGUB 59, Irungucholam, <u>Bundela</u> , Paiyur
SF DH (%)	28.4	77	47.2	12	35.8	Balapur local, Newara and Gird 3
Tannin content (% CE)	0.18	1.60	0.33	0.03	0.20	Low- Gird5, Newara local 2, Byhatti, Sindkhed, Macia High- Paiyur2, Tenkasi vellai, Irugu cholam, IS25040
TPC (mg GAE/g)	1.44	10.52	3.011	0.131	1.92	Irugu cholam, Tenkasi vellai, Paiyur 2, IS 25040
TFC (mg CE/g)	19.73	50.06	29.16	1.71	22.01	Macia, Irugu, Vellai cholam, IS 25040, Local 2
Amylose content (%)	7.03	21.39	16.47	0.398	17.76	High- Gird 36, Gundari, Bundela, Gird 31, Ramkel Low- Irugu cholam, Tenkasi vellai, Gird 3, IS 25040

(GMS - Grain mold score; SFDH - Shoot fly deadhearts; TPC - Total phenolic content; TFC - Total flavonoid content, Kar – Karnataka, Tel – Telangana, MP – Madhya Pradesh, Mah – Maharashtra, TN = Tamil Nadu, AP – Andhra Pradesh)

A derivative of guinea race sorghum with bold grain in high yield back ground

SPV 3031 is a derivative of the cross, (NR10-15 × IS 31065) × *rabi* local from Gulbarga, which was tested in AICRP-Sorghum trials during *rabi* 2022-23 and 2023-24. The germplasm line in the parentage, IS 31065 was from Uganda and belongs to Guinea-caudatum race. SPV 3031 recorded significant increase in 100-

seed weight over the checks, CSV 29R and M 35-1 with more than 10% improvement in grain size in both the years under multilocation testing (Table 1.8). Its grain yield is statistically on par with the checks. This line can serve as a genetic stock for grain size improvement.

Table 1.8. Performance of SPV 3031 in AICRP-Sorghum *rabi* trials during 2022-23 and 2023-24

	100-Seed weight (g)					% increase over checks	Grain yield (kg/ha)			Fodder yield (q/ha)		
	2022		2023		Av.		2022	2023	Av.	2022	2023	Av.
Entry	Mean	R	Mean	R			Mean	Mean		Mean	Mean	
SPV 3031	3.80	1	3.82	1	3.81		3350	2866	3108	82.5	89.0	86.1
CSV 29R	3.49	9	3.33	12	3.41	11.7	3285	3299	3292	79.3	90.2	84.7
M 35-1	3.35	14	3.30	15	3.33	14.4	3133	2906	3020	72.3	80.2	76.2
CV (%)	15.22		9.00				13.97	15.5		17.8	13.0	
CD (5%)	0.24		0.16				285.3	348.4		7.61	9.09	
CD (1%)	0.32		0.21				375.6	459.4		10.0	11.9	

Table 1.8 Contd. Performance of SPV 3031 in AICRP-Sorghum *rabi* trials during 2022-23 and 2023-24

Entry	Days to flower			Days to maturity			Plant height (cm)		
	2022	2023	Av.	2022	2023	Av.	2022	2023	Av.
	Mean	Mean		Mean	Mean		Mean	Mean	
SPV 3031	73	74	74	119.3	119	119	231.5	232.2	231.8
CSV 29R	72	74	73	118.2	119	118	236.1	251.9	244.0
M 35-1	71	71	71	118.0	115	117	220.8	231.7	226.2
CV (%)	4.26	3.54		3.16	2.44		8.70	8.5	
CD (5%)	1.7	1.66		1.8	1.64		10.3	11.7	
CD (1%)	2.3	2.19		2.4	2.16		13.5	15.4	

b) *Rabi sorghum*

IIMR/CI/2020-2025/122: Genetic enhancement of *rabi sorghum* adaptive traits for improved varietal performance (PI: Parashuram Patroti)

Development of high yielding and stress resilient sorghum cultivars using a multi-parent crossing approach

Forty-five genotypes, which included sixteen 2-way, eight 4-way and four 8-way cross derivatives, along with their 17 parental lines, were evaluated in an alpha lattice design with three replications in large plots. Significant differences were observed among the test entries for most traits, except panicle exertion and test weight. The measured traits showed high variability, with the highest coefficient of variation observed for grain yield, panicle yield and peduncle length. Grain yield ranged from 1014 to 5984 kg/ha, stover yield from 5119 to 11728 kg/ha, and 100-seed

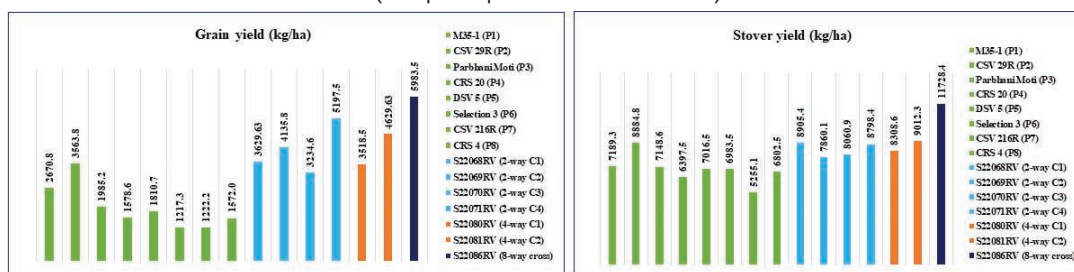
weight from 2.75 to 4.24 g (Table 1.9) This substantial variation in dual-purpose characteristics presents an excellent opportunity to improve yield. Among the 28 test entries, the 8-way cross-derived lines demonstrated the highest grain and stover yields, as well as favourable agronomic traits, compared to the 2-way and 4-way cross derivatives and their parental lines. Specifically, the 8-way cross-3 (S22086RV) had the highest grain yield, stover yield and 100-seed weight, followed by the 8-way cross-2 (S22085RV) and 8-way cross-4 (S22087RV) (Fig. 1.11). The 4-way cross derivatives outperformed the 2-way cross derivatives. Schematic illustration of the multi-parent crossing approach employed in the study to generate multi-parent crosses (Fig. 1.11). The diagram depicts the specific scheme for the development of the 8-way cross-3, involving a multi-stage hybridization process and subsequent pedigree selection.

Table 1.9. Mean performance of selected multi-parent cross derived lines along with parental lines (2nd year)

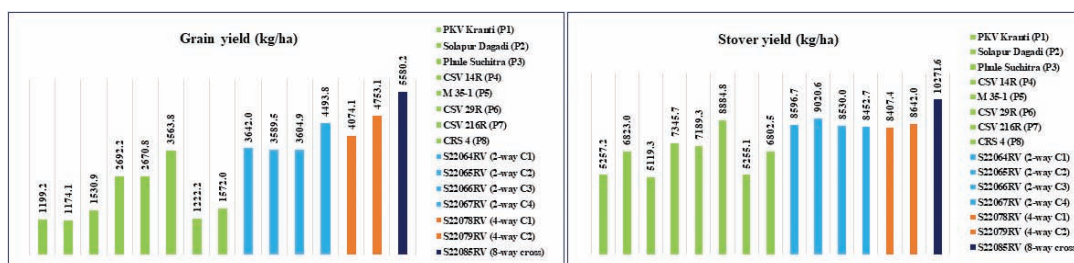
Identities	DFF	DM	PH	PE	Ped. L	PL	PW	PWt	GY	SY	TW
S22063RV	76	127	252	11.45	16.25	13.67	2.78	4938	4136	8107	2.84
S22065RV	78	128	241	9.00	26.05	18.17 #	3.47	5802	5136 #	9021	2.92
S22067RV	68	118	275	11.55	17.65	14.67	2.83	5062	4494	8453	3.05
S22071RV	72	123	260	8.18	28.90 #	14.17	3.52	5556	5198 #	8798	2.82
S22073RV	76	126	274	12.20	18.10	16.67	2.87	5802	5210 #	9070	2.82
S22074RV	76	126	262	15.13	25.97	15.00	3.53	4815	4148	7878	2.98
S22075RV	77	125	276	10.27	23.43	17.17	2.27	5062	4321	7984	2.98
S22077RV	75	124	231	13.75	26.90	13.67	2.95	6049	4099	9432 #	2.84
S22078RV	74	125	222	15.17 #	21.95	10.50	2.98	5556	4074	8407	2.76
S22079RV	68	116	250	14.60	26.13	15.50	3.12	5679	4753	8642	2.72
S22081RV	68	118	244	11.87	24.93	16.67	3.33	5802	4630	9012	3.18
S22083RV	76	125	240	14.00	20.75	13.50	2.58	5874	4827	9116	2.93
S22084RV	68	118	234	9.88	25.87	17.50	3.27	5951	4617	8889	3.19
S22085RV	67 #	117	230	15.02 #	27.37	15.50	3.57	7889 #	5580 #	10272 #	3.36 #

Identities	DFF	DM	PH	PE	Ped. L	PL	PW	PWt	GY	SY	TW
S22086RV	67 #	112	218	16.18 #	32.40 #	19.20 #	4.48 #	8436 #	5984 #	11728 #	4.24 #
S22087RV	73	123	257	14.97	29.65 #	20.50 #	3.53	6944	5465 #	11029 #	3.35 #
CSV 14R	74	120	196	12.62	16.67	15.38	3.08	4305	2692	7346	2.97
Solapur Dagadi	75	121	193	14.17	17.33	15.03	4.02	2905	1174	6823	3.04
CRS 4	68	122	150	13.45	18.17	17.38	3.17	1371	1041	6831	3.09
Phule Revati	73	120	234	11.05	17.00	19.23	4.30	3057	1348	7613	3.04
CSV 22	73	121	204	13.55	17.33	18.07	3.88	4379	2745	8494	2.90
Phule Chitra	71	121	236	12.25	18.17	17.95	3.32	2630	1930	6487	3.28
PKV Kranti	70	119	243	12.37	33.00	18.00	4.73	1582	1199	5257	3.42
Phule Suchitra	70	121	208	10.90	18.67	16.47	3.62	2000	1531	5119	2.97
CSV 216R	69	120	314	11.25	22.00	20.27	3.50	1737	1222	5255	2.83
Parbhani Moti	75	122	224	11.18	21.33	17.98	3.67	3104	1985	7149	3.07
CRS 20	76	119	238	10.75	22.00	18.62	4.82	1874	1579	6398	3.62
DSV 5	75	123	251	9.67	25.33	16.88	3.23	2300	1811	7016	3.14
Selection 3	64	114	172	13.63	18.97	19.29	3.02	2414	1217	6984	2.90
DSV 4	74	119	228	13.15	25.67	18.87	4.15	2817	1572	6802	3.27
CSV 29R (NC)	75	124	246	13.45	27.20	18.83	2.65	5230	3564	8885	3.43
CSV 26R (NC)	73	123	235	12.83	27.17	15.80	4.63	3861	2621	7181	3.26
M 35-1 (PLC)	74	124	254	10.70	28.87	16.11	3.55	3465	2671	7189	3.48
Mean	72.51	121.87	236.64	12.53	23.45	15.97	3.39	4580	3359	8038	3.06
SEm	0.53	0.54	4.05	0.31	0.69	0.39	0.09	244	208	197	0.04
Min	64.00	112.00	150.00	8.18	16.25	10.00	2.27	1371	1014	5119	2.72
Max	78.00	128.00	314.00	17.00	33.00	20.50	4.82	8436	5984	11728	4.24
CV (%)	5.0	3.0	11.0	17.0	20.0	17.0	18.0	36.0	41.0	16.0	9.0

(# Superior performance for the trait)



a) 8-way cross-3 (S22086RV): [(M35-1 × CSV 29R) × (Parbhani Moti × CRS 20)] × [(DSV 5 × Selection 3) × (CSV 216R × CRS 4)]



b) 8-way cross-2 (S22085RV): [(PKV Kranti × Solapur Dagadi) × (Phule Suchitra × CSV 14R)] × [(M 35-1 × CSV 29R) × (CSV 216R × CRS 4)]

Fig. 1.11. Mean grain and fodder yields in two distinct outstanding lines (S22086RV and S22085RV)

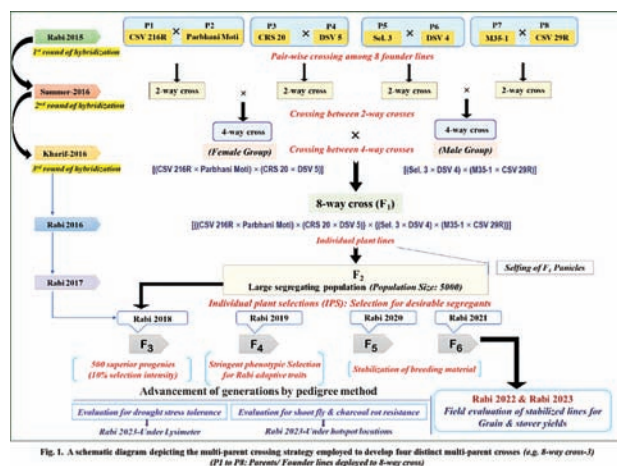


Fig. 1.12. Schematic illustration of the multi-parent crossing approach

This study demonstrated the use of a comprehensive multi-parent crossing strategy (Fig. 1.12) to combine desirable traits from the eight founder lines and develop dual-purpose, high-yielding genotypes with improved tolerance to drought, shoot fly and charcoal rot in post-rainy season sorghum. The systematic evaluation of advanced-generation derivatives from 8-way, 4-way, and 2-way crosses led to the identification of several promising lines exhibiting remarkably higher grain and fodder yields up to 60-70% and 15-30%, respectively, compared to the existing national check CSV 29R. The lines, SS22086RV, a derivative from the 8-way cross [(M35-1 × CSV 29R) × (Parbhani Moti × CRS 20)] × [(DSV 5 × Selection 3) × (CSV 216R × CRS4)] and SS22085RV, a derivative from the cross [(PKV Kranti × Solapur Dagadi) × (Phule Suchitra × CSV 14R)] × [(M 35-1 × CSV 29R) × (CSV 216R × CRS 4)] displayed excellent agronomic attributes, such as bold seeds, long and compact panicles, and better peduncle length and panicle exertion. The medium maturity and medium-tall plant height of these multi-parent cross-derived (MPCD) lines further enhance their suitability for post-rainy season cultivation. Importantly, these MPCD lines possess key water-use efficiency traits, conferring enhanced drought tolerance, as well as remarkably low incidences of shoot fly (<15% DH) and charcoal rot (<10 CRI), making them valuable genetic resources for stress resistance breeding.

Development of improved versions of popular *rabi* sorghum cultivars

In an effort to develop improved versions of popular *rabi* cultivars for key insect-pest and diseases, eight BC₂F₄

populations for the traits like stem borer, aphid, shoot bug, rust, drought and stay green in the background of popular *rabi* cultivars (SPV 2217, Parbhani Jyoti, CSV 29R, BJV 44, PKV Kranti, Phule Vasudha and CSV 26R) were generated using a back-cross breeding approach. These lines are under evaluation during this *rabi* 2024 for the target traits.

Deployment of indigenous and exotic germplasm for broadening genetic base

Twenty-eight crosses generated using indigenous and African durra (Cameroon, Yemen), best Indian landraces and multi-trait specific germplasm is in advanced generation of testing (F₄) and around 130 desired progenies were selected.

RIL development from multi-parent cross populations

Three RIL populations were generated for genetic dissection of *rabi* adaptive traits by using eight *rabi* based founder lines and are in F₇ generation. One RIL population from the diverse set of eight parents chosen from the global mini-core collection of ICRISAT [(IS-1041 × IS-1212) × (IS-14779 × IS-15744)] × [(IS-28141 × IS-16382) × (IS-30466 × IS-21512)] was developed by SSD method and the population is in F₄.

IIMR/CI/2023-27: Breeding *rabi* sorghum hybrids with enhanced productivity (PI: Dr. B Amasiddha)

Development of new B lines

A set of 25 new B lines derived from *rabi* × *kharif* lines were developed and are currently in F₄ generation. The *rabi* lines 104B and AKMS66-2B were crossed with *kharif* lines 279B and AKMS14B to generate this material. Another set of 151 new B lines are in F₅ generation which were developed by involving 104B, AKMS66-B, AKR82B, BJMS3B and M31-2B.

Development of new R lines

A new set of 74 R lines (F₄) were developed by using early and dwarf progenies viz., M35-1, CSV-29R, RS585 and CSV26R crossed with CSV17 (early *kharif* variety). Another set of 167 new R lines are in F₅ generation, which were developed by crossing CSV216R, M35-1, RS585 and CSV 26R with CSV17, CS3541 and C43.

Development of stay green lines

A set of 37 stabilized stay green lines were developed in the background of *rabi* sorghum varieties CSV 26R (10 lines), CSV 29R (11 lines) and M 35-1 (16 lines).

Identification of restorer lines for M31-2A

Six stable restorer lines were identified for Maldandi based cytoplasmic male sterile M31-2A and these can be used in the *rabi* sorghum hybrid breeding programme.

c) Sweet sorghum

IIMR/CI/2021-2026/140: Genetic enhancement of energy sorghums for renewable fuels and fodders (PI: AV Umakanth)

Sweet sorghum hybrid evaluation

During *kharif* 2024, 14 hybrids including the check CSH 22SS were evaluated for sweet sorghum productivity traits. Significant differences were observed among

the hybrids for most of the characters studied. For total fresh biomass, the hybrid IIMR 35A × ICSV 17335 recorded the highest biomass yield of 85.6 t/ha and was 33% superior to the check CSH 22SS (64.4 t/ha) (Table 1.10). The same hybrid also recorded highest fresh stalk yield of 55 t/ha which was 62% higher than the check CSH 22SS (33.9 t/ha), highest juice yield of 24804 L/ha, which was 58% higher than the check CSH 22SS (15744 L/ha) and highest ethanol yield of 2014 L/ha which was 67% higher than the check CSH 22SS (1208 L/ha).

Hybrid 2295A × 11NRL recorded the highest stem girth (2.13 cm) while for plant height, the hybrid 356A × RSSV 260 was superior (383 cm). The hybrid, Tx 623 A × SPV 2593 recorded highest juice extraction percentage (52.3%) and hybrid 479A × RSSV 558 recorded highest brix (18.1%).

Table 1.10. Performance of sweet sorghum hybrids for productivity traits

S. No.	Entry	Stem girth (cm)	Plant height (cm)	Total fresh biomass (t/ha)	Fresh stalk yield (t/ha)	Juice extraction (%)	Juice yield (L/ha)	Brix (%)	Ethanol yield (L/ha)
1	IIMR 35A × ICSV 17335	1.93	302	85.6	55.0	41.8	24804	17.2	2014
2	Tx 623A × SPV 2593	1.97	292	81.1	39.4	52.3	22236	16.2	1699
3	Tx 631A × SPV 2593	1.95	292	78.9	44.7	44.5	21384	15.8	1604
4	126A × SSR 7	2.01	317	82.2	41.9	37.9	17178	17.8	1434
5	2295A × 11NRL	2.13	296	70.0	38.6	41.1	17148	17.0	1365
6	356A × RSSV 260	2.11	383	80.0	51.7	24.8	13860	17.3	1129
7	AKMS 90A × SSR 12	1.61	293	43.9	27.2	52.0	15120	15.8	1128
8	Tx 623A × 11 NRL	2.12	314	61.1	26.7	42.8	12288	16.5	953
9	I-15A × RSSR 91	1.82	312	66.1	35.7	30.0	11388	17.4	931
10	473A × SSR 7	1.99	264	53.9	23.9	46.0	11748	16.5	907
11	479A × RSSV 558	1.83	283	48.9	24.7	35.8	9552	18.1	812
12	Wheatland A × 11 NRL	2.00	271	57.8	21.1	36.1	8232	17.7	685
13	PMS 42A × ICSV 15021-1	1.87	323	76.1	30.7	19.7	6102	14.7	428
14	CSH 22SS	2.03	299	64.4	33.9	43.2	15744	16.4	1208
	Mean	1.93	296	65.2	33.8	39.5	14157	16.4	1101
	C.V. (%)	8.13	8.39	16.48	15.31	11.08	13.77	6.65	19.06
	F Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Brown midrib sorghum evaluation for single-cut forage traits

During *kharif* 2024, 15 hybrids including the checks CSH 54 BMR and CSV 43 BMR were evaluated for single-cut forage traits. Significant differences were observed among the hybrids for most of the characters studied. For green fodder yield, hybrid IIMR BMR6A ×

S 21-BC-10 recorded highest yield of 588 q/ha which was 22% higher than the check CSH 54 BMR (482 q/ha) and 62% higher than the other check CSV 43 BMR (363 q/ha) (Fig. 1.13). The same hybrid also recorded highest dry fodder yield of 235 q/ha, highest stem girth (2.90 cm), highest plant height (277 cm). This hybrid has shown highest brix among all the hybrids (14.9%).

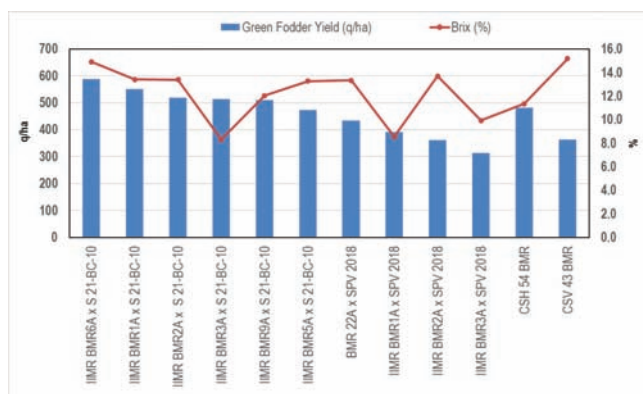


Fig. 1.13. Performance of BMR hybrids for green fodder yield and brix content

d) Forage sorghum

IIMR/CI/2022-27/158: Breeding forage sorghum for higher productivity (PI: B Venkatesh Bhat)

Evaluation of Sorghum × Sudangrass derivatives

Forage sorghum, an important source of green fodder in India, is grown during *kharif* and summer seasons, either as single-cut (mostly in *kharif*, as rainfed) or as a multi-cut (summer and *kharif*) forage crop. To

develop improved varieties of multi-cut forage, a total of 257 F_7 genetic stocks (sorghum × sudangrass derivatives) were evaluated for multi-cut forage traits in an augmented block design along with check CSV 33MF. Four genetic stocks were found to be superior to the check in respective blocks. The promising genetic stocks would be further evaluated for one more year for confirmation.

Evaluation of experimental multi-cut forage parents and hybrids

New female lines: Seventy new A/B pairs have been developed. About 250 hybrids were developed using new A lines and evaluated during summer 2024. Fifty-two hybrids out of 250, exceeded the check CSH 24MF. Based on the collective performance, best A lines identified were 309A, NSS 1003A, NSS 23A, 435A, 11A2 and 322A. The performance of hybrids with highest green fodder yield is given in Table 1.11. Female line performance - Top 6: 309A > NSS 1003A > NSS 23A > 435A > 11A2 > 322A.

Table 1.11. Performance of selected hybrids based on new A lines

Hybrid	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf width (cm)	Stem girth (mm)	Green fodder yield (q/ha)
NSS 1003A × UPMC 503	235	8.00	77.3	6.1	12.25	1031
442A × UPMC 503	255	10.67	75.7	6.0	11.68	892
353A × CSV 33MF	213	11.33	78.0	6.1	12.37	833
336A × SGL 87	198	7.00	75.7	5.0	7.89	819
301A × SSG 59-3	238	10.33	76.3	5.6	10.45	749
322A × PC 615	217	10.00	83.7	7.3	12.41	726
CSH 24MF (Check)	223	8.67	83.0	5.6	13.01	574

R line performance: Based on the collective performance of the hybrids, the R lines used in making hybrids have been characterized as given in Table 1.12.

Table 1.12. Performance of selected R lines

R line	Green fodder yield (q/ha)	No of hybrids evaluated	Regeneration score (1-5 scale)
PC 615	618	40	3.46
SGL 87	546	74	3.32
SSG 59 3	549	48	3.56
UPMC 503	586	45	3.72
CSV 33MF	576	44	3.51

Evaluation of Single-cut genotypes for fodder yield

A total of 28 new genotypes (progenies of higher biomass sweet sorghum × forage types in F_7) developed for single-cut forage system were evaluated for forage

traits during *kharif* season. The data on green fodder yield of promising lines is depicted in Fig.1.14. IIMR 606, IIMR 613, IIMR 651 and IIMR 609 exceeded the check CSV 35F by more than 25% for green fodder yield.

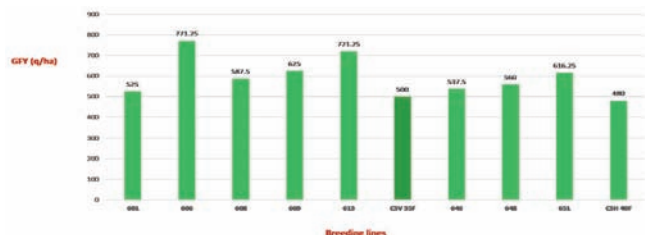


Fig. 1.14. Performance of new advance breeding lines for green fodder yield

Improving genetic diversity in cultivars

In order to enhance genetic diversity in forage cultivars by the use of Sudan grass lines, sorghum × sudangrass crosses were made. Sweet sorghum lines used are SG-65-1, GR-337-1, GR-345-2, GR-484-1 and NSSV 261, while Sudangrass lines are IS 2887, IS 3274, IS 3338, IS 3342 and IS 3347. Advancement of segregating generations (F_2 to F_7) from 47 crosses is in progress in various generations (F_2 to F_3 – 140 progenies from 16 crosses; F_4 to F_5 – 328 progenies from 12 crosses and $F_{5/6}$ to $F_{6/7}$ – 239 lines from 19 crosses).

Introgression of desired traits into promising genetic background

For varietal improvement and hybrid male parent development, 37 new crosses were made in Sorghum × Sudangrass (SSG) - (High biomass × germplasm) and SSG (R lines) × Sudan grass (germplasm) combinations. Fifteen new crosses were made for varietal development, while 12 crosses were made to improve variety CSV 33MF and R line UPMC 503.

Selection of potential forage R lines

Sudangrass types (SSG types) were selected based on the traits tan plant, taller height (5-6 feet), medium thick stem (0.8-1.3 cm), loose panicle with more flowers, leafy, preferably erect and narrow long leaves. Fifty selections were made from F_7 generation while 20 selections were made from germplasm. These will be multiplied, characterized and evaluated in crossing with good combiners to make hybrids.

New parental lines for developing multi-cut sorghum hybrids

Forty A/B pairs have been developed with synchrony in flowering, good seed set and stable male sterility expression. Twenty-five high biomass B × B crosses were advanced to next filial generations. One hundred and twenty selections from 13 crosses involving forage × forage and sweet sorghum × forage crosses were advanced to F_6 .

e) Sorghum Biofortification

CRP on Biofortification in selected crops for nutritional security (PI: K Hariprasanna)

Grain Fe and Zn status in the released cultivars and parental lines

The grain iron (Fe) and Zinc (Zn) content in the sorghum cultivars and parental lines of hybrids were assessed using Atomic Absorption Spectroscopy (AAS). The mean grain Fe was 26.1 ppm in the released grain sorghum cultivars with a range of 19.4 to 39.9 ppm, while Zn ranged from 14.0 to 37.7 ppm with a mean of 19.2 ppm (Fig. 1.15). Among the fodder/sweet sorghum cultivars mean grain Fe was 29.3 ppm (22.0-41.4 ppm) and grain Zn was 21.9 ppm (16.9-33.5 ppm). In the parental lines Fe ranged from 19.3 to 36.3 ppm with a mean of 27.4 ppm, while Zn had a range of 12.6 to 24.1 ppm with a mean of 19.3 ppm. Sorghum variety PDKV Hurda Kartiki among the specialty sorghums had higher Fe (34.5 ppm) and Zn (33.8 ppm) content in the grains.

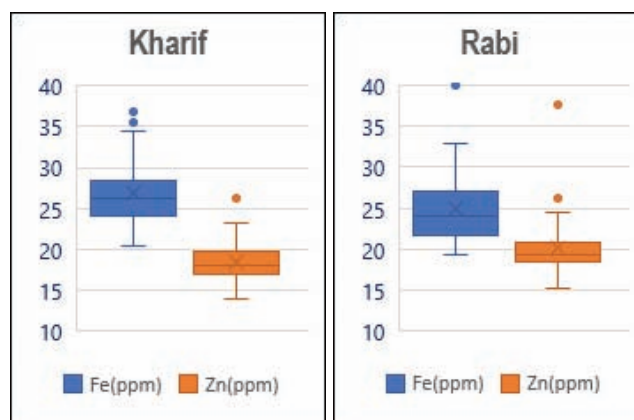


Fig. 1.15. Variation for grain Fe and Zn content in sorghum cultivars and parental lines

Station varietal trials

Ninety-five entries (advance breeding lines and hybrids) were evaluated along with Parbhani Shakti (ICSR 14001) and CSV 20 as checks. Wide variation was observed for grain yield and related traits. Twenty-five breeding lines recorded >10% grain yield advantage over the best check CSV 20 (3715 kg/ha), while 61 had >10% advantage over P. Shakti (3022 kg/ha) (Table 1.13). Grain Fe content ranged from 16.7 ppm to 34.5 ppm with a mean of 22.5 ppm, while P. Shakti recorded 21.6 ppm. Grain Zn ranged from 16.0 ppm to 33.4 ppm with a mean of 22.7 ppm, while P. Shakti had

19.7 ppm. A total of seven genotypes recorded grain Fe > 30 ppm while 23 had >25 ppm grain Zn. IIMRV 23360 (PVK 801 × IS 20962) had high grain yield and moderate levels of Fe and Zn, while IIMRH 23386 (CMS 1A × 19140), IIMRH 23388 (CMS 2A × P. Shakti) and IIMRV 23340 (CSV 15 × IS 27054) had high grain yield and Zn content. The grain Fe and Zn content were

highly positively correlated (0.65), while seed size had no significant correlation with both grain Fe (0.094) and Zn (-0.04). The grain yield had a significant negative correlation with both Fe (-0.54) and Zn (-0.43) content. Entries IIMR 23359, IIMR 23389, IIMR 23374, IIMR 23380, IIMR 23369 and IIMR 23338 had superiority for both Fe and Zn but with poor grain yield.

Table 1.13. Performance of superior breeding lines in station varietal trial -1

Genotype ID	DTF	PH (cm)	PL (cm)	GY (kg/ha)	TW (g)	Fe (ppm)	Zn (ppm)
IIMR 23330	82	141	27.6	5195	3.27	16.7	17.7
IIMR 23363	88	153	25.4	5050	2.92	19.1	22.6
IIMR 23348	88	188	29.8	4951	2.41	19.7	24.5
IIMR 23360	113	269	27.0	4733	2.93	31.8	26.8
IIMR 23301	79	104	24.9	4718	3.41	22.1	23.4
IIMR 23332	86	136	22.7	4631	3.11	19.0	19.3
IIMR 23308	81	125	27.3	4561	2.75	17.7	20.6
IIMRH 23392	81	137	30.7	4561	2.53	17.1	19.4
IIMR 23309	84	121	29.6	4518	2.88	20.0	19.6
IIMR 23362	88	230	23.7	4509	3.18	21.2	19.7
P. Shakti (Ch)	78	121	27.0	3022	2.58	21.6	19.7
CSV 20 (Ch)	78	173	24.0	3715	2.89	17.4	17.4
Mean	84	153	26.3	3524.0	2.81	22.5	22.7
SE(m)	3	18	1.3	524	0.28	2.7	2.4
CD (5%)	9	50	3.8	1471	0.78	7.5	6.8

(DF: Days to flower, PH: Plant height, PL: Panicle length, GY: Grain yield, TW: 100-Seed weight)

Breeding nursery

In the breeding nursery segregating generations in F_2 (39), F_3 (60), F_4 (17), F_5 (130), F_6 (35) and F_7 (62) from previous crosses were planted for advancement and phenotypic single plant selections were effected (197, 76, 18, 102, 24 and 45, respectively) based on plant and panicle traits in the field. Estimation of grain Fe and Zn content in the selections showed wide variation for Fe (20 to 52 ppm in F_3 , 20 to 40 ppm in F_4 , 19 to 52 ppm in F_5 , 21 to 39 ppm in F_6 , 18-57 ppm in F_7 and above) and Zn (18 to 45 ppm in F_3 , 19 to 42 ppm in F_4 , 18 to 58

ppm in F_5 , 20 to 38 in F_6 , 19-46 ppm in F_7 and above) in the selections (Fig. 1.16). The selections made (F_3 to F_7) were planted for further advancement during *rabi* 2023-24. Out of total 197 single plant selections in F_3 planted 758 selections were made based on panicle and grain characters. In F_4 , 76 progenies were planted and a total of 131 selections were made. In F_5 - F_7 , 48 single plant progenies (were planted and a total of 49 phenotypic selections were made (19, 19, 11 in F_5 , F_6 and F_7 , resp.). Grain Fe and Zn analysis is in progress.

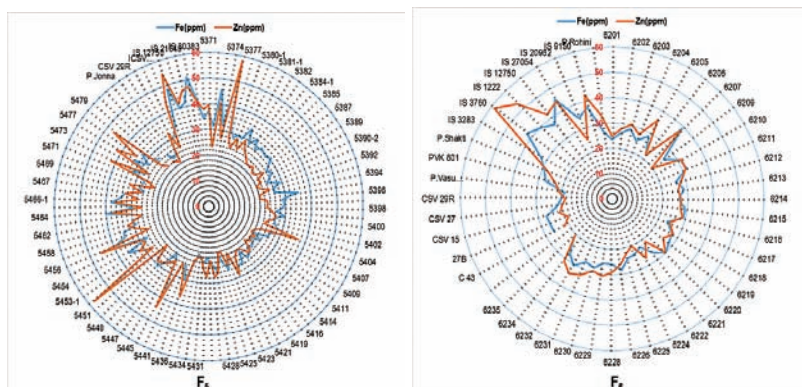


Fig. 1.16. Grain Fe and Zn status in segregating sorghum breeding material – F_5 and F_6

Multi-location evaluation of advance breeding lines

Selected advance breeding lines with moderate grain Fe and/or Zn content or high grain yield were evaluated at four locations (Hyderabad, Akola, Dharwad and Solapur) to identify stable superior genotypes. Breeding line means as well as location means were significantly different. There was a significant location $\times$ genotype ($G \times E$) interaction for all the traits studied. Significant variability was observed for both grain Fe and Zn content at all the locations apart from grain yield and related traits (Fig. 1.17). Mean grain Fe ranged from 26 to 44 ppm (18-44 ppm at Hyderabad, 22-51 ppm at Dharwad, 23-53 ppm at Akola and 23-50 at Solapur) and Zn from 18 to 36 ppm (18-46 ppm at Hyderabad, 13-33 ppm at Dharwad, 16-45 ppm at Akola and 16-38 at Solapur). Grain yield per plant ranged from 21.5 g to 60.5 g with an average of 38.3 g, while seed size (measured as test weight) ranged from 1.62 to 3.51 g per 100-seeds with a mean of 2.43 g. Breeding lines with stable performance and high mean value will be identified for grain Fe and Zn content as well as grain yield.

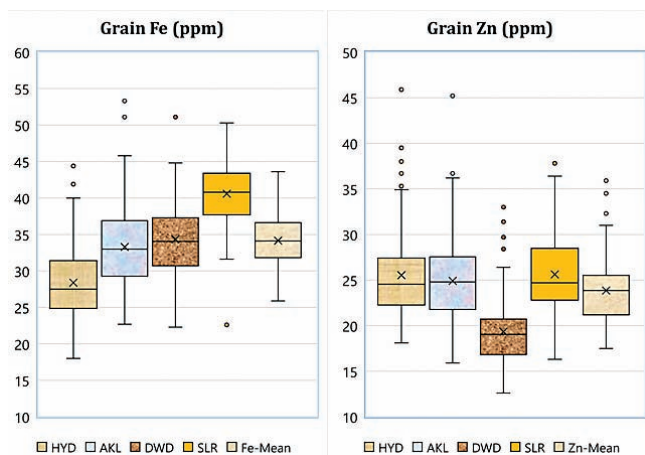


Fig. 1.17. Variability for grain Fe & Zn content in 110 lines across 4 locations

f) Sorghum DUS testing and PPV&FRA related activities (PI: K Hariprasanna)

DUS testing trials were conducted during *rabi* 2023-24 and *kharif* 2024 seasons for characterizing the DUS descriptors in candidate varieties and reference varieties of sorghum as per the PPV&FR Authority guidelines. During *rabi* 2023-24, three candidate varieties were tested for DUS along with two national

check hybrids under 1st year testing. Crop growth and expression of DUS descriptors in all the entries was satisfactory. Data were recorded for all the 32 DUS descriptors and submitted to PPV&FR Authority, New Delhi. Maintenance breeding and characterization was undertaken for 138 reference varieties (including OPVs, parental lines and $A \times R$ hybrids) under enforced selfing/controlled hand pollination (Fig. 1.18). Genetically pure single plants were harvested in each genotype for maintenance of reference varieties. Characterization data on 32 DUS traits were collected as per the revised guidelines and reference variety database was updated, and submitted to PPV&FR Authority.

During *kharif* 2024, three farmer varieties were tested for DUS traits along with 11 reference varieties including national checks in a replicated trial (Fig. 1.19). Two farmer varieties were planted for characterization. Initial crop growth and expression was very good. All the five entries were very tall, flowered very late and seed setting was very poor. Heavy incidence of foliar disease was observed in all the five farmer varieties. All the 56 *kharif* adapted reference varieties were planted in a replicated trial for characterization and data were recorded. Twenty-one entries from the advanced trials (grain, forage and sweet sorghum) of AICRP on Sorghum including checks were also characterized for DUS traits to enable faster plant variety protection in case of varietal identification and release. During the year, nine new applications of extant varieties were submitted for PPV&FRA registration. Annual fee was paid for 23 registered varieties of sorghum, which are in seed chain.



Fig. 1.18. Maintenance breeding of reference varieties



Fig. 1.19. Field view of DUS testing plot

III. Small millets

a) Finger millet

IIMR/CI/2021-2026/143: Development of improved finger millet genotypes for grain yield and related traits (PI: KN Ganapathy)

Stable white finger millet genotypes for grain yield and related traits

A set of 50 white finger millet germplasm accessions obtained from IIMR genebank were evaluated at four locations/seasons for identification of superior and stable genotypes for grain yield and other related traits. AMMI stability analysis was performed and stability parameters such as AMMI stability index and Modified AMMI stability index were calculated. Combining grain yield and stability parameters, eight genotypes were identified with superior and stable grain yield over locations/seasons. Among various genotypes, IC0065595, IC0474206, IC0474233 were promising with grain yield levels of 3.8 t/ha comparable to coloured finger millet checks PR 202 and GPU 67 (Fig. 1.20). Other promising genotypes for grain yield and stability across locations were given in Table 1.14. The promising lines identified are now being utilized in hybridization programme for developing improved breeding lines for grain yield and quality traits in white grain background.

Table 1.14. Mean grain yield and stability parameters of promising white finger millet germplasm

Genotype	Grain Yield (t/ha)	Yield Rank	AMMI stability Index (ASI)	ASI Ranking	ASI Simultaneous selection index	Modified AMMI stability index	Modified AMMI stability index Ranking	MASI Simultaneous selection index
IC0065595	3.88	6	0.28	12	18	0.31	13	19
IC0474206	3.83	8	0.39	18	26	0.40	18	26
IC0474233	3.71	13	0.35	15	28	0.35	15	28
IC0473858	3.89	5	0.50	26	31	0.50	24	29
IC0474065	3.51	20	0.26	10	30	0.27	9	29
IC0402775	3.72	12	0.39	17	29	0.39	17	29
IC0473973	3.46	27	0.16	5	32	0.18	3	30
IC0621993	3.77	9	0.50	27	36	0.51	26	35
PR 202	3.95	2	0.46	22	24	0.52	27	29
GPU 67	3.67	15	0.42	19	34	0.43	19	34



Fig. 1.20. Finger traits of promising white finger millet genotypes

Evaluation of *Eleusine coracana* x *Eleusine africana* interspecific derivatives for panicle weight and grain yield

One hundred and five interspecific derivatives derived from set of 771 lines were selected based on grain yield components during *rabi* 2023-24. The selected lines were evaluated for grain yield and related traits during *kharif* 2024. From analysis for grain yield and related traits, 16 derivatives were identified with more than 20% grain yield superiority over VL 376 and CFMV 2. The interspecific derivatives IIMR/K24/2868, IIMR/K24/2869 and IIMR/K24/2855 recorded mean grain yield of > 3.0 t/

ha as compared to CFMV 2 and VL 376 which recorded 2.6 and 2.2 t/ha, respectively (Table 1.15). The improved interspecific derivatives recorded higher tillering as compared to checks and also recorded higher panicle weight. The promising derivatives will be evaluated for grain yield and blast resistance during subsequent seasons to identify superior interspecific derivatives. The finger traits of the improved interspecific derivatives are given in Fig. 1.21.

Table 1.15. Performance of selected interspecific derivatives for grain yield and related traits

Genotypes	Days to 50% flowering	Panicles/plot	Panicle weight (g/plot)	Grain yield (kg/ha)
IIMR/K24/2868	90.5	60	664	3688.5
IIMR/K24/2869	93	60	586	3252.4
IIMR/K24/2855	85	62.5	548	3044.1
IIMR/K24/2912	86	45.5	539	2991.3
IIMR/K24/2862	85	48	532	2955.2
IIMR/K24/2850	89	49	478	2655.2
IIMR/K24/2893	86.5	47	513	2849.7
IIMR/K24/2883	86.5	43.5	468	2596.9
IIMR/K24/2891	92.5	29	496	2755.2
IIMR/K24/2863	85	44	469	2605.2
IIMR/K24/2914	85	39.5	454	2519.1
IIMR/K24/2887	86.5	41	454	2521.9
IIMR/K24/2882	87.5	46	484	2685.8
IIMR/K24/2836	93	42	471	2616.4
IIMR/K24/2901	85.5	41.5	411	2283.1
IIMR/K24/2854	85	45.5	465	2580.2
CFMV 2	82	36	459	2546.9
VL 376	76	44	380	2108.1
LSD (5%)	3.5	12.6	77	239.7
CV (%)	2.0	16.8	11	10.7
Mean	87.8	37.8	337	2736.5



a. High tillering plant types



b. Dwarf plant types



c. Variable panicle type

Fig. 1.21. Variation among Finger millet interspecific derivatives for yield traits

b) Little millet

IIMR/CI/2021-2026/144: Development of improved little millet genotypes for grain yield and related traits (PI: KN Ganapathy)

Superior genotypes for grain yield and related traits

A set of 73 elite germplasm selections and advanced derivatives were evaluated for grain yield and related traits during *kharif*, 2024. Wide variability was observed among the 73 lines evaluated for grain yield. Promising

lines for grain yield are presented in Table 1.16. Most of the lines identified with high grain yield were early to medium flowering. Advanced derivatives JK-8 × IPmr 1075, IIMR-7092 × 7103-4 and IIMR-7091 × IIMR-7103-2 (Fig. 1.22), and germplasm selections GPMR-960-2 and GPMR-325 were superior among the various lines tested and recorded yield superiority more than 10% over the best check CLMV 1.

Table 1.16. Performance of selected genotypes with high grain yield

Lines	Grain yield (kg/ha)	% superiority over CLMV 1	Days to 50% flowering	Plant height (cm)
JK-8 × IPmr 1075	2744.4	69.2	72.0	110.0
GPMR-960-2	1894.4	16.8	75.0	112.5
IIMR-7092 × 7103-4 (DHLM 36-3)	1883.4	16.1	69.5	115.0
IIMR-7091 × IIMR-7103-2 (DHLM 36-3)	1883.3	16.1	74.0	115.0
IIMR-Elan-7-1	1872.2	15.4	75.0	120.0
GPMR-325	1788.9	10.3	74.5	125.0
IPMR-1036	1750.0	7.9	72.0	115.0
IC-0404853-2	1750.0	7.9	74.0	117.5
IC-0483221	1694.5	4.5	71.5	105.0
IPMR-1036-6	1650.0	1.7	72.0	125.0
GPMR-960-4	1644.5	1.4	72.5	122.5
IC-O483359	1633.3	0.7	70.0	112.5
CLMV 1 (Check)	1622.2		77.0	120.0
BL 6 (Check)	1522.2		72.5	115.0
Mean	1256.5		74.7	117.0
CV (%)	24.9		4.2	6.5
LSD (5%)	624.4		6.3	15.2



IIMR-7092 × 7103-4 (DHLM 36-3)



JK-8 × IPmr 1075

Fig. 1.22. Superior advanced cross derivatives in little millet

c) Foxtail millet

IIMR/CI/2021-2026/142: Genetic improvement of foxtail millet for grain yield and nutritional quality (PI: K Hariprasanna)

CFXMV-2 (FXV 647): A high yielding medium duration foxtail millet variety

FXV 647 (CRS FxM-4) is a pureline selection from germplasm accession GS 510 with high grain yield and medium duration. Over three years (14 trials), in three states of Karnataka, Maharashtra and Madhya Pradesh the genotype recorded 2789 kg/ha grain yield which was 5% increase over check, SiA 3156 (2653 kg/ha) and 9% increase over check, DHFt 109-3 (2554 kg/ha) (Table 1.17). The variety recorded 3.2% fodder yield (5792 kg/ha) advantage over the check SiA 3156 (5611 kg/ha) over three years of testing. It took 54-56 days to flower and 87-90 days to mature, which was on par with checks SiA 3156 (52 and 85 days, respectively) and DHFt 109-3 (53 and 87 days, respectively). FXV 647 is resistant to rust and moderately resistant to brown spot, leaf blast and banded blight and is superior to both the checks SiA 3156 and DHFt 109-3. It is tolerant to shoot fly infestation (7.5% and 8.4% deadhearts at 21 DAE and 28 DAE, resp.) and is on par with the checks. FXV 647 recorded 10.7% protein, 4.9% fat, 37 ppm iron, 48 ppm zinc content. The plant is medium statured, bearing oblong shaped panicles with short and thin lobes, medium sized bristles, and grayed yellow colour seeds (Fig. 1.23). Because of high grain yield and disease resistance, the variety will be well accepted by the farmers of Karnataka, Maharashtra and Madhya Pradesh for rainfed *kharif* season.

Table 1.17. Performance of FXV 647 in multi-location trials of AICRP on Small millets

Parameter	FXV 647	SiA 3156	DHFt 109-3
Grain yield (kg/ha)	2789	2653	2554
Duration (days)	89	85	87
Days to flowering (days)	55	52	53
Plant height (cm)	117	117	121
Productive tillers	3.8	3.5	3.2
1000-Grain weight (g)	2.63	2.67	2.67
Brown spot (G) (1-9)	3.52	3.68	3.74
Rust (G) (1-9)	2.75	4.23	3.96

Parameter	FXV 647	SiA 3156	DHFt 109-3
Leaf blast (G) (1-9)	3.41	3.48	3.63
Banded blight (PDI) (%)	25.0	28.5	29.4
Shoot fly deadhearts (%) (21 DASE)	7.5	4.9	10.2
Protein (%)	10.73	10.13	10.00
Fat (%)	4.93	4.56	5.43
Iron (ppm)	37.0	29.7	31.6
Zinc (ppm)	48.4	47.7	50.4



Fig. 1.23. Field view of foxtail millet variety CFXMV-2 (FXV 647)

Promising genotypes in station trials

Fifty-seven promising selections were evaluated in a replicated station yield evaluation trial for grain yield and related traits at Hyderabad and CRS, Solapur. Grain yield ranged from 1015 kg/ha to 2778 kg/ha with a mean of 1882 kg/ha. Days to flowering ranged from 50 to 63 days, while days to maturity ranged from 80 to 91 days with a mean of 85 days. Six genotypes recorded >10% grain yield advantage over the best check DHFt 109-3 (2194 kg/ha). Over two years 12 genotypes recorded >10% grain yield advantage over best check DHFt 109-3 (1825 kg/ha) (Fig. 1.24). Genotypes FxM 24011, FxM 24012, FxM 24054, FxM 24056, FxM 24058 and FxM 24060 had very long panicles (>22 cm) compared to best check DHFt 109-3. At CRS, Solapur grain yield showed very wide variation ranging from 613 kg/ha to 2061 kg/ha with a mean of 1286 kg/ha. Days to flowering ranged from 40 to 55 days, while days to maturity ranged from 75 to 85 days with a mean of 80 days. Only one entry FxM 24048 recorded >10% grain yield advantage over best check Suryanandi (1670 kg/ha).

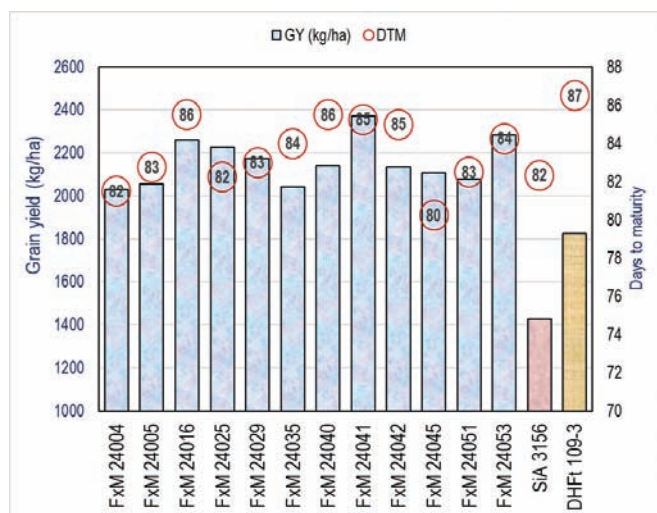


Fig. 1.24. Performance of promising foxtail millet genotypes at Hyderabad

Evaluation of mutants of foxtail millet

Superior mutants (41) in advance generation were evaluated along with the parents viz., Suryanandi and SiA 3156. Grain yield ranged from 1036 to 2894 kg/ha with a mean of 1817 kg/ha. Four (out of 11) mutants of Suryanandi recorded grain yield advantage of > 10% with on par maturity duration (Table 1.18). Ten (out of 30) SiA 3156 mutants recorded grain yield advantage of >10% over parental line SiA 3156. The highest grain yield of 2303 kg/ha was recorded in Fxm1043 (M8 SiA800-24), which was on par with SiA 3156 for flowering and maturity duration (Table 1.18). The panicle length ranged from 15.1 to 28.1 cm while the parents Suryanandi and SiA 3156 had 15.1 and 19.1 cm, respectively.

Table 1.18. Performance of selected foxtail millet mutants with high grain yield

GenID	GY (kg/ha)	DTM	PH (cm)	PL (cm)	BL (cm)	Till	Lobes	LL (cm)	GY/ P (g)	TW (g)
Fxm1008	2894	82	91	22.1	0.9	3.3	75	0.9	6.75	3.09
Fxm1010	2550	78	84	21.0	0.8	2.8	72	0.6	3.73	2.72
Fxm1007	2501	80	87	19.6	0.6	3.4	61	0.7	4.58	2.83
Fxm1011	2442	79	75	17.7	0.7	2.8	74	1.0	4.84	2.86
Suryanandi (Ch)	2153	81	77	15.1	0.2	2.9	64	0.4	3.36	2.77
Fxm1043	2303	83	81	18.2	0.5	3.1	70	0.5	5.10	2.92
Fxm1024	2221	84	91	20.7	0.5	2.8	81	0.7	7.08	3.10
Fxm1030	2007	78	68	18.9	0.7	2.2	66	0.8	6.22	2.55
Fxm1035	1959	84	93	25.6	0.6	2.0	71	0.7	7.73	2.81
SiA 3156 (Ch)	1613	80	76	19.1	0.6	2.7	69	0.5	5.03	2.76
Mean	1817	81	87	21.2	0.6	2.5	70	0.7	5.84	2.75
S.E.m	311	1.2	5.6	1.5	0.1	0.5	3.3	0.1	1.2	0.1
C.D. (5%)	-	3.5	-	4.4	0.2	-	9.3	0.4	-	0.3

(GY: Grain yield, DTM: Days to maturity, PH: Plant height, PL: Panicle length, BL: Bristle length, Till: No. of productive tillers, LL: Lobe length, GY/P: Grain yield/panicle; TW: 1000-seed weight)

Evaluation of novel foxtail millet mutants in multi-location trial

Novel mutants of foxtail millet (28) with long inflorescence derived from gamma ray irradiation were evaluated at six locations to identify stable mutants. The length of inflorescence ranged from 17 to 29 cm with an overall mean of 23.4 cm. Genotypes IIMR Fxm-23323, 23324, 23328, 23308, 23307, 23326, 23313, 23301, 23327, 23305 and 23309 had very long inflorescence (>25 cm)

(Table 1.19). In the pooled analysis both genotype and location means were found to be significantly different, while significant genotype × location interaction was also observed for the trait. Genotypes IIMR Fxm-23315, 23316, 23314, 23318, 23317, 23310, 23319, 23313, 23307 and 23311 had very broad inflorescence (> 2.5 cm) (Table 1.19). Grain yield ranged from 1674 to 2581 kg/ha over locations; eight mutants had >10% grain yield advantage over the check, SiA 3156.

Table 1.19. Mean performance of selected foxtail millet mutants in multi-location trial

GenID	GY (kg/ha)	Inflorescence length (cm)					Inflorescence width (cm)				
		NDL	VZNR	HYD	SLR	Mean	NDL	VZNR	HYD	SLR	Mean
IIMR FxM-23301	1823	28.7	23.5	22.7	28.7	25.9	1.9	1.5	2.1	3.0	2.13
IIMR FxM-23305	2067	29.9	18.8	26.3	27.5	25.6	2.0	2.3	2.0	3.4	2.39
IIMR FxM-23307	1969	27.9	19.8	25.1	32.1	26.2	2.6	2.7	1.9	3.4	2.64
IIMR FxM-23308	2035	33.5	19.6	24.1	29.4	26.7	1.8	2.4	1.9	2.9	2.24
IIMR FxM-23309	2452	27.4	22.0	23.1	29.8	25.6	2.0	2.2	2.0	2.3	2.11
IIMR FxM-23313	2037	25.6	23.9	25.1	29.3	26.0	2.3	2.5	2.4	3.5	2.66
IIMR FxM-23323	2312	29.9	22.5	27.6	36.0	29.0	1.8	1.6	2.0	3.3	2.17
IIMR FxM-23324	2145	31.2	22.4	27.4	33.4	28.6	1.8	2.1	1.9	2.7	2.10
IIMR FxM-23328	2027	28.8	20.6	28.4	35.4	28.3	2.2	2.1	2.2	2.6	2.26
Suryanandi (Ch)	2378	16.9	14.5	14.8	21.7	17.0	1.5	1.9	1.6	1.7	1.66
SiA 3156 (Ch)	2129	22.7	15.3	17.0	22.9	19.5	2.6	1.5	1.4	1.9	1.87
Location Mean	2163	24.8	19.3	21.9	27.7	23.4	2.1	2.2	2.1	3.0	2.37
CD (5%)		6.7	4.0	3.5	5.0		-	-	0.6	0.8	0.57

(GY: Grain yield, NDL-Nandyal, VZNR-Vizianagaram, HYD-Hyderabad, SLR-Solapur)

d) Kodo millet

IIMR/CI/2021-2026/146: Improvement of kodo millet for economically important traits and development of markers for cultivar identification (PI: C Deepika)

Mutagenesis to generate variability for yield related traits

In order to create variability for yield and yield related traits, variety TNAU 86 was treated with gamma irradiation at BAARC, Mumbai and effect of gamma irradiation on M_1 generation was studied. With increasing dose germination and survival decreased. Abnormal panicles, striata and xantha mutants were observed in M_1 generation in 200, 300 and 400 Gy. As there was no variation observed in subsequent generations like M_2 and M_3 , the population was advanced up to M_6 generation where the variability for various yield related traits were observed and recorded.

In the M_1 generation effect of gamma irradiation on pollen sterility was also recorded. Pollen sterility increased with increasing dose but spikelet fertility was not affected much. Pollen sterility ranged from 4%-19% in TNAU 86 but the spikelet fertility not decreased with increase in dose, and trend was irregular (Fig. 1.25). Later in M_6 generation individual plant selection was done for the yield related traits. In 200 Gy short height and peduncle length was observed ranging from 31 to 38 cm and 1.5 to 3 cm, respectively. There was not much variation observed in grain yield, which ranged from 20-30 g/plant, that was very less compared with the check TNAU 86 (32 g/plant). High fodder yield was observed,

which ranged from 60 to 90 g/plant and it was very high compared to check TNAU 86 (44 g/plant). In 300 Gy mutants grain yield ranged from 31-35 g/plant, fodder yield from 70 to 94 g/plant and panicle length from 7.5 to 8.4 cm, which was very high compared to the check TNAU 86. In 400 Gy, short plant height was observed that ranged from 27 to 41 cm far less compared to check, and high fodder yield ranging from 50 to 70 g/plant was observed when compared with check. The selected individual lines have been advanced to the next generation in plant to row fashion to check for homogeneity of the traits.

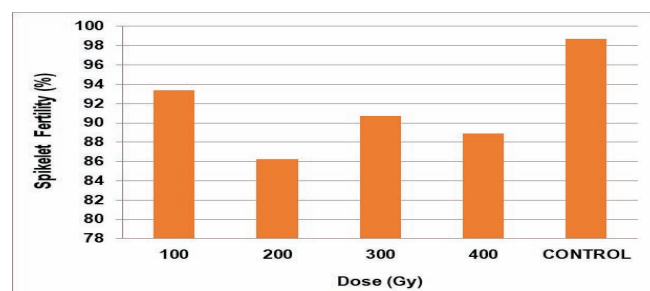


Fig. 1.25. Effect of gamma irradiation on spikelet fertility of kodo millet

e) Barnyard millet

IIMR/CI/2021-2026/145: Development of dual purpose barnyard millet cultivars with improved quality (PI: B Amasidda)

Constitution of diversity set and evaluation in multi-locations

A diversity set of 150 accessions with multiple trait superiority were evaluated at five locations (Vizianagaram, Hyderabad, Ranichauri, Almora and

Waghai). Diversity observed for panicle traits, test weight, plant height, maturity etc. were included in the diversity set. Two identified lines were used in breeding program (BAR 1221, BAR 1235) and the probable F_1 s were selected in *kharif* 2023 and advanced to F_2 generation in *rabi* 2023-24. Individual plant selections were made and selfed to generate F_3 seeds. Two lines identified for test weight (BAR 565, BAR 577) were used in the current *rabi* season to make crosses with elite lines CBYMV-1 (BMV 611).

Screening of germplasm lines for leaf diseases

A total of 562 lines including released cultivars, advanced lines of F_5 and F_6 and mutants were screened for 2nd year under natural conditions. Among 562 lines, seven were found to be resistant with disease score of 1-5%, 45 were with 6-10% and 55 were moderately resistant

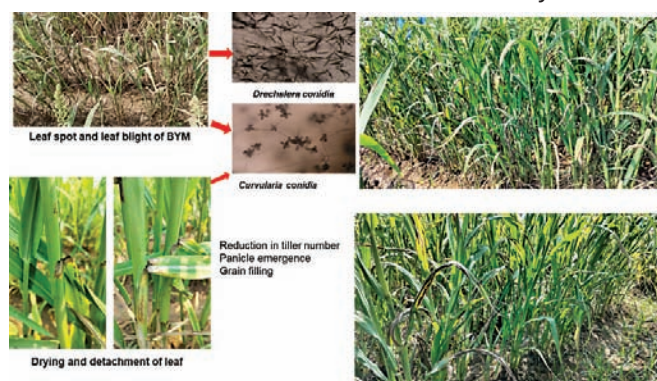


Fig. 1.26. Symptoms of *Drechslera conidia* and *Curvularia conidia* causing leaf spot and leaf blight in barnyard millet

with score of 11-20% and 71 were with 21-30% score. Three seventy-nine were susceptible with a score of 31-40% and five were with 41-50% susceptible score and one genotype with highly susceptible reaction. In the pathological screening it was observed that the presence of *Drechslera conidia* causing leaf spot and *Curvularia conidia* causing leaf spot and leaf blight disease in barnyard millet (Fig. 1.26). One genotype IIMR-BM-Kh23-533 ((DHBM 93-3-60-183(2)-17-7-8×IEc 566)-391-533) was found highly susceptible with reduced tillers and affected panicle emergence and grain filling.

Analysis of grain samples for nutrient composition including dietary fibre content

One hundred and thirty-six lines (germplasm, advanced genetic material, mutants) were analysed for protein,

dietary fibre, Fe and Zn content. The four genotypes with high dietary fibre content ranging from 9.7% to 10.51% were identified with good grain and fodder yielding ability. The identified lines with high values of dietary fiber along with grain and fodder yield were given in the Table 1.20.

Table 1.20. Genotypes containing high dietary fibre content with good grain and fodder yield

S. No.	Genotypes	Dietary Fibre (%)	GY (kg/plot)	FY (kg/plot)
1	BAR 1452	10.12	0.68	1.11
2	IIMR-BM-189-1 (46) Mu	10.51	0.35	1.15
3	IIMR-BM-189-2 (47) Mu	9.53	0.37	1.21
4	IIMR-BM-2-1-23-2-1-1	9.7	0.34	1.08
Check	DHBM 93-3	9.47	0.61	1.10
Check	VL 207	8.37	0.30	0.85

The seven genotypes containing high Fe and Zn content, ranging from 29.2 ppm to 43.3 ppm of Fe and 40.9 ppm to 60.2 ppm of Zn along with better grain and fodder yielding ability are presented in Table 1.21.

Table 1.21. Genotypes with high values of Fe and Zn content along with better grain and fodder yield

S. No.	Genotypes	Fe (ppm)	Zn (ppm)	GY (kg/plot)	FY (kg/plot)
1	BAR 683	39.0	42.9	0.58	1.10
2	IIMR-BM-1-3-3	43.3	44.7	0.21	1.24
3	IIMR-BM-48-67-2-1-1	39.3	44.8	0.27	1.10
4	IIMR-BM-2-1-23-4-1-1	35.1	52.3	0.61	1.14
5	IIMR-BM-128-12-1-1	38.5	60.2	0.30	1.11
6	IIMR-BM-32-59-1-1	29.2	50.8	0.21	1.34
7	IIMR-BM-2-1-23-4-1-1	35.1	52.3	0.64	1.22
Check	DHBM93-3	32.9	40.9	0.61	1.10
Check	VL 207	30.0	42.5	0.30	0.85

The four genotypes containing high protein content ranging from 13.30% to 14.06% along with better grain and fodder yielding ability are presented in Table 1.22.

Table 1.22. Genotypes with high values of protein content along with better grain and fodder yield

S. No.	Genotypes	Protein (%)	GY (kg/plot)	FY (kg/plot)
1	BAR 1452	14.06	0.68	1.11
2	IEc 647	14.06	0.58	1.13
3	BAR 1446	13.36	0.65	1.17
4	BAR 1453	13.50	0.51	1.01
Check	DHBM93-3	11.62	0.61	1.10
Check	VL 207	13.37	0.30	0.85

Evaluation of cross derivatives for grain yield and fodder yield performance

The panicles of the probable F_1 s identified in different crosses were taken (Fig. 1.27) and compared with respective parental types for heterosis studies. The

visual observations indicate that the panicle length and width has increased in the F_1 plants and there is good scope to exploit heterosis in barnyard millet.



VL 207× BAR 1221 cross derivatives



VL 207× BAR 1221 cross derivatives

Fig. 1.27. Variability in panicles of probable F_1 plants of different crosses in Barnyard millet

Evaluation of cross derivatives Indian × Japanese species

The Indian and Japanese species types were crossed during *rabi* 2022-23 and advanced up to F_4 generation. The individual progeny families selected based on agro-morphological traits are presented in Fig. 1.28. Most of the cross derivatives were found susceptible to leaf blight disease even though the performance for panicle

related traits like panicle length, width and seed weight were higher than parents and check varieties. All the interspecific cross derivatives were observed to have problem of complete grain filling, reduced tiller number and prostrate growth habit leading low yields than checks.



Fig. 1.28. Panicles of *Indian × Japanese* species cross derivatives in Barnyard millet

f) Proso millet

IIMR/CI/2021-2026/147: Genetic improvement of proso millet for yield and protein content (PI: Avinash Singode)

Identification of true hybrids

A total of 58 SSR markers were screened for polymorphism in two proso millet parental lines, IIMR-PM-59 and IIMR225, and 10 were found polymorphic. Four markers were able to distinguish the parental lines and F_1 s generated. The true F_1 were heterozygous for the parental SSR alleles (Fig. 1.29). Details of the marker and alleles produced are given in Table 1.23.

Table 1.23. SSR Markers used for hybridity assessment

Markers	IIMR-PM-59 (Parent 1)	IIMR225 (Parent 2)
IIMR-Pm1-2	280 bp	300 bp
IIMR-Pm2-1	300 bp	330 bp
IIMR-Pm3-3	350 bp	370 bp
IIMR-Pm8-1	380 bp	400 bp
IIMR-Pm11-4	280 bp	270 bp
IIMR- Pm11-5	370 bp	350 bp
IIMR- Pm13-5	350 bp	380 bp

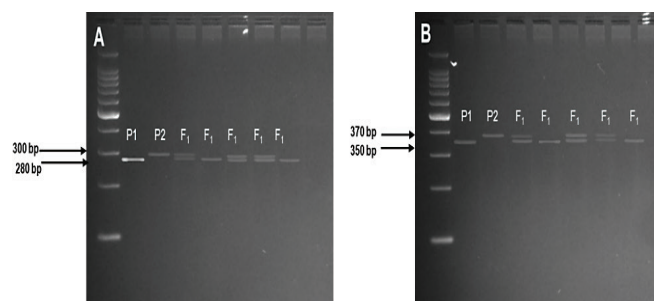


Fig. 1.29. Allelic pattern in parents and F_1 s; (a) IIMR-Pm1-2, (b) IIMR-Pm-3-3

Performance of F_2 population from four crosses

A total of 225 F_2 plants from a cross IIMR Pm59 x IIMR225 were planted in the field (Table 2), and data were recorded for 14 traits. Considerable variability was observed for all the traits in the F_2 population. Variability and mean values for different traits in the population are given in Table 1.24. Individual plant selection was performed to select 11 plants out of 225 planted that were early flowering, early maturing and had high panicle length (Table 1.25) (Fig. 1.30).

Table 1.24. Mean performance of F_2 population genotypes for 14 traits in proso millet

Traits	Mean	Range	
		Minimum	Maximum
Days to 50% flowering	49	24.0	76.9
Days to maturity	74	39.3	116.2
Plant height (cm)	100.9	52.5	151.2
Flag leaf length (cm)	31.8	16.7	46.3
Flag leaf width (cm)	1.2	0.2	2.3
Leaf length (cm)	33.3	16.7	50.1
Leaf width (cm)	2.0	0.9	3.1
Number of leaves per plant	6.2	2.8	9.3
Number of basal tillers per plant	5.3	2.6	8.0
Peduncle length (cm)	10.9	5.4	16.9
Panicle length (cm)	24.2	11.1	36.1
1000 seed weight (g)	4.35	1.74	6.41
Grain yield per plant (g)	22.5	5.9	43.2

Table 1.25. Cross details and selections made

S. No.	Cross details	F_2 population size	No. of selected lines
1	IIMR-Pm59/ IIMR 225_ F_2	75	3
2	IIMR-Pm59/ IIMR 225_ F_2	90	4
3	IIMR-Pm59/ IIMR 225_ F_2	62	4
Total		225	11



Fig. 1.30. Selected panicles in F_2 population of proso millet

GWAS for grain yield and protein content

Using 10,269 SNPs GWAS was performed to identify marker-trait associations for grain yield and related traits, and protein content. The BLINK model was used for GWAS analysis. Ninety-two significant associations were

identified for traits viz., plant height, flag leaf length, flag leaf width, protein content, and grain yield (Table 1.26). Manhattan plots showing significant SNPs association for yield and protein content is presented in Fig. 1.31.

Table 1.26. Significant markers associated with various traits in proso millet

S. No.	Traits	Chromosome	Marker position (bp)	Gene
1	Plant height	18	3617581	mRNA-hypothetical protein
2	Plant height	5	53486499	KH domain-containing protein SPIN1-like
3	Plant height	7	3433766	mRNA-uncharacterized protein
4	Flag leaf length	1	19033125	mRNA-haloacid dehalogenase-like hydrolase domain-containing protein
5	Flag leaf length	17	4082539	mRNA-SWI/SNF complex subunit SWI3C-like
6	Flag leaf length	9	45266283	mRNA-hypothetical protein
7	Flag leaf width	4	1451974	mRNA-Clathrin heavy chain 2 -like protein
8	Flag leaf width	7	32118024	mRNA-uncharacterized protein
9	Protein %	18	14527886	mRNA-haloacid dehalogenase-like hydrolase domain-containing protein
10	Protein %	3	7288323	mRNA-putative receptor-like protein kinase
11	Grain yield	16	29793425	mRNA-hypothetical protein
12	Grain yield	7	35872337	mRNA-putative receptor-like protein kinase
13	Grain yield	11	28692595	mRNA-uncharacterized protein
14	Grain yield	15	27649683	mRNA-hypothetical protein

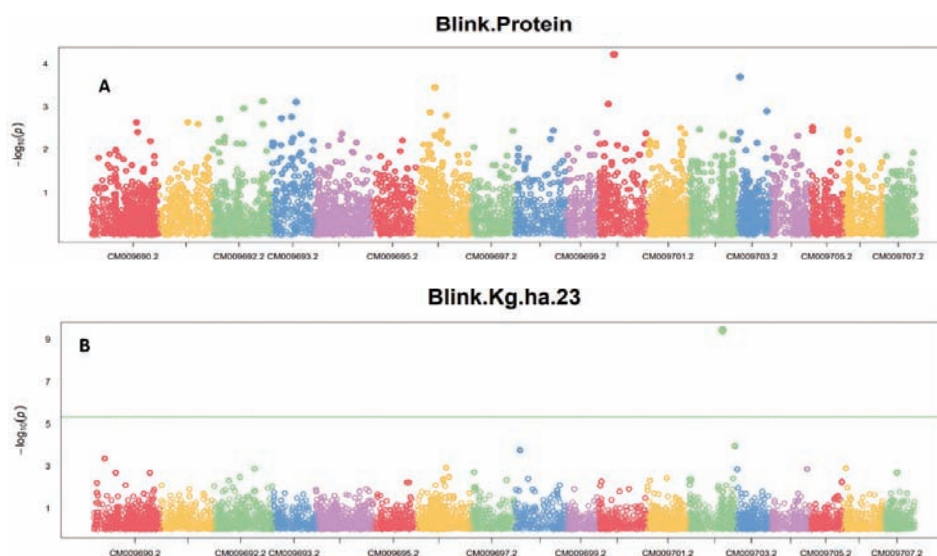


Fig. 1.31. Manhattan plots showing associated SNPs for (a) Protein content, (b) Grain yield in proso millet

g) Brown top millet

IIMR/CI/2017-22/115 Brown top millet characterization and genetic Improvement (PI: Venkatesh Bhat)

Germplasm evaluation

A total of 31 brown top millet genotypes were evaluated. The morphological traits data revealed that the crop has adequate range of variation for grain yield, plant

height, panicle length and number of tillers (Table 1.27). Compared to previous year, the range increased for days to flowering due to early and low yielding germplasm entry IC 589398. Most of the genotypes were of semi-erect type (13 of 24) and with loose panicle (15 of 24). There was no significant association of panicle type with grain yield. Based on the performance, the divergent

germplasm were identified (Table 1.28). These potential lines may be further used for trait improvement programmes.

Table 1.27. Mean and range for different parameters in Brown top millet

Parameter	Minimum	Maximum	Average
Plant height (cm)	66	93	77
Panicle length (cm)	5.4	16.5	12.7
No. of Tillers	10.5	22.0	17.2
Grain yield/plant (g)	9.2	42.0	27.8

Table 1.28. Mean and range for different parameters in Brown top millet

Trait	Entry that recorded minimum value	Entry that recorded maximum value
Days to flowering	IC 589398 (41)	IC 0589392 (56)
Plant height (cm)	IC 589398 (66)	IC617959 (93)
Panicle length (cm)	IC617953 (5.4)	IC 617960 (16.5)
Tillers (no.)	IC617953 (10.5)	IC617957 (22.0)
Grain yield/plant (g)	IC 589398 (9.2)	IC613553 (42)

Mutation and selection

Mutant lines from irradiated local collections were advanced to M₄ and screened for useful mutations. No *de novo* yield-enhancing traits were observed. The lines were tested for grain yield and related traits. Five selections with high grain yield were advanced.

Selection 5-2 was taller with high grain and fodder yield. Selection 8-3-1 recorded both high grain and fodder yield.

Evaluation for high temperature stress tolerance

Two check varieties of brown top millet, HBr-2 and GPUBT-6, were evaluated for physiological response to high temperature. These were sown at one week interval (7th and 15th Feb. 2024) in a replicated trial and observations were recorded on Canopy Temperature Depression (CTD), Chlorophyll (SPAD), flag leaf area and 100-grain weight. CTD and SPAD were recorded at 50% flowering whereas flag leaf area was taken at physiological maturity stage. CTD was calculated as CTD = Air temperature x Canopy temperature. Genotypes with cooler canopy temperature (high CTD) have transpiration cooling to prevent excess desiccation. Genotype GPUBT-6 had higher CTD than HBr-2 indicating that it can better withstand desiccation due to higher temperature (Fig. 1.32). The Chlorophyll content (SPAD reading) was affected in HBr-2 due to higher temperature whereas GPUBT 6 was not affected (Fig. 1.33). Flag leaf area as observed at physiological maturity was not affected by heat in both genotypes. In case of 100-seed weight, lower per centage reduction over first date of sowing in GPUBT-6 compared to HBR-2 indicated that GPUBT-6 had better heat tolerance, corroborating the trends of CTD, and SPAD observations.

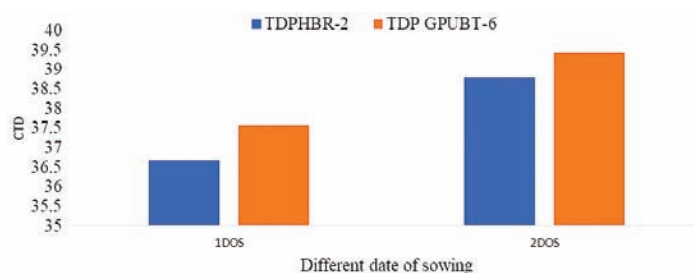


Fig.1.32. Canopy temperature Depression (CTD) at different dates of sowing in Browntop millet

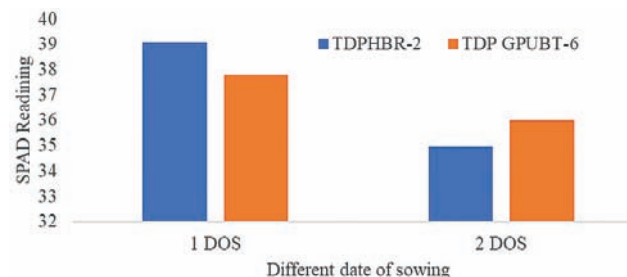


Fig.1.33. SPAD-reading at different dates of sowing in Browntop millet

Metabolite profiling of brown top millet whole grains

LC-MS based metabolic profiling of whole grains of four brown top millet genotypes (IC0617958, IC0613556, GPUBT 6 and HBR-2) was carried out to identify the metabolites/bioactive molecules present. Around 2000 plant specific metabolites were identified across the

genotypes. These included 20 standard amino acids and their derivatives, 64 compounds under the class vitamins and their metabolites, 298 phenylpropanoids (including phenolic acids and flavonoids), 212 alkaloids and 203 terpenoids.

1.3. Seed Science

IIMR/SS/2020-2025/126: Investigations on genetics of seed vigour and longevity, and effect of foliar plant nutrition on seed yield and quality in small millets (PI: N Kannababu)

Effect of foliar sprays and soil application of zinc and boron on seed yield and quality of kodo millet

Micronutrients play a vital role in plant nutrition and plant production. Agricultural soils generally show deficiency in micronutrients such as zinc, boron, iron and copper. It was reported that Boron (B) is an essential plant food element, having a specific role in growth and development of plants, whereas Zinc (Zn) is essential in protein synthesis and gene expression in plants. An experiment was conducted with kodo millet (cv. JK41) during rainy season of 2023 with 3 replications in split plot design to study the effect of foliar sprays and soil application of B and Zn on seed yield and seedling vigour aiming to develop and refine the seed production technology (Fig. 1.34). The treatments consisted of four foliar sprays [M1: Boron (0.5% $\text{Na}_2[\text{B}_4\text{O}_5(\text{OH})_4] \cdot 8\text{H}_2\text{O}$; 14.5% B), M2: Zinc (1% $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ with 21% Zn), M3 : Boron (0.5%) + Zinc (1%), M4 : Control (Water spray) and no soil application]; and three stages of sprays [S1 : Panicle initiation (PI), S2 : 50% flowering (FFL), S3 : PI + FFL, S4 : soil application before sowing].



Fig. 1.34. Foliar spray of B and Zn in kodo millet

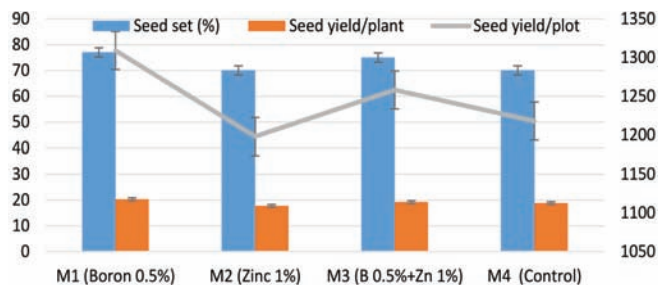


Fig. 1.35. Effect of foliar sprays and soil application of B and Zn on seed yield in kodo millet cv. JK41

Seed yield and agronomic traits: In kodo millet, B has markedly enhanced the seed yield per plant over no spray (control) while Zn application alone or in conjunction with B did not bring any significant improvement (Fig. 1.35). Soil application (SA) proved promising in enhancing seed yield over foliar application at panicle initiation (PI), flowering (FL) and PI + FL. Foliar spray at PI and FL were comparable (Fig. 1.36). The growth and yield parameters were not significantly influenced by foliar sprays / stages of application except hundred seed weight which was highest with application of B. The seed setting (%) did not vary with micronutrient application, and it was maximum with soil application (SA) before sowing and comparable to foliar application at PI. Interaction effects on seed yield revealed that irrespective of micronutrient used (B, Zn, B+Zn) the highest seed yield per plant was obtained with soil application (SA) before sowing.

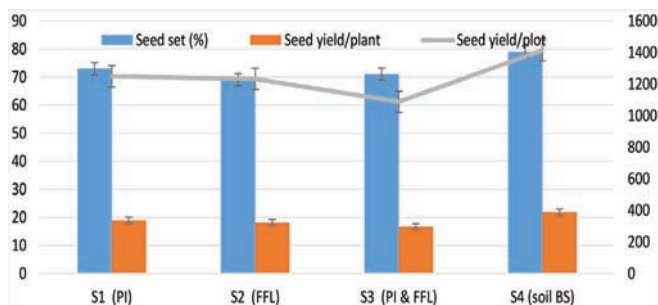


Fig. 1.36. Effect of foliar sprays and soil application (B & Zn) at different stages of crop growth on seed yield in kodo millet cv. JK41

The application of Zn or Zn + B at PI + FL brought a reduction in seed yield when compared to control revealing a toxic effect. The micronutrient application either sole or in combination did not prove effective in enhancing seed yield when applied at PI or FL stage.

Seed quality traits: In kodo millet, B, Zn and B + Zn had significantly better impact compared to control on seed germination (SG), field emergence (FE) and seedling vigour index-2 traits, however either B + Zn was effective than either B or Zn for FE. Among the methods of micronutrients application, foliar spray at PI, FL, PI + FL, and soil application (SA) were on par for seed germination. SA was significantly better for field emergence and seedling vigour index-2 traits, whereas for seedling vigour index-1, foliar sprays at PI, FL and PI + FL stages were significantly effective.

Sieve size optimization for seed grading during seed processing of foxtail millet

Seed size is one of the important seed quality attribute that may vary due to various seed production environment and cultural practices. To eliminate the foreign seeds, under-sized and low-quality seeds of same species or cultivar, grading acts as an integral part of seed production and enhancing the planting value. Studies pertaining to seed grading based on seed size in relation to seed quality characters are important, as the amount of food reserve in seed is the basic requirement to germinate and establish in field.

The pre-cleaned seeds of six foxtail millet cultivars (IIMR-FXM12, IIMR-FXM13, IIMR-FXM14, IIMR-FXM15, IIMR-FXM16 and IIMR-FXM17) were size graded using sieve sizes (round perforations) of 1.3, 1.4, 1.5, 1.8, 1.9 and 2.0 mm. The cumulative seed recovery (%), seed test weight (mg), germination (%), root length (cm), shoot length (cm), seedling dry weight (mg), seedling vigour index-1 and 2 were assessed for the seeds retained on these sieves. The maximum recovery of seeds was recorded with 1.8 mm round sieve in all the six cultivars (Fig. 1.37 & 1.38). Seed quality traits were highest with the seeds retained over 1.9 and 2.0 mm sieves in IIMR-FXM14, however, were on par with 1.8 mm for seed vigour traits (Fig. 1.38). The study revealed that 1.8 mm round perforation sieve appears to be optimum for seed grading during processing to achieve about 98% cumulative seed recovery and higher seed quality in all six cultivars of foxtail millet.

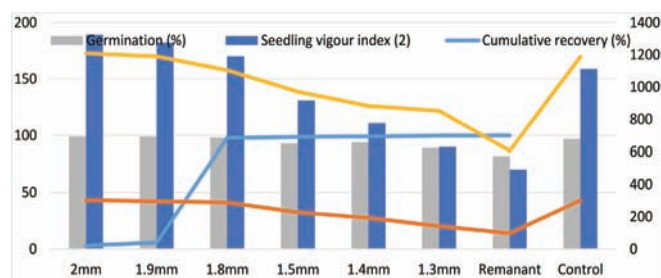


Fig. 1.37. Effect of sieve size on seed recovery and quality traits of foxtail millet cv. IIMR-FXM14

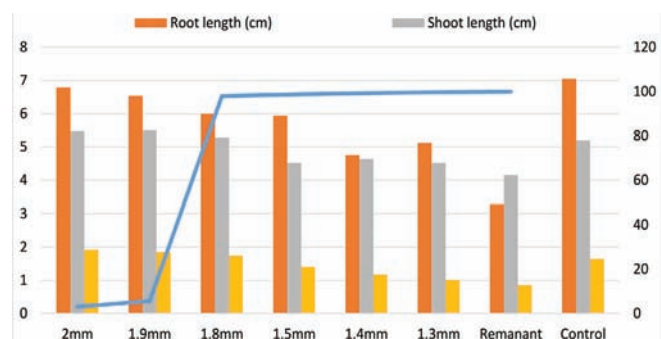


Fig. 1.38. Effect of sieve size on seed recovery and quality traits of foxtail millet cv. IIMR-FXM14

CRG 000477-SERB (ANRF)-DST: Identification of SNP-trait associations for seed longevity traits through association mapping in pearl millet and finger millet (PI: N Kannababu)

Identification of SNP-trait associations for seed longevity traits through association mapping

The seed vigour and longevity studies of small millets have received less attention as compared to other fine cereals. As seeds age some genotypes of finger millet, maintain viability to certain period of storage and subsequently enter a period of decline during which some completely fail to germinate; while others germinate and grow normally. The genetic behaviour of finger millet for seed longevity traits is not known and there is an urgent need for identification of SNP markers for seed longevity for its utilization in crop improvement programmes.

A comprehensive Genome-Wide Association Study (GWAS) was taken up on seed traits of diverse panel comprising 221 finger millet accessions of Global representation sourced from 20 different countries spanning all races and most of the sub races.

Phenotyping was performed for nine seed longevity traits in fresh and accelerated aged seeds to predict seed longevity. Through Genotyping by sequencing (GBS) we identified 11,832 SNPs that were used for the GWAS analysis (Fig. 1.39). Using a stringent P-value threshold (0.0005) across five models in Genome Association and Prediction Integrated Tool (GAPIT) v3.0 in R revealed 1236 significant marker trait associations (MTAs) for all traits. MLM identified the highest MTAs (298), followed by MLM (214), BLINK (215), farmCPU (250), and GLM (259). Accelerated aged seeds had more SNPs (637) than fresh seeds (599). Pleiotropic QTL (FM_SNP_3851) was captured by all models (except FarmCPU) and surpassed FDR-corrected threshold, associating with traits like root length and seedling vigor index-1. Locus FM_SNP_3303 governing two traits, explained 45.34% and 47.94% of phenotypic variance for germination rate index and mean germination time, respectively. These findings collectively contribute to a deeper understanding of the molecular mechanisms governing finger millet seed traits and provide valuable insights for breeding programmes aimed at improving seed longevity.

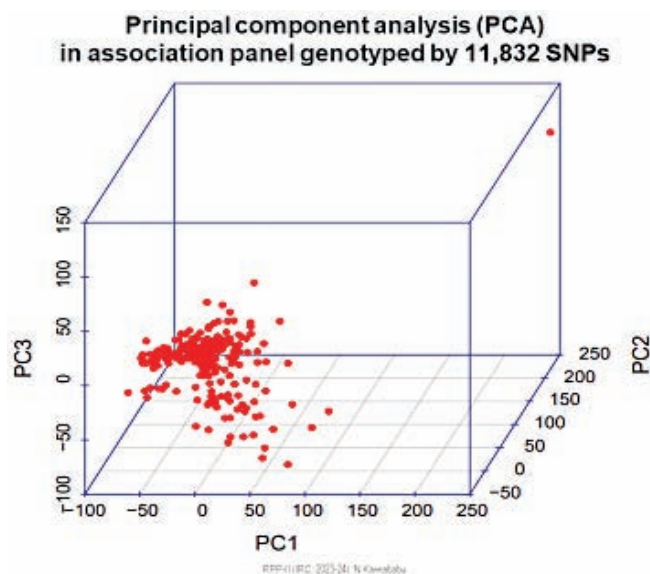


Fig. 1.39. Principal component and kinship analyses of finger millet genetic data on seed vigour and longevity

IIMR/SS/2023-2026: Studies on seed treatment technologies for better crop establishment and yield in millets (PI: Sooganna)

Effect of different seed treatments on crop growth, pest incidence, diseases and yield was studied in sorghum,

pearl millet and finger millet during *kharif* 2024. Control treatment (T16) recorded higher incidence of shoot fly and fall army worm as compared to other treatments. However, seed treatment with various pesticides noticed less than 2% shoot fly infestation, less than 6% stem borer infestation and less than 40% fall armyworm infestation. Among various treatments, Thiamomethoxam 30% FS @ 10 ml/kg + Metalaxyl 35% WS @ 6 g/kg of seed (T7) recorded relatively lower incidence of all the major pests of pearl millet followed by Arka microbial consortia @ 10 g/kg + Azoxystrobin 2.5% @ 4 g/kg (T14) (Fig. 1.40).

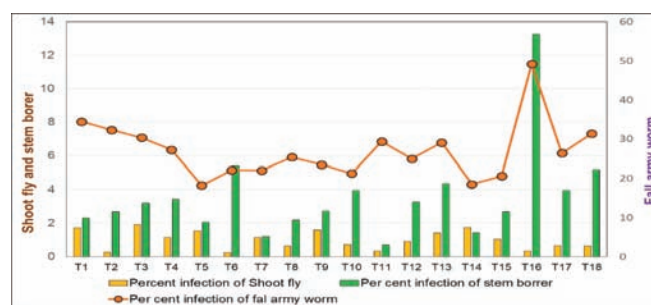


Fig. 1.40. Per cent infestation of various insect pests on pearl millet

Grain yield was higher under the treated seeds condition as compared to control, where T8 (Thiamomethoxam 30% FS @ 10 ml/kg + Azoxystrobin 2.5% @ 4 g/kg of seed) recorded 2658 kg/ha grain yield, which was significantly superior than many other treatments (Table 1.29).

Table 1.29. Grain yield in pearl millet and sorghum as influenced by various seed treatments

Treatments	Grain yield (kg/ha)	
	Pearl millet	Sorghum
T1	2105	2526
T2	2183	2620
T3	2198	2637
T4	2169	2603
T5	2382	2858
T6	2470	2964
T7	2321	2785
T8	2658	3189
T9	2405	2886
T10	2578	3093
T11	2064	2477
T12	2198	2638
T13	2248	2698
T14	2274	2728

Treatments	Grain yield (kg/ha)	
	Pearl millet	Sorghum
T15	2213	2656
T16	2005	2006
T17	2356	2366
T18	2490	2236
SEm	106	117
CD (5%)	279	340

In case of sorghum, control treatment (T16) noticed higher incidence of shoot fly and fall army worm as compared to other treatments. However, seed treatment with various pesticides noticed less than 8% shoot fly infestation and less than 70% fall army worm infestation. Among various treatments, Thiamomethoxam 30% FS @ 10 ml/kg + Metalaxyl 35% WS @ 6 g/kg of seed (T7) recorded relatively lower incidence of all the major pests of sorghum crop followed by Arka microbial consortia @ 10 g/kg + Tebuconazole 2% DS @ 6g/kg of seed (T15) as noticed in Fig. 1.41. Grain yield was higher under the treated seeds condition as compared to control, where T8 (Thiamomethoxam 30% FS @ 10 ml/kg + Azoxystrobin 2.5% @ 4 g/kg of seed) recorded 3189 kg/ha grain yield, which superior than other treatments (Table 1.29).

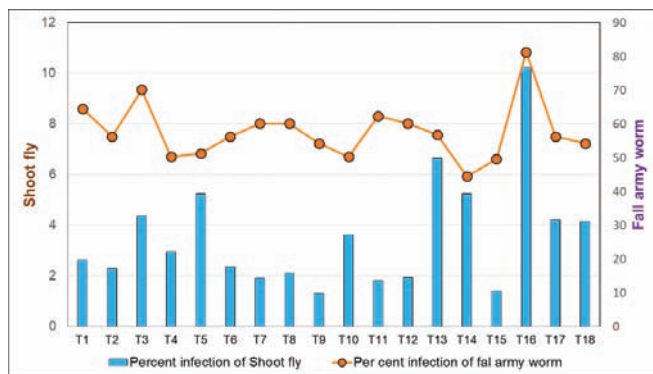


Fig. 1.41. Per cent infestation of various insect pests on sorghum

In case of finger millet, per centage infestation of major insect pests viz., shoot fly, fall army worm and stem borer was maximum under the control treatment (T16) followed by lower grain and fodder yield. Seed treatment with Tebuconazole 2% DS @ 6 g/kg seed + Tricyclazole 75 WP @ 2 g/kg seed (T8) recorded significantly lower incidence of major pests where 45% of the incidence was reduced as compared to control treatment. However, it was on par with Tricyclazole 75 WP @ 2 g/kg + Carbendazim 50% WP @ 2 g/kg seed

(T10). The best treatment recorded 30% higher grain yield than control (Table 1.30). Since no infestation of major diseases were noticed the observations on disease incidence was not recorded.

Table 1.30. Incidence of major pests and yield of finger millet

Treat-ments	% infection of Shoot fly	% infection of fall army worm	% infection of stem borer	Grain yield (Kg/ha)
T1	4.03	11.52	5.07	2005
T2	3.55	10.13	4.47	2079
T3	3.76	10.75	4.20	2093
T4	3.73	10.67	4.53	2066
T5	2.97	8.47	3.80	2268
T6	2.54	7.27	3.47	2352
T7	3.20	9.14	3.80	2210
T8	2.32	6.64	3.20	2531
T9	2.84	8.13	3.47	2290
T10	2.50	7.15	3.47	2455
T11	4.11	11.73	5.40	1965
T12	3.39	9.69	4.07	2094
T13	3.24	9.26	4.00	2141
T14	3.24	9.25	3.93	2165
T15	3.24	9.26	4.00	2108
T16 (Control)	4.91	14.04	6.47	1910
SEm	0.32	0.98	0.45	101
CD (5%)	1.05	3.41	1.56	255

The experiment was conducted at Vizianagaram also, where seed treatment with Tebuconazole 2% DS @ 6 g/kg seed + Tricyclazole 75 WP @ 2 g/kg seed (T8) recorded significantly lower incidence of major diseases where 50% of the incidence was reduced as compared to control treatment. However, it was on par with T9 (Tebuconazole 2% DS @ 6 g/kg seed + Carbendazim 50% WP @ 2 g/kg seed). Grain yield was 24% higher in T8 than control.

2. Application of Basic and Strategic Sciences in Crop Improvement

2.1 Pre-breeding

IIMR/CI/2021-2016/148: Pre-Breeding of sorghum and finger millet for specific trait improvement (PI: K Venkatesh)

The objective of the project is to screen wild accessions of sorghum including *S. purpureosericeum* accessions against shootfly and transfer the trait to adapted germplasm through wide hybridization. After two years of screening of 30 wild sorghum accessions against shootfly, the results obtained did not show any repeatability and

promising tolerance levels. Therefore, it was proposed to collect a new set of wild sorghum accessions which were reported to be tolerant against shootfly from ICRISAT genebank for fresh screening. During 2023-24, a new set of 18 accessions of wild sorghum (Table 2.1) were collected from ICRISAT genebank and were multiplied for screening against shootfly.

Table 2.1. New set of wild sorghum accessions being screened against shootfly

S. No.	Accession identifier	Alternate accession identifier	Species
1	IS 14564	-	bicolor
2	IS 14717	-	bicolor
3	IS 18813	<i>S. virgatum</i>	bicolor
4	IS 18819	HD 767	bicolor
5	IS 18826	<i>S. arundinaceum</i>	bicolor
6	IS 18830	S 3	bicolor
7	IS 18845	<i>S. halepense</i>	halepense
8	IS 18849	<i>S. halepense</i>	halepense
9	IS 18883	HW 653	bicolor
10	IS 18891	HW 689	halepense
11	IS 18943	<i>S. purpureosericeum</i>	purpureosericeum
12	IS 18944	Anees	purpureosericeum
13	IS 18945	Anees	purpureosericeum
14	IS 18947	-	purpureosericeum
15	IS 18956	<i>S. australiense</i>	australiense
16	IS 20995	No. 48810	bicolor
17	IS 23177	Para sorghum	versicolor
18	IS 27584	-	bicolor

2.2 Molecular breeding

IIMR/CI/2021-2026/149: Generation of genomic resources and its application for the improvement of millets (PI: P Rajendrakumar)

Whole genome de novo sequencing of kodo millet

De novo whole genome sequencing of kodo millet cultivar RK 390-25 was performed through long read sequencing using PacBio Sequel II platform. Approximately 0.9 Gb of the kodo millet genome was assembled from a total of 69,86,096 reads. The GS content of the genome is 45.84% while the N50 value is 41.24 Mb. The genome assembly was analysed for the structural and copy number variants in comparison with foxtail millet, finger millet and proso millet. More structural variants were observed in kodo millet with respect to proso millet, while more copy number variants were observed in kodo millet with respect to foxtail millet. Genome-wide simple sequence repeats were also identified, which will be useful for SSR marker

development (Fig. 2.1). Dinucleotide repeats were abundant followed by trinucleotide repeats.



Fig. 2.1. Genome-wide variants and SSRs in kodo millet

Optical maps were generated using the Saphyr system and the *de novo* assembly of the optical maps was performed using the Bionano Access v1.8 and Bionano Solve v3.8 software. The assembly type performed was the “non-haplotype” with “no extend and split” and “cut segdups”. Single-enzyme hybrid scaffolding was performed using Bionano Access v1.8 and Bionano Solve v3.8. Default settings was used to perform the hybrid scaffolding. The BioNano assembly statistics are as follows: Number of scaffolds – 30; Assembly size – 850 Mb; Largest contig – 56.09 Mb; GC content – 45.99%; N50 value – 40.67 Mb and L50 value – 9.

Development of genetic diversity kit for finger millet

About 100 hypervariable genomic SSR markers were selected, and the thermal profiles were standardized using the genomic DNA of four finger millet genotypes (IE 2882, GE 4449, GE 3767 and IE 2911). The standardized annealing temperatures were 52°C, 55°C and 57°C. Fifty of these genomic SSR markers were validated in 48 finger millet genotypes, of which, 34 markers were polymorphic, 16 were monomorphic. The number of alleles per SSR locus ranged from 4 to 11. The maximum number of 11 alleles was amplified by FMgSSR14725 markers while minimum number of 4 alleles was amplified by eight SSR markers (FMgSSR26233, FMgSSR41977 and FMgSSR44781). The PIC value ranged from 0.56 to 0.85. The polymorphic markers were used to group the finger millet genotypes through factorial analysis, which revealed good extent of diversity among them (Fig. 2.2).

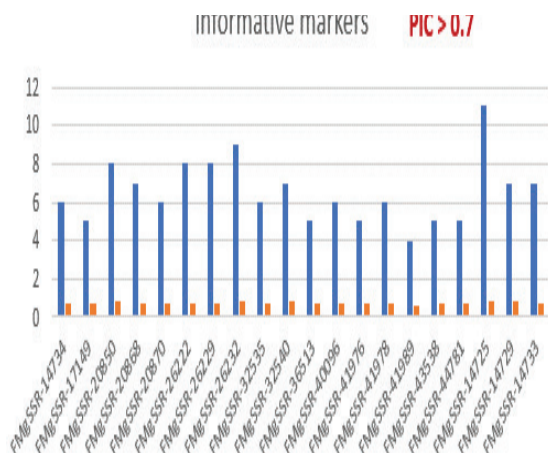
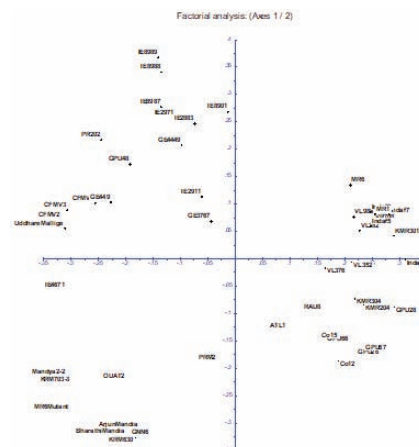


Fig. 2.2. Informative markers and grouping of finger millet genotypes



SERB funded project: Molecular prediction and candidate gene(s) identification for grain yield heterosis in kharif sorghum through genomics and transcriptomics approaches (PI: P Rajendrakumar)

Estimation of heterosis

Sixty-four F_1 hybrids developed by crossing eight male sterile lines (456A, 151A, 415A, 4414A, BPOP16A, 279A, 1176A, 2911A) and eight restorer lines (C 43, CB 11, CB 33, AKR 150, NR10-15, NR4118, NR4018, NR459-15) in a Line $\times$ Tester fashion were evaluated along with their parental lines in a RBD with two replications during *kharif* season for grain yield and its component traits such as days to flowering, plant height, panicle length, panicle weight, grains per panicle, 100-grain weight, days to maturity and grain yield per plant. The extent of heterosis [mid-parent heterosis (MPH) and better parent heterosis (BPH)] for grain yield are shown in Fig. 2.3.

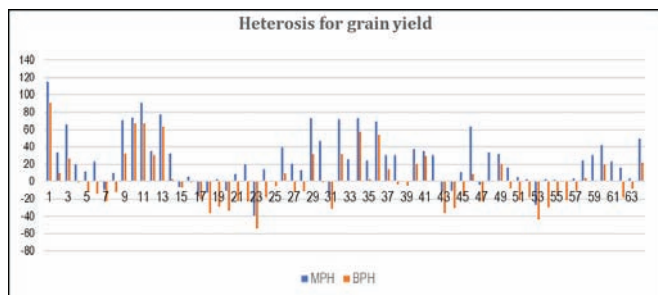


Fig. 2.3. Extent of heterosis (MPH and BPH) for grain yield

Genotyping of parental lines using SSRs

The genotyping of parental lines using 400 SSR markers through polyacrylamide gel electrophoresis (PAGE) revealed that 142 markers exhibited polymorphism among them. Diversity among the parental lines was estimated through the measure, the coefficient of

marker polymorphism (CMP), which ranged between 0.27 (2911A vs. CB11) and 0.61 (151A vs. NR4118).

Identification of markers for prediction of grain yield heterosis

DNA marker polymorphism data and heterosis data were used for the identification of markers possessing the potential for the prediction of grain yield heterosis. Correlation analysis performed between coefficient of marker polymorphism (CMP) among the parental lines (16) and grain yield heterosis of their respective hybrids (64) revealed a moderate, significant and positive correlation for MPH for grain yield ($r = 0.32^*$) as well as BPH ($r = 0.41^*$). To improve the correlation values, the correlation analysis between CMP among the parental lines (16) using 80 SSR markers with PIC value > 0.50 and grain yield heterosis in the respective F_1 hybrids (64 hybrids) revealed a significant, moderate and positive correlation of coefficient of marker polymorphism with MPH for grain yield ($r = 0.43^*$) and BPH ($r = 0.51^*$) (Table 2.2). This positive and moderate correlation values indicated the potential of these molecular

Table 2.2. Correlation between CMP and heterosis for days to flowering and grain yield

Traits	Correlation between CMP and heterosis			
	Total Markers		Selective Markers (PIC > 0.5)	
	MPH	BPH	MPH	BPH
Days to flowering	0.36*	0.40*	0.44*	0.46**
Grain yield	0.29*	0.38*	0.43*	0.51*

2.3 Biotechnology

IIMR/CI/2020-2025/124: Manipulating *SbSERK* gene(s) to understand their effect on generating apomixis components through CRISPR-Cas9 mediated gene editing technology (PI: D Balakrishna)

To generate apomictic mutants in sorghum, three somatic embryo receptor kinase genes (*SbSERK*, *SbSERK2* and *SbSERK3*) were targeted through CRISPR/Cas 9 technology. Nine gRNAs (three gRNAs per each SERK gene) were cloned individually in the site of *BsaI* of pBUN421 binary vector (Fig. 2.4) and mobilized into *Agrobacterium* LBA4404 through freeze thaw method. During the process of *Agrobacterium* mediated genetic transformation, Phosphinothricin (3.0 mg/l) was used as plant selection to develop putative transformants. A total of 140 Phosphinothricin resistant putative genome edited lines were regenerated out of 4500 *Agrobacterium* infected shoot tips of sorghum male sterile line 296A. Out of these, 41 lines were developed for *SbSERK 1* gene (15 lines with pBUN421-SERK1-1 construct, 16 with pBUN421-SERK1-2 and 10 with pBUN421-SERK1-3), 46 lines were developed for *SbSERK 2* gene (12 lines with pBUN421-SERK2-1, 19 with pBUN421-SERK2-2 and 15 with pBUN421-SERK2-3 sg RNA) and 53 lines developed for *SbSERK 3* gene (13 lines with pBUN421-SERK3-1, 24 with pBUN421-SERK3-2 and 16 with pBUN421-SERK3-3).

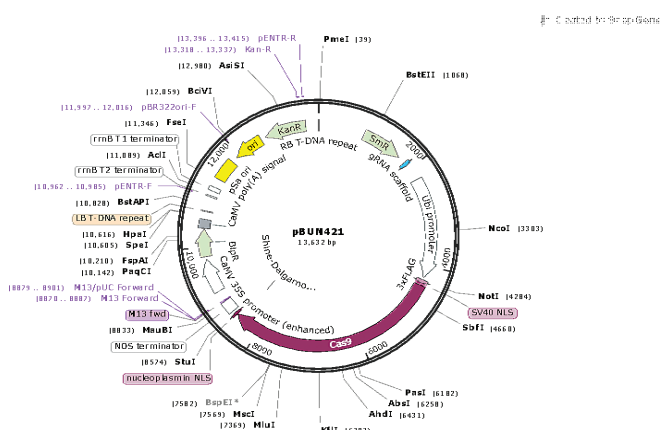


Fig. 2.4. pBUN421 binary vector carries CRISPR-Cas9 used for genome editing in sorghum

ICAR-Genome Editing: Enhancing climate resilience and ensuring food security with genome editing tool (PI: D Balakrishna)

Objective of this project is to develop herbicide tolerance in sorghum and reduced rancidity in pearl millet flour through

CRISPR-Cas9 genome editing. pBUN421 a CRISPR/Cas9 based plant genome editing construct carries a cloned gRNAs under the control of TaU3 promoter and Bar gene for plant selection under the control of CaMV35S promoter. The genome edited lines will be developed through *Agrobacterium*-mediated genetic transformation. During the process of plant regeneration, shoot tip explants of sorghum and pearl millet were subjected to 3.0 mg/l Phosphinothricin (PPT) selection.

Sorghum

Acetolactate synthase (ALS) is a key enzyme in Sorghum in the synthesis of branched-chain amino acids, such as valine, leucine and isoleucine. Herbicides in this group inhibit the activity of ALS and prevent the synthesis of branched-chain amino acids in the plant, which in turn interfere the protein synthesis, cell division and plant growth, and eventually lead to plant death. Currently, the widely used ALS inhibitor herbicides include imidazolinones (IMI), sulfonylureas (SU), triazopyrimidines (TP), pyrimidinylthiobenzoates (PTB) and sulfonylamino-carbonyl-triazolinones (SCT). Three gRNAs were designed and cloned individually in *BsaI* site of pBUN421 resulting in three gene constructs (pBUN421-SbALS1, pBUN421-SbALS2 and pBUN421-SbALS3). A total of 79 PPT resistant putative genome edited lines were regenerated out of 900 shoot tip explants of sorghum genotype C43 infected (25 plants with pBUN421-ALS1 construct, 28 plants pBUN421-ALS2 construct and 26 plants pBUN421-ALS3 construct).

Pearl millet

Development of rancidity in pearl millet flour due to release of endogenous lipases during milling resulting in hydrolysis of storage lipids is a major problem. Therefore, lipases have been target in efforts towards pre and post-processing treatments for storing the milled flour, and these results in reduction in the nutritional properties. For the purpose of gene editing to target lipase gene, nine gRNAs (three gRNAs per each Lipase (LIP) gene) were cloned individually in the site of *BsaI* of pBUN421 binary vector. A total of 1193 shoot tip explants have been infected with nine gene constructs individually and are subjected to 3.0 mg/l Phosphinothricin selection (156 explants with pBUN421-LIP1-1 construct, 96 with pBUN421- LIP 1-2, 120 with pBUN421- LIP 1-3, 168 with pBUN421- LIP

2-1, 156 with pBUN421- LIP 2-2, 117 with pBUN421- LIP 2-3, 120 with pBUN421- LIP 3-1, 127 with pBUN421- LIP 3-2 and 133 with pBUN421- LIP 3-3), and the selection is underway.

Metabolite profiling of millet grains

IIMR/CI/2023-28/163: Identification of bioactive compounds in the grain and gene mining from millets (PI: Jinu Jacob)

Metabolomics is the systematic identification and quantification of small molecules or metabolites in cells, tissues or organisms. It is the most accurate way to depict the molecular phenotype of an organism because it captures the underlying metabolic activity and condition of cells and tissues. Millets are rich in secondary metabolites such as flavonoids, phytosterols, phenols, tannins and quinones, besides proteins and carbohydrates which are also referred to as phytochemicals. They are the major compounds behind the therapeutic properties and health attributes of millets. The major objective of the study was to have an improved understanding of the therapeutic properties of each millet.

To understand the phytochemical composition of millet grains, metabolite profiling of the methanolic extract of seeds of popular variety of each of the millets was carried out using an LC-MS/MS based untargeted metabolomics approach. Grain samples of popular

cultivars of nine different millets, namely sorghum (M35-1 and CSV20), pearl millet (PPMI-683), finger millet (ML 365), foxtail millet (SiA 3156), barnyard millet (BMV 611), little millet (CLMV 1), proso millet (TNPM 230), kodo millet (Indira kodo-1) and brown top millet (GPUBT 6) were included in the study. The output raw mass spectral files were used for the identification of metabolites based on the m/z values and retention time. The raw files were subjected to preprocessing with MZMine 2.53 and the data was statistically analyzed using Metaboanalyst.

The score plot of Partial Least Squares Discriminant Analysis (PLS-DA) revealed a noticeable separation between the sample groups indicating a significant change in the metabolite profile (Fig. 2.5a). A PLS-DA VIP score, or Variable Importance in Projection score, is a measure of how important a variable is in a PLS-DA model. VIP is a number assigned to each metabolite which measures the variable's importance in explaining the differences between groups. VIP values above a certain threshold indicates metabolites that significantly contribute to the separation. Gossypin, allanthinone, Luteolin, thalicarpine, etc. were some of the metabolites having highest VIP scores across the millets which means that they can act as biomarkers in understanding the metabolomics differences among various millets (Fig. 2.5b).

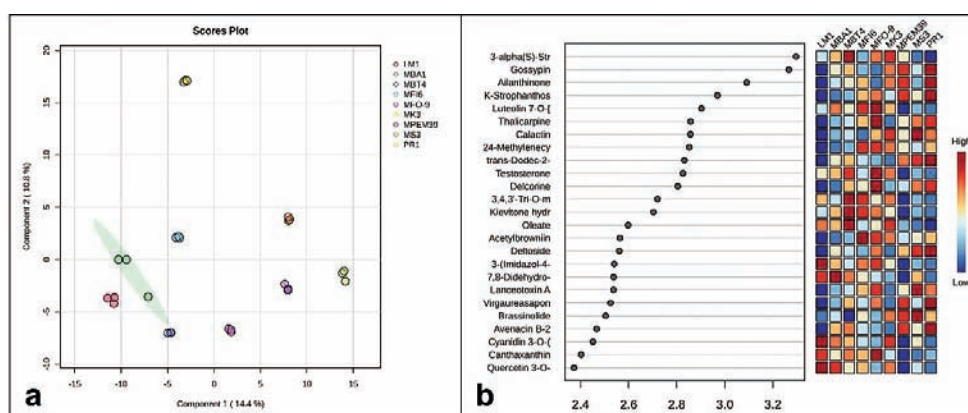


Fig. 2.5. Metabolomics multivariate analysis (a) PLS-DA score plot, (b) VIP score plot of PLS-DA

The peak area of the metabolites from mass spectrometry output was transformed to log 10 values and quantile normalization was used for relative

comparison of quantities. Around 1900 metabolites belonging to various classes were identified across nine millets (Table 2.3).

Table 2.3. Classes of metabolites identified from millets and the number of compounds in each class

Sl. No.	Metabolite classes identified	Number of compounds in each class
1	Vitamins and their metabolites	64
2	Free fatty acids and their metabolites	245
3	Lipids	27
4	Free amino acids and their metabolites	89
5	Amines and related compounds	34
6	Phenylpropanoids	
	(i) Phenolic acids	25
	(ii) Flavonoids	153
	(iii) Tannins and galloyl derivatives	29
	(iv) Other phenylpropanoids	73
7	Terpenoids	205
8	Alkaloids	212

The phytochemical components of millet grains can protect against a wide range of lifestyle conditions, including obesity, constipation, poor colon health, cardiovascular disease, inflammatory disorders, high blood pressure, diabetes and cancer. By analyzing the metabolites of grains, important nutrients (antioxidants, vitamins, bioactive compounds, etc) were identified. This information will contribute to breeding for desired qualities or traits, and further *in vitro* and *in vivo* studies would establish a link between the phytochemical composition and therapeutic potential.

DST-SERB POWER Grant: Development and characterization of trait-specific lines from wide hybridization in sorghum (PI: KBRs Visarada/Jinu Jacob)

Amylose-amylopectin ratio in wide hybridization derivatives of sorghum

Ratio of amylose and amylopectin in grain starch is related to different end-uses. Amylose/amylopectin ratio is an important factor in starch expansion. We crossed the high popping line from sorghum × maize crosses (2012-3) with another local variety which is high popping (Pop 11). Two RIL populations with a forward (2012-3 × Pop 11) cross (designated as PRil)

and a reciprocal cross (designated as PReci) were developed. The amylose and amylopectin content in the selected progenies were estimated in the grain samples. Amylose/amylopectin ratio highly affects the crystallinity of the products developed out of it and the water interactions. These parameters play important role in the popping per centage and expansion volume of the popped grains. A lower amylose/amylopectin ratio is preferred for better popping. The lines in our study showed gradation in amylopectin content. Amylopectin more than 70% was found in 13 lines, while in some lines it was as low as 50% (Fig. 2.6).

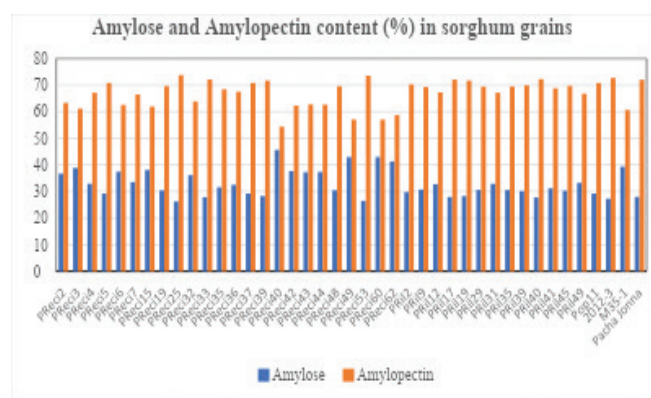


Fig. 2.6. Amylose and Amylopectin content (%) in sorghum grains

2.4. Crop Physiology

IIMR/CPD/2020-2025/128: Physiological dissection of key traits contributing for moisture stress adaptations in post rainy sorghum: with an emphasis on root architectural traits (PI: S Srividhya)

Phenotyping *rabi* sorghum for shoot and root traits under moisture stress - The *rabi* sorghum genotypes were evaluated for their adaptation to moisture stress during critical phenophases, with a focus on key physiological traits and yield responses under field conditions. To explore source-sink limitations, grain ultrastructural changes under terminal drought stress were analyzed using scanning electron microscopy (SEM). Grains from drought-stressed plants were compared with those from well-irrigated conditions. The results indicated that drought stress accelerated grain filling, leading to a reduction in total starch accumulation in the endosperm, which constitutes 65-75% of the grain weight. This reduction in starch content was confirmed through the SEM analysis, which revealed disintegration of starch granules within the endosperm matrix of grains subjected to terminal drought stress (Fig. 2.7.)

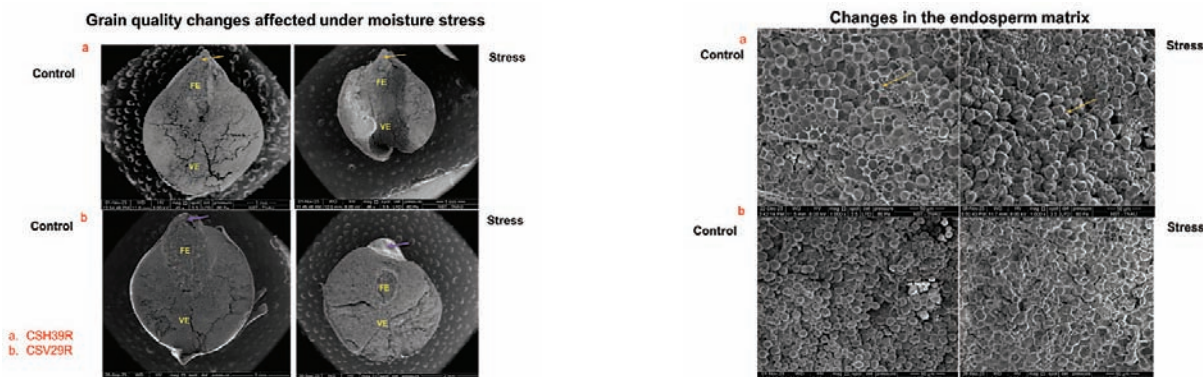


Fig. 2.7. Grain ultrastructural changes under irrigated and drought-imposed conditions

Root traits under moisture limited conditions -

Sorghum genotypes grown under well-irrigated and moisture-limited conditions were phenotyped and classified based on key root traits, including: i) wider & narrow root angles, ii) shallow & deep root types, and iii) root tissue density. The evaluation of root architecture revealed that while rooting depth increased under stress conditions for all genotypes, root volume decreased. Additionally, stress conditions led to an increase in crown root number, crown root angle, and narrow root angle. However, root tissue density and lateral root density were reduced under moisture-limited conditions.

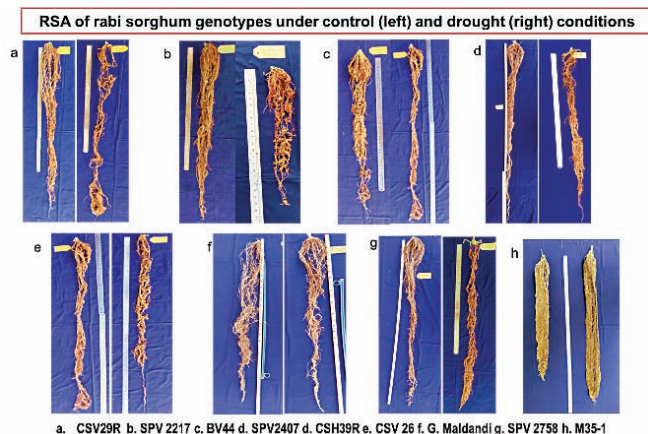


Fig. 2.8. RSA of rabi sorghum genotypes under irrigated and drought stress conditions

Correlation analysis indicated that rooting depth was significantly influenced by other root traits and had a strong correlation with several physiological parameters, including leaf water potential, leaf area index (LAI), shoot biomass, grain yield, and total water use of the plant. Furthermore, root volume and nodal

root angle were significantly correlated with the plant's total water use. Efficient water uptake played a critical role in establishing the LAI at various developmental stages, thereby enhancing photo-assimilation, which ultimately drives biomass and panicle yield formation. It was observed that higher root tissue density is associated with better yield potential, as it contributes to both increased dry matter accumulation and enhanced water uptake during critical crop stages.

IIMR/CP/2020-2025/160: Physiological basis of high temperature stress on summer sorghum (PI: D Seva Nayak)

100 sorghum lines (7 hybrids, 6 *kharif* varieties, 10 *rabi* varieties, 5 R-lines, 14 A & B lines, 8 forage sorghum varieties and 50 germplasm accessions) were evaluated for high temperature stress tolerance under natural field conditions. Staggered sowing (4 different dates of sowing) was adapted in summer-2024 (January to Feb-2024). A randomized block design with 3 replications was followed. Data recorded on weather parameters (maximum temperature, minimum temperature, relative humidity-RH-I and RH-II, rainfall, wind speed, evaporation) from January 2024 to May 2024 and correlated with sorghum growth and yield traits (Fig. 2.9). Rapid screening was done based on growth and yield parameters (Plant height, single leaf area/plant, Chlorophyll (SPAD-reading), Days to 50% flowering, Days to physiological maturity, Canopy Temperature depression (CTD), and weather data. Based on plant height reduction over the control, two hybrids (CSH16 and CSH 45), two *kharif* varieties (CSV41, and CSV17), two *rabi* varieties (BJV44, M35-1), one R line (AKR150) and two A & B lines (2219B,415A, PMS28B, 27A) were found tolerant. Based on leaf area reduction over the control, two

hybrids (CSH16, CSH 45), two *kharif* varieties (CSV 17, CSV 39), three *rabi* varieties (CSV 29, M35-1, SPV2758), one R-line (C43), two B lines (415B, 2219B) were found tolerant. Based on Canopy Temperature depression (CTD) reduction over the control, two

hybrids (CSH 25, CSH 16), two *kharif* sorghum varieties (CSV 39, CSV27), four *rabi* varieties (M35-1, CSV29, SPV2217, SPV2758), one R line (NR459-15), four A & B lines (CTD:151A, 151B,2219A, 2219B) were found tolerant (Fig. 2.9).

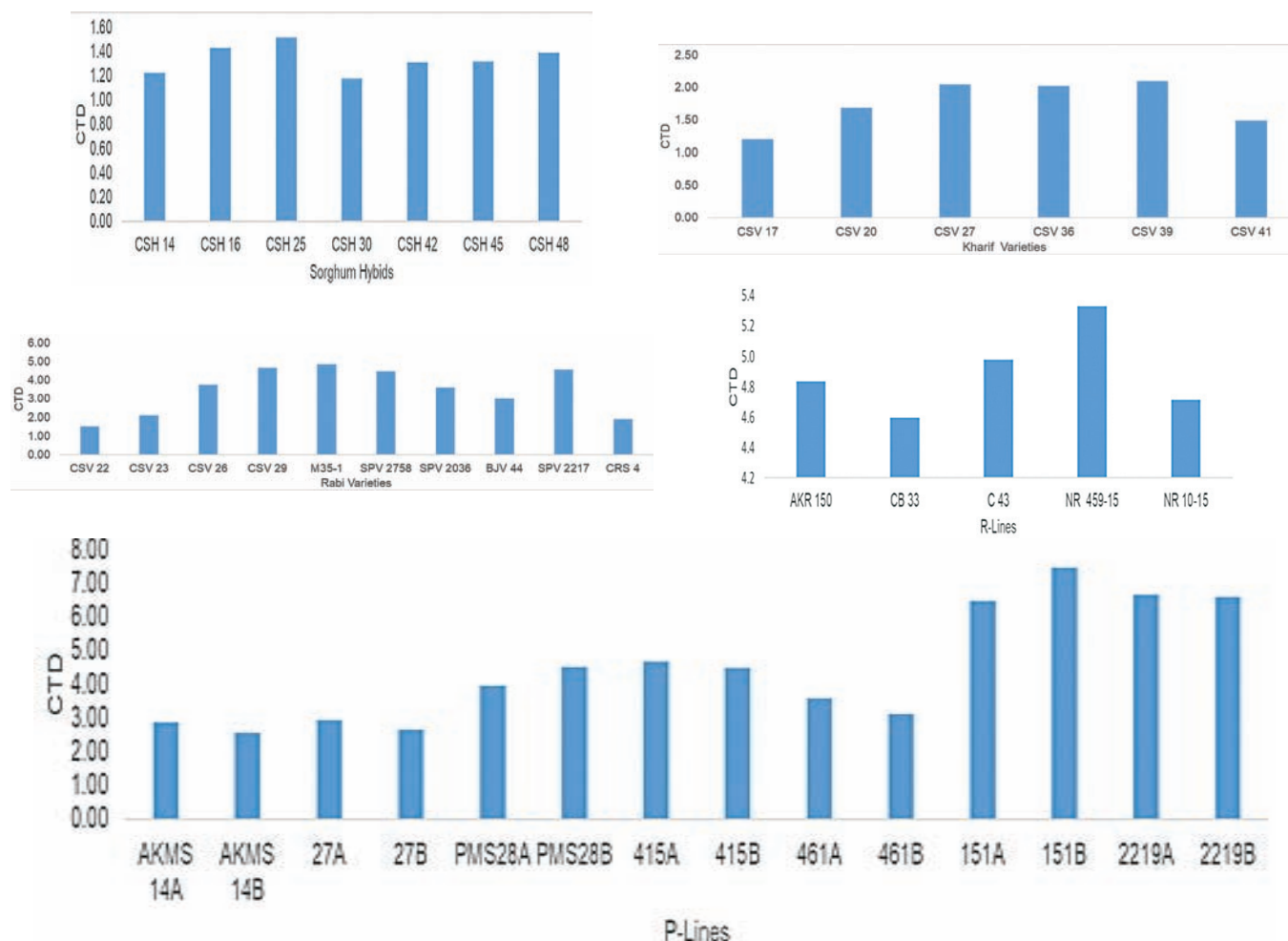


Fig. 2.9. Effects of high temperature (Canopy Temperature Depression -CTD) on sorghum germplasm

Based on Chlorophyll (SPAD) reduction over the control, two (CSH 45, CSH 25) hybrids, two *kharif* sorghum varieties (CSV41, CSV20), two *rabi* varieties (SPV2758, BJV 44) one R- line (NR-10-15), three A & B lines (151A, 415B, 2219A) were found tolerant.

2.5 Biochemistry & Functional Foods

IIMR/FF/2020-2025/127: High calcium accumulation in finger millet and its relationship to grain constituents (PI: R Venkateswarlu)

Amino acid profiling of finger millet grains - The quality of protein is determined by the composition of essential amino acids. In general lysine is the limiting

amino acid in cereals. We have standardized the amino acid profiling of finger millet grain samples. A sample of 150 mg was weighed into glass tube and 10 ml of 6 N HCl was added. The tubes are evacuated and flushed with nitrogen before sealing. The samples were hydrolysed at 110°C for 24 hours. An aliquot sample was neutralized and filtered through 0.2 µ filter and analysed. The hydrolysate was derivatized with OPA and FMOc and separated in a C18 column. The amino acid peaks were identified by comparing with a standard mixture of amino acid separated under similar conditions (Fig. 2.10). All the essential amino acids could be identified in finger millet samples.

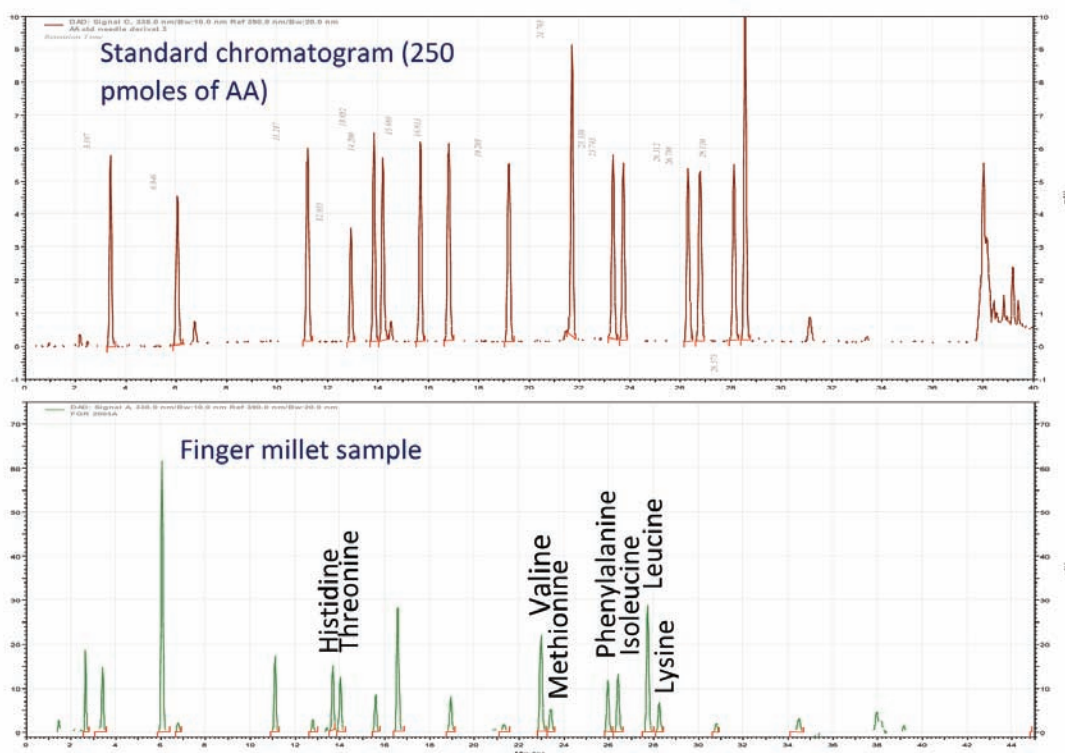


Fig. 2.10. Representative chromatograms of standard amino acid mixture (250 pmol) and finger millet sample

Bioaccessibility of minerals: To estimate bioaccessibility of minerals, 1.0 g of finger millet flour was extracted with 0.2 M glycine solution of pH 1.5 (US EPA method) to mimic gastric phase of digestion. The supernatant was filtered and analysed in AAS. Iron bioaccessibility was 84.4% for a genotype with 32 ppm iron and 96.4% for a genotype with 15.4 ppm iron. Zinc and calcium were practically completely released into solution under acidic conditions.

IIMR/CP/2023-27: Biochemical characterization of iron and zinc rich pearl millet genotypes and their relationship with rancidity, anti-nutrients and seed quality (PI: R Venkateswarlu)

Pearl millet grains when milled into flour develop rancidity very quickly (7-10 days) due to lipolytic enzymes coming into contact with their substrates. Lipase initially releases fatty acids from glycerol which further undergo oxidative and hydrolytic rancidity. Alcoholic acidity (AA) is a simple test for estimation of free fatty acids. However, samples containing more than 10% protein content were very difficult to filter and gave erroneous values. Hence, a modified methodology was applied to pearl millet samples. An experiment with seven lines

was under taken to identify the storage period at which alcoholic acidity can differentiate rancidity development in flour. Flour samples were stored and sampled on 0, 3, 7, 10 and 14th day for alcoholic acidity. Alcoholic acidity on 7th day of storage was found to provide a better differentiation of lines for rancidity development. Alcoholic acidity estimation of 97-R lines and 33-B lines was variable in the range of 0.07 to 0.34 with a mean of 0.15 g sulphuric acid/100g of sample. Alcoholic acidity at two different locations (Hyderabad and Tirupati) had a very strong positive correlation of 0.823 (Fig. 2.11).

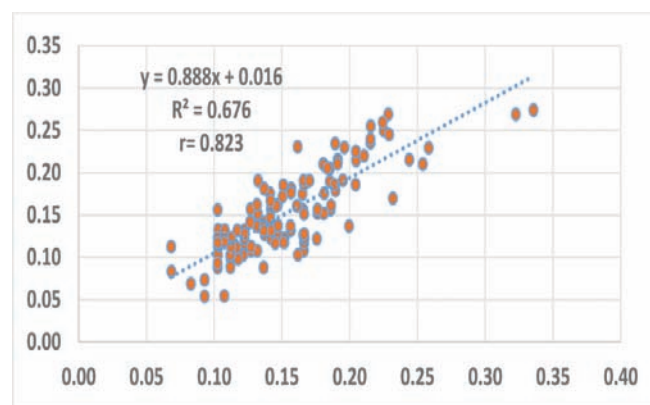


Fig. 2.11. Alcoholic acidity correlation between locations (Hyderabad and Tirupati)

Lines with high and low alcoholic acidity were selected for further analysis of lipase activity (LA). Lipase activity in thirty lines was in the range of 2.6 to 16.8 units showing significant variability. Alcoholic acidity on 7th day had very strong positive correlation with lipase

activity ($r=0.905$). Similarly, lipase activity at two different locations Hyderabad and Tirupati also showed very strong positive correlation ($r=0.884$) which indicated consistent expression of lipase enzyme in inbred lines of pearl millet.

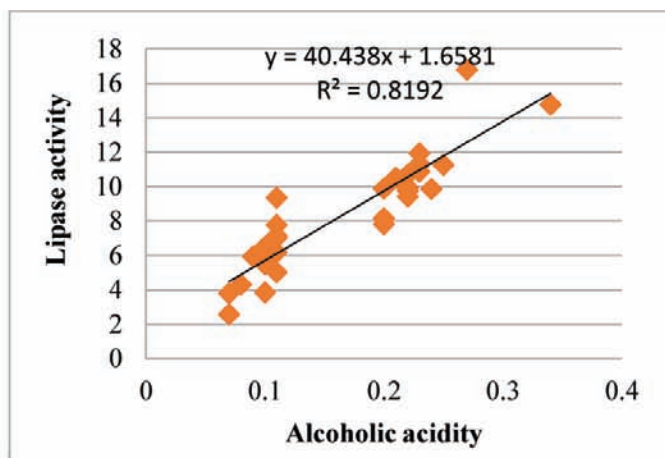
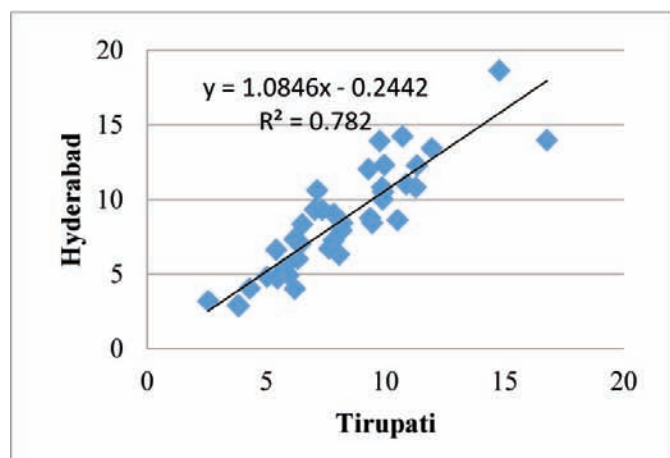


Fig. 2.12. Lipase activity correlation between locations (Hyderabad and Tirupati) and correlation between lipase activity and alcoholic acidity

IIMR/FF/2021-2026/154: Nutritional composition, phenolic profile and bioactivities of sorghum, foxtail, kodo and proso millet grains (PI: VM Malathi)

Nutritional compositional analysis of sorghum landraces - A total of 46 landraces of sorghum (named as KLT 37 to 80, KLT 86 & 87) were analysed for grain nutritional composition. Proximate analysis revealed that the protein content ranged from 7.7 ± 0.38 to $15.2 \pm 0.44\%$. A total of 12 landraces viz. KLT 55 ($13.46 \pm 0.32\%$), KLT 58 ($13.33 \pm 0.42\%$), KLT 60 ($12.90 \pm 0.26\%$), KLT

63 ($12.35 \pm 0.41\%$), KLT 64 ($13.63 \pm 0.47\%$), KLT 66 ($13.10 \pm 0.34\%$), KLT 67 ($13.58 \pm 0.07\%$), KLT 69 ($12.44 \pm 0.00\%$), KLT 70 ($15.23 \pm 0.44\%$), KLT 74 ($12.88 \pm 0.31\%$), KLT 76 ($13.50 \pm 0.11\%$) and KLT 80 ($13.29 \pm 0.47\%$) recorded $>12\%$ protein. The fat content of land races ranged from $0.99 \pm 0.06\%$ to $3.62 \pm 0.26\%$. The highest ash content recorded was $3.68 \pm 0.07\%$ (KLT 71). The moisture content of the sorghum landraces ranged from 10.02 ± 0.02 to $13.26 \pm 0.29\%$. The summary of proximate analysis is presented in Table 2.4.

Table 2.4. Summary of proximate composition of sorghum landraces

Sl. No.	Proximate principle	Content (g/100 g)	Highest content	Lowest content
1	Moisture	10.02 ± 0.02 to 13.26 ± 0.29	KLT 58	KLT 48
2	Crude fat	0.99 ± 0.06 to 3.62 ± 0.26	KLT 66	KLT 42
3	Crude protein	7.71 ± 0.38 to 15.23 ± 0.44	KLT 70	KLT 51
4	Total ash	1.47 ± 0.16 to 3.68 ± 0.07	KLT 71	KLT 78

Fe and Zn content of sorghum land races

The Fe and Zn content of sorghum land races were determined by microwave digestion followed by atomic absorption spectroscopy. The Fe content ranged from 13.97 ppm (KLT 75) to 34.72 ppm (KLT 55) and the Zn

content ranged from 15.18 ppm (KLT 75) to 42.71 ppm (KLT 64). Two land races, KLT 64; and KLT 66 recorded Zn content > 40 ppm (Fig.2.13a, b).

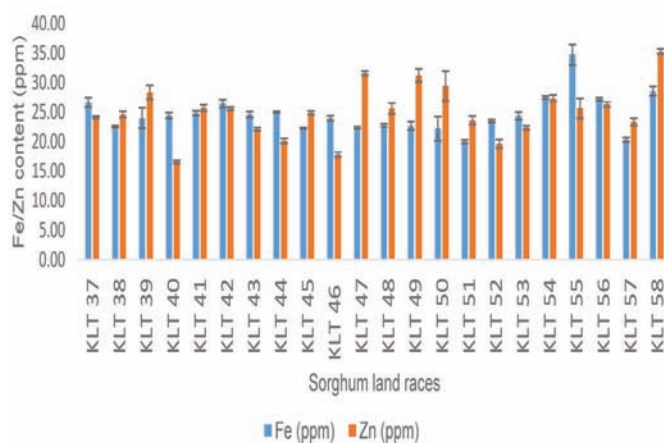


Fig. 2.13 a. Fe and Zn content of sorghum land races

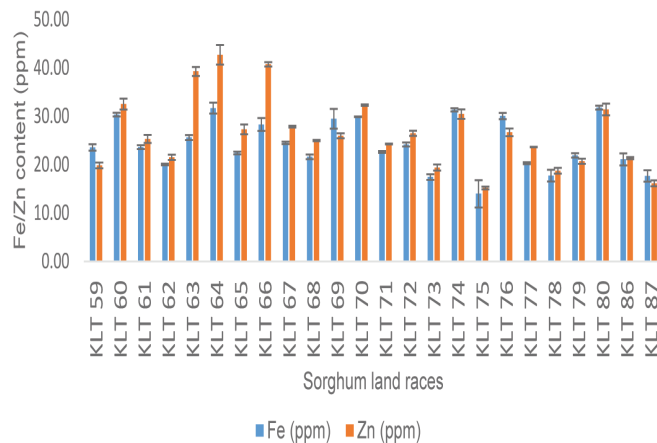


Fig. 2.13b. Fe and Zn content of sorghum land races (contd)

Tannin content of sorghum land races

The content of tannin (an antinutrient) of the sorghum land races as estimated by vanillin-HCl method ranged from 0.181% CE (KLT 66) to 1.598% CE (KLT 76).

Amylose content of sorghum land races

Amylose content is an important biochemical parameter which decides the end use of sorghum grain. Determination of amylose content in sorghum landraces showed that the values ranged from 7.03% (KLT 58) to 21.39% (KLT 65).

IIMR/FF/2021-2026/153: Biochemical characterization of millets and millet food products for nutraceuticals and health benefits (PI: VM Malathi)

Malting of Barnyard millet grains for improved protein digestibility

Two varieties of barnyard millet grains, DHBM93-3 and VL-172 were used in the study. Malting process include three steps soaking, germination and kilning (Fig. 2.14 a, b,c); To study the optimum malting conditions for improved protein digestibility in barnyard millet, eight treatments (T1-T8) involving two soaking times (18h and 24h), four germination times (36h, 60h, 82h, 106h) and a uniform kilning time of 24h were used. Raw grains of each variety served as control. Crude protein content and *in vitro* protein digestibility were studied for all the treatments and compared with corresponding control.

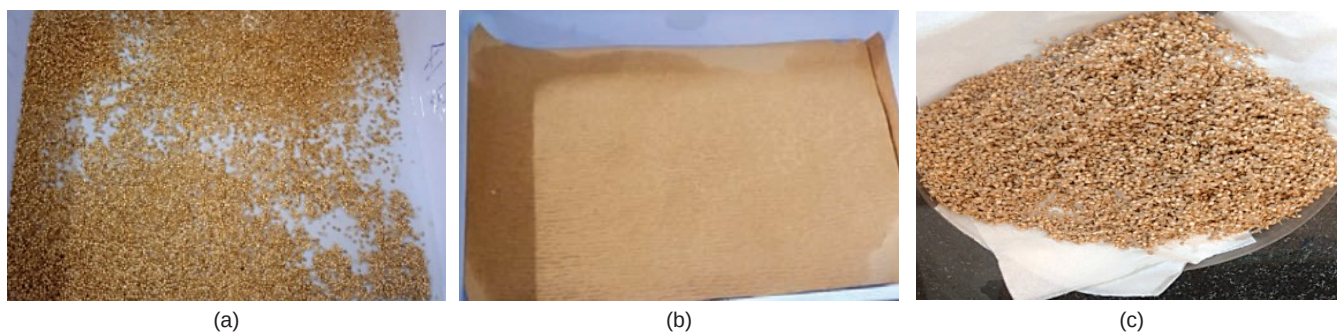


Fig. 2.14. Malting setup: (a) soaking, (b) germination (c) after kilning

The results showed that crude protein content of DHBM 93-3 ranged from 9.45±0.79% (T1) to 11.70±1.18% (T3) while, control (dehulled, raw DHBM 93-3) had a protein content of 10.76±0.18%. The crude protein content of VL-172 ranged from 12.19±0.60% (T4) to 13.06±0.41% (T7) while the control grains had a protein content of 12.28±0.04%.

The results of IVPD showed that the protein digestibility values of all the treatments were higher (72.33±1.25% in T1 to 77.84±3.70% in T4) as compared to control (49.75±1.21%) in DHBM 93-3 (Fig. 2.15a). The IVPD results for VL-172 also showed a similar trend of higher digestibility in treatments (65.84±3.02% in T1 to 74.94±3.32% in T6) as compared to control (53.95±1.25%) (Fig. 2.15b).

This malting is found to be a good strategy to improve the protein digestibility; the conditions for malting have

to be further optimised by considering the yield, malting loss and sensory attributes.

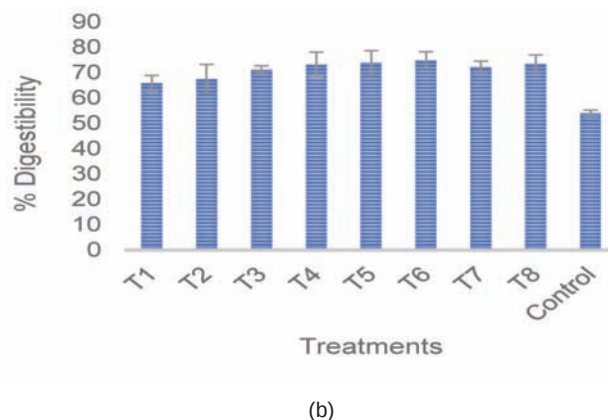
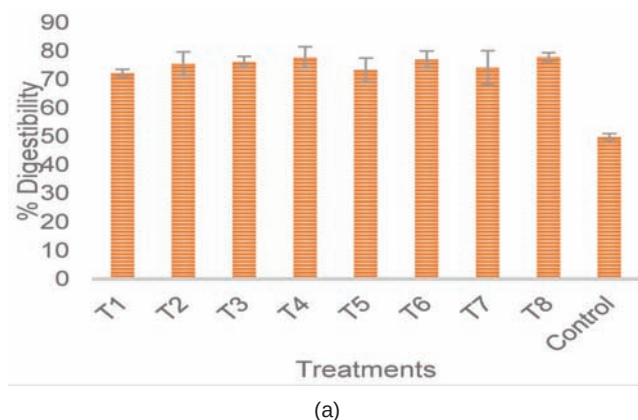


Fig. 2.15. (a) IVPD of DHBM 93-3 (b) IVPD of VL-172

3. Host Plant Resistance Against Insects and Diseases

3.1. Insect management

IIMR/ PP/2023-2028/166: Exploring new plant traits for resistance against major insect pests in millets (PI: A Kalaisekar)

Shoot fly egg structure: Structural adaptations in eggs of shoot flies are very important traits that facilitate the survival and successful hatching of young ones in the phytic environment. Microscopic observations to explore the structure of shoot fly eggs collected sorghum seedlings (variety DJ-6514) using ZEISS Stereo Discovery V20. At 75x magnification, revealed the adaptability of egg surface reliefs to the plant surface with distinct sculpturing, reticulate pattern of hexagonal cells having hydrophobic surfaces. The eggs were cigar shaped, cylindrical, slightly curved, and tapered at one end. Their surface exhibited fine reticulations or sculpturing, likely aiding in attachment to the plant surface. Freshly laid eggs were whitish in colour, gradually darkening as they matured. The eggs were laid singly on the lower surface of leaf like leaf blade, typically near the midrib or the shoot apex.

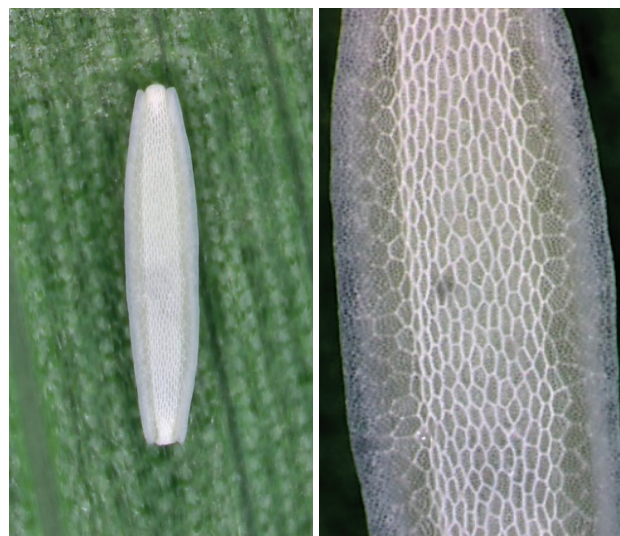


Fig. 3.1. Structure of the shoot fly egg (a) 75x (b) 150x magnification

Parasitoid morphology: Documented the morphological characteristics of Eulophidae parasitoid, *Neotrichoporoides nyemitawus* collected from shoot flies in various millets and alternate hosts like *Cynodon dactylon*. These eulophid size ranging from 1-2 mm in length. The differences between male and female Eulophidae parasitoids include males having more elaborate antennal structures, often with additional segments or specialized sensory features like whorls or setae, which aid in detecting pheromones. In contrast, female antennae are less elaborate and are adapted for locating hosts rather than mates. The head is yellow in colour, and the eyes are distinctly red. The antennal funicle consists of three to four segments.

The tarsi are four-segmented in both sexes, a defining characteristic that differentiates these chalcids from the closely resembling pteromalid group. Additionally, the four-

segmented tarsi are characterized by a short and straight protibial spur.

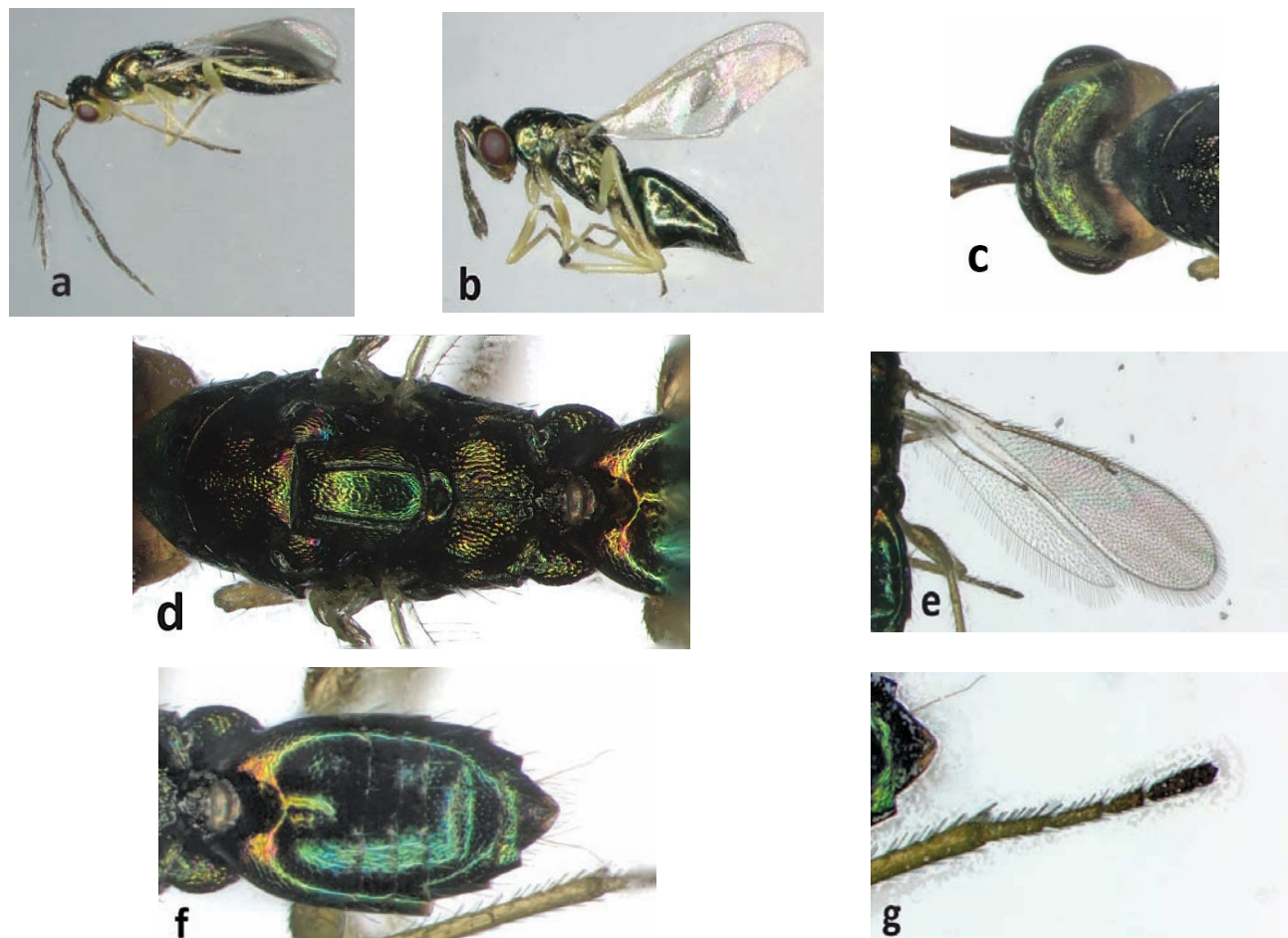


Fig. 3.2. *Neotrichoporoides nyemitawus* (a) adult- Male; (b) adult- Female; (c) Head, dorsal view; (d) Mesosoma dorsal view; (e) Wings, dorsal view; (f) Metasoma, front view; (g) Hind leg, four segmented tarsi

IIMR/CPT/2020-2025/133: Understanding the host pest interactions of shoot fly, stemborer and fall armyworm in millets and management through semiochemicals (PI: PG Padmaja)

Oviposition preference of *Spodoptera frugiperda* in millets

A total of nine millets were grown in pots. The genotypes were sown at a density of 6 plants per pot. For standardization of the experiments, plants were used when they had 8 to 10 completely expanded leaves. The experiments were performed inside screened

cages (5 × 4 × 2.5 m, length, width, and height). Pots were exposed for oviposition. The FAW moths were first reared in the laboratory on the artificial diet until the adult stage. After the start of oviposition in the laboratory, the moths were released inside the cages at the beginning of scotophase in a density of 10 pairs in the cage. Moths were provided with sucrose solution. The plants were observed daily for oviposition (Fig. 3.3). FAW preferred sorghum followed by barnyard millet for oviposition. A total of 4 egg masses were laid on sorghum and two egg masses were laid on Barnyard (Table 3.1).

Table 3.1. Oviposition of FAW in millets

Millet	Genotype	No. of FAW egg masses
Barnyard millet	IEC 53	2
Proso millet	IPM 2229	1
Little millet	OLM-203	-
Foxtail millet	SIE 1598	1
Kodomillet	KOPKM 5	-
Finger millet	KMR 204	-
Pearl millet	HHB 67	1
Browntop millet	IIMR AK2	-
Sorghum	DJ 6514	4

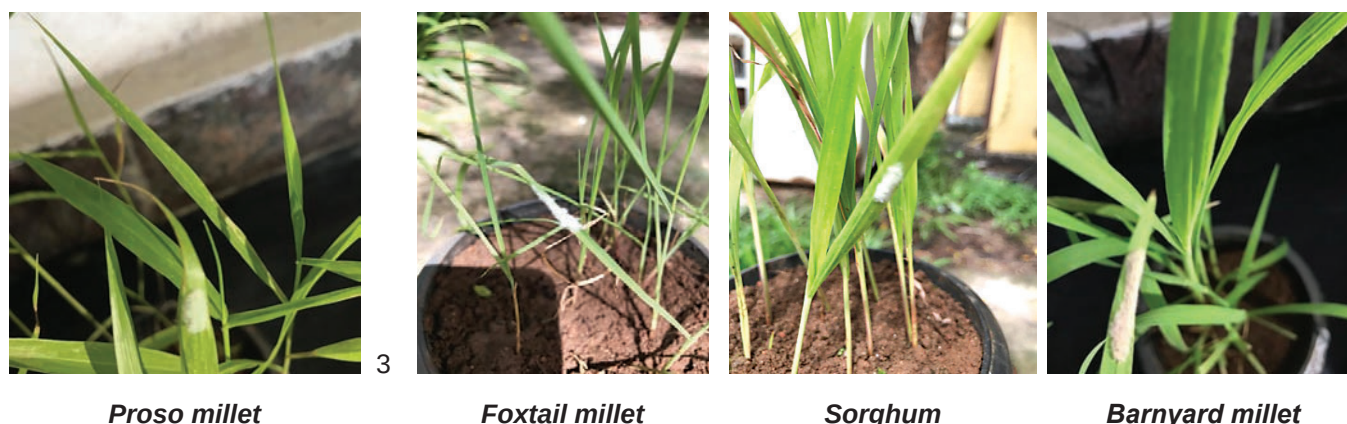


Fig. 3.3. Oviposition of FAW in millets

Nutritional indices of FAW larvae on sorghum

Nutritional indices of FAW larvae was studied on nine sorghum genotypes (five forage and four sweet sorghum). Larvae reared on CSV19SS recorded the highest value of CI and AD. The lowest value of CI was on CSV 33M F (Table 3.2)

Table 3.2. Nutritional indices of FAW larvae on sorghum

Genotype	Index (mean $\pm$ SE)	
	Consumption Index (CI)	Approximate Digestibility (AD)
CSV 30 F	1.33 $\pm$ 0.42b	56.21 $\pm$ 6.47b
CSV 32	1.16 $\pm$ 0.25b	59.91 $\pm$ 9.52b
CSV 33M F	0.93 $\pm$ 0.37b	69.54 $\pm$ 9.72ab
UPMC 503	1.33 $\pm$ 0.28b	64.73 $\pm$ 4.20ab
CSV 21 F	1.66 $\pm$ 0.22b	68.85 $\pm$ 6.39ab
CSV 24 SS	1.43 $\pm$ 0.23b	61.85 $\pm$ 3.01b
SSV 84	1.09 $\pm$ 0.51b	54.52 $\pm$ 13.31b
SSV 74	1.04 $\pm$ 0.23b	65.08 $\pm$ 9.09ab
CSV 19 SS	3.49 $\pm$ 0.50a	80.41 $\pm$ 12.47a

Egg - larval parasitisation of FAW in millets

Parasitization potential of egg-larval parasitoid, *Chelonus* sp on fall armyworm in millets was studied during *kharif* 2024 (Fig. 3.5). Biocontrol potential in terms of per cent parasitization was estimated on the field sampled fall armyworm egg masses and found that per cent parasitization was more in sorghum, proso millet and foxtail millet (Fig. 3.4).

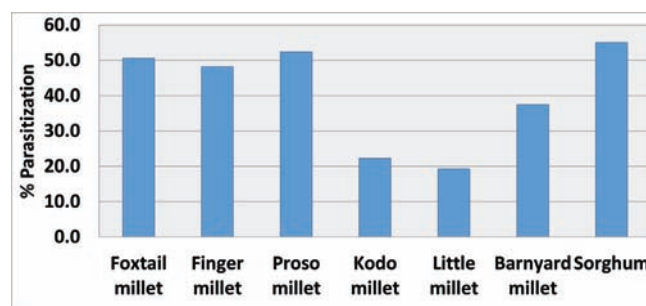
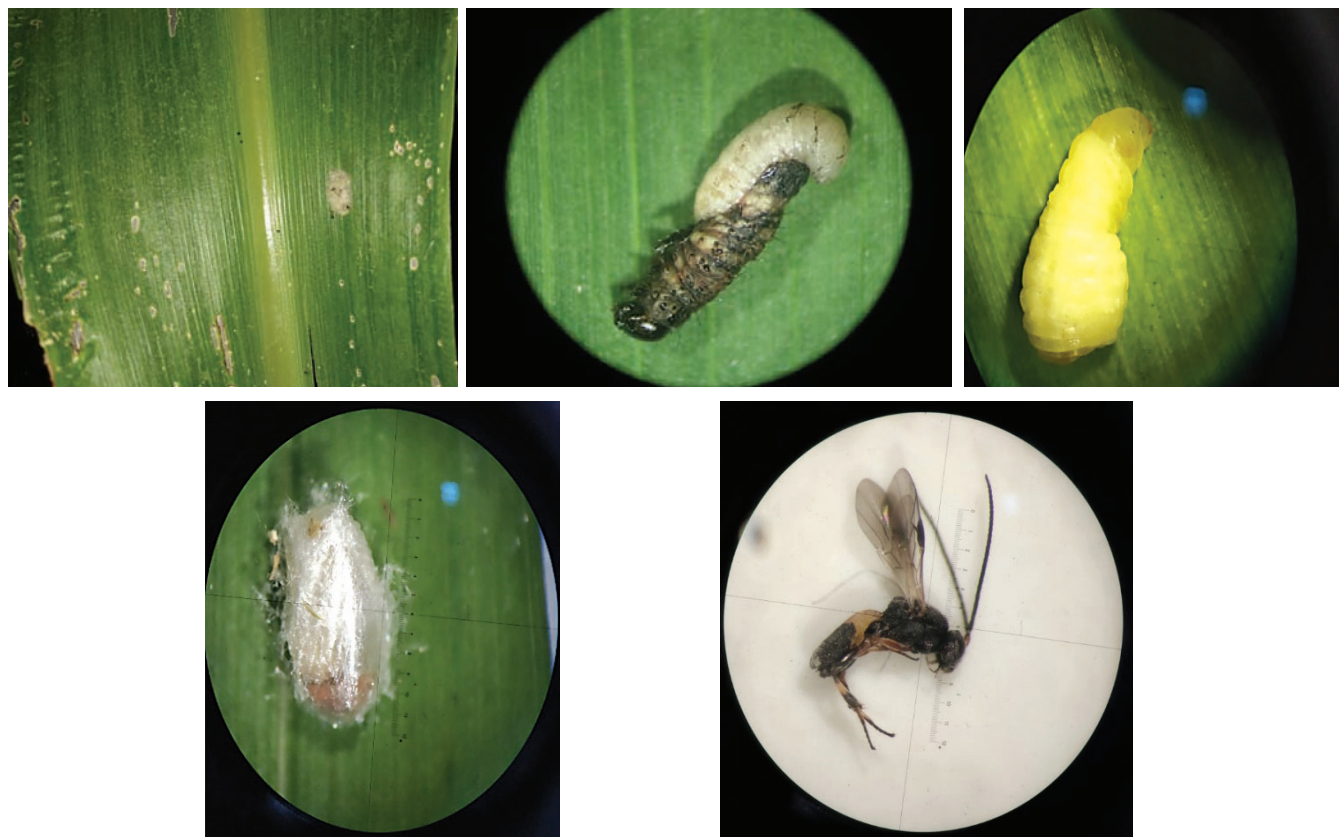


Fig. 3.4. Parasitization of *Chelonus* sp in millets



a. Eggmass of FAW; b. Parasitized FAW larva; c. grub; d. pupa; e. adult *Chelonus* sp

Fig. 3.5. FAW larva parasitized by *Chelonus* sp

IIMR/ CPT /2020-2025/131: Yield loss assessment in Millets due to invasive Fall army worm, (*Spodoptera frugiperda* J. E. Smith) and its integrated management with special emphasis on sorghum (PI: G Shyam Prasad)

Fall armyworm pest situation

The foliar damage caused by fall armyworm on scale of 1-9 during *kharif* 2023, ranged from 1.0 - 3.5. The states of Punjab and Haryana recorded the least damage (1.0) while Gujarat, Rajasthan recorded moderate damage (1.5) whereas Telangana and Karnataka recorded damage to the tune of 2.0 score. Highest incidence was observed in Maharashtra (3.0) and Madhya Pradesh (3.5).

In *rabi* 2023-24, the foliar damage ranged from 3.0 - 3.5 scale, indicating that fall armyworm is emerging as major *rabi* sorghum pest. Maximum damage was observed in Telangana, Karnataka (3.5) followed by Maharashtra (3.0). Overall incidence of fall armyworm was high in *rabi* season compared to *kharif* in sorghum (Fig. 3.6).

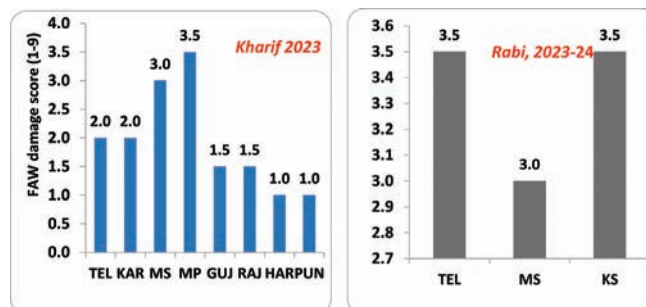


Fig. 3.6. Fall armyworm pest situation (2023-24)

Population fluctuation of Fall armyworm (2023-24)

Population fluctuation of fall armyworm, *S. frugiperda* in sorghum was studied from 25th SMW of 2023 to 14th SMW of 2024 by deploying pheromone traps @ 6 /acre (Fig. 3.7). Four peaks were observed coinciding with 35, 47nd (2023), 1, 4th SMW (2024). The data indicated presence of overlapping generations (3-4). The pest prefers vegetative stages of crop i.e, upto panicle initiation unlike maize wherein it is present throughout the crop season.

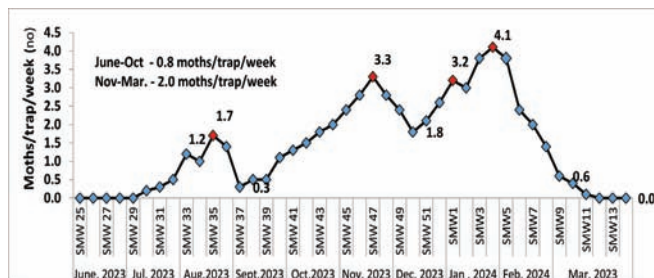


Fig. 3.7. Population fluctuation of fall armyworm in sorghum IIMR, Hyderabad (2023-24)

Evaluation of sorghum against Fall armyworm (Rabi, 2023-24)

Thirty sorghum entries varieties, germplasm lines were screened against FAW under natural infestation. Based upon the whorl damage at 60 DAE the entries Rampur local, CSV 39, IS 4581 recorded whorl damage ranging from 0 - 10.0%. The entries Hathi kunta, IS 12697, C 43, CSV 21F, IS 12735 and Phule Vasuda were very susceptible based on whorl damage which is an important damage assessing parameter (Fig. 3.8).

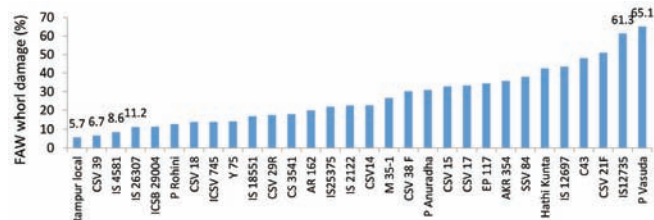


Fig. 3.8. Evaluation of sorghum against fall army worm (Rabi 2023-24) under natural infestation

The entries, Rampur local, CSV 39, IS 4581 were tolerant to *S. frugiperda* with less than 10% whorl damage.

Table 3.3. Validation of FAW management module in sorghum using biocontrol agents (ICAR-IIMR-Hyderabad) - Rabi 2023-24

Treatment	Egg patches/20 plants (20 DAE) *	Larvae/20 plants (35 DAE) *	FAW (1-9) *	Whorl damage (%) (45 DAE)**	Grain Yield (t/ha)	Fodder yield ((t/ha)
T1	0.75 (1.31) ^b	0.75 (1.31) ^b	1.7 (1.65) ^b	11.66 (19.87) ^a	3.35 ^a	6.69 ^a
T2	0.58 (1.24) ^a	0.58 (1.24) ^a	1.3 (1.49) ^a	15.55 (23.00) ^b	3.13 ^a	6.55 ^a
T3	1.25 (1.49) ^c	2.0 (1.73) ^c	2.6 (1.88) ^c	25.86 (30.24) ^c	2.80 ^b	5.93 ^b
CD (0.05)	0.168	0.157	0.144	2.79	0.26	0.64
P = (0.05)	0.00	0.00	0.014	0.00	0.001	0.04
CV (%)	14.65	12.88	10.08	13.44	10.07	11.84

*Figures in parentheses are square root transformed values; **Figures in parentheses are Arc sine transformed values

Validation of bio-control module for management of Fall armyworm in sorghum (Rabi, 2023-24), IIMR

For the management of fall army worm biocontrol agents were tried during 2019,2020 in collaboration with NBAII. The biocontrol agents comprised of egg parasitoid, *Trichogramma chilonis*, use of entomopathogenic bacteria, *Bacillus thuringensis*, entomopathogenic fungus, *Metarhizium. anisopliae* NBAIR -Ma 35, entomopathogenic nematode, *Heterorhabditis indica* NBAIR H38, growth promoting bacteria, *Pseudomonas fluorescens* (Pf DWD 1%) and use of pheromones, with insecticidal check and untreated control. The treatment combinations comprising of *Trichogramma pretiosum* + *M. anisopliae* NBAIR -Ma 35, 0.5% (3 sprays) 1st spray after 20-25 DAS & then at 10 days intervals was found to be effective. Hence this was validated for second year in rabi 2024 in large plots. The details of experiment were as follows:

T1: Release of *T. chilonis* @ 1 card/acre, twice (first release one week of planting & second one after one week of first release + spray of *M. anisopliae* (Ma 35) 0.5% at 20, 35 DAE

T2: Standard Plant protection practice (Seed treatment with Fortanza duo 5ml/kg seed) + application of Chlorantraniprole (18.5% SL) @ 0.3 ml/L (30 DAE of this experiment)

T3: Control

Release of *T. chilonis* one card/acre twice at weekly intervals followed by spray of *M. anisopliae* (Ma 35) 0.5% at 20, 35 DAE was found to decrease the egg patches/10 plants (0.75), larvae numbers per 10 plants (0.75) and whorl damage (11.66%) significantly over the recommended package of practice (Table 3.3). There, was 36, 55% reduction in whorl damage over the recommended package of practice and control (control) respectively.

There was no significant difference in grain yield in T1 and T2 but were superior to T3. There were 7.03 and 19.6% increase in grain yield over the recommended package of practice and control respectively. In case of fodder yield also there was no significant difference in T1 and T2 but were superior to T3 (control). There, was 2.1, 12.8% increase in fodder yield over the recommended package of practice and control respectively.

IIIMR/CPT/2020-2025/134: Integrated Pest Management for major shoot pests of sorghum during post rainy season in dryland ecosystem (PI: B Subbarayudu)

A field trial was carried out to find out the incidence of major insect pests of sorghum during *rabi* 2023-24 at center on *rabi* sorghum Solapur, Maharashtra. The experiment was carried out with the cultivars (24) viz., (CSV 18, CSV-26, CSV-14, CSV-29R, CSV-216R, Phule Revati, Phule Vasudha, Phule Suchitra, Phule Anuradha, Parbhani Moti, PKV Kranti, DSV-4, DSV-5, Solapur Dagadi, Selection-3, CSH-15R, Katar Khatav, Hathi Kunta, M35-1, IS-18551, Y-75, DJ-6514, IS-2205 and Swarna) and replicated five times. All the improved management practices were adopted to raise the crop successfully. Promising genotypes for shootfly: CSV 216 R, CSV14, Phule Revati, Phule Anuradha, DSV 4, Katar Khatav & M 35-1. Promising Genotypes for Stem borer: IS 2205, Y 75, M 35-1 & IS 18551. Promising genotypes for shoot bug: Y 75, CSV 26, CSV 29 R.

To find out the cost effective Integrated Pest Management technology for the major shoot pests of sorghum during post rainy season in dryland region of Solapur, trials were carried out in three modules: The modules, namely, Module 1: (Chemical Based Module 1): CSV 29 R, high seed rate @ (10 kg/ha), ST with Imidacloprid @6 ml/kg of sorghum seed, Fipronil 0.3 GR @ 7.5 kgs/ha (whorl application at 21 Days After Germination (DAG)) & Eamectin benzoate 5% SG (0.3 g/lit of water) (35 DAG). Module 2: (Biointensive Based

Module 2): CSV 29 R, ST with Thiomethoxam 19.8 w/w (6 ml/kg of seed) + Cyantranilprole 19.8 w/w @ 6 ml/kg of seed, release of egg parasitoid, *Trichogramma chilonis* released twice at 20 & 30 DAG @ 125000/ha, Spray of entomopathogenic fungi, (1 x 105 ml/1), (Ma 35) @ 5ml/liter (NBAIR Collaboration) at 45, 60 DAG. Module 3: (Farmer's Practice Based Module 3): CSV 29 R, Seed rate @ 7.5kgs/ha; Eamectin benzoate 5%SG @ 0.3 g/lit of water at 30 DAG. The shoot fly eggs and deadhearts were recorded at 21 days after germination (DAG), stemborer deadhearts recorded at 45 days after germination and shoot bug adults recorded at 60 days after germination (DAG). All agronomic practices were adopted to raise the crop successfully. Of the 3 modules, the grain yields/ha were recorded highest in chemical based module (3.35 tonnes/ha; biointensive module (3.20 tonnes/ha) and with farmers practice (1.95 tonnes/ha). Biointensive module comprised the use of CSV 29 R, ST with Thiomethoxam 19.8 w/w (6 ml/kg of seed) and Cyantranilprole 19.8 w/w @ 6 ml/kg of seed, release of egg parasitoid, *T. chilonis* released twice at 20 and 30 DAE @ 125000/ha and spray of entomopathogenic fungi, *Metarhizium anisopliae* (1 x 105 ml/1), (Ma 35) @ 5ml/litre at 45 and 60 DAE which were found ecofriendly and safety point of view thereby reduced the use of chemical based insecticides.

Economics of these modules calculated and found that chemical based module observed cost effective and is profitable (B:C Ratio = 1:1.80); biointensive module (B:C Ratio = 1: 1.66) and farmer's practice (B:C Ratio = 1: 1.20). The avoidable grain yield loss due to shoot fly was 21.4% in M 35-1.

IIIMR/ PP/2023-2026/167: Popularization of pearl millet in rice fallows of Krishna Godavari Basin, along with study of socio economics, marketing opportunities and biotic stress tolerance under zero tilt conditions (PI: B Subbarayudu)

Evaluated 11 pearl millet hybrids in rice fallows under zero tilt conditions during *rabi* 2023-2024 and the sowing was carried out on 13th December, 2023. Total No of cultivars: (11) viz; 04999 A x 128 R; 296 A x 136 R; 843-22A x 129 R; 269 A x 1458 R; 04999 A x 1012 R; 221 A x 300 R (Hybrid); 291 Ax303R (Hybrid); Kaveri Super Boss (Check); Pratap (Check); PB 1756 (Check); AHB 1200 (Biofortified check) with spacing of 45 x 22 cm at Davuluru village of Guntur district Andhra Pradesh. The

grain yields of pearl millet /ha ranged from 3.75 t /ha (04999 A x 128 R) to 4.14 t/ha (04999 A x 1012 R).

Table 3.4. Yield potentials of pearl millet hybrids grown in rice fallows of Guntur district during rabi 2023-24

Sl. No.	Hybrid	Grain yield/ Plant (g)	Grain yield /ha (tonnes/ha)
1	04999 A x 128 R	25.0	3.75
2	296 A x 136 R	25.5	3.83
3	843-22A x 129 R	25.2	3.78
4	269 A x 1458 R	25.6	3.84
5	04999 A x 1012 R	27.6	4.14
6	221 A x 300 R	25.8	3.87
7	291 A X 303 R	25.6	3.84
8	Kaveri Super	25.8	3.87
9	Pratap	26.0	3.90
10	PB 1756	25.4	3.81
11	AHB 1200	25.2	3.78



Fig. 3.9. Field day organized on pearl millet cultivation, production, productivity and value addition at Davuluru village of Kollipera Mandal, Guntur District, AP on 21.02.2024

IIMR/CPT/2020-2025/132: Risk of pesticide sprays on sorghum: Acute and field toxicities on stem borers and shoot bug and their natural enemies (PI: J Stanley)

Chlorantraniliprole with 1.03 ppm LC_{50} followed by spinetoram was found very effective against third instar larva of stem borer, *Chilo partellus*. Likewise, chlorantraniliprole, emamectin and spinosad were found effective against Pink borer, *Sesamia inferens*. Broflanilide was found effective against shootbug in shoot dip bioassay studies.

The risk of pesticides sprayed on sorghum for the parasitoid, *Cotesia flavipes* with reference to toxicity to

Chilo partellus and *Sesamia inferens* was studied using selectivity ratio, probit substitution method and hazard ratio. Insecticides like emamectin, flubendiamide, chlorantraniliprole, and spinosad were found safer to *Cotesia* in selectivity ratio.

Based on field use Environmental Impact Quotient, insecticides like Fipronil, Thiacloprid and Pymetrozine were found to pose risk to the producer/ farmer. Insecticides like Pymetrozine and thiacloprid are toxic and pose risk to the consumer

Chlorantraniliprole was found very effective in reducing the shot holes in sorghum upto 78.38% followed by spinosad and flubenidamide. Chlorantraniliprole was found to reduce the deadhearts caused by stemborers followed by spinosad and fipronil. None of the insecticide tested was found to leave any residues either in stover or grain of sorghum at harvest time and found safer.

IIMR/CP/2024-2027/173: Mechanism of resistance and effect of Controlled Atmospheric Storage (CAS) in stored grain pest management in millets (PI: J. Stanley)

Screening of small millet cultivars for important stored grain pests

Laboratory screening of small millet cultivars for important stored grain pests was under progress. The stored grain insect pests were viz., rice weevil, *Sitophilus oryzae*; red flour beetle, *Tribolium castaneum* were preconditioned (Growing them for two generations on the sorghum grains). The resultant F_2 progeny were used for the experiment. Ten grams of dehulled grains of small millets were used and ten adults of *S. oryzae* were released into jars containing five different varieties of each small millet viz., foxtail millet (CFXMV-1, HMT-100-1, SiA-3085, SiA-3088, SiA-3156), browntop millet (AK-1, AK-2, GPUTB-6, HBr-2, BTV-44), little millet (IIMR-LM R25-4528, IIMR-LM R23-4527, IIMR-LM R23-4525), kodo millet (JK -106, JK-13, JK-137, JK-155, CO3), barnyard millet (CO1, VL 207, CBYMV-1, DHBM-93-3, MDU-1) and proso millet (IIMR-PM-HP-59, IIMR-PM-HP-188, IIMR-PM-10, IIMR-PM-137, IIMR-PM-163). The data are being collected at weekly intervals such as grain weight, no of insects, weight of dead insects etc. The progeny emergence was high in proso millet (PM-

HP-59 and PM-HP-186) and kodo millet (JK 106). Whereas no progeny emergence was observed in brown top and little millet.

Effect of packaging material on grain storage of small millets

Foxtail millet grain was dehulled and packaged with six different packaging materials. The experiment was conducted with six treatments viz., PET NPT, PET NPT + Vacuum, PET NPT + N₂ filling, MET PET, MET PET + vacuum and gunny bag. Each treatment was replicated seven times with 1kg of grains per replication. Data on insect infestation are being taken after 1, 2, 3, 6 and 8 months after storage. Insect infestation (*Sitophilus oryzae*, *Tribolium castaneum* and *Corcyra cephalonica*) was found very high in gunny bag. In MET PET and MET PET + vacuum insect infestation was not found. Biochemical parameters like total protein content, grain phytic acid content and alcoholic acidity were under assessment to assess the storability of grains.

3.2. Disease management

IIMR/CPT/2021-2026/151: Virulence and host plant resistance studies on important diseases of millets (PI: IK Das)

Identification of rust resistant donors for foxtail millet

Rust is an economically important disease of foxtail millet causing severe rusting of the leaves and damage to the crop (Fig. 3.10). Identification of resistance donor is important for development of rust resistant varieties. A total of 181 foxtail millet genotypes comprised of 179 germplasm accessions, one rust resistant (ISe1177) and one susceptible (SiA 326) check, were evaluated in replicated field trials across six environments. The environments were Vizianagaram (VY1 & VY2), and Bengaluru (BY1 & BY2) for 2 seasons each, and Nandyal (NY1), and Mandya (MY2) for one season each. Data were recorded using a 1 to 9 scale (1 highly resistant, 9= highly susceptible). For data analysis transformed values (Transformed values= 10 minus original values) were used so that greater values become desired as in yield. Eighteen genotypes exhibited rust resistance better

or equal to the resistant check and these genotypes were termed as superior rust resistant genotypes. The superior genotypes were further analyzed for stability of resistance using additive main effects and multiplicative interaction (AMMI) model (Fig. 3.11). Suitable environment for screening for rust resistance was identified using genotype and (genotype x environment) (GGE) biplots. Highly significant ($P < 0.001$) effects of genotype, environment, and genotype x environment interactions was observed for rust resistance. A selection index was developed based on combined performance of the genotypes on resistance and stability. Five genotypes were selected as top performers on resistance and stability and were better than the presently used national check ISe1177 (Table 3.5). The sources were IC0479406 (g44), ISe1177 (g213), IC0479317 (g1), IC0479569 (g6), and IC0308976 (g165). Results revealed that the most suitable environment for screening for rust resistance in foxtail millet in India was Bengaluru (Fig. 3.12). This was the first study, in which large number of genotypes of foxtail millet was tested for rust resistance over multiple locations in India. The stable sources of rust resistance can be used as donor in rust resistance breeding program.

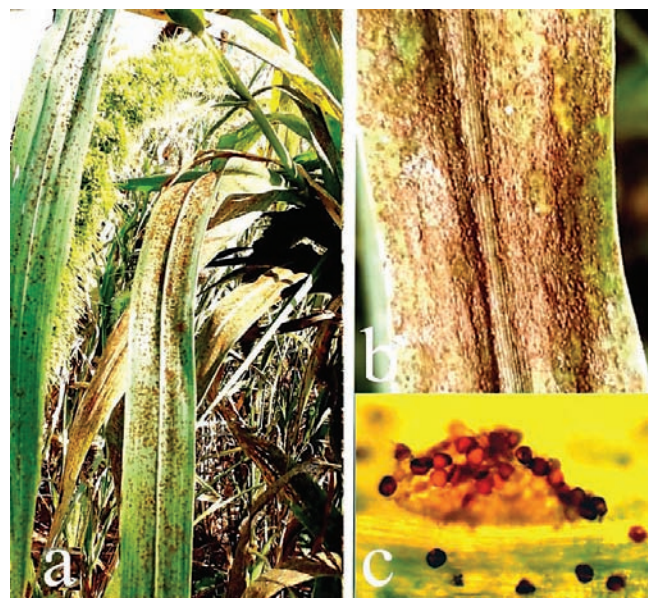


Fig. 3.10. Rust on foxtail millet. a) rust infected plants in a field, b) rust pustules, and c) Sterio-microscopic view of urediniospores in a uredinium

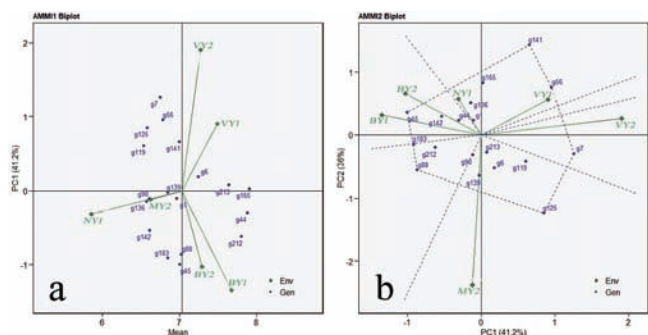


Fig. 3.11. AMMI I (a), and II (b) biplots of 18 foxtail millet genotypes across six environments

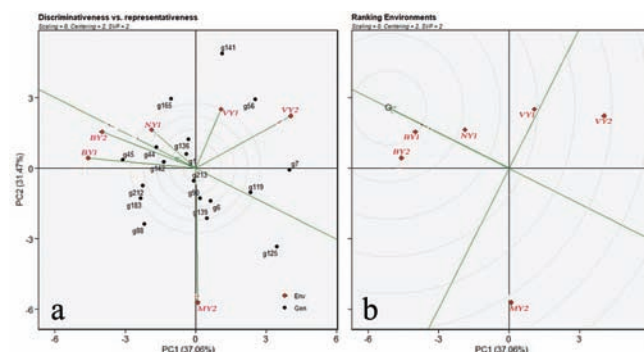


Fig. 3.12. GGE biplots for (a) discriminativeness vs representativeness and (b) ranking of environments for 18 genotypes over six environments

Table 3.5. AMMI stability parameters of superior foxtail millet genotypes for leaf rust resistance

Genotype	Accession No	Transformed rust scores at individual environments [#]						Resistance score	Resistance rank	ASV	ASV Rank	Selection Index
		VY1	VY2	BY1	BY2	NY1	MY2					
g1	IC0479317	7.5	7.3	8.0	8.0	5.0	6.0	7.0	9	0.26	1	10
g6	IC0479569	7.5	8.0	8.0	7.0	5.0	8.0	7.3	5	0.57	6	11
g7	IC0479576	8.5	9.0	5.0	6.0	5.0	7.0	6.8	13	1.47	16	29
g44	IC0479406	9.0	7.3	9.0	9.0	6.0	7.0	7.9	2	0.41	4	6
g45	IC0479713	9.0	4.0	9.0	8.1	6.0	6.0	7.0	7	1.20	14	21
g56	IC0481030	8.5	8.7	6.0	6.0	7.0	4.5	6.8	12	1.33	15	27
g88	IC0403577	6.5	5.7	9.0	8.0	5.0	8.0	7.0	6	1.13	13	19
g90	IC0403586	6.5	6.7	7.0	7.0	5.5	7.0	6.6	15	0.35	3	18
g119	IC0403958	7.5	8.0	6.8	6.0	4.0	7.0	6.5	18	0.81	10	28
g125	IC0404112	7.5	8.0	6.0	5.0	4.0	9.0	6.6	16	1.57	17	33
g136	IC0404242	6.5	7.0	7.0	8.0	6.0	5.0	6.6	17	0.53	5	22
g139	IC0404255	6.5	6.7	7.0	5.9	7.0	8.0	6.9	11	0.65	7	18
g141	IC0404268	9.0	9.0	8.0	7.0	6.0	3.0	7.0	8	1.62	18	26
g142	IC0404282	5.5	6.7	8.0	8.0	6.0	5.5	6.6	14	0.68	8	22
g165	IC0308976	8.5	8.7	8.8	9.0	7.0	5.5	7.9	1	0.83	11	12
g183	IC0120235	5.5	5.7	9.0	7.1	7.0	6.8	6.9	10	1.05	12	22
g212	ISe1745	7.5	6.8	8.8	9.0	6.8	8.0	7.8	3	0.74	9	12
g213	ISe1177 (Resistant)	7.9	7.8	7.9	7.3	7.1	7.9	7.6	4	0.29	2	6
g211	SiA 326 (Susceptible)	2.5	3.5	4.0	4.0	3.7	1.0	3.1	-	-	-	-
LSD (5%)		1.2	0.5	1.1	0.1	0.4	0.5	1.1	-	-	-	-

[#]Transformed scores denote, >8.5 = highly resistant, 6.6-8.5 = resistant, 4.6-6.5 = moderately resistant, 2.6-4.5 = susceptible and <2.5 = highly susceptible.

IIMR/CPT/2020-2025/130: Studies on endophytes for management of major soil-borne diseases of millets (PI: G Rajesha)

Management of banded sheath blight using consortia of bacterial endophytes: The study evaluated the effects of different bacterial consortia on finger millet, kodo millet, and little millet based on plant

height (PT), banded sheath blight severity (BSB), grain yield (GY), and straw weight (ST). In finger millet, the highest plant height (113.33 cm) and grain yield (466 gm) were recorded in T2 (Bacterial Consortia 2) and in little millet, T3 (Bacterial Consortia 1 + 2) resulted in the highest grain yield (364.88 gm) which was on par with chemical control. In Kodo millet, the highest

grain yield (564.13 gm) was achieved in T1 (Bacterial Consortia 1), whereas the lowest disease severity (38.89%) was seen in Nativo which is significantly different with other consortia treatment.

The consortia treatment T3 (Bacterial Consortia 1 + Bacterial Consortia 2: SEB15 + FMEB-18 + KMEB-12

+ LMEB-23) was found to be the most effective method for managing banded sheath blight in finger millet, kodo millet, and little millet. This treatment significantly reduced disease severity while enhancing plant growth and yield across all three millets (Table 3.6).

Table 3.6. Evaluation of endophytic bacterial consortia against banded sheath blight in small millets

Treatments	Finger millet				Kodo millet				Little millet			
	PT	BSB PDI	GY (Gm)	ST (kg)	PT	BSB PDI	GY (Gm)	ST (kg)	PT	BSB PDI	GY (Gm)	ST (kg)
T1- Bacterial Consortia 1 (SEB15+ FMEB-18)	101.34	40.56	364.00	3.88	52.78	52.78	564.13	3.08	144.55	73.89	313.50	1.77
T-2 Bacterial consortia 2 (KMEB-12+ LMEB-23)	113.33	46.67	466.00	3.87	67.78	67.78	399.38	3.11	149.70	70.00	269.50	1.83
T3-Bacterial Consortia 1 + Bacterial consortia 2 (SEB15 + FMEB-18+ KMEB-12+ LMEB 23)	107.62	40.00	416.50	4.10	70.00	70.00	523.13	3.41	151.55	75.00	364.88	2.08
Nativo (Positive control)	102.62	33.33	459.00	4.19	38.89	38.89	469.63	3.32	147.70	52.22	337.50	1.95
Control (Negative control)	107.13	77.78	382.25	3.64	93.33	93.33	462.63	3.15	151.90	92.78	257.88	1.85

PT-Plant height, BSB- Banded sheath blight, GY-Grain Yield and SY- Straw yield

Identification of novel biomolecule/s from endophytes through molecular docking

To screen the VOC obtained from SEB15, FMEB-18 KMEB-12 and LMEB-23, to identify the novel biomolecule/s for the management of *R. solani* and *M. phaseolina* through in silico analysis. Among the different metabolite compounds produced by the bacteria, 1,2,4-Triazine-3,5(2H,4H)-dione, 3-Quinolinecarbonitrile, O-Xylene, Methylparaben, Benzyl mandelate, 2-Methoxyresorcinol, 1-Hexanamine, and Benzyl Alcohol were chosen for docking analysis (Table 3.7).

Molecular docking analysis was carried out to evaluate

the binding affinities of the selected compounds present in the crude metabolite extract with the target proteins of *M. phaseolina* and *R. solani* (Table 3.7). The docking parameters including binding free energy depicted the best binding conformations for the ligands with the target protein. The compound, Benzyl mandelate exhibited higher affinity with the amino acids present in the active site of the protein, endoglucanase of *R. solani*, and Endo-beta-1,4 glucanase D of *M. phaseolina* (Fig. 3.13) and novel biomolecule having the property of fungicidal effect for the management of *M. phaseolina* and *R. solani* in millets.

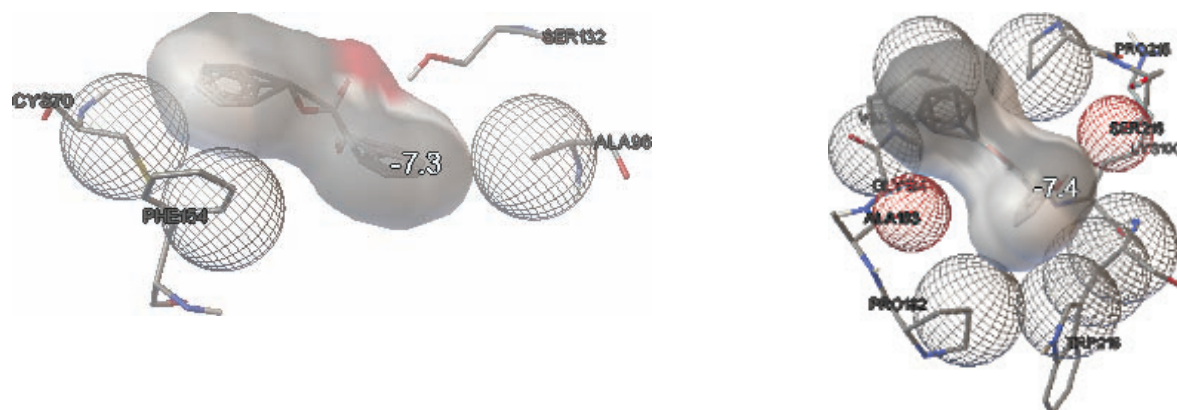


Fig. 3.13. Binding affinity of Benzyl mandelate with a) Endoglucanase of *R. solani*. b) Endo-beta-1,4 glucanase D of *M. phaseolina*

Table 3.7. Binding affinity of target protein with various ligands of elite endophytes

Ligands	Binding Affinity (kcal/mol)	
	Endoglucanase of <i>R. solani</i>	Endo-beta-1,4 glucanase D of <i>M. phaseolina</i>
SEB15		
Benzyl Mandelate	-7.3	-7.4
2-Methoxyresorcinol	-5.1	-4.4
FMEB-18		
1-Hexanamine	-4.4	-4.1
Benzyl Alcohol	-5.0	-5.1
KMEB-12		
1,2,4-Triazine-3,5(2H,4H)-dione	-4.5	-4.4
3-Quinolinecarbonitrile	-6.0	-5.5
LMEB-23		
O-Xylene	-4.5	-4.2
Methylparaben	-5.8	-5.8
Fungicide		
Tebuconazole (Nativo)	-8.0	-6.0

Collection, Isolation and screening of bacterial endophytes of Pearl millet

The pearl millet samples were collected from 5 different growing locations from Rajasthan, Haryana, Gujarat and Karnataka states. A total of 34 bacterial endophytes were isolated from root and stalk pearl millet through sterility check method (Table 3.8). The pearl millet

endophytic bacterial isolates were screened against the *Ralstonia solani* under *in-vitro* condition. Among the tested isolates, PMEB-18 recorded maximum mycelia growth inhibition of 37.04% compared to control.

Table 3.8. Collection of pearl millet samples and isolation of endophytes

SI No.	Place of collection	Part of plant	No. of isolates	Name of the isolates
1	Mandore, Rajasthan	Root	4	PMEB-1, PMEB-2, PMEB-3, PMEB-4
		Shoot	4	PMEB-5, PMEB-6, PMEB-7, PMEB-8
2	Rajasani, Rajasthan	Root	3	PMEB-9, PMEB-10, PMEB-11
		Shoot	4	PMEB-12, PMEB-13, PMEB-14, PMEB-15
3	Jumnagar, Gujarat	Root	3	PMEB-16, PMEB-17, PMEB-18
		Shoot	5	PMEB-19, PMEB-20, PMEB-21, PMEB-22, PMEB-23
4	Hisar, Haryana	Root	5	PMEB-24, PMEB-25, PMEB-26, PMEB-5, PMEB-6
		Shoot	5	PMEB-7, PMEB-8, PMEB-27, PMEB-28, PMEB-29
5	Mysore, Karnataka	Shoot	5	PMEB-30, PMEB-31, PMEB-32, PMEB-33, PMEB-34
			34	

Evaluation of barnyard millet germplasm against leaf blight resistance

Barnyard millet showing the symptom of leaf blight were collected and identified the pathogen responsible for leaf blight. Drying and detachment of leaf symptom was recorded due to infection of *Drechslera* sp., whereas

Curvularia sp. responsible for production of leaf spots on leaf, midrib and sheath regions leads to drying of leaf (Fig. 3.14).



Fig. 3.14. Symptoms of leaf blight in Barnyard millet

a) Drying and detachment of leaf; b) Drying and blighting of Conidia of *Drechslera* and *Curvularia* isolated from leaf blight of Barnyard millet

A total of 562 Barnyard millet germplasms were screened under field conditions for leaf blight resistance during the *kharif* season of 2024. Among them, none exhibited a highly resistant reaction. However, seven germplasms were identified as resistant, showing less than 5% disease severity (Table 3.9). On the other hand, genotype IIMR-BM-Kh23-533 was identified as highly susceptible, with a disease severity of 48%.

Table 3.9. Screening of barnyard millet against leaf blight in 2024

Score	% leaf area affected	Reaction	No. of lines
1	<1%	HR	-
2	1-5%	R	7
3	6-10%	R	45
4	11-20%	MR	55
5	21-30%	MR	71
6	31-40%	S	379
7	41-50%	S	5
8	51-75%	HS	-
9	>75%	HS	-
Total			562

Evaluation of kodo millet against the leaf blight

A total of 202 lines of kodo germplasm lines were

screened against *Alternaria* leaf blight under field condition at ICAR-IIMR Research farm during *kharif* season, 2024. Among them, 9 genotypes were resistant, 3 genotypes were susceptible and 2 genotypes were highly susceptible to disease.

IIMR/CPT/2022-2027/159: *Characterization, symptomatology and advanced diagnostics of viruses infecting sorghum (PI: Baswaraj Raigond)*

Epidemiology: Vector population vs red stripe disease progression

Viruses in sorghum express a wild range of symptoms including mosaic, chlorotic streaks/stripes on leaves, mosaic and red stripe. Under field conditions insect vectors play crucial role in spreading the disease and hence it's important to understand the host and vector interaction. An epidemiological study was taken up in *rabi* 2023-2024 (DOS: 25-10-2023). Red stripe disease was recorded in per cent and the vector population in 1-9 scale. The first appearance of red stripe and aphids were recorded on 12-12-2023. Over a period of time, there was an increased progression of the disease along with vector population and reached its peak on 16 to 30th

January 2024. Thereon, the vector pressure reduced gradually from 7th February 2024 onwards and on the contrary, viral disease incidence started increasing (Fig. 3.15). Aphid vectors might be the contributing factors for and increasing trend of the viral disease under field conditions. Even the severity of the disease i.e. the intensity of the redness in infected leaves increase

which might be due increase in temperature towards the end of February 2024. In addition to vectors, several weed sp. (Fig. 3.16) such as *Calyptocarpus*, *Calotropis*, *Commelina*, *Alternanthera* and *Malvastrum* present in vicinity sorghum and foxtail millet fields showed several viral symptoms. These weeds can serve as a source of inoculum and can contribute in viral spread.

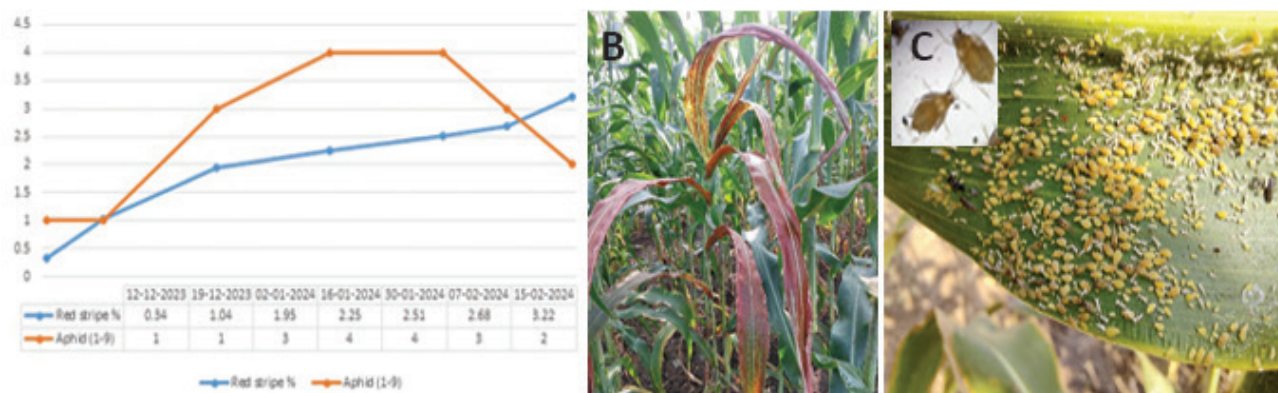


Fig. 3.15. Epidemiology: Vector population vs red stripe disease progression curve (A), red stripe disease on sorghum (B) and insect vector aphids (C)

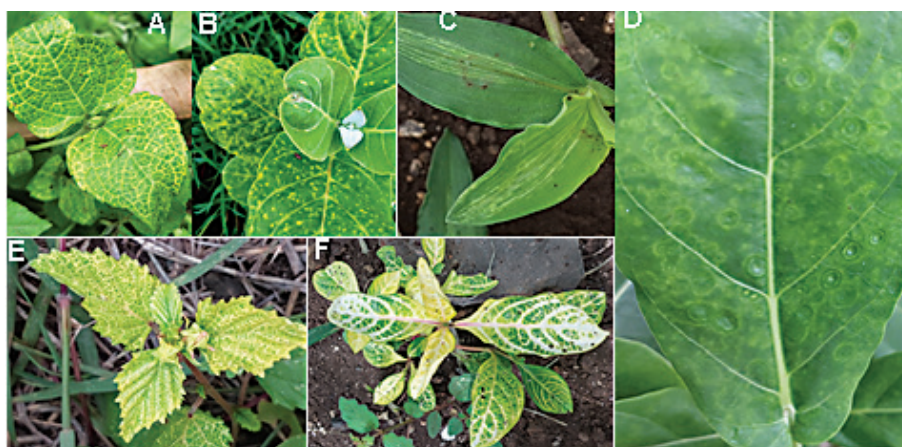


Fig. 3.16. Weed hosts as source in the vicinity of millet crops. *Calyptocarpus* (A), *Calotropis* (B & D), *Commelina* (C), *Malvastrum* (E) and *Alternanthera* (F)

Molecular based RT-PCR assay for detection of suspected viral infection in sorghum and foxtail millets

We have attempted repeatedly for detection of reported viruses infecting sorghum using reported primers along with the optimized PCR conditions and reaction mixture. The end point detection i.e., agarose gel electrophoresis revealed multiple bands or non-specific amplification. An alternative to PCR, we have used an advanced isothermal based molecular assay i.e., Reverse Transcription-Recombinase Polymerase Assay (RT-RPA) (Fig. 3.17). we observed faint or no amplification even in RT-RPA. With respect to foxtail millet, our previous finding, reported an expected amplification of barley virus G (BVG) by RT-PCR assay in infected

leaf of foxtail millet showing continuous chlorotic stripes/ bands. At the same time, Transmission Electron microscopy (TEM) revealed the presence of isometric virions of around 38 nm in diameter. However, in the present scenario, it's necessary to go for nucleotide sequencing and bioinformatics analysis to authenticate the findings. Overall, the findings necessitated to utilize the advanced non-targeted approaches like Next Generation Sequencing (NGS) which can help in identification, genome characterization and in few cases new records of viral infection can also be recorded.

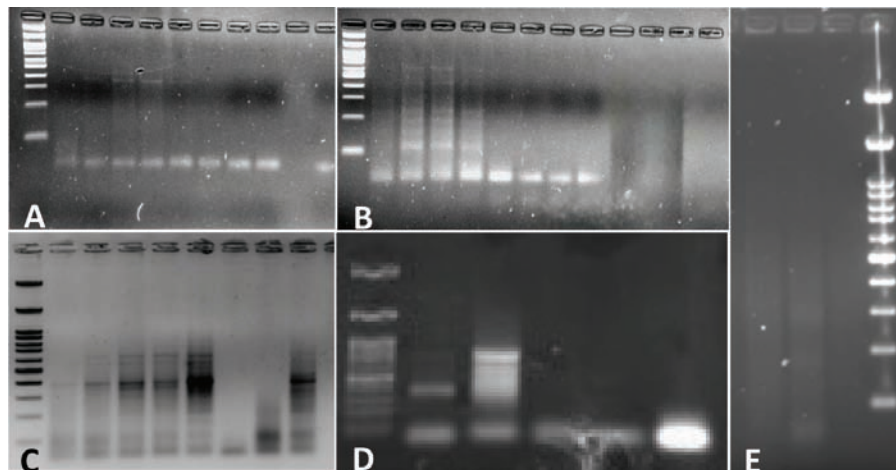


Fig. 3.17. RT-PCR assays for detection of possible viral infection in sorghum (A, B & C), foxtail millet (D) and RT-Recombinase Polymerase Assay (RT-RPA) for detection of sorghum mosaic viruses (E).

RNA-Viromics: An ideal approach to enumerate total viral population in millets

In our previous study, the plants (foxtail millet) showing continuous/ discontinuous chlorotic stripes/ bands and mosaic symptoms or veinal chlorosis showed isometric virions ~38 nm (diameter) under Transmission Electron microscopy and an expected amplicon of ~581 bp corresponding to barley virus G (BVG) by RT-PCR assay. However, to ascertain the same and to enumerate the possibilities of other/ new viral infection, suspected leaf samples were processed for Next

Generation Sequencing (NGS). In addition, the leaves of finger millet expressing chlorotic spots were also included in the study. The leaf samples expressing the above described symptoms (Fig. 3.18) were preserved in dry-ice packs and processed for NGS. NGS can aid in identifying the viruses, including divergent viral variants, which could be difficult through PCR/RT-PCR based molecular assays particularly for those viruses whose nucleotide sequences are not available.

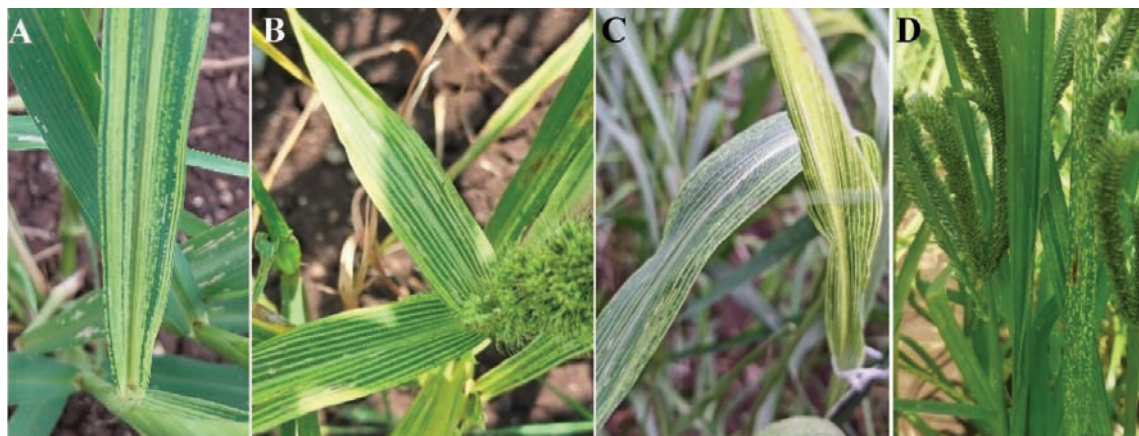


Fig. 3.18. Different symptoms expressed in millets leaves due to suspected viral infection. Foxtail millet leaves expressing continuous/ discontinuous chlorotic stripes/ bands (A), mosaic symptoms or veinal chlorosis (B, C) and chlorotic spots on finger millet (D).

Total RNA was isolated using commercially available kit followed by rRNA depletion to enrich viral RNA. Later, cDNA synthesis, fragmentation and adapter ligation were performed using the NEBNext Ultra II RNA Library Prep Kit (Illumina) followed by PCR amplification and library preparation. The fragment analysis was carried

out on High Sensitivity D1000 ScreenTape by the Agilent 4200 TapeStation System (Fig. 3.19). Trace analysis shows that average size of fragments in the library were 428 bp. The qualified libraries were processed further for next generation sequencing (NGS) on an Illumina NextSeq 2000 using a 300 cycle paired end chemistry.

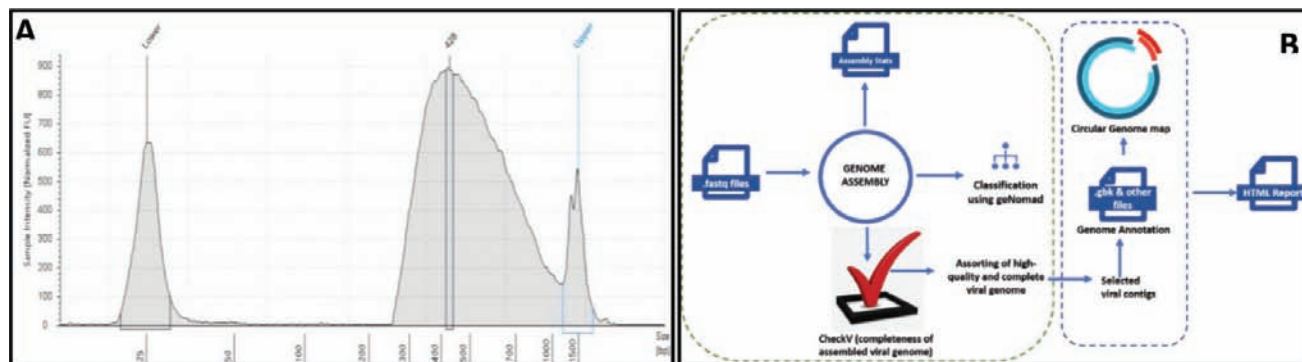


Fig. 3.19. Tapestation analysis for NGS libraries (A) and Workflow of whole genome (B)

The raw data generated (fastq files) after sequencing were subjected to adaptors trimming and then high quality (HQ) fastq files were processed for further error correction in reads. A De Novo de-bruijn graph based assembly was carried out to assemble the short reads into larger stretches of DNA (contigs). Quality assessment for genome assemblies were generated by using two different assemblers i.e., Spades and Megahit

using Quast tool. The assembly generated by Megahit assembler had comparatively larger assembled contigs than Spades. Hence, megahit assembler was used for taxonomic assignment and viral genome identification using geNomad tool where we could get viral hits in all the three samples. However, a detailed bioinformatics analysis is being carried out which will be presented upon its completion.

New viral disease record: Suspected viral disease on other millet crops and weed hosts

In addition to the previously reported viruses on sorghum and foxtail millet, the crops like brown top millet and little millet started expressing viral like symptoms i.e., continuous/ discontinuous chlorotic stripes/ bands. On

the other hand, finger millet is expressing chlorotic spots on leaves. In sorghum, a new viral like symptom i.e., a suspected sorghum yellow banding virus (SYBV) was also recorded (Fig. 3.20).

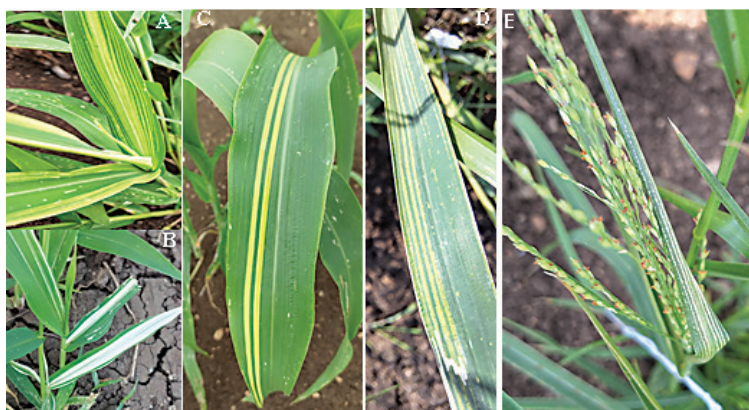


Fig. 3.20. New records suspected viral diseases in millets. Brown top millet (A & B), suspected sorghum yellow banding virus (C) and Little millet (D & E)

4. Resources Management for Higher Millets Productivity

IIMR/CPD/2020-2025/129: Development of intra millet intercropping systems for resilience and sustainability (PI: B Gangaiah)

Field studies were conducted during *rabi* 2023 on pearl millet based millet intercropping systems at IIMR Hyderabad. Seventeen treatments formed by 9

sole millet crops and 8 additive series intercropping of sorghum with millets in 1:1 ratio were evaluated in RBD with 2 replications. Results indicated that sole pearl millet grain productivity (1850 kg/ha) was significantly improved due to its intercropping with foxtail millet, little millet, proso millet, barnyard millet and sorghum and the increase in productivity was highest (92.5%) with pearl millet + sorghum

intercropping (Table 4.1). The increased productivity of intercropped pearl millet was reflected in improved Land Equivalent Ratio (LER) that ranged from 12%

when finger millet is intercrop and to 57% when intercrop is sorghum.

Table 4.1. Performance of millets in sole and intercropping with pearl millet

Treatment	Pearl millet grain yield (kg/ha)	Intercrop grain yield (kg/ha)		PMGEY (kg/ha)	Land Equivalent Ratio (LER)		
		In sole stands	In intercropping		Pearl millet	intercrop	System
Pearl millet (PM)	1850	-	-	1850	1.00	-	1.00
PM + Brown top millet	1450	750	385	2066	0.78	0.51	1.30
PM + Foxtail millet	1630	1125	525	2470	0.88	0.47	1.35
PM + Finger millet	1585	1500	390	2185	0.86	0.26	1.12
PM + Kodo millet	1710	965	315	2214	0.92	0.33	1.25
PM + Little millet	1770	1275	405	2418	0.96	0.32	1.28
PM + Proso millet	1720	800	350	2280	0.93	0.44	1.37
PM+ Barnyard millet	1650	965	400	2290	0.89	0.41	1.31
PM + sorghum	1400	2100	1700	3562	0.76	0.81	1.57
CD 5%	185	-	-	375	-	-	0.16

***PMGEY**: Pearl millet grain equivalent yield. (PMGEY worked out based on MSP (Rs/kg grain) sorghum, pearl millet, finger millet and all other millets: 31.80, 25.00, 38.46 and 40.00)

Sorghum based millet inter cropping systems validation / upscaling studies were done under AICSIP at 6 locations (Akola, Chamarajanagara, Hagari, Indore, Rahuri, Surat) with 15 treatments (8 sole millet crops and 7 additive series intercropping of sorghum with millets in 1:1 ratio) during *kharif* season of 2023 in RBD with 2 replications. Mean data of the study (Table 4.2) revealed that intercropping of sorghum with millets

has improved Land Equivalent Ratio (LER) by 23-44% as compared to sole sorghum. Intercropping of sorghum with millets is significantly more productive than cultivation of other millets in sole stands. Location wise, sorghum intercropping with finger millet or bajra at Akola, little millet at Chamarajanagar, foxtail millet at Hagari, barnyard millet at Indore, Rahuri and Surat are the best.

Table 4.2. Performance of millets in sole & intercropping with sorghum assessed through Sorghum Grain Equivalent Yield (SGEY) and Land Equivalent Ratio (LER)

Treatment	Mean Sorghum Grain equivalent yield (t/ha)	Mean LER
Sole sorghum (S)	2.96	1.00
Sole Bajra	1.60	1.00
Sole Proso millet	2.23	1.00
Sole Foxtail millet	2.53	1.00
Sole Finger millet	2.33	1.00
Sole Little millet	1.49	1.00
Sole Barnyard millet	1.95	1.00
Sole Kodo millet	1.90	1.00
S + Bajra	3.26	1.44
S + Proso millet	3.22	1.28
S + Foxtail millet	3.14	1.27
S + Finger millet	3.34	1.23
S + Little millet	3.04	1.30
S + Barnyard millet	3.37	1.34
S + Kodo millet	3.09	1.32
C.D. (5%)	0.510	0.170

SGEY worked out based on MSP (Rs/kg grain) sorghum, pearl millet, finger millet and all other millets: 31.80, 25.00, 38.46 and 40.00)

Leaf Colour Chart (LCC) development for nitrogen fertilizer top dressing in sorghum, pearl millet and finger millet (PI: B Gangaiah)

A field experiment was conducted during *kharif* 2023 season at arboretum farm, Rajendra nagar with the objective of finding out the impact graded levels of NPK fertilization (0, 50, 100 and 150% RDF) on SPAD readings of five cultivars of sorghum, bajra and ragi. Treatments formed by combination recommended dose of NPK fertilizers (RDF) in main plot and crop cultivars in sub-plot were evaluated in Split Plot Design with two replications. During *rabi* season, study was conducted on sorghum only with five cultivars (M-35-1, CSV-216R, CSV 29 R, CSH 15 R and CSH 16 R) at GTC. Bajra and sorghum crops were sown on 10th July 2023 in rows 45 cm apart with a plant to plant spacing of 10 cm while ragi was sown on 4th August 2023 in rows 30 cm apart with a plant to plant spacing of 10 cm. A recommended dose of fertilizer of 60:40:40 kg/ha N:P₂O₅:K₂O in ragi and 80-40-40 in sorghum and bajra were used in the study. Entire PK fertilizers as SSP and MOP along with 50%N as prilledurea was applied basal while rest of N was top dressed on 30 days after sowing as per treatment. SPAD values were recorded at fixed time (10

AM-12 PM) under clear sun using SPAD-502, Spectrum Technologies, Inc, Minolta for the top most fully opened leaf at frequent intervals (weekly). The leaf green ness was matched with Maize LCC.

Results indicate that SPAD values increased with increased RDF level from 0 (control) to 150% in all the three millet crops during *kharif* season and in sorghum during *rabi* season (Table 4.3- Table 4.6). A maize LCC strip value of 4.5 corresponded with 100% RDF application (sorghum and bajra) and with 4.0 for ragi. Varieties of crop differed for SPAD values but have near identical Maize LCC values. Based on two years study, LCC values were given to Nitrogen parameters (the funding agency) for preparation of LCC for millets.

Table 4.3. Bajra (*kharif*): SPAD values and LCC matching

% RDF	SPAD value before N top dressing (10-08-2023)	Maize LCC matching	SPAD value 13 days after N top dressing (23-08-2023)	Maize LCC matching
0	33.7	3.5	38.4	3.5
50	36.5	3.5	46.3	4.0
100	37.5	4.0	48.3	4.5
150	38.2	4.5	49.2	5.0

Table 4.4. Sorghum (*kharif*): SPAD values and LCC matching

% RDF	SPAD value before N top dressing (11-08-2023)	Maize LCC matching	SPAD value 18 days after N top dressing (29-11-2023)	Maize LCC matching
0	31.5	3.0	33.0	3.5
50	33.9	3.5	40.0	4.0
100	34.6	4.5	41.6	4.5
150	36.4	5.0	42.5	4.5

Table 4.5. Ragi (*kharif*): SPAD values and LCC matching

% RDF	SPAD value before N top dressing	Maize LCC matching	SPAD value 15 days after N top dressing	Maize LCC matching
0	27.5	3.0	36.1	3.0
50	31.3	3.0	39.0	3.5
100	33.8	3.5	41.0	4.0
150	36.0	4.0	42.5	4.5

Table 4.6. Sorghum (*rabi*): SPAD values and LCC matching

% RDF	SPAD value before N top dressing	Maize LCC matching	SPAD value 15 days after N top dressing	Maize LCC matching
0	25.3	3.0	35.8	3.0
50	28.1	3.5	38.5	3.5
100	31.0	4.0	43.7	4.5
150	31.8	4.0	45.2	4.5

IIMR/CPD/2021-26/152: Improving water use efficiency of finger millet & foxtail millet under limited moisture conditions (PI: Swarna Ronanki)

Field experiments were conducted in factorial RBD to evaluate the effect of application of N and K on growth and yield of finger millet. The results revealed

that application of 120 kg N/ha resulted in significantly higher growth, yield attributes and yield of finger millet compared to other N levels. Similarly, among the K levels, application of 40 kg K/ha resulted in significantly higher yield of finger millet compared to other levels.

Table 4.7. Effect of N and K levels on growth and yield of finger millet

Treatment	Plant Height (cm) at Flowering	Dry matter at harvest (kg ha ⁻¹)	No. of fingers/ear head	1000 grain weight (g)	Grain Yield	Stover Yield
Nitrogen Level (kg/ha)						
0	68	3802	4.47	2.26	1604	3180
40	75	4053	5.03	2.35	1820	4387
80	84	4217	5.46	2.80	1918	4273
120	88	4810	6.05	3.10	2054	4963
SEm±	1.44	233	0.15	0.12	51	143
CD (P 0.05)	4.28	700	0.39	0.26	138	496
Potassium Level (kg/ha)						
0	76	3120	5.11	2.33	1723	3169
20	78	4175	5.28	2.36	1811	3351
40	78	5240	5.37	2.38	2020	3387
SEm±	1.61	201	0.07	0.06	68	77
CD (P 0.05)	NS	681	0.21	0.18	203	NS

Effect of application of K on grain yield of finger millet under various irrigation regimes

Field experiments were conducted in split plot design with three replications to evaluate the effect of application of K on growth and yield of finger millet under three irrigation regimes. The main plot treatments comprised of 3 irrigation regimes (I1 - No stress (25% DASM); I2 - Moderate Stress (50% DASM); I3 - Severe Stress (75% DASM), and the sub plot treatments comprised of 4 potassium levels (0, 20, 40 and 60 kg K/ha). The results revealed that increase in the application of potassium to 60 K/ha did not exert significant influence on grain yield of finger millet under I1 conditions. However, under stress conditions, increase in the application of potassium to 60 K/ha resulted in significantly higher growth, yield attributes and yield of finger millet compared to other K levels. The Grain Yield improvement with K4 over K1 is 1%, 4% and 17% in I1, I2 and I3 respectively.

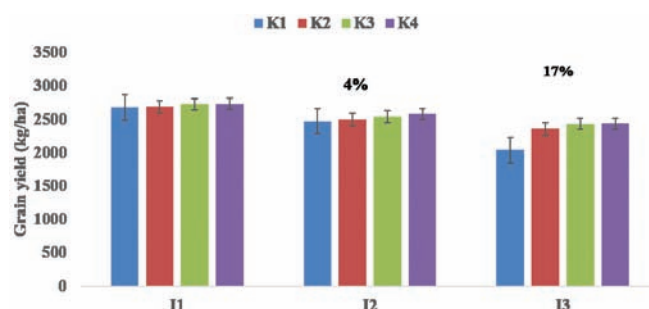


Fig. 4.1. Effect of application of K on grain yield of finger millet under various irrigation regimes

5. Extension research, Economics and Value-addition

5.1 Extension Research

IIMR/ER/2021-2026/156: Yield gap and constraints analysis of sorghum production in traditional area (PI: RR Chapke)

Although, the sorghum productivity was increased during last 3-4 decades due to adoption of improved production technologies by the farmers, there is still wide yield gap exists between potential yield

with improved technology developed by research institutes and state yield average with farmers' practice. To determine yield gap at different levels, data on sorghum yields were collected from farmers of Surat and nearby districts of Gujarat directly and secondary sources on *kharif* sorghum of last four years (2019-2023). The results from the study showed that technology gap was of 5.35 q/ha and extension gap was of 8.50 q/ha. Crop damage by birds and animals was found to be top most serious constraint in sorghum production.

The technology gap between recommended yield of the cultivars and their yield under demonstrations was observed to be 5.35 q/ha. The reason for high technology gap was due to difference in local climate coupled with variation of soil fertility status and adoption of management practices by farmers. Regarding Yield Gap-II which is extension gap, was found to be 8.50 q/ha. This shows need of emphasizing on effective transfer of technologies of millets and adoption of the high yielding cultivars along with improved cultivation practices. In view to assess

feasibility of the latest technologies, technology index (TI) was calculated which showed to be 17 per cent during the same period. As technology index indicates the feasibility of the improved technology in farmer's field, higher technology index (17%) reflected the inadequate feasibility to use the sorghum technologies by the farmers. It needs to be taken care by scientists who developed technologies. From the above study, technology gap was of 5.35 q/ha and extension gap was of 8.50 q/ha were observed. Value of technology index (TI) was 17 which need to be reduced by making technology more feasible to the farmers. Significant knowledge gap was found ($t=2.34^{**}$), inferring that beneficiary farmers had more knowledge compared to non-beneficiary farmers on improved practice. Crop damage by birds and animals was found to be top most serious constraint in sorghum production. It can be concluded that problem-based solutions in time will help farmers to encourage and sustain sorghum production. Therefore, problem-based solutions in the form of production technologies will help farmers to sustain sorghum production.

Table 5.1. Yield, extension gaps and technology index of rainy sorghum production

Year	Recom. yield (q/ha)	Demo yield (q/ha)	FP yield (q/ha)	Increase over FP (%)	Techno. gap (q/ha)	Exten. gap (q/ha)	Techno. index (%)
2023-24	34.50	26.90	21.80	23	7.60	5.10	22
2022-23	37.15	33.90	23.50	44	3.25	10.40	9
2021-22	28.25	21.90	12.40	76	6.35	9.50	22
2019-20	29.20	25.00	16.00	56	4.20	9.00	14
Mean	32.28	26.93	18.43	50	5.35	8.50	17

FP= Farmer's practices

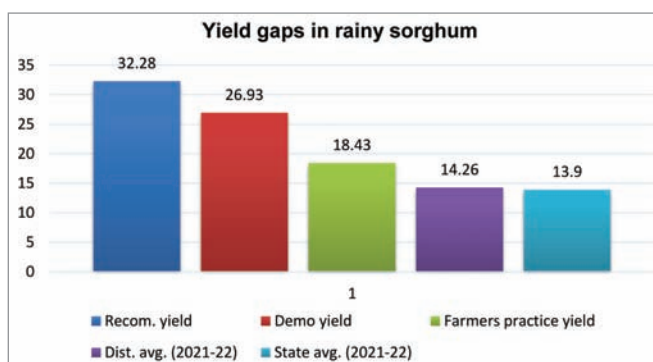


Fig. 5.1. Potential, demonstration, farmers practice and state average yield of *kharif* sorghum cultivation

Farmer FIRST Project on Participatory technology validation, diversification, value addition for small holders livelihood improvement of central Telangana zone (PI: RR Chapke)

The purpose of the project is to validate proven technologies and success stories of the institute along with allied enterprises in the farmers' fields as integrated farming system for enhancing farmers' income and livelihood. Total, three millets-based modules viz., (i) Crop module, (ii) Natural resource management (NRM) module, (ii) Livestock-based module, (iv) Horticulture module and (iii) Enterprise-based module which were implemented in the project. Each component-and

module-wise trials were conducted in the farmers' fields during 2023-24.

During 2023-24, a total of twelve technology interventions were organized under crop module in nine villages of Nyalkal, Jharasangam and Raikode mandals of Sangareddy district in central Telangana viz. (i) introduction of improved *kharif* sorghum varieties, CSV 39 (12 trails) and CSV 15 (5 trails) (ii) introduction improved sorghum hybrid with CSH 41 (17 trails), (iii) introduction of improved pearl millet (MPMH 21) variety (27 trials), (iv) introduction of improved finger millet variety CFMV 1 (25 trials), (v) introduction of improved foxtail millet variety (SiA 3156) (15 trials), (vi) introduction of improved barnyard millet (DHBM 93-2) variety (5 trials), (vii) introduction of improved little millet (OLM 203) variety (7 trials), (viii) introduction of improved kodo millet (JK 41) variety (7 trials), (ix) introduction and demonstration of red gram production technologies WRGE 97 (60 trials), (x) introduction of improved *rabi* sorghum variety (CSV 29R) (20 trials) during *rabi* season, (xi) introduction of forage sorghum (CSV 33MF) variety along with production technologies (10 trials) and (xii) introduction of intercropping with redgram in millets (10 trials). In livestock module, (i) maintenance and monitoring of improved poultry (Vanaraja) birds (60 families) and (ii) maintenance and monitoring of improved breed of sheep (Nellore) (30 families) was done. Under enterprise module, assessment of two roti making machines was carried out which were introduced in Gangapur and Chalki villages to two SHGs. These apart, primary processing facilities on millets which is helping the farmers to realize higher income from de-hulled grains. In horticulture module, kitchen gardening with improved technologies was introduced by providing kitchen garden kits (8 trials) to enhance food and nutritional security of mostly landless farmers. Under natural resource management (NRM) module, wild animal repellent (herbolive+) was introduced among millet farmers to avoid crop damage from wild animals (40 trials) and line sowing method demonstration trials (90 trials) were also conducted. In this year, 2023-24, three pre-season trainings were organized viz., technology orientation along with seeds allocation to the trial farmers and awareness-cum-

interaction programme at Chalki and Mungi villages during mid-*kharif* and pre-orientation along with seed allocation for *rabi* crops at Chalki and Rukmapur villages. Programmes like World soil day, Farmers day and Swachta Pakwada were organized in project village to create awareness and generate farmers interest in cultivating millets, sustainably. Also, regular monitoring and evaluations during mid-season organising total of four field days and field visits. Advisory was provided to 150 farmers regularly through WhatsApp group "Millet farmers (Telugu)" in which IIMR scientists and experts were involved to provide solution to solve farmer's queries.



Fig. 5.2. IIMR scientists monitoring *rabi* sorghum trials at Mungithanda village



Fig. 5.3. IIMR scientists monitoring farm trials in project village

Though, improved millets technologies were proven to be profitable under crop module in this study, millets, and allied enterprise like, livestock and business move could assure the enhancement of farmers' income in rainfed areas. Millets-based farming like, backyard poultry, dairying and goat farming were enabled to make additional income through utilizing by-products and farm-waste which was found to be an imperative move for optimum output.

Frontline Demonstrations on *rabi* sorghum 2023-24:

FLD is one of the important programmes to evaluate and demonstrate the production potential of the recently developed sorghum technologies including package of practices in the farmers' fields. Besides, it enables to build-up confidence of the farmers to adopt the latest technologies and help to collect valuable feedback to modify the research programme based-on their field experiences regarding performance of the technologies. In view to introduced latest sorghum production technologies in farmers' fields, FLDs on sorghum were organized during *rabi* 2023-24. During *rabi* 2023-24, in total 275 frontline demonstrations (FLDs) on sorghum were organized in nine districts across five *rabi* sorghum growing states viz., Maharashtra, Karnataka, Telangana, and summer sorghum in TamilNadu. Latest sorghum production technology viz., moisture conservation technology (MCT), zero tillage cultivation with high yielding varieties; CSV 29R, CSV 26R, Phule Suchitra, Parbhani Super Moti, Parbhani Shakti, Trombay Akola Suruchi 5 (TAKPS 5), SPV 2217 and Tandur Jonna 1 (TJ 1) were demonstrated along with locally popular cultivar as a check in farmers' fields at different locations. The demonstrated *rabi* sorghum varieties gave 34% higher grain as well as same fodder yields than the local checks. On an average, the demonstrated technologies could earn additional net returns of Rs.73,027/- on the cost of Rs. 28,105/- per ha, which was more than 40 per cent (41%) than the local checks. Moreover, sorghum cultivars (Co 32, CSV 39, CSH 16) performed better during summer season in Tenkashi district of Tamil Nadu during summer 2023. It yielded 72 per cent higher grain yield and 33 per cent stover yield than the local check (Tenkashi White) which resulted into more than double (113%) additional net return.

Since, the demonstrated technologies have potential to increase the yields and profits over local cultivars (Table 5.2), FLDs may be organized systematically in all the regions

Table 5.2. Yield gap between the FLDs and local check (LC) during *rabi* 2023-24

S. No.	Location	Grain yield (t.ha-1)			Stover yield (t.ha-1)		
		FLD	LC	Yield gap (%)	FLD	LC	Yield gap (%)
1	Rahuri	2.22	1.44	54	5.20	2.66	95
2	Parbhani	2.20	1.40	57	5.70	3.50	63
3	Solapur	2.03	1.26	61	3.91	2.79	40
4	Akola	2.44	1.75	39	13.05	9.56	37
5	Bijapur	1.26	1.11	14	3.53	3.31	07
6	Dharwad	2.47	2.16	14	6.79	6.00	13
7	Tandur	1.69	1.55	09	4.34	3.90	11
	Mean	2.04	1.52	34	6.07	4.53	34

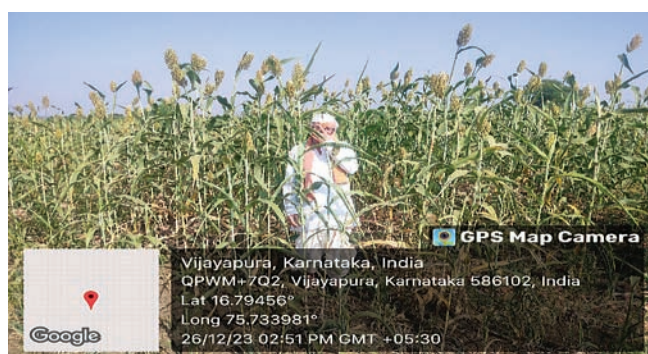


Fig 5.4: Field view of *rabi* sorghum FLDs in a village, Vijayapura, Karnataka State

IIMR/ER/2022-2026/161: Adoption and impact of improved millets production technologies in India (PI: A Srinivas).

A study was conducted to assess the knowledge, level of adoption and impact of the foxtail millet demonstrated technologies in retrospect (*after the-fact*). This was conducted in foxtail millet FLDs implemented districts i.e Kolar, Chikballapur, Tumukur and Ballary of Karnataka and Kurnool, Nandyal district of Andhra Pradesh. An ex-post-facto survey design was employed since the variables chosen for the study have already been occurred. Purposive random sampling method was followed for selection of respondents out of the participatory farmers of FLDs. The sampling was done by selecting 180 farmers randomly from the study area who were beneficiaries of the FLDs during 2018-2023. The respondents belonged to different categories (marginal, small, medium, and large), were selected randomly.

Impact of the demonstrated technologies were observed with lower adoption level in Eastern Dry Zone of Karnataka. To promote this crop, linkage with market and processing facilities should be established in this area. Impact of the demonstrated technologies was observed with higher adoption level in North Eastern Dry Zone of Karnataka and Andhra Pradesh resulting in higher grain yield with better quality and fodder yield, and ultimately net returns over pre demo. This impact enabled to motivate the farmers to extend area under foxtail millet in North Eastern dry zone of Karnataka and Andhra Pradesh. Out of fourteen demonstrated practices, only eight practices namely, land preparation, use of high-yielding variety, timely sowing, weed control measures, application of FYM, N fertilizer application, disease control and timely harvesting were found to be adopted by the farmers. It was found from the study that the variables viz., age, education, land size, extension contact, per cent of change in adoption, grain yield, fodder yield and marketing were found to be positively correlated with the knowledge and adoption of demonstrated practices. The findings aptly indicated that the impact of the production technologies was very vital in meeting out the farmers' social, educational, health and financial needs apart from food and fodder. It was found that the farmers would like to continue with their own input arrangement after withdrawal from the scheme (post-FLD period). The major constraints in foxtail millet cultivation were labour scarcity (83%), rainfall during harvesting (69%), Seed germination problem due to deep placement (53%), price fluctuation (82%), lack of cooperatives for procurement (65%) and Lack of processing facilities (52%). To boost-up the adoption of demonstrated foxtail millet production technologies, FLDs scheme should be extended to new areas with more number of demonstrations and the demonstrated technologies should be popularized by line departments and other extension functionaries through demonstrations, field days, trainings etc.

5.2 Economics

IIMR/EVA/2020-2025/136: Economic analysis of production, marketing, utilization, and policy perspectives of sorghum in India (PI: Anuradha Narala)

Analyzed decadal growth and instability of area under bajra between 1966 and 2021. For the country the area under bajra persistently declined during the study period. The deceleration in the area was much deeper (- 2.89%) in the decade 2006-2021, followed by 1986-95, 1966-75, 1996-2005 and 1976-85 with CAGR of -1.02%, -0.57%, -0.38% and -0.06% respectively. Instability was highest during 1986-95 followed by 1996-2005, 1966-75 and 2006-2021. During last decade 2006-2021, West Bengal (8.75%), Delhi (7.45%) Madhya Pradesh (5.24%), and UP (0.92%) witnessed growth. Highest negative growth was observed in Punjab (-29.09%) followed by Pondicherry (-22.97%). While high instability was observed in Punjab (63.01%), lowest instability was observed in Rajasthan (7.75%). State-wise decadal growth rate of production under bajra reveals that during all decades overall, the country witnessed a growth except in the second decade 1976-86. The highest growth was registered during the third decade (1986-96) at 3.23 per cent. Uttar Pradesh (3.68%), Jammu & Kashmir (3.70%), Gujarat (4.03%), Rajasthan (5.59%), West Bengal (5.68%), Maharashtra (6.52%), Haryana (6.58%) and Delhi (8.06%) witnessed a growth. Overall, the country witnessed a growth of 0.24% during this decade. However, yield witnessed growth during all decades except during the 1976-86 period which has shown negative trend. Highest growth was observed during the last decade with 3.00 per cent.

Analyzed the state wise decadal growth trend of ragi from 1966-67 to 2021-22. During last four decades area and production witnessed negative growth trend. Only during 1996 -76 the area and production registered growth of 1.68 per cent and 4.09 per cent respectively. During 2006-2021 Uttar Pradesh and Madhya Pradesh registered highest growth of 17.93 and 14.36 per cent respectively. In case of production Madhya Pradesh and Uttar Pradesh witnessed highest

growth trend of 30.55 per cent and 11.36 per cent respectively. However, the yields have shown growth during last five decades with 2.37, 0.87, 3.52, 0.3 and 0.56 per cent respectively. Highest yield growth was reported in West Bengal during 1986-95 with 15.90 per cent and in Madhya Pradesh during 2006-2021 with 10.71 per cent.

Total Factor Productivity (TFP) of pearl millet in Rajasthan and Maharashtra was worked out by using DES, GOI data (Includes both *kharif* and *rabi*) from 1991-92 to 2020-21. The Divisia-Tornqvist index or translog index was used in this study for computing the total output, total input, and TFP indices. Also estimated the annual growth rates in output use, input use and TFP growth during three periods 1991-92 to 2004-05, 2005-06 to 2018-19 and 1991-92 to 2020-21 (overall). Total factor productivity is the change output growth is not due to change in input growth, it is due to non-conventional factors such as research, extension, education, infrastructure, rainfall etc. The total factor productivity estimates in sorghum crop in Rajasthan indicates that there is substantial growth with fluctuations in TFP. The research and extension contributions were the reasons for positive TFP growth. During the period I (1991-92 to 2004-05) TFP of pearl millet registered growth rate of 5.53 per cent and during Period II (2005-06 to 2018-19) which increased significantly with a growth rate of 6.02 per cent per annum (Table 5.3). It is observed that the TFP for pearl millet in Maharashtra registered growth rate of 1.33 per cent per annum during 1991-92 to 2020-21. The highest TFP index was observed in 2015-16 (2.09). However, during 2005-6 to 2020-21 registered a negative growth of -4.40 per cent. (Table 5.4). Analyzed Total Factor Productivity (TFP) of finger millet in Karnataka, it was observed that the TFP registered growth rate of 1.92 per cent per annum during 1991-92 to 2020-21. The highest TFP index was observed in 2016-17 (2.88). During the period 2005-06 to 2020-21 the TFP growth witnessed highest with 6.02 per cent per annum (Table 5.5).

Table 5.3. Annual growth rates in output, input use and TFP growth in pearl millet from 1991-92 to 2021-22 (In per cent) in Rajasthan

S. No.	Period	Total Output	Total Input	TFP
1	1991-92 to 2004-05	0.57	-1.75	0.77
2	2005-06 to 2020-21	0.16	0.45	1.12
3	1991-92 to 2020-21	1.76	-1.68	1.99

Table 5.4. Annual growth rates in output, input use and TFP growth in pearl millet from 1991-92 to 2020-21 (In per cent) in Maharashtra

S. No.	Period	Total Output	Total Input	TFP
1	1991-92 to 2004-05	8.04	4.02	3.24
2	2005-06 to 2020-21	-0.58	5.12	-4.40
3	1991-92 to 2020-21	4.54	7.65	2.05

Table 5.5. Annual growth rates in output, input use and TFP growth in Finger millet from 1991-92 to 2020-21 (In Per cent) in Karnataka

S. No.	Period	Total Output	Total Input	TFP
1	1991-92 to 2004-05	0.81	-4.21	5.53
2	2005-06 to 2020-21	0.58	-5.25	6.02
3	1991-92 to 2020-21	1.99	-3.08	4.15

5.3 Value-addition and Commercialization

IIMR/VA/2021-2026/155: Development of millet based composite foods in fortification with fisheries, dairy, meat and horticultural commodities in collaboration with the ICAR Institutes. (PI: B Dayakar Rao)

Value Addition:

Instant Ragi-Rice based Mudde (Sankati) Mix:

The instant ragi mudde mix combines the health benefits of finger millet (ragi) with the ease of ready-to-use food products. Ragi is rich in essential minerals, making it a valuable addition to modern diets. Twelve formulations were developed using cooked ragi flour (CRF), germinated cooked ragi flour (GCRF), rice grits (RG), and rice flour (RF) in varying ratios of 60:40, 70:30, and 80:20. CRF was made by cooking ragi grains for 45 minutes, freezing, thawing, drying, and milling into flour. GCRF underwent germination before cooking, enhancing its nutritional profile. Rice grits and flour were similarly prepared, with milling adjusted for texture. The formulations were analysed for sensory qualities (taste, texture, and overall acceptability) and physico-chemical

properties, including moisture, protein, fat, and other key nutrients. Among all combinations, the 70:30 ratio of GCRF with rice components delivered the best sensory results, particularly in taste and texture. This formulation offers a balanced combination of nutrition, convenience, and flavor, making it ideal for health-conscious consumers. The GCRF 70:30 mix holds great potential for commercial production, addressing the growing demand for nutritious, quick-to-prepare meal options while preserving the traditional essence of ragi mudde.

Table 5.6. Physio-chemical parameters of instant ragi mudde

Moisture (%)	7.377±0.365
Alcoholic acidity (%)	0.12±0
Fat (%)	1.467±0.0
Protein (%)	6.91±0.02
Ash (%)	1.62±0.27
WAI (g/g)	3.439±0.136
WSI (%)	3.403±0.918



*WAI- Water absorption index, WSI – Water soluble index,

Fig. 5.5. Ragi mudde from instant mix

2. Instant foxtail millet Bisibellebath (foxtail millet and red gram dhal)

An instant bisibellebath mix was developed using foxtail millet and red gram dhal in varying proportions (T1-45:15, T2-40:20, T3-35:25, and T4-30:30) and evaluated for its nutritional, rehydration, and sensory attributes. The preparation process involved cooking, followed by different drying methods such as freeze, tray and microwave drying. Among these drying methods, the freeze-dried sample exhibited the shortest rehydration

time of 3 minutes, while tray drying and microwave drying required 8 and 7 minutes, respectively. Sensory analysis revealed that the T3 formulation with 35% foxtail millet and 25% red gram dhal was the most preferred, offering superior taste, texture, and overall acceptability. The inclusion of red gram dhal significantly enhanced the nutritional profile, increasing protein, dietary fiber and mineral content. This study highlights the potential of combining millet and legumes in instant food products to provide convenience, improved nutritional value, and healthier dietary options.



Fig. 5.6. Instant Foxtail millet Bisibellebath - 3 min rehydration

Table 5.7. Nutritional parameters of different drying techniques of bisibellebath (T3)

Parameters	Tray Drying	Microwave Drying	Freeze Drying
Moisture (%)	7.37	6.89	4.67
Protein (g)	10.91	12.5	13.47
Fat (g)	12.7	12.62	12.99
Dietary fiber (g)	5.06	5.09	5.16
Ash (g)	6.77	7.24	6.39
Carbohydrate (g)	62.25	60.75	62.48

APEDA - Refinement of millet value chain for export markets in the wake for international markets. (PI: B Dayakar Rao)

Antioxidant activity of Millets-DPPH Radical Scavenging activity:

Antioxidant activity refers to the ability of a substance to neutralize harmful molecules called free radicals, which can cause damage to cells in our body. One way to measure this antioxidant activity is by using a test called DPPH Radical Scavenging Activity. Thus, DPPH Radical Scavenging Activity is a way to measure

how well a substance can “scavenge” or neutralize free radicals. IC_{50} is the concentration of a substance that inhibits 50% of a target’s activity under specific experimental conditions. Lower IC_{50} Values: indicates higher potency, which indicate lower concentration of the substance is sufficient to achieve 50% inhibition. In the present study anti-oxidant activity of nine millets was evaluated. The antioxidant activity was found to

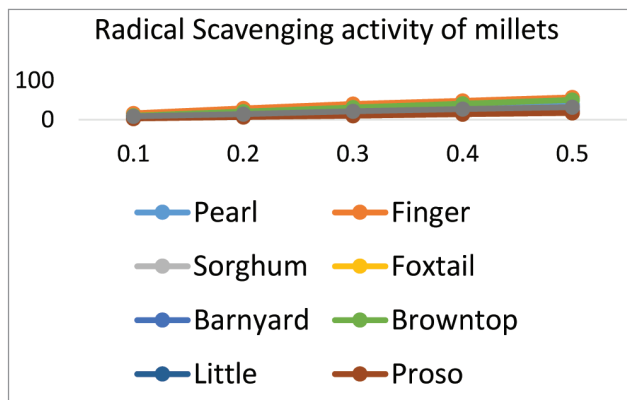


Fig. 5.7. Radical scavenging activity of millets

be higher in finger millet followed by brown top, pearl, sorghum, kodo, barnyard, little, foxtail, and proso millet. Subsequently, Inhibitory Concentration (IC_{50}) was observed to be lowest (requiring the least dosage) in finger millet (4.22), followed by brown top millet (4.94), and highest (requiring the highest dosage) in proso millet (14.10).

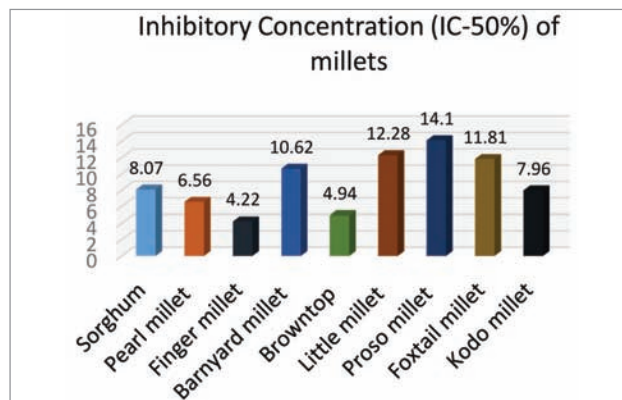


Fig. 5.8. Inhibitory concentration of millets

Shelf-Life enhancement of dehulled little millet with improved packaging:

Dehulled little millet accelerated (RH 85%, 45°C) shelf-life study was conducted by using different

treatments like pre-treatment, packaging material and preservatives.

Following are list of treatments:

1. LM-LDPE: Little millet packed in LDPE pack (control)
2. TPLM-LDPE: Treated little millet (soaked and dry heated) and Packed in LM-LDPE with pouch.

The control has shown a significant increase in moisture,

water activity, and microbial growth during the storage period and had a shelf life of 3 months. Treated little millet with vacuum packing has shown a higher shelf life of up to 10 months.

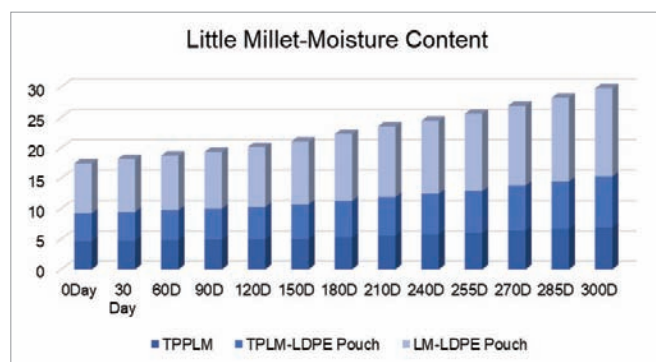


Fig. 5.9. Little millet moisture content

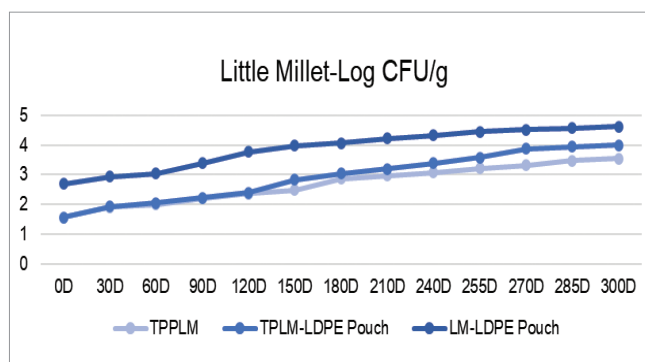


Fig. 5.10. Little millet-Log CFU/g

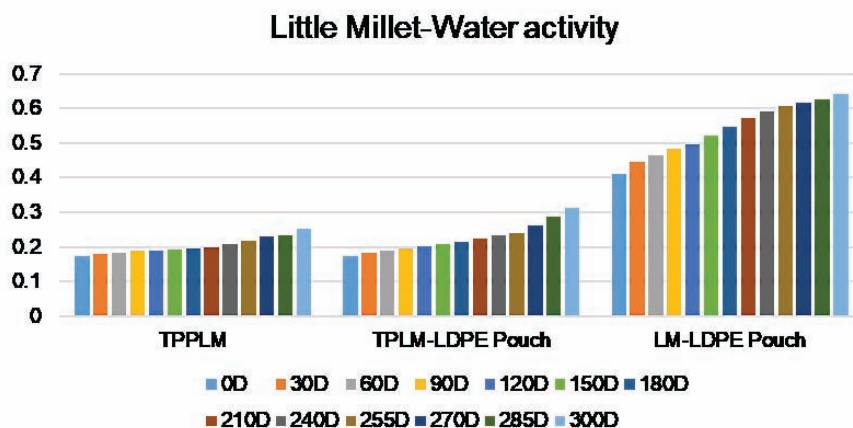


Fig. 5.11. Little millet-water activity

NFSM- A comprehensive study to establish the health benefits (in vivo) of Nutri cereals: A way forward for mainstreaming millets. (PI: B Dayakar Rao)

Value addition- Fortification:

Development of Millet-Based Products: Two millet-based products were developed: a finger millet laddu, enriched with calcium, and a pearl millet-based health mix, rich in iron and zinc.

1. Finger millet laddu: The calcium-rich laddu was developed to address nutritional deficiencies in school children, particularly focusing on increasing calcium intake. Using germinated ragi flour and other fortified ingredients, the formulation aimed to enhance both taste and nutritional value. Initially, the finger millet laddu was fortified with calcium-rich ingredients, including sesame, urad dal, besan, groundnut, rava, and germinated ragi flour (in a 50:50 ratio of ragi flour to other ingredients). These formulations were then subjected to sensory evaluation and mineral analysis. The sensory evaluation revealed that formulation T4

(Groundnut: Ragi Laddu) received the highest overall acceptability score of 8.45. The scores for individual attributes were as follows: appearance (8.32), color (8.20), flavor (8.04), taste (8.13), and texture (8.08). In contrast, T1 (Rava: Ragi Laddu) had the lowest acceptability with an overall acceptability score of 7.01. Based on these findings, formulation T4 was selected for further development. Five new formulations were created with varying amounts of ragi flour, ranging from 0% (T1) to 100% (T5), combined with groundnut. Sensory evaluation showed that formulation T3 (Ragi: Groundnut Laddu, 50:50 ratio) was the most acceptable. Initial mineral analysis revealed lower-than-expected mineral content, prompting modifications to the T3 formulation by incorporating 53.3% ragi flour, and reaming with other ingredients like sesame, black gram dal, and almonds. This final formulation improved mineral content, with 350.81 mg of calcium, 5.37 mg of iron, and 2.52 mg of zinc respectively.



Fig.5.12. Different treatments of ragi laddu with different ingredients

T₁-Rava:Ragi laddu, T₂-Urad Dal: Ragi laddu, T₃-Besan:Ragi laddu, T₄-Groundnut:Ragi laddu, T₅-Sesame laddu, T₆-Ragi laddu

2. Multi Millet Health Mix : The iron and zinc-rich health mix was developed to address nutritional

deficiencies in school children, with a particular focus on boosting iron and zinc intake. By incorporating

germinated pearl millet, ragi flour, and other fortified ingredients, the formulation aimed to improve both taste and nutritional value. The health mix was developed through four different formulations, each varying in the proportions of germinated finger millet, pearl millet, urad dal, almonds, sago, horse gram, poppy seeds, cardamom, and jaggery. These formulations underwent sensory evaluation and mineral analysis, with the first evaluation revealing that formulation T4, containing 60% pearl millet and 30% finger millet, had the highest overall acceptability score of 8.46. However, the strong flavor of horse gram led to its removal, and the amount of poppy seeds was reduced to balance the flavor, resulting in the development of T5 and T6. The second sensory evaluation revealed that T6 had the highest acceptability index of 8.83, with individual attributes such as appearance (8.73), color (8.76), flavor (8.91), and taste (8.86) scoring highly, making it the preferred variant based on taste, texture, and overall acceptability. Nutritional analysis of T6 showed 291.82 mg of calcium, 11.48 mg of iron, and 3.72 mg of zinc per serving.



Fig. 5.13. Multi millet health mix (raw and cooked)

IIMR/VA/2023-26/170: Development of novel products with different texture characteristics and bio-degradable films for packaging of the different value-added products made from millets (PI: Er. P. Hemashankari)

Sorghum and ragi starch were extracted using normal soaking method as native starch for overnight for 1 kg grain. The mc of the initial sorghum and ragi grains were found to be 4.68% wb and 4.59% wb using Sartorius moisture analyser. The weight of the soaked sorghum grain was 1.44 kg and that of ragi grain was 1.82 kg. The wet grain was grinded in mixie and 2-3 washings were done along with filtration in the muslin cloth to get starch and thippi separately.

Then the wet starch was centrifuged at 2000 rpm for 15 minutes in batches of 50 ml capacity tubes of 6 in number. Then the protein and fine starch settled at bottom were separated manually and dried in tray drier with stainless steel trays at 40°C for 2 days. Then the recovery of the starch was calculated and found to be 27.7% for sorghum starch and 20.2% for ragi starch. The starch moisture content in sorghum was 9.5% wb and of ragi was 9.44% wb. Water activity of sorghum starch was 0.29 and that of ragi starch was 0.28. The protein and thippi of sorghum and ragi were 7.62% wb, 6.44% wb and 0.44 and 0.29 respectively. Weight of sorghum protein was 132 g, thippi was 327g and starch was 277.7g out of 1 kg. The losses were found to be 26.3%. Weight of ragi protein was 172 g, thippi was 391g and starch was 202 g out of 1 kg. The losses were found to be 23.5%. Particle size of sorghum starch was 23.91µm, ragi starch, 22.2µm, sorghum protein, 100.2µm, ragi protein, 53.36µm, sorghum thippi, 191.49 µm and ragi thippi, 182.91µm and were found out using particle size analyser.



Fig. 5.14. Sorghum starch and Ragi starch

Formation and Promotion of Farmers Producer Organization FPO Project (PI: Sangappa)

Free Millet seed distribution through SFAC Millets & SFAC Oilseeds Projects

To promote millet cultivation, ICAR-IIMR in Hyderabad distributed 10,696 kg of free millet seeds to farmers, Krishi Vigyan Kendra's (KVKs), Farmer Producer Organizations (FPOs) and various state government departments across more than 10 states as part of the SFAC Millets & SFAC Oilseeds projects. This initiative aimed to encourage farmers to diversify their crops and increase the area dedicated to millet farming, which is gaining recognition for its nutritional value and sustainability. In addition, ICAR-IIMR organized

training sessions on best cultivation practices to boost millet productivity, improve soil health, and promote sustainable farming methods. The distribution of free high-quality millet seeds was intended to raise

awareness, support the adoption of millet farming, and help FPOs assist millet farmers in improving their income, ultimately building a millet-based ecosystem that strengthens market linkages.

Table 5.8. Millet seed distribution through ICAR-IIMR, Hyderabad

S. No	State	Quantity of Seed distributed in Kgs								Total Quantity (Kgs)
		Foxtail	Little	Kodo	Finger	Barnyard	Sorghum	Proso	Bajra	
1.	Haryana	2	2	2	2	2	2	2	2	16
2.	Telangana	43	1	3	7	27	1415	3	3	1502
3.	Chhattisgarh	8					6		6	20
4.	Karnataka	773	547	7	234	879	1773	321	8	4542
5.	Tamil Nadu	2	2	2	2	2	2	2	2	16
6.	Jharkhand	1	1	1	1	1	1	1	1	8
7.	Andhra Pradesh	700	423			420	1793	263		3599
8.	Rajasthan	2		2	328.5	0.5	0.5		0.5	334
9.	West Bengal	10				10				20
10.	Uttar Pradesh	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	20
11.	Tripura	10					9		12	31
12.	Meghalaya	50	32			36	144	56	70	388
13.	Assam				2		3		2	7
14.	Maharashtra	2					126			128
15.	Madhya Pradesh	2	2	2	2	2	2	2	2	16
16.	Odisha					48				48
Total										10,696



Fig. 5.15. Millet seed distribution through ICAR-IIMR, Hyderabad

Establishment of Custom Hiring Centres (CHC), Processing facility & FPO Outlet

ICAR-IIMR, Hyderabad in collaboration with foundations like ICICI, SELCO and through some government schemes like PMFME has established Custom Hiring Centres and Processing facilities at FPO level. Custom Hiring Centres include paddy dryer, paddy straw bailer, etc. Processing facilities

include Millet Primary Processing Units, Dal Mills, Rava Makers, Pulverisers, Laddu Making Units, Oil Mills, and Cold Press Oil Expellers, set up through support from NABARD Andhra Pradesh, NABARD Telangana, SFAC Oilseeds, and SFAC Millets projects.

These centres empower FPOs to enter the output market by adding value to the products available at the FPO level, thereby enhancing their sustainability and ensuring their long-term viability. With the support of ICAR-IIMR, FPO outlets have also been established, providing farmers with direct access

to consumers and markets. These outlets serve as a platform for FPOs to showcase and sell millet-based products and other agricultural commodities, ensuring better price realization and reducing the role of intermediaries.



Fig. 5.16. Millet Primary Processing Unit



Fig. 5.17. Pulveriser at Nidagundi FPO



Fig. 5.18. Collection centre & Cold Storage Unit



Fig. 5.19. Millet Primary Processing Unit



Fig. 5.20. FPO Outlet at Thandavavalley



Fig. 5.21. FPO Outlet at Lambasingi

Training Programmes

ICAR-IIMR, Hyderabad conducted a series of training programs for farmers, FPO staff, students, entrepreneurs etc aimed at exploring millet-based entrepreneurial opportunities, introducing newly developed millet cultivars, and familiarizing participants with value-added technologies. These sessions also focused on promoting startup opportunities through millet FPOs to strengthen market linkages. Emphasizing the nutritional and commercial benefits of millets, the training also showcased the importance of mechanization through demonstration of millet primary processing equipment available at IIMR.

The training covered various topics, including Millet Production, Processing, and Value Addition

Technologies, Redgram Nipping, Soil and Water Conservation, Biofortified Millets Production and Marketing, Organic Farming, Crop Diversification through Millets, Advanced Production Technologies for Soybean, Redgram, Greengram, and Blackgram Crops, and Popularizing non-Ragi Millets in Odisha through IIMR's interventions.

Additionally, ICAR-IIMR organized a free drone spraying demonstration over 150 acres of paddy and cotton fields, benefiting over 100 farmers. This initiative encouraged the adoption of drone technology for efficient fertilizer and pesticide application, helping modernize farming practices and boost productivity.

Table 5.9. Training Programmes conducted by ICAR-IIMR for FPOs

Training Program Title	Dates	Duration (in days)	Number of Participants	Category of Participants (ICAR Employees, Entrepreneurs, Farmer's, Students etc.)
Certified Millets Advisor Program Module- II	22/1/24-5/2/24	15	19	Aos, AEOs, SERP Coordinators and FPO coordinators
Awareness, Training and Exposure visit of Telangana FPOs	25/1/24	1	43	Farmers, FPO CEOs & BoDs
Research Facility Training to Research Scholars	1/2/24	1	21	Research Scholars
Online collaborative Training by MANAGE & ICAR-IIMR, Hyderabad	5-12/2/24	8	52	Officers from agriculture line departments, NGOs, FPOs, farmers, students, and extension professionals
Training programme to women farmers on preparation of millet value added products	7/2/24	1	13	Women farmers
Collaborative webinar between MANAGE & ICAR-IIMR, Hyderabad	23/2/24-1/3/24	8	21	Officers from agriculture line departments, NGOs, FPOs, farmers, students, and extension
Training on Natural Farming techniques to Premasai Navakisan FPO farmers promoted by ICAR-IIMR, Hyderabad	4/3/24	1	32	Farmers
Training cum awareness program on "Crop Diversification through Millets"	13/4/24	1	40	Farmers
Training on diversity of Crops by Millets	19/4/24	1	55	Farmers
Capacity Building training programme to CEOs and BODs of NABARD AP FPOS	25/4/24	1	21	FPO CEOs & BoDs
Seed Production Awareness Program to TS FPOs of ICAR-IIMR, Hyderabad	1/5/24	1	15	FPO CEOs & BoDs
Training Program on Preparation of Jackfruit Value Added Products	1-3/5/24	3	13	Farmers
Virtual Training Program on Advanced Production Technologies in Soyabean, Redgram, Greengram and Blackgram crops	8/5/24	1	21	Farmers
Mission LiFE Awareness Programme with the Theme of World Environment Day 2024, "Land Restoration, Desertification and Drought Resilience"	22-24/5/24	3	228	Agri Stakeholders from diff states
Field Day and Seed Distribution Program to Transfer the Improved Technologies to Farmers	3/6/24	1	35	Farmers

Training Program Title	Dates	Duration (in days)	Number of Participants	Category of Participants (ICAR Employees, Entrepreneurs, Farmer's, Students etc.)
Training program on seed production and certification	5/7/24	1	45	FPO Shareholders
Training on crop diversification and promotion of Millets	10/7/24	1	31	Farmers
Training on adoption of IIMR technologies and millet seed distribution	16/7/24	1	24	Farmers and FPO members
Training programme on "Millets Production, Processing, Value Addition Technologies and Rice Fallows with non-Ragi Millets"	6-9/8/24	3	27	Farmers
Training program on Agri products - value addition	12/8/24	1	150	Women farmers
Free Drone Spraying Demonstration at Tekmal Mandal, Telangana	20/8/24	1	50	Farmers
Farmer Scientist Interaction and Farmers Field Day at Tekmal FPO promoted by IIMR	21/8/24	1	50	Farmers
AGM Meeting of S.Kota FPO organized by ICAR-IIMR, Hyderabad	28/8/24	1	27	Farmers & FPO Shareholders
Training program on 'Millets Production, Processing, and Value Addition Technologies' to Bihar farmers	4-6/9/24	3	35	Farmers
Redgram Nipping Training Program at Jewargi Taluka Millets FPCL promoted by ICAR-IIMR, Hyderabad	10/9/24	1	28	Farmers
Awareness Programme to Aland Bhootai Millets FPCL Farmers on PMKSN scheme	11/9/24	1	12	FPO CEOs & BoDs
Barnyard Seed Production Field Day at Bettada Basaveshwar FPCL promoted by ICAR-IIMR, Hyderabad	12/9/24	1	18	Farmers
Virtual Buyer Seller meet conducted by FPO-NEST Team of ICAR-IIMR, Hyderabad	13/9/24	1	24	Farmers
Training Program on soil and water conservation conducted by Jewargi Taiuka Millets FPCL promoted by ICAR-IIMR, Hyderabad	13/9/24	1	39	Farmers
Webinar on Biofortified Millets production, Processing, Value addition & marketing	12/9/24	1	20	Millet stakeholders
Organic Farming Training Program to Farmers by Amruthvahini FPCL promoted by ICAR-IIMR, Hyderabad	22/9/24	1	32	Farmers
Training program on Millet Cultivation and Marketing at Aland Bhootai Millets FPCL, promoted by ICAR-IIMR Hyderabad	24/9/24	1	19	Farmers
Farmers Connect Program on sustainable farming practices	24/9/24	1	21	Farmers
Training on Sustainable Agriculture Practice through Millets to FPO coordinates	23-26/9/24	3	16	FPO Coordinators
Farmers Field Day on Crop Diversification through Millets & Value Addition of Millets at Tekmal Farmers Producer Cooperative Society	24/9/24	1	56	Farmers
Training programme for Betelvine farmers of Thandava Valley FPO	18/10/24	1	16	Farmers
Workshop on strengthening the capacity of FPOs performance	23-24/10/24	2	24	BoDs & CEOs of FPOs
Workshop on Area Expansion of Sunflower in Paddy Fallows	25/10/24	1	48	Farmers
Training program on "Popularization of non-Ragi Millets in Odisha state through IIMR interventions" under Odisha Millet Mission	6-11/11/24	5	21	Farmers
Awareness program on Pulse Magic growth promoters	11/11/24	1	20	Farmers

Training Program Title	Dates	Duration (in days)	Number of Participants	Category of Participants (ICAR Employees, Entrepreneurs, Farmer's, Students etc.)
Training program to Odisha Agriculture Officers on "Millet's seed Production, Processing and Certification"	20-22/11/24	3	22	Farmers
Workshop cum training program for AP FPOs promoted by ICAR-IIMR, Hyderabad	23-24/11/24	2	19	BoDs & CEOs of FPOs
Training on "Millets Seed Production, Processing, Certification & Value Addition" to Odisha Farmers	3-5/12/24	3	21	Farmers
Training on Introduction of Advanced Millet Technologies to Odisha Farmers	4-7/12/24	3	19	Farmers
Certified Millets Advisor program	9-23/12/24	15	15	Agriculture Officers
State level workshop on Agro Based Food Processing Industry (ABFPI)	18/12/24	1	50	Millet stakeholders and Farmers
Training program on Millet's production, Processing, Value Addition, Branding and Marketing to Prospective FPOs of Odisha	18-20/12/24	2	23	Farmers
Training program on "Promotion of Millet Technologies among Scheduled Caste Farmers" in Vijayapura District	23/12/24	1	16	Farmers



Fig. 5.22. Glimpses of training programmes

Market Linkages

As a Cluster-Based Business Organization (CBBO), ICAR-IIMR successfully facilitated market linkages for Farmer Producer Organizations (FPOs) in the output

marketing of various commodities. By strengthening FPO networks, ICAR-IIMR enabled farmers to collectively negotiate better prices, reduce dependency

on middlemen, and enhance their market reach. These efforts have empowered FPOs to establish direct ties with institutional buyers, food processing industries, and retail markets, ensuring fair pricing and increased profitability. ICAR-IIMR inked MoU with Krishisamruddhi

FPC, Dharwad, Dasohi Poultry Farmer Producer Company Limited (FPCL) ICAR-IIMR as CBBO successfully connected FPOs for Output marketing of the following commodities

Table 5.10. FPOs Output marketing of commodities

S. No	Commodity	Quantity	Transaction Value	Benefited farmers
1.	Chia Seeds	15.06 MT	15.68 lakhs	35
2.	Jowar	20.00 MT	6.36 lakhs	26
3.	Red gram	12.00 MT	6.000 lakhs	21
4.	Soyabean	350 MT	1.62 crore	214



Fig. 5.23. Chia Procurement



Fig. 5.24. Jowar Procurement

NEH Projects achievements

During 2024, ICAR-IIMR, Hyderabad provided significant support to four FPOs in and around Arunachal Pradesh, benefitting a total of 483 shareholders. As part of this initiative, 5.2 quintals of millet seeds were distributed freely through these FPOs, with a notable increase in the participation of women members in millet cultivation, processing, and value addition activities. The project also focused on linking smallholders to markets through digital platforms such as ONDC and FPO Kisan Bazar. Additionally, two PMFME applications for millet processing units and one Credit Guarantee Fund application were submitted, which is expected to

generate employment for local youth through the FPOs. Over 500 individuals were made aware of the nutritional health benefits of millets through more than 25 programs, while critical inputs were distributed to over 500 farmers across five districts in the state. More than 10 training and demonstration sessions were held through FLDs, alongside a millet walkathon that attracted over 600 participants, creating massive awareness. Furthermore, a two-day regional workshop, which included a recipe cooking competition and a millet quiz competition, was organized to engage the community and promote the benefits of millet farming.



5.25. Awareness Drives to FPO farmers in NEH areas



Fig. 5.26. Trainings & Capacity Building Programs to NEH Areas

6. Global Centre of Excellence on Millets (Shree Anna)

IIMR/GC/2023-26/171A: Global centre of excellence on millets (Shree Anna) (Director & All Scientists)

The Indian Government has taken a significant step towards promoting the importance of millets worldwide. It has designated the ICAR-Indian Institute of Millets Research in Hyderabad as the “Global Centre of Excellence on Millets (Shree Anna)”. This center aims to facilitate research, development, and dissemination of knowledge about millets at a global scale, highlighting their immense nutritional and economic benefits. Through this initiative, awareness will be created about the potential of millets to contribute to food security, climate resilience, and sustainable agriculture.

The establishment of this global center holds a significant promise in promoting research activities, infrastructure, millet cultivation, value addition and collaborations worldwide. It enhances the capacity

building of researchers and stakeholders, as well as developing their skills to produce high-quality research outputs. Additionally, the center aims to foster strong linkages among stakeholders in different sectors to create a network of experts working towards a common goal of advancing research and innovation. Overall, this initiative is a significant step towards recognizing and harnessing the potential of millets, which have long been neglected despite being a rich source of essential nutrients and a vital component of many traditional diets.



The Hon'ble Prime Minister of India, Shri Narendra Modi ji declared the Indian Institute of Millets Research

of ICAR as a Global Centre of Excellence during The Global Millets (Shree Anna) Conference at New Delhi on 18th March, 2023

Major Components:

1. Establishing global germplasm medium-term storage facility to strengthen millets GeneBank for conservation, trait-specific characterization and utilization of millet biodiversity for crop improvement
2. Global Technology Innovation Centre for trait, seed and crop Improvement of millets for enhancing yield and productivity
3. Nutricereal analytical, food safety and quality assurance National Referral Laboratory for millets

4. Global Centre of Excellence for Millet Value Chain for Entrepreneurship, Incubation and Start-up Nurturing
5. Establishment of International knowledge, skill development and capacity enablement Centre with International Millet Museum & Halls of Residence
6. Global facility for Millet Pilots on feed, fodder, biofuels, malting, brewing and promotion of industrial utilization of millets
7. Regional Millet Technology Innovation and Outreach Hubs

Fund received in September 2023 and ICAR initiated GCoE in EFC mode from 2023-24 to 2026-27.

Collaboration with the Institutes

S. No	Name of Collaborators	Title of the project
1	ICAR-IARI (Division of Genetics), New Delhi	Evaluation of hybrid parental lines and phenotyping of pearl millet GWAS panel and SPARSE trial
2	ICAR-IARI (Division of Biochemistry), New Delhi	De novo transcriptome data analysis and metabolite sensor development for rancidity
3	ICAR-NBPGR, New Delhi	Genetic resource management of millets for enhanced utilization
4	ICAR-NIPB, New Delhi	Screening for drought tolerance and epigenetic characterization of differentially expressed genes in pearl millet
5	ICAR-IIAB, Ranchi	Deciphering gene network for conferring tolerance to aluminium toxicity in finger millet
6	ICAR-VPKAS, Almora	Association Mapping and trait phenotyping for Blast, Smut and Nutritional Traits in Barnyard Millet
7	ICAR-CAZRI, Jodhpur	Evaluation of hybrids and diverse lines under moisture stress in pearl millet
8	ICAR-CIPHET, Ludhiana	Develop millet-based value-added products and processing technologies at the farmer and processor level
9	ICAR-CRIDA, Hyderabad	Response of millets to elevated CO ₂ and phenotyping of kodo millet lines for grain yield and related traits
10	ICAR-NRC Camel, Bikaner	Maximizing nutrient out put through bio-fortification of dual-purpose pearl millet for augmenting livestock production
11	ICAR-CIRB, Hisar	Evaluation of feeding value of promising millet fodder cultivation (sorghum and pearl millet) in Buffaloes: effects on body weight gain, milk production and enteric methane emission
12	ICAR-NDRI, Karnal	Valorization of pearl millet straw for production of gut health caring nutraceuticals
13	ICAR-CIRG, Makhdum	Utilization and evaluation of millets stover and by-products in quality and feed economics in goat
14	ICAR-CIAE, Bhopal	Millets processing and value addition
15	ICAR-IGFRI, Jhansi	Harnessing genetic diversity in pearl millet and sorghum for development of trait specific genotypes and trait mapping for fodder yield and quality traits

Salient progress on various components

1. Establishing a Medium-term Germplasm Storage Facility to Strengthen Millets GeneBank for Conservation, Trait-specific Characterization and Utilization of Millet Biodiversity for Crop Improvement

A set of 952 germplasm accessions of various millets (Finger millet-286; Foxtail millet-190; Proso millet-476) were multiplied in *kharif* 2024 for rejuvenation and conservation and were harvested. More than 2,000 accessions of various millet genotypes were distributed

to different stakeholders for research purposes. Received 4,191 sorghum accessions from ICAR-NBPGR Regional Centre, Akola, and the preparatory work for the conservation of these accessions at the gene bank was completed. A set of 348 accessions of small millet germplasm was planted, and characterization was completed. Characterization of quantitative data of descriptor traits like panicle length

and width (barnyard millet), plant height (all millets), panicle shape (barnyard millet), number of productive tillers (all millets), number of fingers (finger millet), thumb raceme length and number of racemes (kodo millet); post-harvest data on grain yield, 100 seed weight, and other yield-related traits of 348 accessions of small millet germplasm (Barnyard millet, finger millet, and kodo millet) were also collected.



Fig. 6.1. Characterization of various millet accessions

A set of 1000 genetically diverse sorghum accessions were selected and characterized for further genomics experiments. Single sorghum panicle (50 panicles) was collected. Data on race, grain size, colour, shape, 1000-grain weight were collected. Postharvest operations for 1,700 accessions of sorghum planted for multiplication were completed. Germination, vigour and related traits were characterized for 50 accessions of each finger millet, foxtail millet, kodo millet, little millet, and Barnyard millet germplasm from the *kharif* 2024

evaluation. A panel of 192 kodo millet accessions was identified to develop an association mapping panel for genetic mapping of various traits.

2. Technology Innovation Centre for Trait, Seed, and Crop Improvement of Millets for Enhancing Yield and Productivity

Pearl millet:

A diverse panel of 201 pearl millet genotypes were phenotyped for nine traits related to seed vigour and

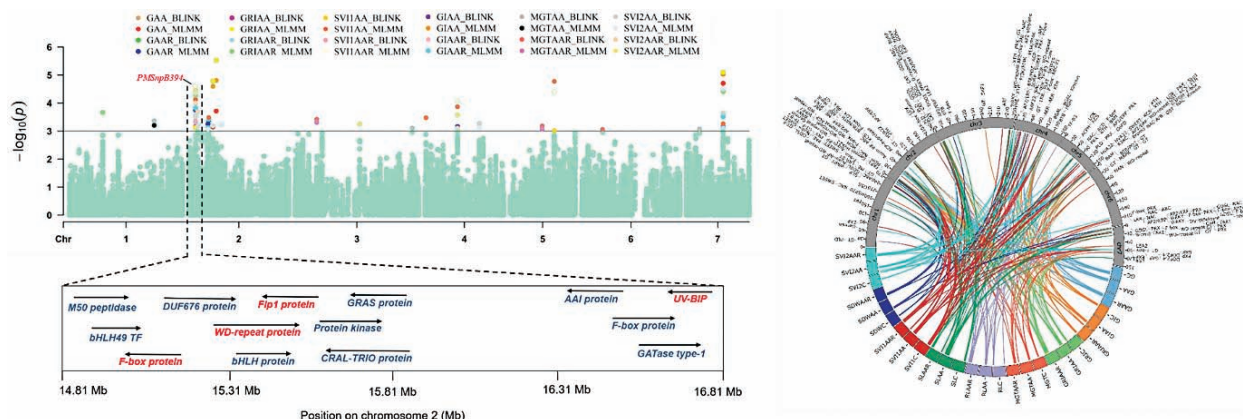


Fig. 6.2. Significant SNPs and genes related to various seed traits in pearl millet

longevity under three experimental conditions (control, accelerated aging and their relative measures). Genome-wide association study identified 413 significant marker-trait associations from 2015 SNPs leading to key genes involving *MYB*, *DOG1* and *WRKY* in ABA and auxin pathways, identified as regulators of seed dormancy, germination, and stress response, enhancing seed longevity. Other set of genes include *GDSL lipase*, *glutathione transferase* and *3-ketoacyl-CoA synthase* involved in lipid metabolism and seed coat development, supporting germination, seed resilience and enhancing seed longevity.

Whole genome transcriptome sequencing of two contrasting pearl millet inbreds, EGTB 1034 (heat tolerant) and EGTB 1091 (heat sensitive) identified genes encoding ROS scavenging enzymes, *WRKY*, heat shock proteins (HSPs) and several transcription factors (TFs) involved in cross-talking of temperature stress responsive mechanisms.

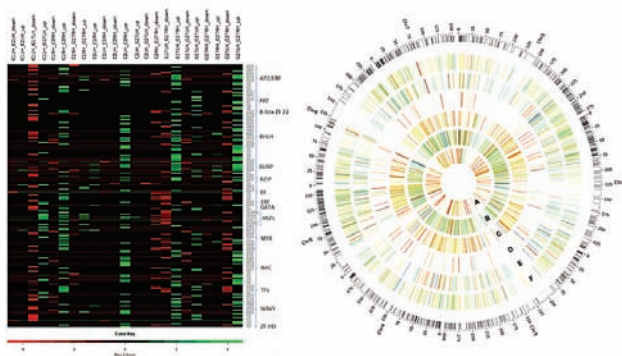


Fig. 6.3. Expression pattern of heat tolerant genes in pearl millet

Another Genome-wide Association studies (GWAS) conducted in pearl millet for blast trait revealed important genes such as *NLR proteins*, *WRKY* and *MYB transcription factors* as key regulators for defense response to the blast fungus, facilitating reactive oxygen species production and cell wall strengthening in pearl millet. Some other key genes involved in programmed cell death (PCD) and *E3 ubiquitin ligases* were identified through GWAS approach, playing a significant role in enhancing resistance mechanisms against blast in pearl millet through the hypersensitive response.

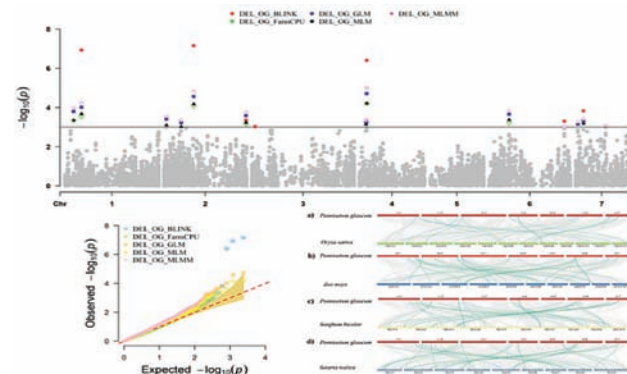


Fig. 6.4. Blast resistant SNPs identified in pearl millet and synteny mapping of these SNPs with other cereals

Genome-wide transcriptomic analysis from leaf and root samples of two inbreds, ICMR 101205 (drought-tolerant) and ICMR 101580 (drought-susceptible), generated 2.3 billion raw reads, with 1.68 billion aligning to the reference genome after quality control. Analysis of 40 different combinations (between treatments, leaf, root, leaf vs root and genotypes) revealed 95,052 differentially expressed genes.

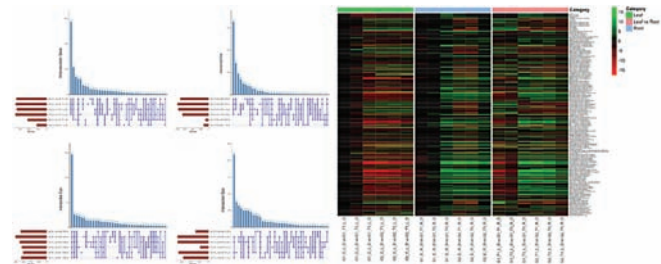


Fig. 6.5. DEGs obtained in transcriptome analysis for drought in pearl millet

A comprehensive GWAS phenotyping trial with 300 genotypes was constituted and under evaluation at IGFR, Jhansi; CAZRI, Jodhpur; IARI, Delhi, RARS -Vizianagaram, Andhra Pradesh and Koraput, Orissa for mapping yield, nutritional and blast traits. The same panel was developed for seed multiplication in *kharif* 2024 for trait mapping in pearl millet. Estimation of iron and zinc content in pearl millet GWAS Panel using XRF is in progress.

Seeds of various A1, A2, A3, A4, and A5 pearl millet CMS lines, selected were acquired from the national and international gene banks for genomics experiments in the month of August 2024. Sequencing of the genome of these lines was carried out resulting in whole genome data of

A4 and A5 cytoplasm (20X coverage), A-B pairs of A3 cytoplasm (25X coverage), A-B pairs of A2 CMS cytoplasm (20X coverage) and A-B pairs of A4 CMS cytoplasm (25X coverage). Quality check and sequence alignment of the whole genome data of A3 CMS cytoplasm of pearl millet is in progress. Sequencing data of an A4 CMS line, HMS 37A was generated and analysed for read length and quality statistics. Leaf samples have been collected for mitochondrial DNA isolation of A-B pairs of A1 to A5 CMS lines of pearl millet. Primers were designed and synthesized for mitochondrial-specific genes (*cox2*, *nad6*, and *atp6*) in pearl millet.

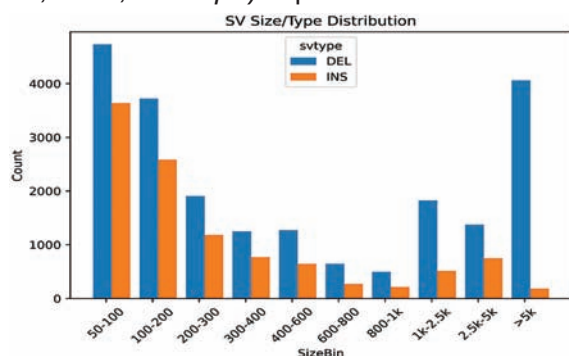


Fig. 6.6. Structural variants detected in A3 CMS line of pearl millet

A total of 28 pearl millet hybrids were evaluated in elite early maturing hybrid trials at Hyderabad, Solapur, and Mandor. Twelve hybrids were selected with a grain yield ranging from 3.28 to 5.05 t/ha and obtained flowering in 40-45 days. Inbreds, TCB 139 and New IC S23-346 were identified as low-rancid lines in pearl millet for further molecular characterization. Pearl millet blast-infected samples were collected from the states of Rajasthan and Haryana in September 2024. Thirteen pearl millet blast isolates were cultured from different locations and hotspots in Rajasthan.

Sorghum:

Diverse sorghum germplasm lines (Bicolor, Guinea, Caudatum, Kafir, Durra) were identified for developing a new 5K mid-density SNP panel. Whole-genome resequencing data of 956 diverse sorghum germplasm lines (Bicolor, Guinea, Caudatum, Kafir, Durra) has been retrieved from public databases to develop the mid-density panel consisting of 4k to 5k SNPs. Based on genome coverage (2X-25X), around 650 diverse germplasm lines have been selected for mining highly informative and highly polymorphic SNPs.

In-silico mining pipeline

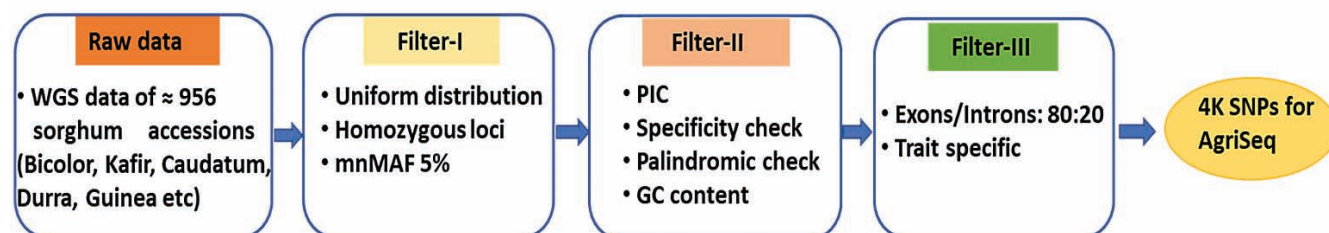


Fig. 6.7. Pipeline of sorghum 4K SNP MID-DENSITY PANEL

Characterization of 54 sorghum breeding materials for grain mold resistance was carried out and four superior lines were identified (N-327, BN-315, BN-306 and BN-210), which combined resistance to grain mold with other desired characters such as bold seed, medium flowering and tolerant to leaf diseases. Two lines S23051RV (17.2%-dead hearts), S23036RV (17.8%-dead hearts) tolerant to shoot fly and S23030RV (13.97-CRI), S23032RV (14.70-CRI) tolerant to charcoal rot disease were identified. A total of 42 sorghum germplasm (*kharif* hybrids, *kharif* varieties, *rabi*

varieties, R-lines) was evaluated for high temperature stress tolerance based on grain yield reduction over the control and identified more than 10 genotypes tolerant to stress in various categories. A dual purpose (grain and dry fodder), medium maturing, non-lodging, *rabi* sorghum genotype SPV 2918 developed from MAGIC approach was identified with multiple resistance to key insect pest and diseases, such as shoot fly, stem borer, aphid, shoot bug, charcoal rot, rust & leaf blight using MLT data of three years.

Twenty different backcross populations (BC_2F_2 s) were generated in the background of seven popular *rabi* cultivars namely, SPV 2217, Parbhani Jyoti, CSV-29R, BJV-44, PKV Kranti, Phule Vasudha and CSV- 26 R. The entries such as, IS- 4698 & HC-308 (Stem borer); SLR 31 (aphid); SLR 10 & Y-75 (shoot bug); IS-23684 (rust); RSV-827 (drought); RNTN-13-37 & RNTT- 8-32 (stay green) were used as donors for introgression for respective traits. To develop high-performing, stress-resilient post-rainy season sorghum cultivars, a comprehensive multi-parent crossing approach was developed as a novel approach that resulted in two 8-way cross-derived lines, S22086RV and S22085RV, outperforming the national check cultivar CSV 29R by nearly 70% and 60% in grain yield, and over 30% and 15% in stover yield, respectively.

RILs development from multi-parent cross populations (diverse parents) for genetic dissection of *rabi* adaptive traits in sorghum is under progress. Seed multiplication of 15 superior sorghum and foxtail millet genotypes was taken up for AICRP trials. A bold-seeded sorghum line S23027RV with a test weight of 4.29 g, grain yield of 5054 kg/ha and stover yield of 11646 kg/ha was identified for AICRP multi-location testing. Root phenotyping of sorghum under well-watered and drought stress conditions using modified lysimeters for key root traits is in progress.

Protocol for isolating DNA from seeds of pearl millet and sorghum was standardized, which reduces time and cost during marker-based early generation selection (MEGS). A study on genome editing to induce apomixes has been initiated and three SERK (SbSERK 1, SbSERK 2, and SbSERK) genes of sorghum were targeted to understand their effect on apomixis using CRISPR-Cas9 gene editing technology. Nine sgRNAs (three for each gene) were designed and cloned into the pBUN421 vector, which also carried the bar gene as a plant selectable marker. The nine vectors carrying sgRNAs were then individually mobilized into *Agrobacterium* LBA 4404 for the transformation of the sorghum male fertile line (296B/C43).

Shoot fly

The structure of the shoot fly egg collected from twenty-five-day-old sorghum seedlings (variety DJ-6514) was documented, which displays a white sculptured surface at 75X magnification and a distinct reticulate pattern of hexagonal cells at 150x magnification.

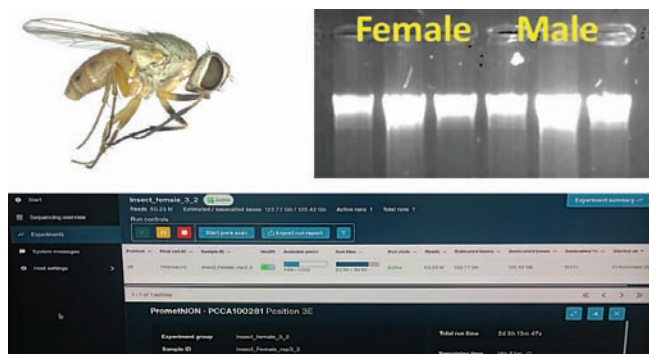


Fig. 6.8. Female sorghum shoot fly using Stereozoom (12X), DNA of male and female sorghum shoot fly and progress of Nanopore sequencing of shoot fly

Morphological characters of sorghum shoot fly larva such as mouth hook and a pair of anterior spiracles on the anterior portion of head, posterior spiracle and anal division at the posterior end were documented using the Stereo zoom microscope (ZEISS SteREO Discovery. V20), from the Bermuda grass (*Cynodon dactylon*), an alternate host for the shoot fly. Developing individuals of *Atherigona orientalis* were collected and preserved for morphological examination using a stereomicroscope. The documented morphological characters included basal scutellar setae, quadriserial presutural acrostichal setae, and the preapical dorsal seta on the hind femur. Whole genome sequencing of shoot flies was initiated, in which different DNA isolation protocols from male and female shoot flies were developed and standardized. Genomic DNA isolation protocols from male and female shoot flies were optimized and library preparation of female sorghum shoot fly is under progress by November 2024. Whole genome DNA sequencing of the sorghum female shoot fly was completed with >100X genome coverage using the nanopore long-read sequencing approach.

Management of Fall armyworm in sorghum

Broflanilide was the most effective insecticide with

the least median lethal concentration values followed by chlorantraniliprole, Spinosad, spinetoram and Emamectin benzoate against fall armyworm 3rd instar larvae in sorghum. Biocontrol module comprising of release of egg parasitoid, *Trichogramma pretiosum* @ 1 card/acre, twice (first release one week of planting & second one after one week of first release along with spray of *Metarhizium anisopliae* (Ma 35) @ 0.5% at 20, 35 DAE was effective in managing *Spodoptera frugiperda* in sorghum.

Finger millet:

To understand the genes responsive to Fe and Ca stress conditions, total RNA was isolated from 48 samples of finger millet grown under different Fe and Ca stress conditions and transcriptomes were sequenced using RNASeq approach resulting in 200 GB of raw sequencing data. Comprehensive whole-transcriptome analysis of the contrasting pair of finger millet genotypes under various Fe and Ca treatments revealed 23,000 differentially expressed genes (DEGs) associated with Fe and Ca regulation under different stress conditions and alignment analysis revealed that leaf and root samples under control conditions achieved a high alignment rate up to 95.20%.

Employing GWAS on 221 diverse finger millet accessions with high-density GBS and phenotyping data on 9 seed traits under control and accelerated ageing treatments identified 54 significant marker-trait associations (MTAs). Functional annotation of the MTAs identified MACPF domain-containing proteins, retrotransposons, glutamate dehydrogenase as the promising genes governing seed germination and seedling traits in finger millet. A finger millet GWAS panel of 250 genotypes is under evaluation for genome wide association studies at IAB, Ranchi for study on aluminium toxicity and at VPKAS, Almora for blast and nutritional traits. Genome-wide identification of chitinase genes, in silico analysis, and expression studies are being carried out to study their role in blast resistance in finger millet.

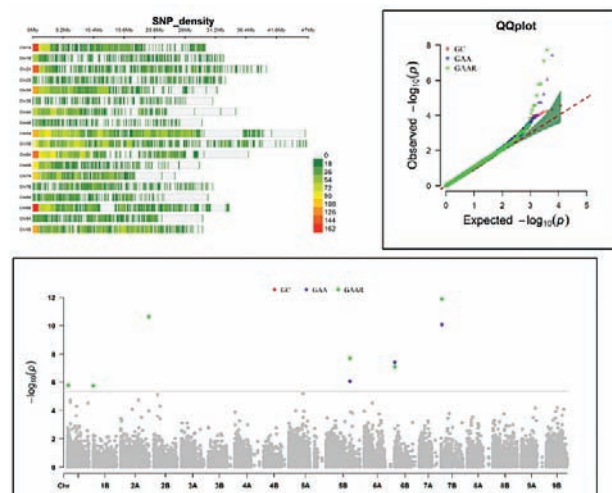


Fig. 6.9. GWAS for seed longevity traits in finger millet

To strengthen the recombination breeding in finger millet, Trifluoro Methane Sulfonamide (TFSMA) was tested as a gametocide at 3 different concentrations (1, 2, 3%) and three different flowering/ growth stages during *kharif* 2024. The study revealed that the application of TFSMA at 2% and 3% during an early booting stage at the juncture of the leaf sheath is effective in inducing sterility. Seed multiplication of four new finger millet genotypes was carried out in *kharif*, 2024 for AICRP varietal testing towards developing improved varieties in finger millet. A trial has been constituted with 42 finger millet released varieties at 6 locations to evaluate the benchmark grain calcium and other grain micronutrients. An improved mutant MR 6 finger millet variety was developed and identified with 6 days early maturity, improved grain size and grain yield. Sixteen lines were identified with more than 20% grain yield superiority over VL 376 and CFMV 2 from a set of 105 interspecific finger millet derivatives. Data recorded on growth and physiological traits in field experiments to identify the best INM package in finger millet and optimize the N and K dosage in finger millet and foxtail millet. Characterisation of 29 foxtail millet and 35 finger millet varieties in lysimeter for water use efficiency is in progress.

Little millet:

A total of 41 little millet lines derived from CLMV × BL 6 were evaluated during *kharif* 2024 for grain yield and related traits. Two promising derivatives (LMV 518-2-2 and LMV 518-2-3) were identified over the latest check CLMV 1 with grain yield improvement of

8-12%. Two promising little millet lines were evaluated and IIMR-LM-R23-5129 showed superiority with an average productivity of 12-14 q/ha at Chitradurga District in Karnataka, which is a promising production ecology. Seeds of another four promising little millet genotypes were multiplied and contributed to AICRP small millet trials. About 50 in-house genomic SSR markers developed in little millet were validated for their polymorphism in 24 diverse genotypes, resulting in the identification of 18 polymorphic markers.

A GWAS panel of 300 genotypes in little millet was constituted and raised in controlled conditions for mapping nutritional traits.

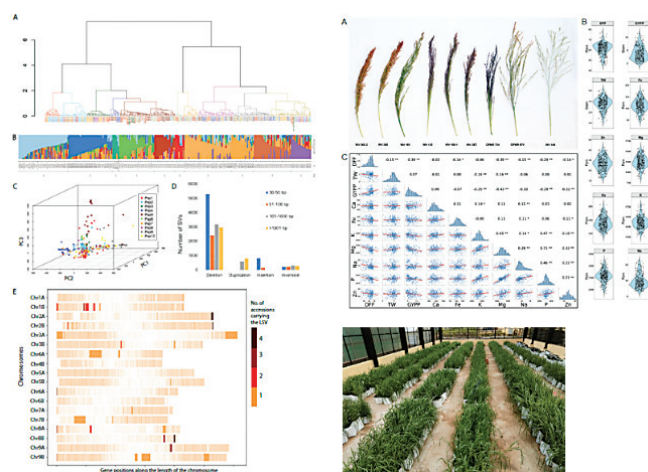


Fig. 6.10. Genetic and phenotypic diversity in Little millet genome sequencing panel

Various morphological, agronomic traits along with nutrient content of grains (Ca, Fe, Zn, K, P, Mg, and Na) were phenotyped in *kharif* 2024. The phenotype data of the little millet GWAS panel is curated to map the QTLs associated with those traits. GWAS analysis in little millet for mapping days to 50% flowering (DFF), 1000-grain weight (TW), grain yield per plant (GYPP) and concentrations of six grain micronutrients (Ca, Fe, K, Mg, Na, P, and Zn) traits using MLM and BLINK models revealed highly significant marker-trait-associations (MTAs) namely, Chr2A_3693904 (TW), Chr4B_27491672 (GYPP), Chr1B_39041529 (P), Chr1A_560273, Chr2A_32889668 and Chr1A_560273 (Fe) in little millet. Further chromosome-scale reference genome assembly of little millet, comprising 18 chromosomes and 59,045 annotated protein-coding genes is developed. Seven chromosomes were

assembled telomere-to telomere, while others split into 2-5 contigs. The 850 Mb genome, a recent tetraploid, closely resembles the broomcorn millet genome and exhibits early diploidization features including gene fractionation and sub- genome dominance. Re-sequencing 300 diverse accessions provided insights into genome-wide diversity of SNPs and structural variants, while genome-wide association studies identified several high micronutrient accessions with breeding potential and key loci associated with grain micronutrient content, including multiple loci linked to iron enrichment.

Kodo millet:

Kodo millet genome of the cultivar RK390-25 has been sequenced *de-novo* and assembled. A total of 450, 56 and 57 structural variants and 42, 42 and 106 copy number variants were identified, respectively, by comparing the sequence with proso millet, finger millet and foxtail millet, respectively.

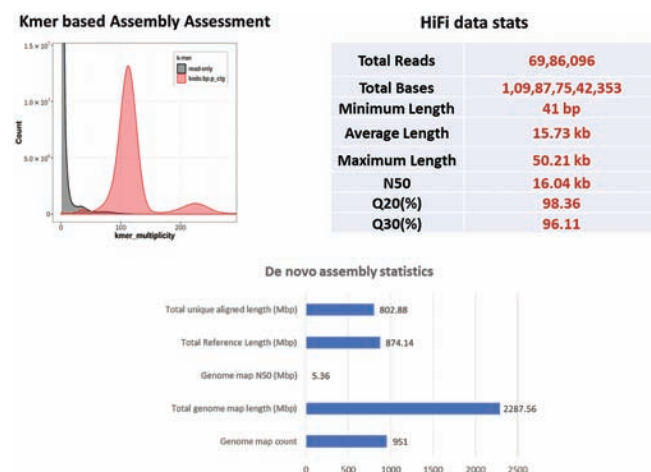


Fig. 6.11. De-novo sequencing of reference genome in kodo millet

Phenotyping of the kodo millet GWAS panel (246 genotypes) for grain yield and related traits is in progress in collaboration with CRIDA, Hyderabad. In another study, kodo millet seeds were irradiated with three doses (500 Gy, 400 Gy, and 300 Gy) of gamma rays to create variability and were subjected to a germination test. Evaluation of 205 germplasm lines of kodo millet for yield-related traits led to the identification of five potential lines in *kharif* 2024, and these lines will be multiplied for seeds during *Rabi* 2024. Kodo millet storage pathogens, namely, *Aspergillus* sp. and *Penicillium* sp., were isolated from the grain, and the

morphological characterization was carried out to identify them at the genus level.

Foxtail millet:

Twenty six resistant foxtail millet genotypes were identified from a panel of 179 accessions evaluated in replicated field trials for rust at six environments across India. The genotypes exhibited rust resistance better or equal to the currently available resistant check ISe1177, which will be used as resistant sources in breeding leading to identification of two stable donors for rust resistance namely IC0404112 and IC0308976 in foxtail millet. Genomic DNA of 64 diverse foxtail millet genotypes was isolated and quantified. Genotyping was performed for these genotypes using 15 genomic SSR markers, of which 12 markers were polymorphic, exhibiting number of alleles ranging from 2 to 6. Promising foxtail millet genotypes were phenotyped in different station trials for grain yield, yield components, flowering duration and plant pigmentation. Suitable sieve size (1.8mm) was identified for better seed recovery and quality in foxtail millet for grading of seeds during seed processing.

Barnyard millet:

Phenotyping of barnyard millet GWAS panel consisting of 200 genotypes to carry out genome wide association studies for smut, nutritional traits and various agronomic traits is carried out in collaboration with VPKAS, Almora. A set of 45 barnyard millet genotypes is under evaluation in control and salinity treatments to understand the seedling level salinity stress tolerance. Seed yield and quality enhancement through boron and zinc foliar sprays in barnyard millet experiments were concluded.

Browntop millet:

DNA was extracted from twenty-eight genotypes, including cultivars and germplasm lines, to conduct molecular diversity studies in brown top millet (*Urochloa ramosa*). A total of 24 SSR markers from *Urochloa* species were shortlisted from published literature and synthesized for characterization. Emasculation in browntop millet using hot water treatment was conducted and it showed that the seed set was satisfactory (60%) when treated with hot water of 55°C for 5 min compared to all other treatments.

Other experiments:

A detailed experiment to study the response of 9 different genotypes of 9 millet crops, sorghum, kodo millet, little

millet, proso millet, browntop millet, foxtail millet, finger millet, barnyard millet and pearl millet to elevated CO₂ and temperature is performed in collaboration with CRIDA, Hyderabad. These are phenotyped under CTGC facility and data obtained is further utilised for statistical analysis. The data were recorded for various morpho-physiological and yield traits. The results showed most of these traits responded differently for different crops under different treatments. Grain yield per plant showed an increasing trends at elevated temperature (+1 to +3 ° c over ambient condition) and also in combination with elevated CO₂ in case of pearl millet, sorghum and brown top millet.

Thirty two endophytes of pearl millet were screened against *Rhizoctonia solani* and *Macrophomina phaseolina* for bread antifungal properties and plant growth promotion activities. Molecular docking experiments were carried out to identify the best ligands from elite endophytes for the management of banded sheath blight and charcoal rot of sorghum. The GC/MS analysis of the best strains of finger millet endophytes against foot rot pathogen was carried out and identified bio-molecules responsible for biocontrol potential against *Sclerotium rolfsii* of finger millet. Standardization of spore production technique in Magnaporthe is under progress. Molecular identification of elite finger millet endophytes against foot rot pathogen has been completed.

Experiments on formulation of crop boosters and evaluating the physiological impact of nutrient consortia on the productivity of small millets for yield enhancement are conducted and formulation is initiated to enhance yield. Data is recorded on yield attributes and yield in field experiments to identify the best INM package in finger millet and optimize the N and K dosage in finger and foxtail millet. Collection of export and import data of pearl millet and finger millet was completed, and the Markov chain analysis of pearl millet exports data is in progress.

3. Nutri-cereal Analytical, Food Safety and Quality Assurance National Referral Laboratory for Millets

Five different biochemical assays (alcoholic acidity, comprehensive acid value, lipase, peroxidase, and lipoxigenase) were standardized to phenotype rancidity in pearl millet flour. Characterization of lipase activity in grains of 130 pearl millet inbreds revealed a range of 2.6 to 16.8 units. Study on alcoholic acidity of pearl millet

flour on 7th day had strong positive correlation with lipase activity in the flour ($r=0.905$; $p<0.01$) and no correlation with lipoxygenase activity in flour. LC-MS and GC-MS based analyses were performed further to identify the metabolites related to pearl millet rancidity. LC-MS based profiling was carried out and whole genome metabolite fold change values were calculated from normalized data of two pairs of high and low-rancid pearl millet inbreds, which revealed significant metabolites. Assessment of crude fat content, lipase activity and alcoholic acidity in flour samples of pearl millet inbred lines as part of the pearl millet rancidity studies is under progress, as of January 2025. Metabolites related to iron, zinc content in pearl millet were also determined using LC-MS, and GC-MS based profiling.

Metabolite analysis of genetically diverse genotypes of different millets, kodo millet (8 genotypes), foxtail millet (10), barnyard millet (8), brown top millet (4), sorghum (31), pearl millet (44), finger millet (8), little millet (8), proso millet (15) was carried out yielding whole genome metabolite data of these nine millet crops. Using different statistical models, heat maps of target metabolites were created and genotypes were grouped to compare the prominent metabolites within and across millet crops. First step of untargeted metabolome analysis identified 3400 metabolites across all nine millets, out of which 23 vitamins, 234 metabolites from the phenyl

propanoid pathway (consisting of 10 phenolic acids, 166 flavonoids, 45 anthocyanins etc), 126 free fatty acids and their metabolites, 75 free amino acids and their metabolites, 222 terpenoids and 186 alkaloids were identified. Distribution of each compound across millet species has been determined using heat maps and unique metabolites were identified from coloured genotypes of sorghum, foxtail millet, little millet and finger millet. There are 1942 plant-specific metabolites across millet crops falling under different classes of compounds, such as, vitamins and their derivatives, including B vitamins such as thiamine, riboflavin, niacin, pyridoxine, biotin, and folate (64) along with intermediates in vitamin metabolism. Fatty acids and their metabolites (245), including saturated (myristic acid, lauric acid, stearic acid, etc) and unsaturated fatty acids (oleic acid, linoleic acid, linolenic acid, etc) and other metabolites in the fatty acid biosynthesis pathway were also identified. Secondary metabolite profiling identified 205 compounds (belonging to the terpenoid class including the mono, di, and trisesquiterpenoids), 89 free amino acids and their metabolites (including phenyl alanine, valine, methionine, tyrosine and other metabolites including L-Homocysteine, L-ornithine). A technical booklet is also prepared on 'Comparative metabolite profile of millet grains', in October 2024.

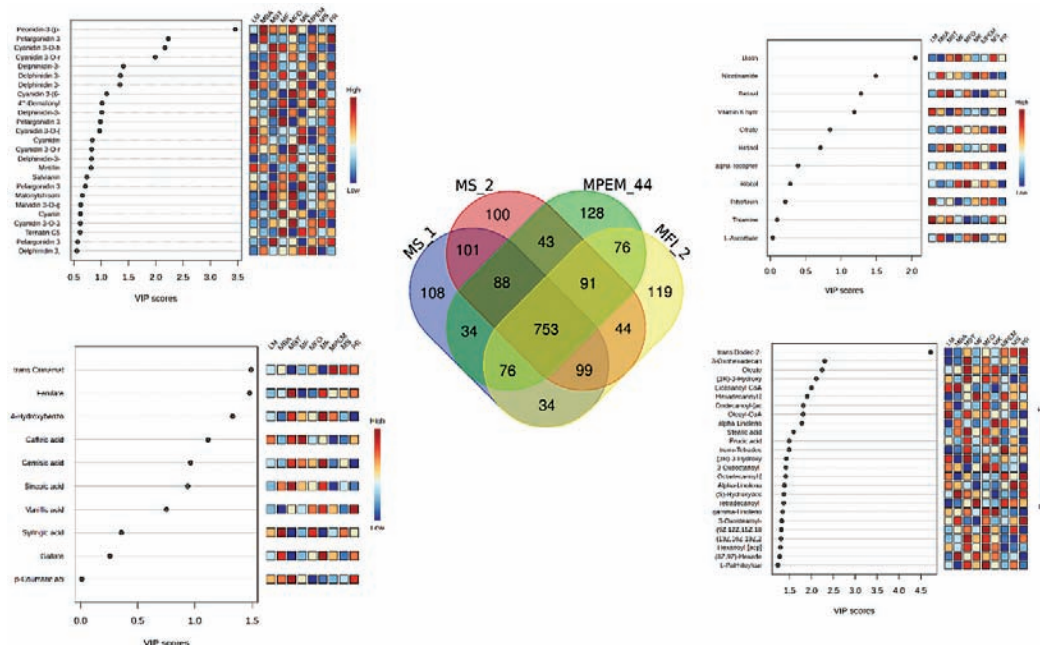


Fig. 6.12. Genome-wide metabolite analysis of nine different millets

Determination of tannin content in sorghum grains as part of the AICRP trials and amino acid profiling of 180 sorghum samples for association mapping is in progress. Estimation of starch content in sorghum landraces is completed as of May 2024. Estimation of Sorghum landraces (40 landraces) for amylose content, crude protein content (Kjeldahl method) and total ash content was carried out and their range was 7-21%, 7.71% - 15.23% and 1.47 - 3.68%, respectively. Quantification of phenolic acids, flavanoids, tannins, vitamins, phytic acid in the control and treated samples of sorghum genotypes was completed from the metabolite data and further analysis is in progress. X-ray fluorescence spectrometer (XRF) was calibrated for iron and zinc in pearl millet grains and validated with the test set, the coefficient of determination of 0.897 for iron and 0.931 for zinc was achieved between AAS and XRF values. X-ray fluorescence spectrometer (XRF) was calibrated for iron and zinc in sorghum grains and validated with test set to obtain r^2 of 0.797 for iron and 0.859 for zinc; and for sorghum flour an r^2 of 0.906 for Iron and 0.978 for zinc between AAS and XRF values.

GWAS panel of little millet consisting of 300 genetically diverse genotypes was profiled to determine the content of various micronutrients, Ca, Fe, Zn, K, P, Mg, and Na. Elite finger millet released varieties (42 varieties) were evaluated for grain micronutrients (iron, zinc and calcium) over 4 locations/seasons.

The average iron content was 25 ppm, zinc was 18 ppm and calcium was 2800 ppm and the line, IC0473957/2022 recorded high grain iron of 45 to 55 ppm across locations. Studies were also carried out to identify causative agent of poisoning in Kodo millet, cyclopiazonic acid (CPA), the causative agent was identified using standardized Thin layer chromatography (TLC) based method. Estimation of dietary fibre in foxtail millet grains is under progress. The amylose content of 25 foxtail millet varieties was ranging from 18.23% to 24.8%.

4. Centre of Excellence for Millet Value Chain and Business Facilitation for Entrepreneurship, Incubation and Startup Nurturing

Development of various value-added millet recipes:

Various value-added millet recipes such as, foxtail kajjikayalu, jowar donut, ragi sundalu, foxtail half-moon biscuit, little millet balls, kodo millet katha matri, little millet peanut bar, ragi murmura laddu, Bajra peanut butter crackers, multi millet chana poda, jowar besan burfi, and little millet halwa, proso millet chicken nuggets, barnyard potato roll chips, barnyard Ganji annam, bajra sticks, proso millet cheese slings, proso millet butter chakli, multi millet carrot halwa, multi millet namkeen, foxtail millet sweet mathri, bajra gram brittle, proso millet ariselu, and ragi dry fruit chocolate slice were developed.



Fig. 6.13. Value added millet products developed

Training programs and other exposure visits conducted:

Two training programs, startup ignition and cooking with millets, with 84 participants from nine states, were organized in the month of April 2024. Learning & exposure visits from different institutions such as ICMR - NIN and APPC etc. and state led delegations were organized, where more than 350 people took part in the visit in April 2024. "Learning the essentials", a training program cum workshop for the start-ups incubated at IIMR was organized on 29 & 30 April, 2024, where more than 60 start-ups from various states across the country have participated. Two training programs, startup ignition and cooking with millets were organized on 16 & 17 May, respectively and about 71 participants from five states participated in the training. Two-month intensive training program for pre-seed and seed-stage millet startups was organized from 20 May wherein 28 start-ups from across the country are participating. Cooking with Millets program was organized on 13 June 2024 with 28 prospective entrepreneurs from Maharashtra, Gujarat, Telangana, Karnataka and Tamil Nadu. Startup ignition program on "Emerging Business Opportunities in the Processing of the Millet Sector" was organized on 14 June, 2024 with 47 prospective startups from Maharashtra, Gujarat, Karnataka, Rajasthan, Tamil Nadu, Chhattisgarh, Andhra Pradesh and Telangana states. A start-up ignition program on "Emerging Business Opportunities in the Processing of the Millet Sector" was organized on 23 August, 2024 with 41 prospective start-ups from Maharashtra, Gujarat, Karnataka, Rajasthan, Tamil Nadu, Chhattisgarh, Andhra Pradesh and Telangana states, of which 32% were women participants. Technology training on multi-millet bread was provided to M/s MILEAT, Hyderabad in the month of August 2024. A start-up ignition program on "Emerging business opportunities in the Processing of the Millet Sector" was organized on 27 September, 2024 at Nutri-hub, ICAR-Indian Institute of Millets Research, Hyderabad with 43 prospective start-ups from Maharashtra, Gujarat, Karnataka, Rajasthan, Tamil Nadu, Chhattisgarh, Andhra Pradesh and Telangana states. The "Cooking with Millets" program was organized on 21 November, 2024 with 16 prospective participants including 7 women entrepreneurs from Maharashtra, Gujarat, Telangana, Karnataka, and

Tamil Nadu. The startup ignition program on "Emerging Business Opportunities in the Processing of the Millet Sector" was organized on 22 November, 2024 with 28 prospective startups from Maharashtra, Uttar Pradesh, Tamil Nadu, Andhra Pradesh and Telangana states and about 75% of the candidates attended were women. The monthly flagship program, "Cooking with Millets" was organized on 19 December, 2024 with 15 prospective entrepreneurs including six women from Maharashtra, Gujarat, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu, Madhya Pradesh, Rajasthan, Odisha, and Uttar Pradesh. The startup ignition program on "Emerging Business Opportunities in the Processing of the Millet Sector" was organized on 20 December, 2024 with 32 prospective startups from Maharashtra, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Telangana, West Bengal, Kerala, Rajasthan, Madhya Pradesh and about 35% of women attended the training program.



Fig. 6.14. Training and capacity building programs at value addition facility of IIMR

Collaboration with M/s Britannia Industries Ltd. on product development is initiated in April 2024. In April 2024 six value added products (VAPs) were licensed to Gold Dust Kitchen, two value added products to Vaishnavi Agro Foods; eight VAPs and 10 VAPs were transferred to Arogya Millets Producer Comp. Ltd and Tashvika India Pvt Ltd, respectively in May, 2024. Three new incubations were made with technology transfer on millet value added products in May 2024. Five startup companies were incubated: M/s. Bibraj F & B Private Limited, M/s. Mashroom Dots Enterprises, M/s. Vaishnavi Agro Food Industries, M/S Kathirava

Naturals Private Limited, and M/s. Sanjay Rice Mill in June 2024. An MoU was signed for the transfer of six technologies to M/s Avani Agro Food Products, Nellore, Andhra Pradesh in June 2024. An MoU to transfer Multi millet Bread technology to M/s MILEAT, Hyderabad was signed on 20th July 2024. In the same month, three start-ups were incubated; two start-ups were graduated; conducted training on six millet value-added technologies to the start-ups.

In the month of August 2024, four start-ups were graduated and a MoA was signed for licensing of technology, Multi-millet idli mix to Manga Srinivas Foods Int. Ltd, Hyderabad on 12th of August 2024. In the month of September 2024, technologies of various value added products were licensed to Kathirava Naturals Private Ltd (3 products), Maagaani Foods Private Ltd (3 products) and Sri Surya Organics, Hyderabad (6 products).

Licensing of six millet value added technologies was completed in October 2024 to Wholesome, Hyderabad and six value added products each to Millets Growers, Hyderabad and Mavy Nutrition Pvt Ltd in December 2024. Five start-ups were graduated in the months of September and October 2024. A total of six start-ups, Nutri Honey Flakes LLP - Andhra Pradesh, Shyamaka Millet Foods Pvt Ltd- Andhra Pradesh, Pranav Super Foods – Maharashtra, Myshta Organics (OPC) Pvt Ltd – Telangana, Simply Go Green LLP – Telangana, Skandhanshi Agro Foods Pvt Ltd – Telangana were graduated in November, 2024. An MoU was signed with M/s Millet Growers on 5th December 2024 to transfer six millet value-added product technologies namely, finger millet flour, sorghum rawa, sorghum instant kichadi mix, sorghum extruded snacks, finger millet-based energy bar and kodo millet smart rice.



Fig. 6.15. MOAs for licensing of millet cultivars

An MoU was signed with M/s Mavy Nutrition Private Limited on 6th December 2024 to transfer six millet value-added product technologies, sorghum muffins, millet (sorghum) chivda, sorghum puffs, sorghum-almond cookies, finger millet-based energy bar and multi millet laddoo. M/s. Renegizr Industries Pvt Ltd has completed its incubation program and M/s. Millet Growers has been selected for incubation in December 2024.

Review of literature was carried out on physico-chemical and functional properties of millet cultivars in May 2024. The correlation between proximates and textural parameters of selected value-added products of millets was completed in June 2024. The functional properties of hydration capacity, hydration index, swelling capacity, and swelling index were determined

for jowar analogue, ragi analogue and rice (control). The engineering properties of bulk density, true density, porosity, hausner ratio, mc (% wb) and mc (% db) were determined using standard procedure and textural characteristics in July, 2024. Textural characteristics of millet products, vermicelli, chikki bar, cookies, choccos, extruded flakes, pasta, extruded flakes, millet balls, millet sticks and muffin millets were tested. Pearson correlation coefficient of all textural characteristics in the selected value-added products was worked out along with nutritional attributes in October 2024. Experimental evaluation trials in the pilot plant flaking unit with ragi grain for ISAE-2024 were in progress, and the protocol of flaking of ragi millet was achieved in the month of November 2024. Extraction of sorghum and ragi starch were extracted and quality characteristics were

analyzed. Quality characteristics of sorghum starch, including moisture content, % wb, water activity, particle size analysis, pH, Oil absorption capacity (%), loose and packed density, Carr index, Per centage solubility and swelling power were determined.

5. Establishment of International Knowledge, Skill Development and Capacity Enablement Centre with International Millet Museum & Halls of Residence

Establishment of new building along with research lab facilities and procuring equipment:

Several infrastructure facilities, including the Global centre of Excellence building and Field research facility are under progress. The concreting of the Ground Floor slab for the residential block of the GCoE building is completed. The centering and shuttering work for the 1st floor slab of the residential block is in progress. In the main building part-1, the centering and shuttering work for the GF floor slab is also underway. In the main building part-3, the plinth beam and PCC under the grade slab have been completed, and the rising of columns is currently in progress.



Upcoming Global Centre of Excellence on Millets building



Fig. 6.16. Construction of Global Centre of Excellence on Millets building at ICAR-IIMR, Hyderabad

Field Research Facility (Advanced Phenomics Facility)

The footings work of the total columns of the Field Research Facility is completed. Columns rising to the plinth level are in progress. All-around retaining wall steel bar bending work is in

progress. Filling of excavated earth is in progress. The second installment of Rs 9.49 crore was deposited with the CPWD in 2024-25.



Fig. 6.17. Construction of Field Research Facility at ICAR-IIMR, Hyderabad

Advanced research equipment is procured to carry out various research experiments in genomics, functional

genomics, molecular breeding, biochemistry, value-addition and processing programs.

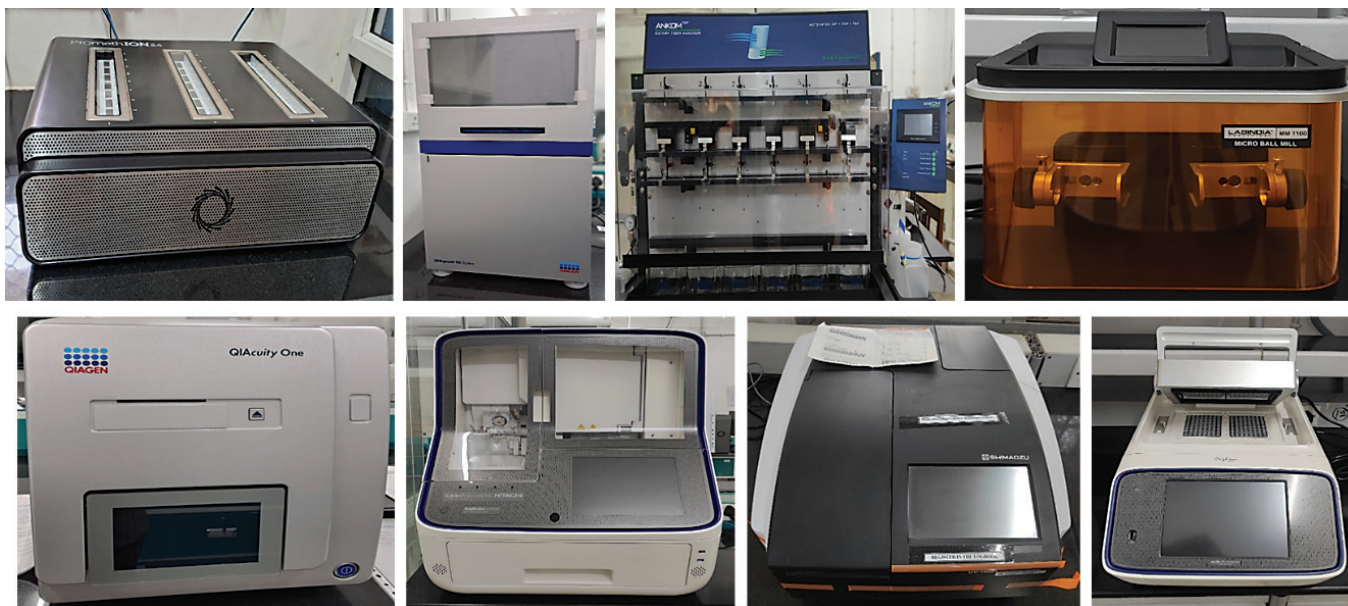


Fig. 6.18. Equipment procured under GCoE

Table 6.1. List of equipment procured under GCoEs in 2024-25:

S NO.	EFC NO.	Equipment Name	Units
IIMR - HYDERABAD			
1	3	Genetic Analyser-APPLIED Biosystems	1
2	9	96-well Thermal Cycler	4
3	10	Gel Documentation System	2
4	14	Deep Freezer (-80°C)	2
5	17	Ice Flaking Machine	2
6	19	Refrigerated Water Bath Shaker	4
7	20	Autoclave	4
8	27	Liquid Nitrogen Containers	6
9	29	ELISA Reader	1
10	30	Refrigerator	4
11	31	Hot air oven with Rechargeable Battery	2
12	33	Sonicator	1
13	43	ICP-OES	1
14	46	Cell Culture Laminar Airflow	1
15	47	Solvent Extractor with Accessories	1
16	48	Rancidometer	1
17	54	2D Electrophoresis	1
18	59	Incubator	2
19	60	Chlorophyll fluorescence meter	1
20	61	Canopy Analyzer	1
21	62	Infra-Red Thermal imaging	1
22	63	Soil Moisture sensor	2
23	64	UV-Vis spectrophotometer	1
24	80	Seed Desiccator	2
25	85	Table Top Seed Counter	1
26	90	Tractor	1
27	92	Multi-millet Thresher	2
28	93	Panicle Thresher	3
29	94	Seed Dryers	5
30	95	Automated seed counter	1
31	97	Garden Equipment	1
32	98	Crusher (Juice extractor) with establishment	1
33	99	Fully automatic Primary processing line	1
34	102	Fully automatic bread line	1
35	104	Fully automatic cold Extrusion line	1
36	107	Mixograph/Farinograph	1
37	111	FT-NIR	1
38	112	Probe sonicator	1
39	115	Grader cum Aspirator cum Destoner	1
40	116	Millet De-Husker/Polisher	1
41	117	De-huller with aspirator	1
42	118	Grader cum Aspirator cum separator	1
43	120	Vacuum Packing machine	1
44	121	Chekki Mill	1
45	122	Hammer Mill	1
46	123	4STAGE or 4 Deck Vibro Sifter	1
47	124	Blender Multi Rava and Flour Products	1

S NO.	EFC NO.	Equipment Name	Units
48	132	Electrophorater	1
49	132	Autoclave	2
50	132	MiniCentrifuge	2
51	132	Flame Photometer	1
52	132	Hand Held CO2 Meter	1
CRS – SOLAPUR			
1	138	Micro-Centrifuge	1
2	142	Vortexer	1
3	144	Stereo Binocular Microscope	1
4	148	Horizontal Gel Electrophoresis System	1
5	152	Straw Chopper Machine	1
RRS – GUDAMALANI, BARMER			
1	154	Vacuum Cleaner	1
2	154	Camera	1
3	154	Submersible Pump	1
4	154	Disc Plough	1
5	154	Cultivator	1
6	154	Land Leveller	1
7	154	Rotavator	1
8	154	Tractor Trolly	1
9	154	Tractor	1
10	154	Galvanized Steel Barbed wire	1
11	154	HDPE Polyethylene Pipe 63MM	1
12	154	100 Kg Weighing Balance	1
13	154	Laminar Air Flow	1
14	154	Vertical Autoclave	1
15	154	MFD Printer	1
16	154	MFP printer	1

Trainings and workshops conducted for knowledge and skill development:

The International workshop on ‘Advances in Millets Production, Processing, and Value Chain Development’ under the ‘International exchange program (Asia-Africa South-South Cooperation) of FAO and IIMR is conducted from 22 April 2024 – 1 May 2024, by ICAR-IIMR, Hyderabad. A delegation from the University of KwaZulu-Natal, Durban, South Africa visited IIMR on 20 July 2024 to discuss possible collaboration and replication of a successful millet value chain model in South Africa. A workshop on “Unlocking the Power of Next Generation Sequencing for Crop Improvement” was organized by the Global Centre of Excellence on Millets, ICAR-IIMR, on 1 August, 2024 for the benefit of students, scientists and stakeholders. The Global Centre of Excellence on Millets, ICAR-IIMR, organized a workshop on plant genome sequencing on 23 August 2024 to provide details on sequencing technologies for millets and their utilities for students, scientists, and stakeholders. Dr S Srividhya and Dr B Amasiddha,

IIMR attended one-week online training program on Phenomics and High Throughput Phenotyping: Dissection of Traits for Abiotic Stress Tolerance, conducted by IARI, New Delhi held from 25 August 2024 -1 September, 2024. Dr R Swarna, IIMR attended a 10-day online training program on ‘Integrated weed management strategies under changing Agricultural Scenario’ from 28 August 2024 to 06 September 2024 organized by the Indian Society of Weed Science and ICAR- Directorate of Weed Research, Jabalpur, India. ICAR-IIMR, Hyderabad organised Virtual Buyer Seller meet on 13 September 2024. The meeting aimed at facilitating direct interactions between millet farmers, FPOs, entrepreneurs, sellers and potential buyers. ICAR-IIMR organized the International Nutri-Cereal Convention 6.0 (Nutri-Cereal R & D convention and Start-up convention) from 17-19 October 2024 at ICAR-IIMR, ICAR-NAARM and HICC, Novotel, Hyderabad.



International workshop on Advances in Millets Production, Processing and Value Chain Development



IIMR team and scientists of South African country at ICAR-IIMR, Hyderabad.



INCC 6.0 (International Nutri-Cereal Convention) a three-day mega event organized by ICAR-IIMR

Fig. 6.19. International training and conventions conducted for knowledge and skill development

MoA was signed for licensing of sorghum fodder hybrid cultivar, CSH 24MF between ICAR-IIMR and various second party agencies, Rasi Seeds Private Limited; Ajeet Seeds Private Limited, Hyderabad (September, 2024); Bhadra Agro Services, Malleshwara Agro Agencies, Bellary (October, 2024); Foragen Seeds, Hyderabad (October, 2024); Bharatiya Beej Sahakari Samiti Ltd., Delhi (January, 2025); Classic Hybrids Pvt Ltd, Gujarat; Krishi Vikash Sahakari Samiti Ltd., Delhi. New technologies such as bajra vermicelli, bajra cookies, multigrain muesli, multi millet choccos and jowar noodles were showcased during visit of DDG (CS) and ADG (Seeds) on 9 May 2024.

6. Global Facility for Millet Pilots on Feed, Fodder, Biofuels, Malting, Brewing and Promotion of Industrial utilization of Millets

Evaluation of sweet sorghum lines for photo insensitivity and yield was completed by April 2024. *Kharif* experiments to evaluate sweet sorghum breeding stocks for photo-insensitivity based on phenology and agro-meteorological indices were completed. Studies on enhancing shelf-life of sweet sorghum juice was completed. Harvesting of sweet sorghum breeding stocks (hybrid trial) is completed and the juice quality studies were done. Studies on the shelf-life of sweet sorghum cane under field conditions up to 4 days of

harvesting were conducted. Sweet sorghum breeding stocks were evaluated for juice quality in brix content and total and reducing sugar content. Data on stem weight, juice volume, Brix content, and total and reducing sugar estimation, as part of the cane shelf-life studies conducted under field conditions, have been reported, and the analysis has been completed.

Comparative transcriptome analysis was carried out using a high brix (HB) Indian genotype (SSV84; 18-19% brix) and a low brix (LB) Indian genotype (ICS675B; 8-12% brix) of sweet sorghum through RNA sequencing approach. The total number of transcripts identified was 50095, of which 1318 were significant transcripts. Of the significant transcripts, 477 were upregulated in SSV84 while 49 were down regulated. Pathway analysis and expression studies are under progress by May 2024. Studies on the sugar accumulating enzymes on released varieties of sweet sorghum to decipher genotypic variation in sucrose accumulation were completed. Studies on gene expression of invertase enzyme in sweet sorghum have been initiated in December 2024 and is under progress by January 2025. Samples of high biomass sorghum were sent to CSIR- Indian Institute of Petroleum Research, Dehradun, for compositional analysis viz. cellulose, hemicellulose and lignin.

One sweet sorghum entry derived from intergeneric hybridization (sorghum x maize) was promoted to advanced varietal trials after multilocation testing in May 2024. A set of 18 hybrids along with two checks CSH 22SS and RVICSH 28 were evaluated for sweet sorghum productivity traits. For total fresh biomass, the hybrid ICSV 14030 X RSSV 138-1 (107.2 t/ha) recorded 54.5% higher biomass than the hybrid check, CSH 22SS 28 (69.4 t/ha). The same hybrid also recorded the highest juice yield (36120 L/ha), brix (16.3%), total sugars (14.40%) and computed ethanol yield (2764 L/ha). 15 hybrids along with one check CSH 22SS were evaluated in HT-II for key biofuel traits. Hybrid Tx631 A x RSSV 260 (87.2 t/ha) recorded 35.4% higher yield than the hybrid check, CSH 22SS (64.4 t/ha) for total fresh biomass. The same hybrid recorded the highest juice yield (16836 L/ha) which was 26% higher than CSV 24SS (13296 L/ha). Twenty-five high biomass sorghum breeding derivatives including three checks CSV 48, CSV 54HB and CSH 47 were evaluated for biomass traits in a replicated trial. The entry (SSV 84

Tall X SPV 2072)-1-1-3-1-1-1 recorded 60.1 t/ha fresh biomass followed by the entry (IS 18542 X SSV 74)-3-2-2-1-1-2 which recorded 54.8 t/ha fresh biomass which were 37% and 25% higher than the best check CSV 48 (43.9 t/ha) respectively. The entry (SSV 84 Tall X SPV 2072)-1-1-3-1-1-1 performed best for dry biomass (35.0 t/ha) which was 25% higher than the best check CSV 48 (28.0 t/ha) in the same trial. In the high biomass trial, the entry (SSV 84 Tall x SPV 2072)-1-1-3-1-1-1 recorded 60.1 t/ha fresh biomass, followed by the entry (IS 18542 x SSV 74)-3-2-2-1-1-2 which recorded 54.8 t/ha fresh biomass and these are 37% and 25% higher than the best check CSV 48 (43.9 t/ha). The entry (SSV 84 Tall x SPV 2072)-1-1-3-1-1-1 performed best in terms of dry biomass (35.0 t/ha), which was 25.17% higher than that of the best check, CSV 48 (28.0 t/ha). Brewing activity with different millets (sorghum, pearl millet, ragi, and barnyard millet) has been undertaken in collaboration with NSI, Kanpur, and beer production is initiated in November and under progress on experimental scale.



Fig. 6.20. Industrial utilization of Millets-Brewing experiments

7. Regional Millet Technology Innovation and Outreach Hubs

Various training programs, online sessions and visits conducted through ICAR-IIMR:

ICAR-IIMR Hyderabad (FPO NEST team) organized training and awareness program on Crop Diversification through Millets to Tekmal & Yeldurthy Mandal Farmer

Producer Cooperative Limited at Naryankhed, Sangareddy District on 13 April 2024. A group of 40 women from Tekmal Mandal FPCL got hands-on exposure to millet value addition and crop diversification techniques. ICAR-IIMR organized a workshop on Diversity of Crops by Millets on 19 April 2024 at Kusangi Rythu Vedika in Tekmal Mandal, Medak, Telangana, to

create awareness on millets and increase the area under cultivation of millets in the mandal through FPO where hundred farmers participated in the meeting. The FPO NEST team of ICAR-IIMR conducted a capacity building and training program on “Developing the Business Models for the Sustainability of Andhra Pradesh FPOs” at SVDS office, Anakapalli District on 25 April 2024. The FPO NEST team interacted with the participants and provided valuable insights about the business aspects, business models and market linkages. ICAR-IIMR organized a 4-day training program for 25 farmers from Goalpura district of Assam through Gram Vikas Farmer cluster as part of millet awareness program and CAT exposure visit from 18 to 20 May 2024. Farmers were exposed to the latest production technologies of millets, processing aspects, and value addition with the co-ordination of FPO-NEST team.

ICAR-IIMR, Hyderabad and Mission LiFE organized awareness program on “Land Restoration, Desertification and Drought Resilience” towards the theme World Environment Day 2024, on 22 & 24 May 2024 virtually. The program highlighted the drought-resilient measures through millets for sustainable agriculture. Bettada Basaweshwara Farmer Producers

Company, promoted by ICAR-Indian Institute of Millets Research Hyderabad, organized millet seed distribution program on 3 June 2024, at the Jakkaldinni village of Raichur district, Karnataka. Farmers received free millet seeds of Barnyard (CBYMV-1, DHBM 93-2), Little (CLMV-1), and Multicut Fodder Sorghum (CSH 24MF) from ICAR-IIMR scientists, more than 50 farmers participated in the event. A special training program on the “Millet Value Chain” was organized on 10 June 2024 at Nutrihub, ICAR-IIMR, Hyderabad, for 45 SHG women from Mahabubabad District, Telangana state. A total of 15 agricultural extension professionals from various states attending the induction training program for agricultural extension professionals organized by the National Institute of Agricultural Extension Management (MANAGE), Hyderabad being held from 5 to 25 June 2024 visited various facilities of ICAR-IIMR on 12 June, 2024. Lecture session on the importance of millets as climate-resilient and nutritious crops, their role in enhancing food security, and the potential benefits for farmers’ livelihoods through millet-based business ventures was also arranged.



Fig. 6.21. Training programs and Extension activities conducted for FPOs

Veterinary College, Bidar (KVAFSU, Bidar), ICAR-IIMR, Hyderabad and Hulsoor Mahila Kisan Millets Producer Company Ltd. jointly organised one day training program entitled “Sheep, Goat and Poultry production for sustainable livelihood” on 13th June 2024. A total

of 50 farmers participated in the training program from Basavakalayan, Bhalki, Bidar and Humnabad blocks of Bidar district of Karnataka state. Millet fodder seeds and animal feeds were distributed to SC participants free of cost during the training by FPO NEST team

of ICAR-IIMR, Hyderabad. FPO NEST of ICAR-IIMR organized a review meeting with Andhra Pradesh FPOs promoted by ICAR-IIMR at Vantlamamidi (V), Paderu block on 13 June 2024. Seven FPOs from ASR and Visakhapatnam districts participated in the meeting. The NSC, ICAR-IIMR Hyderabad, and ICAR-KVK Vijayapur jointly organized one-day training program on seed production and certification for Farmer Producer Organizations (FPOs) on 5 July 2024 at ICAR-KVK Vijayapur. A total of 45-member farmers from Nidgundi Sri Hadi Basavanappa Oilseed and Millets FPCL, Indi Savayava Hagu Siridhanya FPCL, promoted by ICAR-IIMR Hyderabad, participated in the training. A workshop on landraces collection and awareness among farmers on millet cultivation was organised on 7 July 2024 at IIMR Regional station, Gudamalani, Barmer.

ICAR-IIMR organised a 'Training on crop diversification and promotion of Millets' about the importance and cultivation practices of millets and encourage farmers to establish millet primary processing machinery at the farm level at the Kanakapura FPO on 10 July, 2024. ICAR-IIMR, organized a training program on 16 July 2024 (on the eve of ICAR Foundation Day), to discuss the latest technologies developed by IIMR at Medak district, Telangana. ICAR-IIMR, Hyderabad (FPO-NEST team) organized 4 days training program on "Millets Production, Processing of non-Ragi Millets in Rice Fallows" from 6 to 9 August 2024 as a part of the Odisha Millet Mission project and 27 farmers from Rayagada, Odisha participated in this training program. Thandava Valley FPO, promoted by ICAR-IIMR Hyderabad, organized a training program on "Agri products - value addition" for 150 women farmers on 10 August 2024. One-day exposure visit to fields, millets production, and processing technologies at ICAR-IIMR on 14th August, 2024 was arranged for 35 participants from NRLM training program on Branding, Packaging & Marketing of Rural Products" at NIRDPR. On 14 August 2024, 60 students from Shramshakti College of Food Technology, Maldad, Maharastra visited ICAR-IIMR. Orientation about millets, visit to fields, millets production and processing technologies and guided tour to primary processing unit, CoE and secondary processing units was arranged.

On 14 August 2024, 46 participants of the Seed stage startups (SAIP), Pre-seed stage startups (AOP), and Student Startups (SOP), visited a one-day exposure visit to fields, millets production, and processing technologies at ICAR-IIMR. ICAR-IIMR organised a training program on millets production, processing, and value addition technologies from 4 to 6 September 2024 to the farmers from Bihar at ICAR-IIMR, Hyderabad. ICAR-IIMR, Hyderabad, hosted a virtual meeting focused on millet value chain development in collaboration with FAME on 17 September 2024. ICAR-IIMR, Hyderabad and MANAGE Hyderabad organized a field day at IIMR on 11 October 2024 for 32 ITEC participants from 14 countries. The participants were given exposure to various activities at ICAR-IIMR and free millet seed kits were distributed to the participants for establishing small-scale farms, conducting research, and promoting millet cultivation among local communities. A visit to IIMR facilities for ATMA Farmers from Thirumangalam, Usilampatti, Thiruvurur, Thalaivasal and Panamarathupatti locations of Tamil Nadu on 07 & 08 October 2024 and 15 to 18 October 2024 was organised. Scientific staff from ICAR – CRIDA had a visit to the institute under 'Smart Digital Tools for Sustainable Agriculture' on 22 October 2024.

ICAR-IIMR Hyderabad, Central University of Karnataka, and ICAR-KVK Kalaburgi jointly organised a state-level workshop on "strengthening the capacity of Farmer Producer Organizations (FPOs) for improved performance and sustainability" on 23 October 2024.

ICAR-IIMR organized a training program on "Popularization of Non-Ragi Millets in Odisha State through IIMR Interventions" from 6 to 11 November 2024, with the support of Govt. of Odisha and SACAL NGO. An interstate exposure visit to IIMR facilities was organized for about 30 farmers from Vellore, Tamil Nadu, under the Agriculture Technology Management Agency (ATMA) on 20 November 2024. ICAR-IIMR organized a training program on "Millet seed production, processing and certification" from 20 to 22 November 2024 for the Odisha farmers. ICAR-IIMR, organized a three-day training program on "Millets Seed Production, Processing, Certification, and Value Addition" from 3 to 5 December 2024 to FPOs, NGOs & Progressive

Farmers. ICAR-IIMR, organized a training program on “Introduction of Advanced Millet Technologies to Odisha Farmers” from 4 to 7 December 2024 at ICAR-IIMR, Hyderabad, aimed to equip Odisha farmers with the latest techniques to enhance millet cultivation and value addition.

ICAR-IIMR and MANAGE collaboratively organized the Certified Farm Advisor (CFA) Program to 16 Agriculture Officers of Tamil Nadu, Himachal Pradesh, Karnataka, Tripura and Andhra Pradesh from 9 to 23 December 2024. ICAR-IIMR, organized a training program focused on “Millets Production, Processing, Value Addition, Branding, and Marketing to the prospective Farmer Producer Organizations (FPOs) of Odisha” held from 18 to 20 December 2024. The Khadi and Village Industries Commission (KVIC) organized a State-level Workshop on ‘Agro-Based Food Processing Industry

(ABFPI)’ in collaboration with ICAR-IIMR, Hyderabad on 18 December 2024 for 120 participants. ICAR-IIMR, Hyderabad, organized a training program titled “Millets for Prosperity: Strategies for Production, Branding, and Market Linkages” for Odisha farmers from 6 to 9 January 2025 where practical demonstration of various millet technologies (processing unit, chikki mill) was conducted to the participants. ICAR-IIMR, in collaboration with MANAGE, Hyderabad organized an online training program on “Abiotic Stress Management in Agriculture for Enhancing Farmers’ Income with Special Reference to Millets and Fodder Crops Cultivation in Arid and Semi-Arid Regions of India” held from 6 to 10 January 2025. A visit to the processing facilities of ICAR-IIMR was organized for the farmers under ATMA, SSEPERS, Thiruvannamalai, on 09 Jan 2025 as a part of their interstate exposure visit.



Training program on Millets Production, Processing and Value Addition Technologies



Training program on “Millets Production, Processing of non-Ragi Millets in Rice Fallows of Odisha”



Training on Millet Seed Production, Processing and Certification



Training on Popularization of Non-Ragi Millets in Odisha State

Fig. 6.22. Training programs conducted at ICAR-IIMR

Extension and outreach activities conducted:

35 training programs were conducted to date with 1680 participants consisting Farmer producer organizations (FPOs), farmers, CEOs and BODs. Other activities include capacity building at farm gate (21) with 940

participants, involving FPOs and farmers; 89 exposure visits for students, farmers, entrepreneurs and FPOs benefitting 5156 participants in total; nine field days for farmers and other stakeholders containing 490

participants. Various online workshops/trainings were conducted (20 in number) benefitting more than 550 participants belonging to FPOs, farmers, students, Self-help groups (SHGs), Women Self-help groups (WSHGs) and entrepreneurs. 14 millet awareness programs were conducted benefitting more than 24500 farmers and FPOs. Exhibitions (22) were also conducted for the benefit of more than 1,11,500 FPOs, farmers, students, SHGs, WSHGs, entrepreneurs and

start-ups. Various training programmes and exposure visits have been conducted to students from various institutions and farmers from ATMA of different districts to improve their awareness on millets, millet production practices and various millet-processing technologies. Around 2600 students, farmers, trainees and agriculture officers were benefitted from these visits until January 2025.



Fig. 6.23. Exposure visits of students and farmers to ICAR-IIMR, Hyderabad

Infrastructure development at Millet Regional Center at Barmer:

The construction of a new administrative and laboratory building at the IIMR-Pearl Millet Regional Centre, Gudamalani, Barmer, is in progress with an estimated

cost of ₹5.29 crores. The Shuttering of the first floor of the administrative and laboratory building is completed and the slab casting of the first floor is in progress.



Fig. 6.23. Honorable Vice President of India Shri Jagdeep Dhankhar, laid the foundation stone of the ICAR-IIMR, Regional Research Station on Pearl millet at Gudamalani, Barmer, Rajasthan



Fig. 6.24. Construction of ICAR-IIMR, Regional Research Station on Pearl millet at Gudamalani, Barmer, Rajasthan

Trainings & Capacity Building

Trainings Attended – (Physical)

S. No	Name of Employee	Title of the training	Organized by	Venue /place	Dates
1	V.M. Malathi	Agri-derived nutrition and nutraceuticals for innovative health goods: Tools and strategies	Division of Biochemistry, ICAR-IARI	ICAR-IARI campus, New Delhi	15 Dec 2023-24 Jan, 2024
2	V. Ravikumar	Big data analysis for weather based crop management	CRIDA, Hyderabad	CRIDA, Hyderabad	29 Jan - 7 Feb, 2024.
3	V.M. Malathi	Interactive meet on Conservation of Indigenous Millets and Ethnomedicine	NCERT, New Delhi	NCERT, New Delhi	29 Feb, 2024
4	B. Subbarayudu A. Srinvas D. Seva Nayak R. Venkateswarlu	Millets, local crops cultivation, production, and their innovative processing technologies under ICAR-AICRP- Pearl millet-SCSP	ICAR-IIMR	Ramanappapalem Village, Guntur Dist, A.P	16 Mar, 2024
5	Jinu Jacob	Winter school on application of mass spectrometry in biomedical research	GITAM University, Vizag	Gitam University, Vizag, A.P.	19-22 Mar, 2024
6	V.M. Malathi	Brainstorming workshop on millets and other neglected and under utilised species	Gitam University and Coventry University, UK.	Gitam University, Hyderabad	26 Mar, 2024
7	K. Hariprasanna V.M. Malathi R. Venkateswarlu	Elemental Analyses Services workshop for South Asia	CGIAR & HarvestPlus	ICRISAT, Patancheru	12-14 Aug, 2024
8	S. Srividhya	Phenomics and High-Throughput Phenotyping	IARI and ICAR-IASRI	IARI, New Delhi	25-31 Aug, 2024
9	P. Hemashankari	Marketing of science and technology for social good	Department of Science and Technology and Osmania University, Hyderabad	Osmania University, Hyderabad	18-22 Nov, 2024
10	A. Kalaisekar	Effective data visualization for the data driven organization	Indian Institute of Management, Ahmedabad	IIM, Ahmedabad	16-19 Dec, 2024

Trainings Attended – (Online with Certificate)

S. No	Name of Employee	Title of the training	Organized by	Venue /place	Dates
1	Baswaraj Raigond	"AgriIP 2024" online short course on patents.	Jointly by IP&TM, ICAR N. Delhi and ZTM-Agribusiness Incubation Centre, ICAR-CIFT, Cochin	ICAR, New and ICAR-CIFT, Cochin	15 Jan-15 Feb, 2024

S. No	Name of Employee	Title of the training	Organized by	Venue /place	Dates
2	D. Seva Nayak	International webinar on De-novo-Domestication of crops for salt affected environments	MANAGE	Online	28 Mar, 2024
3	D. Seva Nayak	Agriculture Scheme & Indian Agriculture Vision- 2050	Gujarat Natural Farming Science University, Anand, Gujarat; GBPUAT, Pantnagar; ICAR-IRR, IIMR (Millets) ICAR-CIRG, ICAR-IIMR (Maize) CAR-IIWB	Hindustan Krishi Anusandhan Bhawan, NH- 24, Delhi Road, Moradabad (UP) 244001	1-30 April, 2024
4	Baswaraj Raigond	Workshop on “Unlocking The Power of Next Generation Sequencing For Crop Improvement”	Global Centre of Excellence on Millets (Shree Anna), ICAR-IIMR, Hyderabad	ICAR-IIMR, Hyderabad	01 Aug, 2024
5	Baswaraj Raigond	Agri Entrepreneurship Development in Plant Protection	ICAR-NCIPM, New Delhi	New Delhi	20-23 Aug, 2024
6	V. M. Malathi	One Country One Priority Product Initiative (OCOP): Capacity Building Workshop on Mainstreaming Nutrition in OCOP for Healthy Diets	FAO and the Institute of Nutrition Mahidol University (INMU)	Online	28-30 Aug, 2024
7	A. Kalaisekar	Fluorescence Microscopy	Harvard Medical School, Core for Imaging Technology & Education (CITE)	Online	11 Sep-09 Oct, 2024

Trainings/ Short courses Organized/ Conducted by IIMR

International training on experience sharing and capacity building in Millets

An international training on “Experience sharing and capacity building to expand the cultivation, use and processing of millet as a climate-resilient crop, and to strengthen agrobiodiversity, balanced nutrition, millet value chain, value addition and entrepreneurship in Africa” was organized by ICAR-IIMR, Hyderabad during 8-11 January, 2024 under India-Africa exchange programme. In the inaugural session, Dr. Raghavendra Kavali, National Coordinator, Indo-German Seed Sector Cooperation Project, welcomed the gathering. Dr. C. Tara Satyavathi, Director, IIMR highlighted the importance of millets to Africa. The purpose of the programme was laid out by Mr. Ekkehard Shroeder, German Project Team Leader, Indo-German Cooperation on Seed Sector Development, Germany. Dr. Vilas A Tonapi Former Director, ICAR-IIMR, gave a detailed account of what India can offer to Africa in terms of millets R&D. Researchers and policy makers from different African countries participated in the programme.

Training programme on “Millets, local crops cultivation, production and their Innovative Processing Technologies”

ICAR-Indian Institute of Millets Research, Hyderabad, conducted the training programme entitled “Millets, local crops cultivation, production and their innovative processing technologies” under ICAR-AICRP-Pearl Millet-SCSP” at Ramannapalem Village of Guntur District, Andhra Pradesh on 16 March, 2024. About 700 participants including farmers of Ramanappapalem, Itikampadu, Marripudi, Poondla, Gopapuram and Bodipalem, students of Agricultural college, Agricultural Engineering college, Food and Science Technology college, Pharmacy college, Bapatla; Scientists of ICAR-Indian Institute of Millets Research, Hyderabad; Scientists of ANGRAU; DDM, NABARD, Guntur, Agricultural Officers of Department of Agriculture, AP; artisans of Bapatla Agro Food Processing cluster; members of SARID (NGO), besides Press and media participated in this programme. Dr. C. Tara Satyavathi, Director, ICAR-IIMR, Hyderabad was the chief guest and presented an overview of millets research activities and their nutritional benefits. She also advised farmers

to take up pearl millet cultivation in rice fallows under zero tillage conditions in Krishna Godavari basin which is more remunerative with less inputs. Dr. B. Subbarayudu, Principal Scientist explained the benefits of millets cultivation in rice fallows and explained the success stories of sorghum farmers of Tenali division.

Impact of ICAR-IIMR SCSP Programmes on farmers, entrepreneurs and others in present scenario and their details were given by Dr. A. Srinivas. Dr. T.E.G.K. Murthy, Principal, Bapatla Pharmacy College, Bapatla highlighted the importance of millets role in development of pharmaceuticals in present scenario. Dr. Vijay Bhinandan, Director of Extension, ANGRAU, Lam, Guntur explained about role of agricultural based research institutions in promotion of millets and agro-based industries. Dr. P. Sanjana Reddy explained about Improved cultivars needed to farmers and their crop management practices for pearl millet cultivation in rice fallows. Dr. C. Aruna Reddy shared her experiences with the sorghum growers about the many fold advantages of sorghum hybrids in general and particularly dwarf sorghum hybrids. Dr. R. Venkateswarlu narrated about how nutritional values of millets cater the needs in present and future. Dr. D. Seva Nayak delivered a talk on Importance of climate resilient crops in zero tilt situations in Western Krishna basin districts of AP. The benefits of NABARD credit Linked schemes to Schedule Caste farmers addressed by Mr. G. Sarat Babu, DDM, NABARD, Guntur. Dr. L. Madhavi Latha, Principal Scientist, ARS, Perumallapalle, ANGRAU and Dr. T. S.S.K. Patro, Principal Scientist, ARS, Vizianagaram, ANGRAU highlighted the importance of millets cultivation, production and their utilization in coastal districts of Andhra Pradesh. Dr. Wesley, Principal Scientist, Agricultural Engineering college, Bapatla highlighted value added technologies to farmers in millets and other local crops. The advantages of natural farming methods and their role in present scenario to protect the health and wealth of people and animals was explained by Miss Madhavi and Mr. L. V. Ramana. Sri G. Sridhar, progressive farmer motivated all farmers and participants about the cost effective agricultural methods. The value added millet food products of ICAR-Indian Institute of Millets Research, Hyderabad and College of Home Science, Lam, Guntur, ANGRAU

was show cased to the farmers and other stakeholders. Free Health campaign was organized in this training programme.

HRM Training programme organized

A training programme was organized on “Research Facilities for Research Scholars” on February 1, 2024, at ICAR-IIMR under Scientific Social Responsibility (SERB-SSR) activity of the externally funded project CRG000477-SERB-DST. The aim of this program was to mentor and enhance the skills and knowledge of research personnel in the field of millet scientific research. A total of 41 Research personnel (Ph. D scholars, post graduates and graduates) from Andhra Pradesh, Telangana and Karnataka states participated actively and interacted with the scientists of Seed Science & Technology, Biochemistry, Biotechnology, Millet processing and Nutrihub to learn about new facilities and research techniques available at IIMR.

Training program on Pioneering Extension through IFS & Agri Business Models

Agricultural College, Aswaraopet, PJTSAU, in collaboration with MANAGE, Hyderabad, organized a three-day online training program on “Pioneering Extension through IFS & Agri-Business Models” from 5-7 June, 2024. As part of this initiative, Dr. Sangappa, Scientist, ICAR-IIMR, Hyderabad, delivered a lecture on “Empowering Farmers through Millet Businesses.” During his session, Dr. Sangappa highlighted the vast potential of millet-based enterprises in driving economic growth in rural areas. He addressed various business opportunities in the millet sector, including value addition, processing, marketing, seed hubs, millet-based restaurants, and aggregation models. He also introduced innovative business strategies to enhance the profitability and sustainability of millet farming. The lecture provided practical knowledge and skills to integrate millets into Integrated Farming Systems (IFS), equipping participants with insights to support farmer entrepreneurship and rural development.

Induction Training Programme for Agricultural Extension Professionals

National Institute of Agricultural Extension Management (MANAGE), Hyderabad, organized an Induction Training Program for Agricultural Extension Professionals from

5-25 June, 2024. As part of the program, 15 Agricultural Extension Professionals from various states visited the ICAR-Indian Institute of Millets Research. During the visit, Dr. Sangappa, Scientist, enlightened them on Empowering Farmers through Millet Business Opportunities.

Workshop on Advanced Microscopy for Biological Sciences

Workshop on Advanced Microscopy for Biological Sciences was conducted physical and online mode on 11-12 July, 2024 at ICAR-IIMR. Eighty participants including scientists, research scholars, students across the country have participated in the workshop. Experts and application specialists in advanced microscopy have conducted hands-on



sessions on Fundamentals of Microscopy: Basics of Microscopy, Digital Classroom Concept, Plant Karyotyping, Selecting the right microscope for your application, Advanced Microscopy Techniques in fluorescence, confocal, light-sheet, live cell imaging, super resolution, 3D microscopy imaging, Electron microscopy, and X-Ray microscopy.

Training programme on Millets Production & Processing for Bihar Farmers

ICAR-IIMR, Hyderabad, organized a three-day training program on Millets Production, Processing,



and Value Addition Technologies for 26 farmers from Bihar, held from 4-6 September 2024 with support from ATMA, Gaya. The program, inaugurated by Dr. (Mrs.) C. Tara Satyavathi, Director, IIMR, covered topics on pearl millet production, suitable millet varieties for Bihar, the formation of Farmer Producer Organizations (FPOs) and, soil health test kits were provided free of cost.

Training on “Millet Seed Production, Processing and Certification”

Training on “Millet Seed Production, Processing and Certification” under the aegis of Odisha Millet Mission was organized by ICAR-IIMR, Hyderabad during 20-22 November, 2024. Dr. C Tara Satyavathi, Director, ICAR-IIMR Hyderabad inaugurated and delivered the opening remarks of the programme. The training course covered various topics in the broad areas of Seed



production, seed processing and seed certification, its applications, seed drying, seed storage, etc. It provided in depth knowledge on theoretical and hands on experience on practical aspects of seed production, seed processing and seed storage etc. The training included field and lab visits to and exposure visit to private seed industry, i.e., Ganga Kaveri Seeds Pvt. Ltd. to learn and practice post-harvest handling of seed. A total of 31 participants including officials from Department of Agriculture Odisha state and OMM project staff participated in the training.

Training on Good Agricultural Practices in Millet Production

On 20 November 2024, ICAR-IIMR, Hyderabad conducted a training session on Good Agricultural Practices for millet production to 30 farmers from Vellore District, Tamil Nadu. This training was part

of an interstate exposure visit organized under the Agriculture Technology Management Agency (ATMA). Dr. S. Srividhya, Scientist, provided insights into millet cultivation, production technologies, and processing methods, focusing on crops like pearl millet, sorghum, and ragi, which are widely grown in their district. The farmers were also introduced to the advantages of cultivating sweet sorghum as a dual crop by Dr. A.V. Umakanth and Dr. V.M. Malathi, Scientists also demonstrated the process of extracting juice from the stalks of sweet sorghum.

International symposium on Shree anna and forgotten foods at convention centre Lok seva Bhawan, Bhubaneswar

Dr. C. Tara Satyavathi, Director, ICAR-IIMR, Hyderabad along with Sh. K. Srinivasa Babu, Drs. Sangappa, Ganapathy, Sooganna & Rafi participated in “International Symposium on Shree Anna and forgotten foods” at convention centre Lok seva Bhawan, Bhubaneswar during 10-11 November, 2024. The symposium highlighted the role of neglected crops in strengthening food security and preserving traditional knowledge, especially among tribal communities. Sh. Srinivasa Babu and Dr. Sangappa presented a “Long-Term Approach for Sustainability of Millet Service Centres,” by pointing the need of resilient supply chains, value-added millet products, and market linkages to improve millet production profitability. They also highlighted the importance of sustainable practices, resource management, and community engagement to support food security, nutrition, and economic stability.

Training programme on “Popularization of non-Ragi Millets in Odisha state through IIMR interventions” under Odisha Millet Mission

A training programme on “Popularization of Non-Ragi Millets in Odisha State through IIMR Interventions” was organized during 6-11 November, 2024 with the



support of Govt. of Odisha and SACAL NGO. Dr. C. Tara Satyavathi, Director, ICAR-IIMR, inaugurated the program with a keynote address, and highlighted the importance of expanding millet cultivation to increase food security, improve nutrition, and farmer income. Sh. K. Srinivasa Babu outlined the initiatives of IIMR in promoting cultivation and processing of non-ragi millets in Odisha. Dr. Sangappa assured that ICAR-IIMR will provide high-quality seeds, technical training, and facilitate market linkages through Odisha Millet Mission for strengthening the economic stability. Key sessions on millet cultivation, disease management, agronomic practices, and hands-on training in operating primary processing units were covered during this training program. Participants also visited Nutrihub and processing unit facilities and gained knowledge in millet value addition. Farmers were also provided with free soil testing kits and high-yielding barnyard millet seeds.

Training program to Odisha Agriculture Officers on “Millets seed Production, Processing and Certification”

During 20-22 November 2024, ICAR-IIMR organized a training program on “Millets Seed Production, Processing and Certification” for 25 Assistant Agriculture Officers (AAOs) of Odisha state under Odisha Shri Anna Abhiyan (OMM Phase II project). The program was inaugurated by Dr. Tara Satyavathi, Director, ICAR-IIMR. Scientists from IIMR introduced the fundamental concepts of seed production, importance of quality seeds for enhancing crop productivity and food security. Detailed sessions were conducted on millet crop management, nutrient and water management practices. Participants gained in-depth knowledge of seed production protocols for millets with a focus on maintaining varietal purity, seed certification standards, and effective management of pests and diseases. Further, exposure visits to seed



industry provided practical insights into seed processing and packaging operations. Additionally, they explored the conservation of millet genetic resources, which are vital for future crop improvement initiatives.

Training on “Millets Seed Production, Processing, Certification & Value Addition” to Odisha Farmers

The 3 days training program on “Millets Seed Production, Processing, Certification, and Value Addition” was organized by ICAR-Indian Institute of Millets Research, Hyderabad from 3-5 December, 2024 to Farmer Producer Organisations (FPOs), NGOs & Progressive farmers of Odisha state under Odisha Millet Mission (OMM). The training program was inaugurated by Dr. C. Tara Satyavathi, Director, ICAR-IIMR, Hyderabad and highlighted the importance of millet cultivation in ensuring nutritional security and sustainable agriculture. During the three-day program, participants attended specialized sessions covering millets seed production, processing techniques, certification standards and value addition units. Farmers were engaged in hands-on activities and exposure visits like millet fields, gene bank, primary processing unit, Centre of excellence and Prasad seed industries.

State level workshop on Agro Based Food Processing Industry (ABFPI)

A State-level Workshop on Agro-Based Food Processing Industry (ABFPI) was organized by Khadi and Village Industries Commission (KVIC) and ICAR-IIMR at the ICAR-IIMR, Hyderabad on 18 December, 2024. Mr. L. Madan Kumar Reddy, Deputy Chief Executive Officer (South Zone), KVIC, Bangalore, Mr. M.N. Sudhakar, Director, KVIC, Telangana and Dr. C. Tara Satyavathi, Director, ICAR-IIMR, Hyderabad inaugurated the workshop by lightening the ceremonial lamp. Dr. C. Tara Satyavathi in her inaugural address highlighted the scope of millet business opportunities in agriculture food processing. Scientists Dr. Sangappa and Sh. Srinivasa Babu presented about the advanced millet technologies developed by ICAR-IIMR and shared the experiences of Nutrihub in shaping millet startups. Dr. Satyamala, Principal Scientist, CSIR-CFTRI, Hyderabad, and Dr. P. Mathur, the Director, ICAR-IIMR, Hyderabad, shared their expertise on food processing innovations and strategies for promoting agro-industrial growth. A total

of 120 participants attended the workshop.

Training programme on Millets production, processing, value addition technologies for Uttar Pradesh farmers

ICAR-IIMR organized a two-day training programme titled ‘Millets Production, Processing and Value-Addition Technologies’ for 15 farmers of Uttar Pradesh during 11-12 November, 2024 with the funding of Agri Clinic and Agri Business Centres, Ghazipur, Uttar Pradesh. The training programme was inaugurated by Dr. C. Tara Satyavathi, Director. During the training the farmers expressed their problems related to millets production & Processing. The director and other resource person of ICAR-IIMR have given training on latest millets production & processing technologies. An interactive session to the farmers about the latest production & processing technology of pearl millet, various techniques such as millets production, protection, processing, value-addition, storage, soil testing etc. Farmers were taken on a guided tour to Millets Gene bank to show millets germplasm diversity, centre of excellence, primary & secondary processing facilities. Apart from this, they were made aware of suitable varieties for Uttar Pradesh, formation of farmer producer organizations and information related to their benefits.

Training programme on Millets production, processing, value addition technologies for Uttar Pradesh farmers

ICAR-IIMR organized a two-day training program titled “Millets Production, Processing and Value-Addition Technologies” for 44 farmers of Uttar Pradesh during 28-29 November 2024 with the funding of Agricultural Technology Management Agency, Agra, Uttar Pradesh. The training program was inaugurated by Dr. C. Tara Satyavathi, Director. During the training the farmers expressed their problems related to millets production & Processing. The director and other resource person of ICAR-IIMR have given training on latest millets production & processing technologies. An interactive session to the farmers about the latest production & processing technology of pearl millet was also organized.

Improved cultivation methods and processing technologies of millets

A training programme on “Improved Cultivation Methods and Processing Technologies of Millets” was successfully organized by ICAR-IIMR from 3-5



December, 2024. The program focused on enhancing millet production and value addition through advanced cultivation techniques, processing innovations, and best agronomic practices. Participants gained insights

into scientific approaches to millet farming, post-harvest processing, and value-added product development. The training aimed to equip farmers, entrepreneurs, and stakeholders with practical skills and knowledge to improve productivity, profitability, and sustainability in millet-based agribusinesses.



Training Programs organized @ IIMR-Nutrihub-2024

S. No.	Date	Program Title	Total Participants
1	19 Jan, 2024	Startup ignition 'Emerging trends in millets production & marketing'	57
2	25 Jan, 2024	Cooking with millets	33
3	27 Jan, 2024	Millet value addition for military women	30
4	16 Feb, 2024	Cooking with millets	30
5	23 Feb, 2024	Startup ignition 'Emerging trends in millets production & marketing'	43
6	27 Feb, 2024	Emerging trends in the millet sector	26
7	15 Mar, 2024	Cooking with millets	25
8	16 Mar, 2024	Startup ignition 'Emerging trends in millets production & marketing'	45
9	18 April, 2024	Emerging trends in millets production & marketing	40
10	25 April, 2024	Cooking with millets	23
11	26 April, 2024	Startup Ignition Program	49
12	10 May, 2024	SHG Cooking with Millets (Mahabubabad)	45
13	16 May, 2024	Cooking with millets	22
14	17 May, 2024	Startup Ignition Program	49
15	13 June, 2024	Cooking with Millets	28
16	14 June, 2024	Startup Ignition Program	47
17	26 July, 2024	Startup Ignition Program	47
18	23 Aug, 2024	Startup Ignition Program	41
19	27 Sep, 2024	Startup Ignition Program	35
20	25 Oct, 2024	Startup Ignition Program	33
21	21 Nov, 2024	Cooking with millets	16
22	22 Nov, 2024	Startup Ignition Program	28
23	19 Dec, 2024	Cooking with millets	15
24	20 Dec, 2024	Startup Ignition Program	32
25	30 Dec, 2024	Cooking with millets	18
26	31 Dec, 2024	Startup Ignition Program	39

CAPACITY BUILDING

M. Sc. Students

S. No	Name of the Student	Discipline	Title of the Research work	Advisor /Co-Advisor from IIMR	University
Passed out during 2024					
1	C. Pranathi	Genetics and Plant Breeding	Assessment of potential restorer lines for yield and quality in forage pearl millet	Dr. D. Seva Nayak	PJTAU
2	Tejashwini Ballolla	Genetics and Plant Breeding	Agro-morphological, biochemical and molecular characterization of little millet (<i>Panicum sumatrense</i> Roth. ex. Roem and Schultz) genotypes	Dr. P. Rajendrakumar	ANGRAU, Guntur, AP
3	Thumma Archana Reddy	Biotechnology	A study on the role of DNAJ of finger millet during abiotic stress conditions.	Dr. Jinu Jacob	Osmania University, Hyderabad
4	Matam Varsha	Biotechnology	Molecular analysis of invertase gene(s) in sweet sorghum	Dr. Jinu Jacob	Osmania University, Hyderabad
5	VVSRA Vaishnavi	Biotechnology	<i>In silico</i> characterisation of chitinase gene family in finger millet (<i>Eleusine coracana</i>)	Dr. Jinu Jacob	Osmania University, Hyderabad
On-going					
1	Pasupuleti Ajay	Genetics and Plant Breeding	Genetic diversity and character association in foxtail millet [<i>Seteria italica</i> (L.) P. Beauv.] genotypes using DNA markers, agro-morphological and nutritional traits	Dr. P. Rajendrakumar	ANGRAU, Guntur, AP
2	Soumya Priyadarsini Dixit	Genetics and Plant Breeding	Agro - morphological and molecular characterization of landraces and varieties in finger millet [<i>Eleusine coracana</i> (L.) Gaertn.]”	Dr. P. Rajendrakumar	IARI Mega University, Hyderabad Hub
3	Manoj Kumar	Entomology	Screening of small millets to stored grain pests and effect of packaging on safe storage	Dr. J. Stanley	IARI Mega University, Hyderabad Hub
4	Tarun Kondagadapu	Biochemistry	Biochemical evaluation of the changes in foxtail millet grains upon thermal processing	Dr. V. M. Malathi	Osmania University (Aurora's College, Chikkadapally, Hyderabad)
5	S. Harikrishna	Genetics and Plant Breeding	Morpho-agronomic, biochemical and molecular characterization of barnyard millet (<i>Echinochloa frumentacea</i> Roxb. Link) genotypes.	Dr. B. Amasiddha	PJTAU, Hyderabad

Ph. D Students

On-going					
1	G. Shravanthi	Plant Physiology	Physiological and biochemical studies on heat stress tolerance in sorghum (<i>Sorghum bicolor</i> (L.) Moench)	Dr. D. Seva Nayak	ANGRAU, AP
2	Supriya Patel	Genetics and Plant Breeding	Genome wide association studies for forage yield and quality in forage pearl millet [<i>Pennisetum glaucum</i> (L.) R. Br.]”	Dr. Avinash Singode (Guide) Dr. D. Seva Nayak (Co-Guide) Dr. R. Venkateswarlu (Co-Guide)	ANGRAU, AP

On-going

3	D. Sravani	Genetics and Plant Breeding	Heterotic grouping of low rancid inbred lines based on morphological and molecular markers in pearl millet (<i>Pennisetum glaucum</i> (L.) R. Br.)	Dr. P. Sanjana Reddy (Co-Guide)	ANGRAU, AP
4	K. Alekya	Genetics and Plant Breeding	Genetic studies of blast resistance in pearl millet (<i>Pennisetum glaucum</i> (L.) R. Br.)	Dr. P. Sanjana Reddy (Co-Guide)	ANGRAU, AP
5	B.K. Nikhil	Genetics and Plant Breeding	Formation of heterotic pools and determining the efficiency of heterotic grouping methods in pearl millet (<i>Pennisetum glaucum</i> (L.) R. Br.)	Dr. P. Sanjana Reddy (Guide)	IARI- Mega University, Hyderabad HUB
6	Ch. Naga Rani	Entomology	Host plant and fall armyworm, <i>Spodoptera frugiperda</i> (J.E. Smith) interactions in millets: A chemical ecology perspective	Dr. P.G. Padmaja (Guide)	IARI- Mega University, Hyderabad HUB
7	Trupti Vhanamane	Botany	Development of Heterotic groups in post-rainy season sorghum (<i>Sorghum bicolor</i> L. Moench)	Dr. Parashuram Patroti (Guide)	Punyashlok Ahilyadevi Holkar Solapur University, Solapur
8	Priyanka Mashale	Botany	Development of high yielding <i>rabi</i> sorghum cultivars with enhanced resistance to biotic and abiotic stresses	Dr. Parashuram Patroti (Guide)	Punyashlok Ahilyadevi Holkar Solapur University, Solapur
9	Archana Basargi	Botany	Exploration of Multiparent Advanced Generation Inter Crosses (MAGIC) for broadening the genetic base and isolation of new genotypes in <i>rabi</i> sorghum	Dr. Parashuram Patroti (Co-Guide)	Punyashlok Ahilyadevi Holkar Solapur University, Solapur, Maharashtra
10	Onkar Bhurale	Botany	Characterization of popular <i>rabi</i> landraces of India & identification of trait specific genotypes	Dr. Parashuram Patroti (Co-Guide)	Punyashlok Ahilyadevi Holkar Solapur University, Solapur, Maharashtra

IARI - MEGA UNIVERSITY (M. SC. & Ph.D. PROGRAM)

S. No	Name of the Student / Roll No.	Year	Degree*	University	Place of Study
1	Devisetti Devi Pratyusha IARIHYD20242004	2024-25	M.Sc. (Entomology)	IARI Mega University, Hyderabad HUB	ICAR-Indian Institute of Millets Research
2	V. Monika IARIHYD20242006	2024-25	M.Sc. (Entomology)	IARI Mega University, Hyderabad HUB	ICAR-Indian Institute of Millets Research
3	P. Sharmila IARIHYD20242007	2024-25	M.Sc. (Entomology)	IARI Mega University, Hyderabad HUB	ICAR-Indian Institute of Millets Research
4	S. Sivakumar IARIHYD20242008	2024-25	M.Sc. (Entomology)	IARI Mega University, Hyderabad HUB	ICAR-Indian Institute of Millets Research

*=Name of the Advisor and Topics are yet to be identified

Awards and Recognitions

Sl. No	Name	Award Details and title of award	Organisation where it's bagged from
1	Baswaraj Raigond	Fellow of Phytopathological Society of India (FPSI)	Indian Phytopathologica Society, ICAR-IARI, New Delhi
2	Baswaraj Raigond	Fellow of Indian Potato Association (FIPA)	Indian Potato Association, ICAR-Central Potato Research Institute, Shimla
3	Baswaraj Raigond	IPA medal for best paper award to the work on "First report of <i>Haplothrips tenuipennis</i> Bagnall (Thysanoptera, Phlaeothripidae) on Potato in North Western Hills of India" published in <i>Potato J</i> , 2020, 47 (1): 92-96 (Sridhar J*, Neelam K, Baswaraj Raigond, Vallepu V, Anuj B, Kamlesh M, Sanjeev S, M Nagesh and SK Chakrabarti).	Indian Potato Association, ICAR-Central Potato Research Institute, Shimla
4	Baswaraj Raigond	Best Oral Presentation on "Investigating viral infection in foxtail millet by symptomatology, electron microscopy and molecular detection" during VIROCON-2023 on "Advancements in Global Virus Research Towards One Health"	IVS, New Delhi and ICAR-NRC on Banana, Tiruchirappalli
5	B. Dayakar Rao	Social Impact	AMITY University, Uttar Pradesh
6	B. Gangaiah	Vice President (South), Indian Society of Agronomy, New Delhi	Elected as Vice President of Indian Society of Agronomy for the biennium 2024-25
7	Sangappa	Shri Guru Seva Ratna Prashasti	Harkuda Samsthana Matha, Karnataka
8	Parashuram Patroti	Best oral presentation on "Breeding for farmer's preferred traits in post-rainy sorghum by using MAGIC approach" during the International Conference on Food & Nutritional Security through Agriculture Ecosystem	MANAGE, Hyderabad
9	Parashuram Patroti	Recognition as Ph.D. guide/supervisor in the discipline of Biotechnology	Punyashlok Ahilyadevi Holkar Solapur University, Solapur
10	Parashuram Patroti	Member, Board of studies in Biotechnology	Walchand college of Arts & Science, Solapur (Autonomous)
Institutional awards during Foundation Day			
11	B. Dayakar Rao	Best Principal Scientist	ICAR-IIMR, Hyderabad
12	R. Venkateswarlu	Best Senior Scientist Award	ICAR-IIMR, Hyderabad

Sl. No	Name	Award Details and title of award	Organisation where it's bagged from
13	Sangappa	Best Scientist	ICAR-IIMR, Hyderabad
14	S. Narender	Best Technical Officer	ICAR-IIMR, Hyderabad
15	Usha Satija & J. Bhagwantham	Best Technical Assistant	ICAR-IIMR, Hyderabad
16	S. Amrut Raj Santosh & Mr. J Narsimha	Best Supporting staff	ICAR-IIMR, Hyderabad
17	Mr. YS Kshirsagar	Best Technical Staff Award (CRS, Solapur)	ICAR-IIMR, Hyderabad
18	Mr. Malik Nanware	Best Supporting Staff Award (CRS, Solapur)	ICAR-IIMR, Hyderabad
19	Mr. Shaik Rukman	Best Staff Account Section	ICAR-IIMR, Hyderabad
20	Ms. Ritu Dalal	Best Staff Admin Section	ICAR-IIMR, Hyderabad
21	B. Dayakar Rao	Best interdisciplinary Award	ICAR-IIMR, Hyderabad
22	A.V. Umakanth	Scientist with more number of Product/Technologies developed	ICAR-IIMR, Hyderabad
23	P.G. Padmaja A. Kalaisekar R. Venkateswarlu B. Dayakar Rao V.A. Tonapi	Research Article with Highest Impact Factor/NAAS Score	ICAR-IIMR, Hyderabad
24	Sangappa	More number of research articles during the calendar year 2023	ICAR-IIMR, Hyderabad
25	C. Tara Satyavathi <i>et al</i> & B. Dayakar Rao	Best in house publication	ICAR-IIMR, Hyderabad
26	R. Madhusudhana & P.G. Padmaja	Best Research Article in interdisciplinary mode	ICAR-IIMR, Hyderabad
27	B. Dayakar Rao	Best Research Article in inter institutional mode	ICAR-IIMR, Hyderabad
28	R. Venkateswarlu V.M. Malathi	Best Laboratory Award (Biochemistry)	ICAR-IIMR, Hyderabad
29	Sangappa	Maximum amount of external funding during 2023	ICAR-IIMR, Hyderabad
30	Swarna Ronanki	Maximum number of external funded projects during 2023	ICAR-IIMR, Hyderabad
31	Sangappa	Scientist working with farmers and created significant impact in promotion of millets	ICAR-IIMR, Hyderabad
32	B. Subbarayudu & Sangappa	Scientist working with vulnerable/weakersections/farmers	ICAR-IIMR, Hyderabad
33	A.V. Umakanth	Scientist with Best Intellectual Property (IP) developed	ICAR-IIMR, Hyderabad
34	B. Venkatesh Bhat	Scientist with Best Highest Revenue Generator	ICAR-IIMR, Hyderabad



Externally Funded Projects-2024

(Rs in Lakhs)

Sr. No.	Project Title	Principal Investigator	Funding Agency	Total budget	Duration
1	Improving the adaptability and productivity of millets in Uttar Pradesh	P. Sanjana Reddy	UPCAR	78.37	2024-2028
2	Deciphering marker – trait associations for blast disease resistance in pearl millet	P. Sanjana Reddy	Ignite life science Foundation	27.5	2024-2026
3	Formation and Promotion of FPOs under NABARD AP Project 2.0	Sangappa	NABARD, AP	125.00	2023-2028
4	Formation and Promotion of FPOs Under NABARD Telangana Project 2.0	Sangappa	NABARD, Telangana	50.00	2023-2028
5	Upscaling millets production through mainstreaming landraces/improved Cultivars, Crop Diversification, Supply of quality seeds (grain and fodder), Capacity Building and Strengthening of Value chain in Millets for Food and Nutritional security of Odisha	K. Srinivas Babu	Government of Odisha	665.828	2023-2027
6	Sustainable enhancement of livelihood of tribal farmers of Tamil Nadu through improved production technologies and value chain of millets	A. Kalaisekar	Government of Tamil Nadu	190	2023-2026
7	Deciphering the marker-trait associations for grain yield and blast disease resistance traits in finger millet through genome-wide association analysis	K. N. Ganapathy	SERB-DST	39.35	2023-2026
8	Evaluation of Nano DAP in pearl millet and sorghum	Swarna Ronanki	Coromandel Fertilizers	12.98	2023-2024
9	Evaluation of foliar application of Coromandel Nano-Urea in sorghum crop	Swarna Ronanki	Coromandel Fertilizers	7.08	2023-2024
10	Evaluation of UPH 2221 for its bio-efficacy against weed flora, phytotoxicity to fodder sorghum and residual effect on succeeding groundnut	B. Gangaiah	UPL, Mumbai	11.60	2022-2024

Sr. No.	Project Title	Principal Investigator	Funding Agency	Total budget	Duration
11	Leaf Colour Chart (LCC) development for N fertilizer top dressing in sorghum, pearl millet and finger millet	B. Gangaiah	Nitrogen Parameters, Chennai	13.00	2022-2024
12	A comprehensive study to establish the health benefits (in vivo) of Nutri-cereals: A way forward for mainstreaming millets	B. Dayakar Rao	NFSM	395.30	2022-2025
13	Molecular prediction and candidate gene(s) identification for grain yield heterosis in <i>kharif</i> sorghum through genomics and transcriptomics approaches	P. Rajendra Kumar	SERB-DST	38.92	2022-2025
14	Development and characterization of trait specific lines from wide hybridization in sorghum	K.B.R.S. Visarada	SERB power grant	30.41	2022-2025
15	Combined effect of elevated CO ₂ and temperature on water use efficiency, productivity, quality of major cereal fodder crops and soil health	Seva Nayak	SERB-CGR	42.86	2022-2025
16	Biodiversity International: Consumption of resilient orphan products for healthier diets	Sooganna	Bioversity International & ICAR-NBPGR	23.00	2022-2025
17	Refinement of millet value chain for export markets - Preparation of export strategy in wake of International year of Millets - 2023	B. Dayakar Rao	APEDA	652.60	2021-2024
18	Research and development for resolving gaps in scaling up of millet value chain for technical backstopping micro units under PMFME	B. Dayakar Rao	MoFPI	354.00	2021-2024
19	Modifying the lignin composition in biomass sorghum and its deployment for enhanced lingo-cellulosic (2G) biofuel production	A.V. Umakanth	DBT	24.80	2021-2024
20	Identification of SNP-trait associations for seed longevity traits through association mapping in pearl millet and finger millet	N. Kannababu	SERB-DST	49.28	2021-2024
21	Formation and promotion of FPOs for oilseed crop and oil palm under Central Sector Scheme for formation and promotion of 10,000 FPOs	Sangappa	SFAC, DAFW	125.00	2021-2026
22	Formation and promotion of FPOs under Central Sector Scheme for formation and promotion of 10,000 FPOs	Sangappa	SFAC, DAFW	125.00	2021-2026
23	Formation and promotion of FPOs under NCDC Telangana	Sangappa	NCDC-ATARI Hyderabad	50.00	2021-2026

Sr. No.	Project Title	Principal Investigator	Funding Agency	Total budget	Duration
24	Formation and promotion of FPOs under NABARD Telangana	Sangappa	NABARD Telangana	50.00	2021-2027
25	Formation and promotion of FPOs under NABARD Andhra Pradesh	Sangappa	NABARD, AP	50.00	2021-2027
26	CRP in 'Biofortification in selected crops for nutritional security'	K. Hariprasanna	ICAR	120	2021-2026
27	CRP on Agrobiodiversity	K. Venkatesh	ICAR	150.00	2021-2026
28	AICRP on Seed (Crops)	B. Venkatesh Bhat	ICAR-IISS Mau	3.50	2021-2026
29	Farmer FIRST programme component of KVK scheme "Participatory technology validation diversification, value addition for small holders livelihood improvement of Central Telangana Zone"	R.R. Chapke	ICAR	24.50 (contd...)	2020-2025
30	Ensuring sustainable enhancement of millets production and value chain system for Food and Nutritional security of Odisha under State scheme "Special Programme for Promotion of Millets in Tribal Areas"	Sangappa	Directorate of Agriculture and Food Production, Odisha, Bhubaneswar	86.54	2020-2024
31	Promotion of FPOs on Nutri cereals (Millets) in AP, TS, MP and Karnataka	Sangappa	SFAC-NFSM	122.94	2019-2024
32	Application of next-generation breeding, genotyping, and digitalization approaches for improving the genetic gain in Indian staple crops	T. Nepolean	BMGF & ICAR	398.00	2018- 2024
33	Creation of Seed-Hubs for increasing production of millet crops in India	B. Venkatesh Bhat	NFSM	175.00	2018-2024
34	Establishment of Agri - Business Incubation (ABI) Centres under XIIth Plan Scheme for National Agricultural Innovation Fund	B. Dayakar Rao	NAIF-ABI	100.00	2017-2024
35	AICRP on Biological Control of Crop Pests Scheme	G. Shyam Prasad	ICAR	2.00 (contd...)	2009- till date
36	Central Sector Scheme for Protection of Plant Varieties and Farmers' Rights Authority	K. Hariprasanna	PPV&FRA	8.50 (contd...)	2008-till date
37	National Agriculture Innovation Fund-ZTMC	J. Stanley	ICAR	12.00 (contd...)	Continuous
38	Frontline demonstration on sorghum	R.R. Chapke	DA&FW, MOA	163.125 (contd...)	2009- till date

Highlights of ICAR-AICRP on Pearl millet, Sorghum & Small millets

Highlights of AICRP on Pearl millet, Sorghum & Small millets

The combined 59th Annual Group Meeting of ICAR-AICRP on Pearl millet, 54th Annual Group Meeting of ICAR-AICRP on Sorghum, and 35th Annual Group Meeting of ICAR-AICRP on Small Millets was organized by RARS, Acharya NG Ranga Agricultural University, Tirupati in collaboration with ICAR-AICRP on Pearl millet and ICAR-AICRP on Sorghum and millets, ICAR-Indian Institute of Millets Research (IIMR), Hyderabad from 27th to 28th June, 2024. As part of combined Annual Group Meeting, the Centre-wise Scientific Work Plan Audit was organized during May 28, 2024 for pearl millet while for sorghum and small millets it was conducted during 5-6 June, 2024 through video conference. Similarly, the technical programme formulation meeting for pearl millet was conducted on May 29th 2024, while for sorghum and small millets; it was on June 7th, 2024. About 200 researchers from different pearl millet, sorghum and small millets centres, voluntary centres, private sector, NGOs, ICRISAT and other collaborating institutes participated in the group meeting.

The Technical session on Presentation of Progress Report 2023-24 and Technical Programme for 2024-25 was held on 27th June under the chairmanship of Dr. TR Sharma, DDG (CS), ICAR and co-chaired by Dr. SK Pradhan, ADG (FFC), ICAR. The presentations were divided into 4 thematic groups- Crop Improvement, Crop Production, Crop Protection, and Out-reach activities, seed production, IPR & ICAR-ICRISAT partnership trials. The chairman and co-chairman of the respective groups over viewed the progress in all the disciplines in all millets. The research in the three IACR-AICRPs was published in peer reviewed national and international journals. The chairman stressed on

the identification of new male sterility system for hybrid development in pearl millet. Possibility of utilization of apomixis for development of true breeding lines and fixation of heterosis should be explored. The co-chair urged that productivity should be increased in all the small millet to make millet cultivation profitable to the farmers. Use of advanced genomic and phenomic approaches should be targeted for nutritional traits.



Earlier the review of research and scientific audit of ICAR-AICRP on pearl millet, sorghum and small millet centres based on their work plan during 2023-24 and plan for next year was conducted under the Chairmanship of Dr S K Pradhan, ADG (FFC), ICAR while Director, ICAR-IIMR cum Project Coordinator, Pearl millet, Dr. (Mrs.) Tara Satyavathi and Dr. R Madhusudhana, Project Coordinator Sorghum and millets were the Co-chairs. Dr. O P Yadav, chairman, PAMC, and Dr. Chennabyregowda, member PAMC were the experts during the presentations. A total of 43 presentations across three ICAR-AICRPs were made by the respective Officers-in-charge of the ICAR-AICRP centres. The presentations covered general information about the centre, staff position, seasonal information, ATR on recommendations of AGM 2023, significant

achievements, priority areas of research for the centre and action plan for each, major efforts and achievements under each priority area and discipline, seed production, transfer of technology, publications, constraints and shortfalls, and work plan for 2024-25. Each presentation was followed by discussion and recommendations for further improvement of the performance of the centre based on regional and national requirements.

The review of research results and progress report under different crops and disciplines was conducted under the Chairmanship of Dr. S K Pradhan, ADG (FFC), ICAR while Director, ICAR-IIMR cum Project Coordinator, Pearl millet, Dr. (Mrs.) Tara Satyavathi and Project Coordinator Sorghum and millets, Dr. R Madhusudhana were the Co-chairs. PAMC chairman Dr. O P Yadav and member Dr. Chennabyregowda were the expert members during the presentations. Scientists from public sector, private sector and ICRISAT attended this online meeting. All the principal investigators (total 27) of ICAR-AICRP on Pearl millet, Sorghum and Small millets presented their technical programmes under different disciplines viz., Plant breeding, Agronomy, Plant Physiology, Agricultural entomology, Plant Pathology, FLDs & TSP, Seed production, Trials and Nurseries, Sorghum genetic resources management and IPR.

The plenary session started with brief welcome remarks by the Chairman, Dr. TR Sharma, DDG (CS), ICAR. This was followed by the presentation of the proceedings/ technical recommendations of various sessions. The session continued with the VIC proceedings (Pearl millet) by Dr. C Tara Satyavathi, Director, ICAR-IIMR and followed by the presentation of VIC proceedings (Sorghum and small millets) by Dr. R Madhusudhana (Project coordinator, Sorghum and millets). Dr. SS Mane (Member, PAMC, ICAR-AICRP on millets), Dr. SK Pradhan, ADG FFC and Dr. TR Sharma, DDG (CS) gave their remarks. Dr. TR Sharma reminded that all the session-wise recommendation/ action points should be implemented in the ICAR-AICRP programs. He stressed that the purpose of the AGM was to have interactions among the participants and to find partners of common research interest and scientists are encouraged to make joint project proposals. Research collaboration with CGAIR Centres is to be

further strengthened. He emphasized on the sharing of the resources following clearly defined procedures and AICRP database generation for all millets. ICAR-AICRP scientists should focus on target oriented approach in research as being followed in ICAR institutes.

Dr Pradhan congratulated all the breeders who released varieties for their efforts and the organizers for successful conduct of workshop. He appreciated the program and mentioned that the centres should involve in studies employing genomic tools which help in the improvement of traits, diversity searching and achieving the production targets for 2047. Marketing strategies of millets should also be strengthened. He also wished success to all the centres in generating better materials, products and publications. Dr. SS Mane in his remarks appreciated the whole program and mentioned that identification of diseases has to be strengthened as there are variability among the pathogens which could be further utilized for gene pyramiding or similar strategies to reduce the disease incidences. Various committees and teams from RARS Tirupati and ICAR-IIMR Hyderabad made all arrangements for the meeting. Dr. IK Das, Principal Scientist, served as the nodal officer from IIMR, Hyderabad.

New millet varieties identified for release

The Varietal Identification Committee meeting was chaired by Dr. TR Sharma, DDG (CS), ICAR and was held on 27th June, 2024 in hybrid mode. A total of 22 proposals (Pearl Millet - 2, Sorghum - 13 & Small Millets - 7) were received. The committee critically examined all the proposals for different zones / states and identified 14 proposals (pearl millet-2, sorghum-6 and small millets-7) for recommendations to CVRC. Two pearl millet hybrids were Hybrid MH 2626 (MP7214), and Hybrid MH 2631 (PB1939). Six sorghum hybrids and varieties were *kharif* sorghum hybrid SPH 1974, *kharif* sorghum variety SPV 2773, Single cut forage sorghum variety SPV 2881 (SH 1955) and SPV 2884, Sweet sorghum variety SPV 2890, and Yellow sorghum variety SPV 2906. Seven small millets varieties included finger millet variety FMV1209, foxtail millet varieties FXV647 and FXV652, little millet variety LMV539, proso millet varieties PMV472 and PMV473 and browntop millet variety MTV31.

Journal papers

>6.0 NAAS score

1. Karthik, K.V.D., Rao, B.D., Das, A., Kiranmai, E., Dharini, M., Mogulla, S.R. and Sharma, D., 2024. Personalized Kodo Millet Rice Analogue (KMRA): Formulation, nutritional evaluation, and optimization. *Future Foods*, 10:100389 (**JrnlID:; Score:13.20**).
2. Pathare, Aniket M., Rekha S. Singhal, Dayakar Rao, B. and Jyoti S. Gokhale. 2024. Extrusion inhibits lipolytic enzymes in pearl millet (*Pennisetum glaucum*) flour. *Innovative Food Science & Emerging Technologies*, 103605 (**JrnlID: I125; Score:12.60**).
3. Singh, S., Prakash, G., Nanjundappa, S., Malipatil, R., Kalita, P., Satyavathi, T.C. and Nepolean Thirunavukkarasu*. 2024. Novel SNPs linked to blast resistance genes identified in pearl millet through genome-wide association models. *International Journal of Molecular Sciences*, 25 (12048). <https://doi.org/10.3390/ijms252212048> (**JrnlID: I315; Score:11.60**).
4. Behera, P.P., Singode, A., Bhat, B.V., Ronda, V., Borah, N., Verma, H., Gogoi, L.R., Borah, J.L., Majhi, P.K., Saharia, N. and Sarma, R.N. 2024. Genetic gains in forage sorghum for adaptive traits for non - conventional area through multi-trait-based stability selection methods. *Frontiers in Plant Science* 15 DOI=10.3389/fpls.2024.1248663. ISSN=1664-462X <https://www.frontiersin.org/journals/plantscience/articles/10.3389/fpls.2024.1248663> (**JrnlID: F107; Score:11.60**).
5. Singh, S., Viswanath, A., Chakraborty, A., Narayanan, N., Malipatil, R., Jacob, J., Mittal, S., Satyavathi, T.C. and Thirunavukkarasu, N., 2024. Identification of key genes and molecular pathways regulating heat stress tolerance in pearl millet to sustain productivity in challenging ecologies. *Frontiers in Plant Science*, 15:1443681. (**JrnlID: F107; Score:11.60**).
6. Balamurugan, A., Mallikarjuna, M.G., Bansal, S., Nayaka, S.C., Rajashekara, H., Chellapilla, T.S. and Prakash, G. 2024. Genome-wide identification and characterization of NBLRR genes in finger millet (*Eleusine coracana* L.) and their expression in response to *Magnaporthe grisea* infection. *BMC Plant Biology*, 24(1):75 (**JrnlID: B162; Score:11.30**).
7. Jacob, J., Krishnan, V., Antony, C., Bhavyasri, M., Aruna, C., Mishra, K., Nepolean, T., Satyavathi, C.T. and Visarada, K.B. 2024. The nutrition and therapeutic potential of millets: an updated narrative review. *Frontiers in Nutrition*, 11:1346869 (**JrnlID: F103; Score:11.00**).
8. Mesías, M., Morales, F.J., Gupta, O.P., Kaur Oberoi, H. and Ganapathy, K.N. 2024. Advances in cereals and millets nutrition research. *Frontiers in Nutrition* 11:1349757. (**JrnlID: F103; Score:11.00**).
9. Palanna, K.B., Vinaykumar, H.D., Prasanna S. Koti, B. Jeevan, B., Rajashekara, H., Raveendra, H. R., Patro, T.S.S.K., Ramesh, G.V., Mudalagiriappa, Laxmi Rawat, Prahlad Netam, Savita Ekka, Rajesha, G., Das, I.K., Chandranayaka, S., Nagaraja, T. E. and Tara Satyavathi, C. 2024. Geographic distribution, host preference and phylogenetic relationships among *Pyricularia* species inciting millet and rice blast disease in India. *Plant Pathology* 73:692-705 (**JrnlID: P118; Score:8.70**).
10. Aruna, C., Madhusudhana, R. and Deepika, C. 2024. Understanding seasonal influence on sorghum productivity traits. *Crop Science*. 14 February 2024 <https://doi.org/10.1002/csc2.21185> (**JrnlID: C183; Score:8.30**).
11. Kanti Meena, Jinu Jacob, Bhavyasri, M., Aruna, C., Sanjana Reddy, P., Rajendrakumar, P., Avinash

- Singode, Tara Satyavathi, C. and Visarada, K. B. R. S. 2024. Wide hybridization in sorghum with tertiary gene pool for diversification of parental lines. *Crop Science* 15 February, 2024. <https://doi.org/10.1002/csc2.21193> (**JrnlID: C183; Score:8.30**).
12. Yadav, O.P., Singh, D.V., Kumari, V., Prasad, M., Seni, S., Singh, R.K., Sood, S., Kant, L., Dayakar Rao, B., Madhusudhana, R. and Bhat, B.V. 2024. Production and cultivation dynamics of millets in India. *Crop Science* (**JrnlID: C183; Score:8.30**).
 13. Sai Bhavana, C.H., Palanna, K.B., Farooqkhan, T. Tharana Poonacha, Gutha Venkata Ramesh, Prasanna S. Koti, Sujata Bhat, Raveendra, H. R., Patro, T.S. S. K., Saralamma, S., Rajesha, G. and Nagaraja, T. E. 2024. Postulation of putative host differentials and pathotyping of *Pyricularia setariae* (Nishikado) causing leaf blast on foxtail millet [*Setaria italica* (L.) Beauv] in India. *Journal of Plant Pathology* <https://doi.org/10.1007/s42161-024-01684-2> (**JrnlID: J472; Score:8.20**).
 14. Naveen, A., Singh, S.P., Singhal, T., Sanjana Reddy, P., Bhargavi, H.A., Yadav, S., Hemanth, S., Kapoor, C., Supriya, P., Singh, N. and Satyavathi, C.T. 2004. Delineation of selection efficiency and coincidence of multi-trait-based models in a global germplasm collection of pearl millet for a comprehensive assessment of stability and high performing genotypes. *Genetic Resources and Crop Evolution* (**JrnlID: G015; Score:8.00**). <https://doi.org/10.1007/s10722-024-02245-3>.
 15. Behera, P.P., Singode, A., Bhat, B.V. Ronda, V., Borah, N., Yue, H., Verma, H., Borah, J.L., Majhi, P., Saharia, N., Gogoi, L.R. and Sarma R.N. 2024. WAASB-based stability analysis and simultaneous selection of forage sorghum for forage yield traits. *Euphytica* 220: 145. <https://doi.org/10.1007/s10681-024-03397-0> (**JrnlID: E128; Score:7.90**).
 16. Kumar, R.R., Singh, N., Goswami, S., Vinutha, T., Singh, S.P., Mishra, G.P., Kumar, A., Jha, G.K., Satyavathi, C.T., Praveen, S. and Tyagi, A. 2024. Hydrothermal infra-red (HT-IR): the most effective technology for enhancing the shelf-life of pearl millet flour without compromising with the nutrient density and flour quality. *Journal of Plant Biochemistry and Biotechnology*:1-15. (**JrnlID: J462; Score:7.90**).
 17. Oberoi, H.K., Manchanda, P., Kumar, A., Umakanth, A.V., Dhakad, A.K., Kaur, M. and Kaur, H. 2024. Moringa Leaf Extract (MLE) seed priming provides early seedling protection to biofuel crop: sweet sorghum-against salinity. *Sugar Tech*: 26(3):835-850. (**JrnlID: S096; Score:7.90**).
 18. Singhal Tripti, Satyavathi C. Tara, Singh, S.P., Sankar Mukesh, M. Mallik, R. Thribhuvan, Yadav Sunaina, Bharadwaj, C. 2024. Elucidating genotype × environment interactions for grain iron and zinc content in a subset of pearl millet (*Pennisetum glaucum*) recombinant inbred lines. *Crop & Pasture Science* 75: CP23120. <https://doi.org/10.1071/CP23120> (**JrnlID: C178; Score:7.90**).
 19. Alekhya, K., Shanthi Priya, M., Sekhar, M.R., Sanjana Reddy, P. and Sravani, D. 2024. Multi-omics intervention in dissecting climate resilient traits in pearl millet (*Pennisetum glaucum* (L.) R. Br.): Current progress and future prospects. *Theoretical Biology Forum* 13(1): 40-46. DOI: <https://doi.org/10.61739/TBF.2024.13.1.40> (**JrnlID: T056; Score:7.50**).
 20. Maninder Kaur, Oberoi Harpreet Kaur and Gangaiah, B. 2024. Evaluation of new generation pre-emergence herbicides in forage sorghum (*Sorghum bicolor* L.). *Phytoparasitica* 52(3): 1-10. <https://doi.org/10.1007/s12600-024-01167-1> (**JrnlID: P080; Score:7.40**).
 21. Malathi, V.M., Reddy, P.S., Ratnavathi, C., Ganapathy, K., Patroti, P., and Satyavathi, C.T. 2024. Genotype × environment interaction for seed amylopectin content in waxy sorghum [*Sorghum bicolor* (L.) Moench]. *Indian Journal of Genetics and Plant Breeding*, 84(02):216-223. <https://doi.org/10.31742/ISGPB.84.2.9> (**JrnlID: I070; Score:7.00**).
 22. Behera, P.P., Singode, A., Bhat, B.V. and Sarma, R.N. 2024. Selection of high-yielding stable forage sorghum genotypes using WAASB and MGIDI methods. *Indian Journal of Genetics and Plant Breeding*, 84(2): 224-231. (**JrnlID: I070; Score:7.00**).
 23. Kannababu, N., Avinash, S., Das, I.K., Padmaja, P.G., Umakanth, A.V., Satyavathi, C.T. 2024. Determining seed longevity and vigor in finger millet [*Eleusine coracana* (L.) Gaertn.] and its genetic implication under storage. *Indian Journal*

- of *Genetics and Plant Breeding* 84(4): 697-708 (**JrnlID: I070; Score:7.00**).
24. Khandelwal, V., Sanjana Reddy, P., Satyavathi, C.T., Gupta, P.C., Jain, S.K., Mungra, K.D., Tripathi, M.K., Yadav, D., Solanki, R.K. and Parashuram Patroti. 2024. Identification of stable cultivars of pearl millet (*Pennisetum glaucum* (L.) R. Br.) based on GGE Biplot and MTSI index. *Indian Journal of Genetics and Plant Breeding* 84(4): 668-678. DOI: <https://doi.org/10.31742/ISGPB.84.4.18> (**JrnlID: I070; Score:7.00**).
 25. Nagaraja, T.E., Parveen, S.G., Aruna, C., Hariprasanna, K., Singh, S.P., Singh, A.K., Joshi, D.C., Joshi, P., Tomar, S.M.S., Talukdar, A. and Kumar, S. 2024. Millets and pseudocereals: A treasure for climate resilient agriculture ensuring food and nutrition security. *Indian Journal of Genetics and Plant Breeding* 84(01):1-37. (**JrnlID: I070; Score:7.00**).
 26. Chapke, R.R., Kanthisri, B.S. and Muppidi, S. 2024. Traditional post-harvest operations of millets and drudgery of women. *Indian Journal of Traditional Knowledge* 23(8):805-811. (**JrnlID: I104; Score: 6.80**).
 27. Kannababu, N., Ganapathy, K.N., Venkateswarlu, R. and Tara Satyavathi, C. 2024. Physiological and harvestable maturity of seeds in finger millet [*Eleusine coracana* (L.) Gaertn.]. *Range Management and Agroforestry* 45 (2): 290-299 (**JrnlID: R006; Score:6.80**).
 28. Chapke, R.R., Spanditha, M., Kanthisri, B.S., Laxmi Prasanna, P. and Tara Satyavathi, C. 2024. Effect of automation on different ergonomic parameters in traditional millet production. *Agriculture Association of Textile Chemical and Critical Reviews (AATCC)* 12 (3):105-110. (DOI: <https://doi.org/10.58321/AATCCReview.2024.12.03.105>) (**JrnlID: A001; Score: 6.00**).
- <6.0 NAAS score**
29. Das, I.K., Palanna, K.B., Patro, T.S.S.K., Saralamma, S., Abdul Salam, S., Raveendra, H.R., Hariprasanna, K., Kannababu, N. and Tara Satyavathi, C. 2024. New sources of rust resistance in a panel of foxtail millet genotypes. *Indian Phytopathology* 10.1007/s42360-024-00791-5 (<https://rdocu.be/dYDEX>) (**JrnlID: I112; NAAS: 5.97**).
 30. Behera, P.P., Singode, A., Bhat, B.V. and Sarma, R.N. 2024. Exploring genetic variability in fodder quality of forage sorghum in the North - Eastern regions of India. *Electronic Journal of Plant Breeding* 15(3): 1-11. <https://doi.org/10.37992/2024.1503.066> (**JrnlID:E042; Score:5.60**).
 31. Narasimhulu, R., Reddy, C.V.K., Kiranmayi, M.J., Hariprasanna, K., Prabhakar, K. and Venkateswarlu, N.C. 2024. Multivariate analysis for assessing the genetic diversity and association patterns of yield attributing traits in little millet (*Panicum sumatrense*). *Electronic Journal of Plant Breeding* 15(1):178-184 (**JrnlID: E042; Score:5.60**).
 32. Akshitha, S., Padmaja, G., Rajesha, G. and Pushpavalli, S.N.C.V.L. 2024. Characterization of endophytic bacteria of finger millet [*Eleusine coracana* (L.)] from southern states of India. *Plant Archives* 24(2):1799-1806. <https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.258> (**JrnlID:P092; Score:5.59**).
 33. Pranathi, C., Shivani, D., Avinash, S., Dheeravathu, S.N. 2024. Evaluation of combining ability effects of restorer lines for yield and yield attributing traits in forage pearl millet. *Plant Archives* 24 (2):1439-1444 (**JrnlID: P092; Score:5.59**).
 34. Sangappa, Rafi, D., Chandhini, K., Charishma, E. and Meghana, G. 2024. Livelihood security index assessment among millet farmers in North Eastern Hill (NEH) states of India. *International Journal of Bio-resource and Stress Management* 15(12):01-07. [HTTPS://DOI.ORG/10.23910/1.2024.5848](https://doi.org/10.23910/1.2024.5848) (**JrnlID: I194; Score:5.40**).
 35. Rafi, D., Sangappa, Chandhini, K., Ramkiran, K., Laxmi, B. and Sujeet K. Jha. 2024. Constraints faced by tribals (FPOs) in cultivation, processing and marketing of millets in hilly areas of Andhra Pradesh: A policy perspective. *Journal of Eco-Friendly Agriculture* 19 (1):205-210 doi: 10.48165/jefa.2024.19.01.35 (**JrnlID: J193; Score:5.36**).
 36. Sangappa, Rafi, D., Meghana, E., Charishma, K., Ramkiran and Chandhini, K. 2024. Knowledge based millet trainings for sustainable nutritional security in the tribal communities of Andhra Pradesh. *Journal of Advances in Biology & Biotechnology* 27: 1347-1358. 10.9734/jabb/2024/v27i81258. (**JrnlID: J011; Score:5.30**).

37. Supriya, P., Avinash, S., Reddy, M., Venkateswarlu, R., Dheeravathu, S.N, and Reddisekhar, M., 2024. Multi-trait analysis and clustering of forage pearl millet genotypes in semiarid conditions. *Journal of Advances in Biology and Biotechnology* 27(11):1602-1613 (**JrnlID: J011; Score:5.30**).
38. Ambawat, S., Tara Satyavathi, C., Vikas Khandelwal, Rajbala Meena, Meena, R.C., Subaran Singh, Manoj Kumar and Bishnoi, J.P. 2024. Characterization of iron and zinc rich pearl millet hybrids and varieties using molecular markers. *International Journal of Advanced Biochemistry Research* 8(2): 542-548 DOI: <https://doi.org/10.33545/26174693.2024.v8.i2g.612>. (**JrnlID: I160; Score:5.29**).
39. Sangappa, Rafi, D., Ravi, S.C., Charishma, E. and Tara Sathyavathi, C. 2024. Assessment of millet stake holders perception towards millets training program during international year of millet. *International Journal of Advanced Biochemistry Research* 8(4S):115-122. DOI: 10.33545/26174693. 2024.v8. i4Sb.915 (**JrnlID: I160; Score:5.29**).
40. Surukuntla HariKrishna, Amasiddha, B., Malathi, V.M. and Sameerkumar, C.V. 2024. Correlation and cluster analysis in phenotypic diversity studies of barnyard millet (*Echinochloa frumentacea* Roxb. L.). *International Journal of Advanced Biochemistry Research* 8(8): 895-898 (**JrnlID: I160; Score:5.29**).
41. Thakare, G., Gangaiah, B., Bhutada, P., Dahiphale, A. and Konde, N. 2024. Quantifying response of azospirillum and phosphate solubilizing bacteria liquid inoculants seed treatment on productivity and profitability of *kharif* grain sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy* 69(1): 48-53 (**JrnlID: I038; Score: 5.21**).
42. Rajyalakshmi, B., Gangaiah, B., Chandrasekhar, K., Prasad Babu, M.B.B. and Srividhya, S. 2024. Biochar production potential of pearl millet (*Pennisetum glaucum* L.) crop residues and its physico-chemical characterization. *International Journal of Research in Agronomy* 7(6): 317-320 (**JrnlID: I428; Score: 5.20**).
43. Jorben, J., Singh, A.M., Satyavathi, C.T., Singhal, T., Thribhuvan, R. and Singh, S.P. 2024. SSR markers based diversity analysis in elite genotypes of pearl millet. *Indian Journal of Plant Genetic Resources* 37(01): 39-46 (**JrnlID: I091; Score:5.17**).
44. Rafi, D., Sangappa, and Palanichamy, N. V. 2024. Determinants that contribute women to join in SHGs in Rayalaseema region of Andhra Pradesh. *Journal of Scientific Research and Reports* 30(1):128-132 (**JrnlID: J513; Score:5.17**).
45. Umakanth, A.V., Paroha, S., Kumar, A., Ranganathan, A. and Swain, D. 2024. Sweet sorghum for biofuel production in sub-tropical India. *Journal of Scientific Research and Reports* 30(4):1-9 (**JrnlID: J513; Score:5.17**).
46. Tejashwini, B., Radhika, K., Ganapathy, K.N., Venkateswarlu, R. and Rajendrakumar, P. 2024. Insights into genetic variability parameters and character association among agro-morphological and biochemical traits in little millet (*Panicum sumatrense* Roth. Ex. Roem and Schultz). *Journal of Experimental Agriculture International* 46(5): 590-601(**JrnlID: J234; Score:5.14**).
47. Uma Maheswari, V., Sanjana Reddy, P., Sameer Kumar, C.V. and Eswari, K.B. 2024. Assessment of heterosis for yield and its component traits in pearl millet (*Pennisetum glaucum* (L.) R. Br. *Journal of Experimental Agriculture International* 46 (9): 489-499. (**JrnlID: J234; Score:5.14**).
48. Usha Sai, P., Sanjana Reddy, P., Reddy, B.R.K. and Santhosh, B. 2024. Heterotic studies for yield and its related traits in pearl millet (*Pennisetum glaucum* (L.) R. Br.). *Journal of Experimental Agriculture International* 46 (9): 849-857(**JrnlID: J234; Score:5.14**).
49. Uma Maheswari, V., Sanjana Reddy, P., Sameer Kumar, C.V. and Eswari, K.B. 2024. Character association studies for yield attributing traits across different seasons in pearl millet [*Pennisetum glaucum*(L.) R. Br]. *International Journal of Plant & Soil Science* 36(9): 368-377(**JrnlID: I335; Score:5.07**).
50. Hemasankari, P., Dayakar Rao, B., Avinash singode, Srinivas, Ganapathi, K.N. and Tara Sathyavathi, C. 2024. Engineering properties of selected finger millet cultivars (*Eleusine Corocana*. L) in three different forms of fresh, cooked and malted condition for development of value added

- products. *Ecology, Environment and Conservation* 30(3): 253-265. DOI No.:<http://doi.org/10.52550/EEC.2024.v30i063.039>, ISSN 0971-765X. (**JrnlID: E023; Score:5.05**).
51. Hemasankari, P., Dayakar Rao, B., Sai Prasanna, E., Vilas. A. Tonapi and Kailappan, R. and Tara Sathyavathi, C. 2024. Design and development of double head dehuller and its performance testing using selected minor millets. *Ecology, Environment and Conservation* 30(4): 68-179. DOI No.:<http://doi.org/10.53550/EEC.2024.V31i.04s.042>, ISSN 0971-765X (**JrnlID: E023; Score:5.05**).
 52. Rajappa, P.V., Krishnaraj, P.U., Hanamratti, N.G., Bagewadi, B., Nawalagatti, C.M., Anisha, A. and Madhusudhana, R. 2024. Assessment of genetic diversity in *rabi* sorghum landraces using D2 statistics. *Journal of Cereal Research* 16 (1): 92-101. <http://doi.org/10.25174/2582-2675/2024/149894> (**JrnlID: J144; Score:5.05**).
 53. Rafi, D., Sangappa, Venkatesa Palanichamy, N., Chandrakumar, M. and Sujeet K. Jha 2024. Empowerment levels among self-help group women in Rayalaseema region of Andhra Pradesh. *Journal of Community Mobilization and Sustainable Development* 19(2): 417-424. (**JrnlID: J171; Score:5.02**).
 54. Hemasankari, P., Dayakar Rao, B., Srinivas, A., Ganapathi, K.N., and Tara Sathyavathi, C. 2024. Chemical properties of selected finger millet cultivars (*Eleusine Corocana*) for development of value-added products in three different forms of fresh, cooked and malted condition. *Asian Journal of Microbiology, Biotechnology & Environmental Sciences* 26(2): 295-306 (**JrnlID: A331; Score:4.93**).
 55. Dheeravathu, S.N. and Vadithe, T.B. 2024. Potential and scope of sorghum cultivation in rice-fallows-an ideal strategy under climate change: a review. *Forage Research* 50(1):1-4 (**JrnlID: F073; Score:4.76**).
 56. Satpal, Gangaiah, B., Maninder Kaur., Kharor, N., Devi, S., Neelam and Ram Niwas. 2024. Foliar spray of growth regulators and mineral nutrients for enhanced productivity and profitability of single cut forage sorghum in semi-arid regions of India. *Forage Research* 49(4): 443-448 (**JrnlID: F073; Score: 4.76**).
 57. Sravanthi, G., Dheeravathu, S.N., Latha, P., Avinash, S., Jacob, J., Vijaya Kumar, G. and Vadithe T.B. 2024. Screening of sorghum germplasm for high temperature stress tolerance at seedling stage. *Forage Research* 50(1): 189-196 (**JrnlID: F073; Score:4.76**).
 58. Gupta, S., Rangari, S.K., Sahu, A., Naik, Y.D., Satayavathi, C.T., Punnuri, S. and Thudi, M., 2024. Meta-QTL analysis reveals the important genomics regions for biotic stresses, nutritional quality and yield related traits in pearl millet. *CABI Agriculture and Bioscience* 5(1):36.
 59. Kanti Meena, Dharmendra K. Meena, Jinu Jacob, Chandrasekhara Aruna and Kurella Bala Rama Saraswati Visarada. 2024. Unveiling the antioxidant arsenal of colored sorghum: A path to functional food development. *Agriculture* 14: 566. <https://doi.org/10.3390/agriculture14040566>.
 60. Khandelwal, V., Patel, R., Choudhary, K.B., Pawar, S.B., Patel, M.S., Iyanar, K., Mungra, K.D., Kumar, S. and Satyavathi, C.T. 2024. Stability analysis and identification of superior hybrids in pearl millet [*Pennisetum glaucum* (L.) R. Br.] using the multi trait stability index. *Plants* 13(8):1101. <https://doi.org/10.3390/plants13081101>.
 61. Pande, H., Kapse, S., Krishnan, V., Kausley, S., Satyavathi, C. T. and Rai, B. 2024. Prediction of shelf life of pearl millet flour based on rancidity and nutritional indicators using a long short-term memory network model. *ACS Food Science and Technology* 4 (3): 786-795, March 1, 2024.
 62. Subbarayudu, B., Shyam Prasad, G., Parashuram, P., Kalaisekar, K., Srinivas, A., Rajappa, P.V., Sevanayak, D., Baswaraj, R., Raghunath, K. and Mukesh, P. 2024. Evaluation of IPM modules against shoot pests of *rabi* sorghum (*Sorghum bicolor*). *Indian Journal of Plant Protection* 51 (1, 2 & 3):40-43.
 63. Elavarasan, K., Malini, M., Ninan, G., Ravishankar, C.N. and Dayakar Rao, B. 2024. Millet flour as a potential ingredient in fish sausage for health and sustainability. *Sustainable Food Technology* 2:1088-1100.
 64. Srivastava, R.K., Chandranayaka, S., Shekar Shetty, H.S., Singh, R.B., Sharma, R., Tara Satyavathi, C., Bollam, S. and Lachagari, V.R.,

2024. Decoding the genome of the pearl millet pathogen *Sclerospora graminicola* unveils the molecular strategies underlying its pathogenesis and evolution. *Access Microbiology* :000951-v1. DOI: 10.1099/acmi.0.000951.v1.

Books

1. Vilas A Tonapi, Nepolean Thirunavukkarasu, SK Gupta, Prakash Gangashetty and OP Yadav. 2024. Edited book, Pearl millet in the 21st century. Springer publication. ISBN 978-981-99-5889-4, Pp 589, <https://doi.org/10.1007/978-981-99-5890-0>.
2. Ramasamy Perumal, P.V. Vara Prasad, Tara Satyavathi, Mahalingam Govindaraj and Abdou Tenkouano. 2024. Edited book, Pearl Millet: A Resilient Cereal Crop for Food, Nutrition, and Climate Security. Wiley Publications Pp 514, ISBN: 978-0-891-18404-1.

Book chapters

1. Bharathi Raja Ramadoss, Ameena Premnath, Thiruvengadam Venkatesan and Nepolean Thirunavukkarasu. 2024. Genomic selection and its application in pearl millet improvement. Chapter 6 In: Pearl millet in the 21st century, Pp. 141-162, <https://doi.org/10.1007/978-981-99-5890-0>.
2. Dayakar Rao, B., Veeresh, S. Wali, Shreeja Kulla and Tara Satyavathi, C. 2024. Pearl Millet: Marketing and Innovation Hubs. Chapter 14 In: Pearl Millet: A Resilient Cereal Crop for Food, Nutrition, and Climate Security, Perumal, R., Vara Prasad, P.V., Satyavathi, C.T., Govindaraj, M., Tenkouano, A. (Eds.) Wiley Publications Pp. 445-483, ISBN: 978-0-891-18404-1. <https://doi.org/10.1002/9780891184034.ch14>.
3. Divya Ramesh, Swati Singh, Priya Shah, Animikha Chakraborty, Tara C. Satyavathi, and Nepolean Thirunavukkarasu. 2024. Trait mapping, marker-assisted selection, and introgression breeding in pearl millet. Chapter 5 In: Pearl millet in the 21st century, Pp. 111-140, <https://doi.org/10.1007/978-981-99-5890-0>.
4. Elangovan, M., Karnam Venkatesh, and Sangappa, B. 2024. Traditional varieties of pearl millet and food diversity. Chapter 20 In: Pearl millet in the 21st Century, Pp. 531-548, <https://doi.org/10.1007/978-981-99-5890-0>.
5. Gangaiah, B. and Yadav, A.K. 2024. Modern crop management practices for pearl millet cultivation in Asia. Chapter 18 In: Pearl millet in the 21st century, Pp. 479-512, <https://doi.org/10.1007/978-981-99-5890-0>.
6. Gupta, S.K., Yadav, O. P. and Sanjana Reddy, P. 2024. Advances in pearl millet hybrid breeding and development of parental lines. Chapter 4 In: V. A. Tonapi *et al.* (eds.), Pearl Millet in the 21st Century, Pages 87-110, Springer Publications. https://doi.org/10.1007/978-981-99-5890-0_4.
7. Jacob, J., Visarada, K. B. R. S., Malathi, V. M., Venkateswarlu, R., Bini Karunakaran, and Kannababu, N. 2024. Advanced biotechnological tools for genetic improvement of finger millet. Pp. 329-349. *In* Genetic Improvement of Small Millets. Eds. Sweta Mishra, Shailesh Kumar and R C Srivastava. ISBN 978-981-99-7231-9. Springer Publication.
8. Kannababu, N., Bhat, B.V., Sooganna, Raghunath, K., Venkateswarlu, R., Jinu Jacob, Malathi, V. M., Srikanth, A., Nepolean, T. and Vilas A. Tonapi. 2024. Hybrid Seed generation system management to ensure the seed quality in pearl millet. Chapter 19 In: Pearl millet in the 21st Century, Pp. 513-530 <https://doi.org/10.1007/978-981-99-5890-0>.
9. Kanti Meena, Jacob, J., Swarna, R. and Deepika, C. 2024. Omics-aided crop improvement in foxtail millet. Pp. 383-404. *In* Genetic Improvement of small millets. Eds. Sweta Mishra, Shailesh Kumar and R C Srivastava. ISBN 978-981-99-7231-9. Springer Publication.
10. Malathi, V.M., Jinu Jacob, Venkateswarlu, R., Kannababu, N. and Ratnavathi, C.V. 2024. Nutritional aspects, phytochemical composition and potential health benefits of small millets. *In*: Genetic Improvement of Small Millets. Eds. Sweta Mishra, Shailesh Kumar and R C Srivastava. ISBN 978-981-99-7231-9. Springer.
11. Padmaja, P.G., Venkateswarlu, R., Singh, S.P. and Vilas A. Tonapi. 2024. Enhancing shelf life of pearl millet flour. Chapter 21 In: Pearl millet in the 21st century, Pp. 549-566 <https://doi.org/10.1007/978-981-99-5890-0>.
12. Rafi, D. and Sangappa. 2024. Role of millet model in generating income to FPOs. *Income*

- augmentation through small agribusiness. ISBN 978-93-58879-54-4, Pp: 95-104.
13. Sanjana Reddy, P. 2024. Germplasm utilization and pre-breeding in pearl millet. Chapter 5 In: Pearl Millet: A Resilient Cereal Crop for Food, Nutrition, and Climate Security, Perumal, R., Vara Prasad, P.V., Satyavathi, C.T., Govindaraj, M., Tenkouano, A. (Eds.) Wiley Publications Pp. 121-164, ISBN: 978-0-891-18404-1.
 14. Satyavathi, C.T., and Bhat, B.V. 2024. Mainstreaming millets for food and nutritional security. In: Transformation of Agri-Food Systems. Pp. 77-90, Singapore: Springer Nature Singapore.
 15. Srividhya, S., Swarna, R., Jinu, J., Dheeraj, C. and Talwar, H.S. 2024. Salinity stress in pearl millet: From physiological to molecular responses. Chapter 14 In: Pearl millet in the 21st Century, Pp. 361-394, <https://doi.org/10.1007/978-981-99-5890-0>.
 16. Swarna, R., Srividhya, S., Dheeraj, C., Bhargavi, B., Deepika, C. and Bhaskar, B. 2024. Crop simulation models for climate change adaptation in pearl millet. Chapter 16 In: Pearl millet in the 21st century, Pp. 415-444, <https://doi.org/10.1007/978-981-99-5890-0>.
 17. Swati Singh, Animikha Chakraborty, Aswini Viswanath, Renuka Malipatil, and Nepolean Thirunavukkarasu. 2024. Omics-based approaches in improving drought stress tolerance in pearl millet. Chapter 8 In: Pearl millet in the 21st Century, Pp. 179-220, <https://doi.org/10.1007/978-981-99-5890-0>.
 18. Tara Satyavathi, C., Supriya Ambawat, Nepolean Thirunavukkarasu, Vikas Khandelwal, Sanjana Reddy, Anuradha Narala. 2024. Global production, status, and utilization pattern of pearl millet. Chapter 1 In: Pearl Millet: A Resilient Cereal Crop for Food, Nutrition, and Climate Security Pp. 1-21, DOI:10.1002/9780891184034.
 19. Umakanth, A.V., Sanjana Reddy, P., Karthikeyan, S., Ramesh, D., Thanuja, G., Kalyanasundaram, and Subbarayan, S. 2024. Biofuel opportunities in pearl millet. Chapter 22 In: V. A. Tonapi *et al.* (eds.), Pearl Millet in the 21st Century, Pp. 567-588, Springer Publications. https://doi.org/10.1007/978-981-99-5890-0_4.
 20. Vermerris, W., Amasiddha, B., Umakanth, A.V. 2024. Breeding techniques for the major sorghum market segments: Grain, forage, biomass, and soluble sugars. In: Habyarimana, E., Nadeem, M.A., Baloch, F.S., Zencirci, N. (eds) Omics and Biotechnological Approaches for Product Profile-Driven Sorghum Improvement. Springer, Singapore. pp. 201-233. ISBN 978-981-97-4346-9.
 21. Vetriventhan, M., Vinod Kumar, Naresh Reddy, Raja Srinivas, Kommineni Jagadeesh, Anil Kumar, Ovais Peerzada, Elangovan, M., Venkatesh, K. and Kuldeep Singh. 2024. Status and utility of pearl millet germplasm for crop improvement. Chapter 2 In: V. A. Tonapi *et al.* (eds.), Pearl Millet in the 21st Century, Pp. 35-60, Springer Publications. https://doi.org/10.1007/978-981-99-5890-0_4.
 22. Yadav, O. P, Gupta, S.K. and Sanjana Reddy, P. 2024. Pearl millet breeding for enhancing yield and stability: Strategies, achievements, and perspectives. Chapter 13 In: V. A. Tonapi *et al.* (eds.), Pearl Millet in the 21st Century, Pp. 331-360, Springer Publications. https://doi.org/10.1007/978-981-99-5890-0_4.
- Presentation in Workshop/Seminars/Symposia/Conferences**
- Invited speaker**
- National**
1. Parashuram Patroti. 2024. Development of farmer's preferred varieties and their value addition in sorghum: IIMR Research & Development (R & D) initiatives. In State level consultation on Revival of sorghum in Marathwada region held at KVK Sagroli, Nanded, Maharashtra on 13-14, Feb 2023.
 2. Parashuram Patroti. 2024. Millets: Improved production, processing & value addition interventions for popularization of millets in Maharashtra / Marathwada. In Brainstorming on Popularization of Millets in Marathwada region held at Cotton Research Station, Nanded, Maharashtra on 11th May, 2024.
- International**
1. Das, I.K. 2024. Major plant health challenges in millets. In: Asia Pacific Association of Agricultural Research Institutions (APAARI) - European Plant

Health Research Coordination (EUPHRESCO) Project Meeting held at NIPHM Hyderabad on 20 December, 2024.

2. Dayakar Rao, B. 2024. International conference on reviving ancient grains: Millets on the Global Stage during 7th-8th February, 2024.
3. Jinu Jacob. 2024. Journey of Millets: From ancient grains to nutraceuticals. In: *International conference on Biotechnology-Way forward* organised by the University of Kerala from 20.11.2024 to 22.11.2024.

Oral presentation

National

1. Das, I.K. 2024. Host plant resistance against complex diseases of millets: challenges and way forward. Oral presentation as lead lecture in 'IPS central zone meeting and DSPP National Conference on 'Recent Advances in Plant Pathology and Innovative Approaches in Plant Disease Management (RAPPID) held at PJTSAU, Hyderabad 12-13 Dec, 2024.
2. Parashuram Patroti, Madhusudhana, R., Baswaraj Raigond, Srividhya, S., Shyamprasad, G., Aruna, C., Malika Nadaf, Sadaf Deshmukh, Yeshwant Kshirsagar, Rajappa, P.V. and Tara Satyavathi, C. 2024. Development of dual purpose and stress resilient post-rainy season sorghum cultivars using a Multi-parent crossing approach. In: Second National Genetics Congress, Dec. 11-13, 2024, New Delhi, pp. 94.

International

1. Parashuram Patroti, Madhusudhana, R., Baswaraj Raigond, Srividhya, S., Shyam Prasad, G., Balakrishna, D., Malika Nadaf, Sadaf Deshmukh, Kshirsagar, Y.S. and Tara Satyavathi, C. 2024. Breeding for farmer's preferred traits in post rainy sorghum by using MAGIC Approach. In: International Conference on Food & Nutritional Security through Agriculture Ecosystem, Feb. 1-2, 2024. pp. 51-52. (*Received Best paper presentation award*).
2. Rajesha, G., Das, I.K., Padmaja, P.G., Ganapathy, K.N., Sooganna and Tara C. Satyavathi. 2024. Screening of bacterial endophytes for plant growth promotion and seedling growth in millets. In:

International Conference on "Food & Nutritional Security through Agriculture Ecosystem held at National Institute of Agricultural Extension Management (MANAGE) during February 1-4, 2024. Pp 139.

3. Rajesha, G., Das, I.K., Baswaraj, R., Padmaja, P.G., Ganapathy, K.N., Sooganna and Tara C. Satyavathi. 2024. Characterization of millets endophytes for the antimicrobial properties. 6th International Conference on *Holistic Innovation and Technological Advances for Sustainable Agriculture (HITASA-2024)* held during 04th- 06th March, 2024 at SR University, Warangal. P 172.

Abstracts

National

1. Akshitha, S., Padmaja, G., Rajesha, G., Pushpavalli, S.N.C.V.L. 2024. Isolation of potential endophytes of bacteria against foot rot incited by *Sclerotium rolfsii* from the districts of Telangana, Andhra Pradesh and Karnataka. National conference on Advances in Science and technology for sustainable development on 22nd March, 2024 held at Hyderabad.
2. Akshitha, S., Rajesha, G., Padmaja, G., Pushpavalli, S.N.C.V.L., Das, I.K. and Vidyasagar, B. 2024. An *In-vitro* study of finger millet endophytes potential for bio-control and plant growth promotion. In: IPS Central Zone Meet and DSPP National Conference on Recent Advances in Plant Pathology and Innovative Approaches in Plant Disease Management (RAPPID) during December 12-13, 2024 held at Hyderabad.
3. Giri, U., Lodh, P., Sangappa, Thangiam, B., Paul, N., Awasthi, D.P., Sen, D. and Das, S. 2024. Effect of fertilizer and spacing on performance of pearl millet under Tripura agro-climatic condition. National Consultation. In: National conference on Advances in innovative technologies & plant health management strategies in climate resilient agriculture (AICRA-2024), Sep 26-27, 2024. pp.39.
4. Hanamaratti, N.G., Bandiwaddar, T.T., Shaila, H.M., Anjum, S.S., Hariprasanna, K. and Madhusudhana, R. 2024. Identification of genotypes with high iron and zinc content for biofortification in sorghum (*Sorghum bicolor* L. Moench.). In: Proceeding of

- the National Seminar on Agricultural Education and Research Empowerment for Climate Resilient Production Systems to Enhance Bio-economy UAS, Dharwad, 3rd to 5th January, 2024. pp. 106-108.
5. Hemasankari, P., Dayakar Rao, B., Vilas. A. Tonapi, Sangappa, B.C. and Tara Sathyavathi, C. 2024. Process standardization of flaking of ragi millet (*Eleusina corocana. L*) using roller flaker in a Pilot plant for production of ragi flakes, FPET-PHAC-O-15, Abstract in Theme II: Food Processing Engineering and Tech -nologies: Novel and emerging post harvest technologies in food processing. 58th Annual Convention of Indian Society of Agricultural Engineers (ISAE) On “Engineering Innovations for Next gen Digital Agriculture and, International Symposium on Agricultural Engineering Education for Aspiring youth in Transforming Agriculture”, Jointly organized by Indian Society of Agricultural Engineers (ISAE) and Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani (VNMKV) on Nov, 12-14, 2024 at Golden Jubilee Convocation Hall, VNMKV, Parbhani, Maharashtra.
 6. Hemasankari, P., Dayakar Rao, B., Sangappa, B.C. and Tara Sathyavathi, C. 2024. Hydration kinetics of selected value added products from millets, FPET-PHAC-O-21, Abstract in Theme II: Food Processing Engineering and Technologies: Post harvest engineering and handling of agricultural and horticultural crops. 58th Annual Convention of Indian Society of Agricultural Engineers (ISAE) On “Engineering Innovations for Next gen Digital Agriculture and International Symposium on Agricultural Engineering Education for Aspiring youth in Transforming Agriculture”, Jointly organized by Indian Society of Agricultural Engineers (ISAE) and Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani (VNMKV) on Nov, 12-14, 2024 at Golden Jubilee Convocation Hall, VNMKV, Parbhani, Maharashtra.
 7. Hemasankari, P., Dayakar Rao, B., Sangappa, B.C. and Tara Sathyavathi, C. 2024. Texture characteristics of selected millet based value added products. FPET-PHAC-P-40, Abstract in Theme II: Food Processing Engineering and Technologies: Post harvest engineering and handling of agricultural and horticultural crops. 58th Annual Convention of Indian Society of Agricultural Engineers (ISAE) On “Engineering Innovations for Next gen Digital Agriculture and, International Symposium on Agricultural Engineering Education for Aspiring youth in Transforming Agriculture”, Jointly organized by Indian Society of Agricultural Engineers (ISAE) and Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani (VNMKV) on Nov, 12-14, 2024 at Golden Jubilee Convocation Hall, VNMKV, Parbhani, Maharashtra.
 8. Hemasankari, P., Dayakar Rao, B., Sangappa, B.C. and Tara Sathyavathi, C. 2024. Sorghum millet milk powder standardization using spray dryer and characteristics. FPET-PHAC-P-42, Abstract in Theme II: Food Processing Engineering and Technologies: Post harvest engineering and handling of agricultural and horticultural crops. 58th Annual Convention of Indian Society of Agricultural Engineers (ISAE) On “Engineering Innovations for Next gen Digital Agriculture and, International Symposium on Agricultural Engineering Education for Aspiring youth in Transforming Agriculture”, Jointly organized by Indian Society of Agricultural Engineers (ISAE) and Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani (VNMKV) on Nov, 12-14, 2024 at Golden Jubilee Convocation Hall, VNMKV, Parbhani, Maharashtra.
 9. Parashuram Patroti, Madhusudhana, R., Baswaraj Raigond, Srividhya, S., Shyam Prasad, G., Balakrishna, D., Malika Nadaf, Sadaf Deshmukh, Kshirsagar, Y.S. and Tara Satyavathi, C. 2024. Breeding for farmer’s preferred traits in post rainy sorghum by using MAGIC Approach. In: International Conference on Food & Nutritional Security through Agriculture Ecosystem, Feb. 1-2, 2024. pp. 51-52.
 10. Parashuram Patroti, Madhusudhana, R., Baswaraj Raigond, Srividhya, S., Shyamprasad, G., Aruna, C., Malika Nadaf, Sadaf Deshmukh, Yeshwant Kshirsagar, Rajappa, P.V. and Tara Satyavathi, C. 2024. Development of dual purpose and stress resilient post-rainy season sorghum cultivars using a Multi-parent crossing approach. In: Second National Genetics Congress, Dec. 11-13, 2024, New Delhi, pp. 94.

11. Premaradhya, N., Sangappa, Shashidhar, K.S., Misinam Pangkam, Pradeep Meena. 2024. An impact of agro-advisory services on enhancing area and production under small millets cultivation by tribal farmers of hilly tracts. In: National consultation on Food system for sustainability and profitability of millets- Abstract Book, Oct. 5-6, 2024. pp. 93.
12. Sangappa, Meghana, G., Rafi, D. and Charishma, E. 2024. Empowering rural communities: Role of millet FPOs in driving agricultural startups and sustainable entrepreneurship In: National conference on Advances in innovative technologies & plant health management strategies in climate resilient agriculture (AITCRA-2024), Sep 26-27, 2024. pp.86.
13. Sangappa and Rafi, D. 2024. Outreach and policy interventions: Innovation, incubation, engagement of farmers, stakeholders and policy support. In: National consultation on Food system for sustainability and profitability of millets- Abstract Book, Oct. 5-6, 2024. pp. 74-75.
14. Vyshnavi, A.B., Dayakar Rao, B. and Hemasankari, P. 2024. Valorization of millet by products: Creating value-added ingredients from milling waste, FPET-UWPT-O-08, Abstract in Theme II: Food Processing Engineering and Technologies: Utilization of food processing waste and newer processing technologies, 58th Annual Convention of Indian Society of Agricultural Engineers (ISAE) On "Engineering Innovations for Next gen Digital Agri -culture and , International Symposium on Agricultural Engineering Education for Aspiring youth in Transforming Agriculture", Jointly organized by Indian Society of Agricultural Engineers (ISAE) and Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani (VNMKV) on Nov, 12-14, 2024 at Golden Jubilee Convocation Hall, VNMKV, Parbhani, Maharashtra.
2. Rajesha, G., Das, I.K., Padmaja, P.G., Ganapathy, K.N., Sooganna and Tara, C. Satyavathi. 2024. Screening of bacterial endophytes for plant growth promotion and seedling growth in millets. In: Veenita Kumari, Sugandha Munshi, Sampri Baruah, K. Naresh, Shirisha Junuthula, S.L. Kameswari and Pragati Shukla (2024). International Conference on Food & Nutritional Security through Agriculture Ecosystem - Compendium of abstracts [e-book] Hyderabad: National Institute of Agricultural Extension Management (MANAGE). Pp 139.
3. Rajesha, G., Das, I. K., Baswaraj, R., Padmaja, P.G., Ganapathy, K.N., Sooganna and Tara C. Satyavathi. 2024. Characterization of millets endophytes for the antimicrobial properties. In: Pares P., Baviskar Mohit Bharadwaj, D.P.S. Badwal, Utkarsha P. Gaware and G Bhupal Raj. 2024. Holistic Innovation and Technological Advances for Sustainable Agriculture (HITASA-2024) 6th International Conference Book of Abstracts. P 172.

Extended summaries/Conference Proceedings

National

1. Das, I.K., Madhusudhana, R., Tara Satyavathi, C. 2024. Proceedings of the 59th Annual Group Meeting of AICRP on Pearl millet, 54th Annual Group Meeting of ICAR-AICRP on Sorghum & 35th Annual Group Meeting of ICAR-AICRP on Small millets hosted by RARS, Acharya NG Ranga Agricultural University, Tirupati in collaboration with ICAR-Indian Institute of Millets Research (IIMR) from 27th to 28th June, 2024. IIMR publication number - 1 / 2024-2025. p174 (June 2024).

International

1. Priya Ayyar, Radhika Dhavale, Urvi Patel, Parashuram Patroti, Vikas Patil. 2024. A green synthesis approach: Manipulating red sorghum for the biosynthesis of silver nanoparticles. In: Proceedings of the 5th International conference on Advanced technologies for societal applications. Springer.

Technical Bulletins

1. Chapke, R.R, Tara Satyavathi, C., Das, I.K., Shyam Prasad, G., Hariprasanna, K., Avinash Shingode, Spanditha, M., 2024. Latest millets production and processing technologies. ICAR-Indian Institute of

International

1. Priya Ayyar, Radhika Dhavale, Urvi Patel, Parashuram Patroti, Vikas Patil. 2024. A Green Synthesis Approach: Manipulating Red Sorghum for the Biosynthesis of Silver Nanoparticles. Techno-Societal 2024. In: 5th International conference on Advanced technologies for societal applications, Dec. 13-14, 2024, Pandharpur, MH. pp. 225.

Millet Research, Hyderabad 500 030, India: 102 p (ISBN: 978-93-94673-38-0).

2. Srividhya, Rajesha, G., Visarada, K.B.R.S., Yadav, S.K. Pradhan and Tara Satyavathi, C. 2024. Shree Anna activities of IYM. Published by ICAR-IIMR, Hyderabad.

Popular Articles

1. Baswaraj Raigond, Verma, G., Manjunathan, N., Raigond, P., Patroti, P., Thorat, U., Das, I. K. and Satyavathi, C.T. 2024. Recombinase Polymerase Assay: Can it be an alternative to Polymerase Chain Reaction? *Food and Scientific Reports* 5(10): 35-40.
2. Baswaraj Raigond, Das, I.K., Parashuram, P., Stanley, J., Avinash, S. and Tara, C. 2024. Viral diseases of sorghum and management. *Food and Scientific Reports* 5(9): 22-27.
3. Meghana, G., Sangappa, Rafi, D., Charishma, E., Ramkiran, K. and Chandhini, K. 2024. Climate resilient millets (*Shree Anna*) for food nutritional security. *Krishi Netra* 2 (4): 10-14.
4. Sooganna, Kannababu, N., Bhat, B.V., Kulakarni, R. and Satyavathi, C.T. 2024. Seed production techniques in millets. *Seed Times* 16(1): 11-31. <https://nsai.co.in/storage/app/media/Seed-Times-Jan-April-2024.pdf>.
5. Tara Satyavathi, C. and Mahesh Kumar, 2024. "Shree Anna sang Vaishvik Kadhya evam Poshan Suraksha", Ekshu-Shree Anna Visheshank January-June, 2023, ICAR-IISR, Lucknow. Pp 7-11.
6. Tara Satyavathi, C. and Mahesh Kumar, 2024. "Shree Anna: Poshan se Bharpur evam Kam Sansadhan, Jyada Arjan", Navonameshi krishi dvara swasthya evam samriddhi – a souvenir of regional agricultural fair 03-05 Feb, 2024. ICAR-IIVR, Varanashi. Pp 9-13.

Pamphlets

1. Juneja, R.P., Shyam Prasad, G., Stanley, J. and Tara Satyavathi, C. 2024. Insect pests of pearl millet and their management. ICAR-IIMR.
2. Shyam Prasad, G., Stanley, J., Kalaisekar, A., Srinivasa Babu, K., Padmaja, P.G. and Subbarayudu, B. 2024. Insect pests of sorghum and their management. ICAR-IIMR.

3. Shyam Prasad, G., Stanley, J., Prabhu C. Ganiger, Kalaisekar, A., Srinivasa Babu, K., Padmaja, P.G. and Subbarayudu, B. 2024. Insect pests of finger millet and their management. ICAR-IIMR.
4. Sangappa, Mahesh Kumar, Rafi, D., Abbu Seth, Srinivas babu, K. and Tara Satyavathi, C. 2024. *Kisan Utpadak Sangathan (FPO)*. ICAR-IIMR, Hyderabad.

Technical Reports

1. Das, I.K., Yogendra Singh, Navgire, K.D., Pokhar Rawal, Gulhane, A.R., Sudha, A., Tushar Ghevariya, Syeda S Anjum, Ashlesha Atri, Manjeet Singh, Govindappa M.R., Girish, G., Madhusudhana, R. 2024. Pathology Annual Progress Report: AICRP-Sorghum *khari* 2023-24. Pp. 1-35, In: Annual Progress Report 2023-24, All-India Coordinated Research Project on Sorghum & Millets, held at RARS Tirupathi 27-28 June, 2024. June 2024.
2. Das, I.K., Navgire, K.D., Syeda S Anjum, Baswaraj, R., Govindappa, M.R., Girish, G., Karabhantanal, S.S. and Madhusudhana, R. 2024. Pathology Annual Progress Report: AICRP-Sorghum *Rabi* 2023-24. Pp. 1-12, In: Annual Progress Report 2023-24, All-India Coordinated Research Project on Sorghum & Millets, held at RARS Tirupathi 27-28 June, 2024. June 2024.
3. Sangappa, Rafi, D., Chandhini, K., Charishma, E., Ramkiran, K., Ashok Sajjan, K. Kailashnath, Abbuseth, Meghana, G., Srinivasa Babu, K. and Tara Satyavathi, C. 2024. Inspiring success stories of FPOs promoted by ICAR-IIMR, Hyderabad. ICAR-Indian Institute of Millets Research, Hyderabad (IIMR). Pp. 1-26
4. Sangappa, Rafi, D., Meghana, G., Chandhini, K., Charishma, E., Ramkiran, K., Srinivasa Babu, K. and Tara Satyavathi, C. 2024. *Chirudanyala sagu padathulu mariyu adhunikha sankethikathalu*. ICAR-Indian Institute of Millets Research, Hyderabad (IIMR). Pp. 1-12.
5. Sangappa, Meghana, G., Chandhini, K., Rafi, D., Amasiddha, B. and Tara Satyavathi, C. 2024. Introduction to millets farming, processing, and value addition. ICAR-Indian Institute of Millets Research, Hyderabad (IIMR). Pp. 1-13.

6. Sangappa, Kailashnath, Abbuseth, Ashok Sajjan, Anup, Laxmi, B., Amasiddha, B. and Tara Satyavathi, C. 2024. *Siridhanyagala Besaya Kramagalu*. ICAR-Indian Institute of Millets Research, Hyderabad, Pp. 1-16.

Lectures delivered in training programmes

1. Aruna, C. 2024. Sorghum overview and seed production. In: Millet Seed Production, Processing and Certification under Odisha Millet Mission (OMM) during 20-22nd November, 2024 at ICAR-IIMR, Hyderabad.
2. Aruna, C. 2024. Breeding end use specific sorghum for food, feed, fodder and biofuel. In: Webinar on International (India-Africa) exchange of experience sharing and capacity building program to expand the cultivation, use and processing of millet as a climate-resilient crop, and to strengthen agrobiodiversity, balanced nutrition, millet value chain, value addition and entrepreneurship in Africa during 8-11 January, 2024.
3. Das, I.K. 2024. Major diseases in millets and their management. In: Certified Farm Advisor (CFA) Program during 9-23 December 2024, at MANAGE Hyderabad. Dec 2024.
4. Kannababu, N. 2024. Principles of quality seed production and maintenance in Millets: A business Perspective. In: Webinar on International (India-Africa) exchange of experience sharing and capacity building program organized by IIMR under Indo-German bilateral cooperation on Seed Sector Development during 8-11 January, 2024.
5. Kannababu, N. 2024. Basic principles of seed processing to ensure seed quality in millets. In: Training Programme on Millet Seed Production, Processing and Certification under Odisha Millet Mission (OMM) during 20-22 November, 2024 organized by ICAR-IIMR, Rajendranagar, Hyderabad.
6. Padmaja, P.G. 2024. Shelf-life enhancement in millets - Challenges and research advancements. In: International Workshop on Millets Production, Processing, and Value Chain Development during 8-11 January, 2024 at ICAR-IIMR, Hyderabad.
7. Rajesha, G. 2024. Major diseases in millets and their management. In: Training programme on Millets Production, Processing and Value Addition Technologies from 6th August to 9th August, 2024 at ICAR-IIMR, Hyderabad.
8. Rajesha, G. 2024. Major diseases in millets and their management. In: Training programme on Millets Production, Processing, Value Addition Technologies for Uttar Pradesh Farmers during 11-12 November, 2024 at ICAR-IIMR, Hyderabad.
9. Rajesha, G. 2024. Major diseases in millets and their management. In: Training Programme Millet Seed Production, Processing and Certification, during November 20-22, 2024 at ICAR-IIMR, Hyderabad.
10. Rajesha, G. 2024. Major diseases in millets and their management. In: Training programme on Introduction of advanced Millet Technologies to Odisha farmers during 04-07 December, 2024 at ICAR-IIMR, Hyderabad.
11. Sanjana Reddy, P. 2024. Pearl Millet: A Potential Crop to Achieve Nutritional Security, CFA training programme, 30th January, 2024, MANAGE, Hyderabad
12. Sanjana Reddy, P. 2024. Breeding End Use specific and Bio-fortified Pearl millet. In: Webinar on International (India-Africa) exchange of experience sharing and capacity building program to expand the cultivation, use and processing of millet as a climate resilient crop, and to strengthen agrobiodiversity, balanced nutrition, millet value chain, value addition and entrepreneurship in Africa during 8-11 January, 2024.
13. Sanjana Reddy, P. 2024. Overview & Seed production in Pearl millet. In: Millet Seed Production, Processing and Certification under Odisha Millet Mission (OMM) during 20-22nd November, 2024 at ICAR-IIMR, Hyderabad.
14. Sanjana Reddy, P. 2024. Pearl Millet overview and Seed Production. In: Training program on Millet Seed production, processing, certification & Value Addition for Farmers & FPOs under Tamil Nadu & Odisha Government funded projects during 03-05 December, 2024 at ICAR-IIMR, Hyderabad.
15. Seva Nayak, D. 2024. Importance of climate resilient crops in zero tilt situations in Western Krishna basin districts of AP. In: Training programme on "Millets, local crops cultivation, production and their Innovative Processing Technologies under ICAR-AICRP-Pearl Millets-

SCSP" on 16 March, 2024 at Ramanappapalem Village of Guntur District, Andhra Pradesh.

Extension Folders

1. Sangappa, Chandhini, K., Rafi, D., Charishma, E., Ramkiran, K., Srinivasa Babu, K. and Tara Satyavathi, C. 2024. Andhra Pradesh *Raitu Vuthpathidarula samsthalu* (FPOs). ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
2. Sangappa, Chandhini, K., Rafi, D., Charishma, E., Ramkiran, K., Srinivasa Babu, K. and Tara Satyavathi, C. 2024. Profile of FPOs promoted by ICAR-IIMR in Andhra Pradesh. ICAR-IIMR, Hyderabad.
3. Sangappa, Chandhini, K., Rafi, D., Charishma, E., Ramkiran, K., Meghana, G., Srinivasa Babu, K. and Tara Satyavathi, C. 2024. Telangana *Raitu Vuthpathidarula samsthalu* (FPOs). ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
4. Sangappa, Charishma, E., Rafi, D., Chandhini, K., Ramkiran, K., Srinivasa Babu, K. and Tara Satyavathi, C. 2024. Profile of FPOs promoted by ICAR-IIMR in Telangana, ICAR-IIMR, Hyderabad. ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
5. Sangappa, Kailashnath, Abbuseeth, Ashok Sajjan and Tara Satyavathi, C. 2024. Profile of FPOs promoted by ICAR-IIMR in Karnataka (SFAC). ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
6. Sangappa, Ashok Sajjan, Kailashnath, Abbuseeth and Tara Satyavathi, C. 2024. Profile of FPOs promoted by ICAR-IIMR in Karnataka (WDD). ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
7. Sangappa, Kailashnath, Abbuseeth, Ashok Sajjan and Tara Satyavathi, C. 2024. *Karnatakadalli Bharatiya Siridhanya Samshodana Samsthayinda Prayojitagunda Raitara Vutpadaka Companygala Vivara* (SFAC). ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
8. Sangappa, Ashok Sajjan, Kailashnath, Abbuseeth and Tara Satyavathi, C. 2024. *Karnatakadalli Bharatiya Siridhanya Samshodana Samsthayinda Prayojitagunda Raitara Vutpadaka Companygala Vivara* (WDD). ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).

Training Manuals

1. Sangappa, Srividhya, S., Malathi, V.M., Rafi, D., Amasiddha, B., Meghana, G., Anuradha, N., Swarna, R., Deepika, C. and Tara Satyavathi, C. 2024. Recent advances in millets crop production, processing, value addition and marketing. ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).
2. Sangappa, Rafi, D., Amasiddha, B. and Tara Satyavathi, C. 2024. Millet's production, processing and value addition technologies for nutritional security for certifies farm advisor on millets. ICAR-Indian Institute of Millets Research, Hyderabad (IIMR).

Plant Germplasm Registration Notice

1. Amasiddha Bellundagi, Elangovan, M., Ganapathy, K.N., Umakanth, A.V., Deepika, C. Swarna, R. and Vilas A Tonapi 2024. DHBM93-3 (IC643966; INGR22034), a barnyard millet (*Echinochloa frumentacea*) germplasm with glumeless florets and seeds. *Indian Journal of Plant Genetic Resources* 37(2):365-366.
2. Ganapathy, K.N., Elangovan, M., Amasiddha, B., Prashant, B. and Vilas A Tonapi. 2024. GPU 28-2081 (IC643979; INGR22033), a finger millet (*Eleusine coracana* ssp. *coracana*) germplasm with longer finger length (10.7 cm). *Indian Journal of Plant Genetic Resources* 37(2):365.
3. Ganapathy, K.N., Elangovan, M., Amasiddha, B., Sooganna, Umakanth, A.V. and Vilas A Tonapi. 2024. LMV 533 (IC483093; INGR22077), a little millet (*Panicum sumatrense*) germplasm with early flowering (50-52 days) and early maturity (83-85 days) and grain and fodder yield advantage. *Indian Journal of Plant Genetic Resources* 37(3):533.
4. Ghorade, R.B., Kalpande, V.V., Elangovan, M., Venkatesh Bhat, B., Amasiddha, B., Ganapathy, K.N., Vilas A Tonapi and SB Thawari, S.B. 2024. SPV 2804 (IC0288432; INGR22024), a sorghum (*Sorghum bicolor*) germplasm with higher leaf stem ratio (0.32) and low HCN content (40.9%). *Indian Journal of Plant Genetic Resources* 37(2):359.
5. Ghorade, R.B., Kalpande, V.V., Elangovan, M., Venkatesh Bhat, B., Amasiddha, B., Ganapathy, K.N., Vilas A Tonapi and SB Thawari, S.B. 2024.

- SPV 2805 (IC643757; INGR22025), a sorghum (*Sorghum bicolor*) germplasm with longer leaves (86.5 cm), greater plant height (276 cm) and more number of leaves per plant (12.9). *Indian Journal of Plant Genetic Resources* 37(2):359.
6. Harshal Eknath Patil, Gopal D Vadodariya, Brijeshkumar K Patel and Elangovan, M. 2024. WN 585 (IC0624599; INGR21211), a finger millet (*Eleusine coracana*) germplasm with early flowering & early maturity (100-110 days), red grain & high yield. *Indian Journal of Plant Genetic Resources* 37(1):162.
 7. Hariprasanna, K, Rajendrakumar, P., Parashuram Patroti, Sharma, K.K. and Vilas A Tonapi. 2024. IIMR FxM-7 (FXV 645) (IC643959; INGR22076), a foxtail millet (*Setaria italica*) germplasm with early duration, multiple disease resistance and thick and compact inflorescence. *Indian Journal of Plant Genetic Resources* 37(3):532.
 8. Harshal Eknath Patil, Elangovan, M., Patel, B.K., and Vadodariya, G.D. 2024. WVN 55 (IC618375; INGR22032), a finger millet (*Eleusine coracana*) germplasm with bold white grains (3.14 g), longer finger length (12.27 cm) and multi-fingers ear head (10.13 cm). *Indian Journal of Plant Genetic Resources* 37(2):364-365.
 9. Kanti Meena, Umakanth, A.V., Elangovan, M., Sanjana Reddy, P. and Visarada, K.B.R.S. 2024. SPV 2596 (SM-2288-3) (IC643980; INGR22026), a sorghum (*Sorghum bicolor*) germplasm for high fresh stalk yield and high biomass. *Indian Journal of Plant Genetic Resources* 37(1):360.
 10. Kanti Meena, Umakanth, A.V., Elangovan, M., Sanjana Reddy, P. and Visarada, K.B.R.S. 2024. SPV 2595 (SM-2144-8) (IC643981; INGR22031), a sorghum (*Sorghum bicolor*) germplasm with higher brix and total sugars (14.3%), early maturing (116 days) and early flowering (80 days). *Indian Journal of Plant Genetic Resources* 37(1):363-364.
 11. Patro, T.S.S.K., Anuradha, N., Elangovan, M., Palanna, K.B. and Das, I.K. 2024. VR 1141 (IC644006; INGR22022), a finger millet (*Eleusine coracana*) germplasm for banded blight resistance. *Indian Journal of Plant Genetic Resources* 37(2):358.
 12. Patro, T.S.S.K., Anuradha, N., Elangovan, M., Palanna, K.B. and Das, I.K. 2024. VR 1122 (IC0644004; 22023), a finger millet (*Eleusine coracana*) germplasm with finger blast resistance. *Indian Journal of Plant Genetic Resources* 37(2):358.
 13. Patro, T.S.S.K., Anuradha, N., Elangovan, M. and Das, I.K. 2024. VR 1128 (IC644005; INGR22030), a finger millet (*Eleusine coracana*) germplasm with neck blast resistance. *Indian Journal of Plant Genetic Resources* 37(2):363.
 14. Sooganna, Venkatesh Bhat, Raghunath Kulkarni, Avinash Singode, Aruna, C., Elangovan, M., Ganapathy, K.N., Amasiddha Bellundagi and Vilas A Tonapi. 2024. SPV 2625 (IC643961; INGR22078), a yellow grained sorghum (*Sorghum bicolor*) germplasm with short height (171.4 cm) and early maturity (110.3 days). *Indian Journal of Plant Genetic Resources* 37(3):533-534.
 15. Sujay Rakshit, Aruna, C., Praduman Yadav, Parashuram Patroti, Girish, G., Ganapathy, K.N., Ratnavathi, C.V., Padmaja, P.G., Elangovan, M., and Bahadure, D.M. 2024. IS 1212-4-1-1 (IC643968; INGR22027), a sorghum (*Sorghum bicolor*) germplasm with high oil content (4.49%); hard seed with bigger germ size. *Indian Journal of Plant Genetic Resources* 37(2):361.
 16. Sujay Rakshit, Aruna, C., Praduman Yadav, Parashuram Patroti, Girish, G., Ganapathy, K.N., Ratnavathi, C.V., Padmaja, P.G., Elangovan, M., and Bahadure, D.M. 2024. IS 31714-2-1-1 (IC643969; INGR22028), a sorghum (*Sorghum bicolor*) germplasm or high oil content (4.17%); very bold seed with medium hardness and small germ size. *Indian Journal of Plant Genetic Resources* 37(2):361-362.
 17. Umakanth, A.V., Amasiddha Bellundagi, Elangovan, M. and Vilas A Tonapi. 2024. SPV 2017 (IC643970; INGR22029), a sorghum (*Sorghum bicolor*) germplasm for high in-vitro true digestibility of dry matter (TDDM/IVDMD), organic matter digestibility (OMD) and Metabolisable energy content (ME); low Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) content. *Indian Journal of Plant Genetic Resources* 37(2):362-363.

List of Institute Projects

Sr. No	Project Title	Principal investigator	Duration	Remarks
CROP IMPROVEMENT				
Pearl millet				
1	IIMR/CI/2021-2026/141: Genetic enhancement of pearl millet for yield and adaptation to arid regions	P. Sanjana Reddy	2021-2026	Ongoing
2	IIMR/CI/2023-28/162: Development of breeding resources and technologies through genomic approaches in pearl millet	T. Nepolean	2023-2028	Ongoing
3	IIMR/CI/2021-2026/120: Forage pearl millet improvement for high biomass	Avinash Singode	2021-2026	Ongoing
Sorghum				
4	IIMR/CI/2021-2026/139: Breeding for genetically diverse <i>kharif</i> sorghum genotypes with improved grain yield, quality, and resistance to important biotic stresses	C. Aruna	2021-2026	Ongoing
5	IIMR/CI/2022-27/158: Breeding forage sorghum for higher productivity	B. Venkatesh Bhat	2022-2027	Ongoing
6	IIMR/CI/2021-2026/140: Genetic enhancement of energy sorghums for renewable fuels and fodders	A.V. Umakanth	2021-2026	Ongoing
7	IIMR/CI/2020-2025/122: Genetic enhancement of <i>rabi</i> sorghum adaptive traits for improved varietal performance	Parashuram Patroti	2020-2025	Ongoing
8	IIMR/CI/2023-27/164: Breeding <i>rabi</i> sorghum hybrids with improved productivity	B. Amasiddha	2023-2027	Ongoing
Small Millets				
9	IIMR/CI/2021-2026/142: Genetic improvement of foxtail millet for grain yield and related traits	K. Hariprasanna	2021-2026	Ongoing
10	IIMR/CI/2021-2026/143: Genetic diversification for grain yield and related traits in finger millet genotypes	K.N. Ganapathy	2021-2026	Ongoing
11	IIMR/CI/2021-2026/144: Development of end-use specific little millet genotypes with improved grain yield and grain micronutrients	K.N. Ganapathy	2021-2026	Ongoing
12	IIMR/CI/2021-2026/147: Genetic improvement of proso millet for yield and protein content	Avinash Singode	2021-2026	Ongoing
13	IIMR/CI/2021-2026/146: Improvement of kodo millet for economically important traits and development of markers for cultivar identification	Ch. Deepika	2021-2026	Ongoing
14	IIMR/CI/2021-2026/145: Development of dual purpose cultivars with improved quality in barnyard millet	B. Amasiddha	2021-2026	Ongoing
15	IIMR/CI/2017-22/115: Browntop millet-Characterization and genetic improvement	B. Venkatesh Bhat	2017-2022	Extended up to 2025
Genetic Resources Management				
16	IIMR/CI/2020-2024/125: Genetic and molecular characterization of intergeneric and interspecific derivatives for enhanced utilization in sorghum breeding	K.B.R.S. Visarada	2020-2024	Concluded
17	IIMR/CI/2021-2026/150: Nutri-cereals genetic resources management	Karnam Venkatesh	2021-2026	Ongoing

Sr. No	Project Title	Principal investigator	Duration	Remarks
18	IIMR/CI/2021-2026/148: Pre-breeding of sorghum and finger millet for specific trait improvement	Karnam Venkatesh	2021-2026	Ongoing
	Seed Science and technology			
19	IIMR/SS/2020-2025/126: Investigations on genetics of seed vigor and longevity, and effect of foliar plant nutrition on seed yield and quality in small millets	N. Kannababu	2020-2025	Ongoing
20	IIMR/CP/2023-2027/165: Studies on seed treatment technologies for better crop establishment and yield in millets	Sooganna	2023-2026	Ongoing
	CROP PRODUCTION & PHYSIOLOGY			
21	IIMR/CPD/2020-2025/129: Development of intra-millet intercropping systems for resilience and sustainability	B. Gangaiah	2020-2024	Extended for 1 year
22	IIMR/CPD/2021-26/152: Improving water use efficiency of finger millet & foxtail millet under limited moisture conditions	Swarna Ronanki	2021-2026	Ongoing
23	IIMR/CPD/2020-2025/128: Physiological dissection of key traits contributing for moisture stress adaptations in post-rainy sorghum: with an emphasis on root architectural traits	S. Srividhya	2020-2025	Ongoing
24	IIMR/CP/2020-2025/160: Physiological basis of high temperature stress on summer sorghum	Seva Nayak	2022-2025	Ongoing
25	IIMR/CP/2024-2029/172: Collection and evaluation of pearl millet landraces and farmers varieties for climate resiliency, higher yield, nutritional and culinary characteristics	S.N. Saxena	2024-2029	Newly Approved
	CROP PROTECTION			
26	IIMR/ CPT/2020-2025/131: Yield loss assessment in millets due to invasive fall army worm, and its integrated management with special emphasis on sorghum	G. Shyam Prasad	2020-2024	Extended for 1 year
27	IIMR/ CPT/2020-2025/133: Understanding the host-pest interactions of shootfly, stemborer and fall armyworm in millets and management through semio-chemicals	P.G.Padmaja	2020-2025	Ongoing
28	IIMR/ CPT/2020-2025/134: Integrated pest management for major shoot pests of sorghum during post rainy season in dryland region	B. Subbarayudu	2020-2024	Concluded
29	IIMR/ PP/2023-2026/167: Popularization of pearl millet in rice fallows of Krishna Godavari basin, along with study of socio economics, marketing opportunities and biotic stress tolerance	B. Subbarayudu	2023-2026	Ongoing
30	IIMR/ CPT/2020-2025/135: Studies on major insect pests of <i>rabi</i> sorghum and development of EILs	K. Srinivas Babu	2020-2025	Ongoing
31	IIMR/ PP/2023-2028/166: Exploring new plant traits for resistance against major insect pests in millets	A. Kalaisekar	2023-2028	Ongoing
32	IIMR/ CPT/2020-2025/132: Risk of pesticides prays on sorghum: Acute and field toxicities on stem borers & shootbug and their natural enemies	J. Stanley	2020-2024	Concluded
33	IIMR/CPT/2021-2026/151: Virulence and host plant resistance studies on important diseases of millets	I.K. Das	2021-2026	Ongoing
34	IIMR/PP/2022-2027/159: Characterization, symptomatology, and advanced diagnostics of viruses infecting sorghum	Baswaraj Raigond	2022-2027	Ongoing
35	IIMR/CPT/2020-2025/130: Studies on endophytes for management of major soil-borne diseases of millets	G. Rajesha	2020-2025	Ongoing
36	IIMR/CP/2024-2027/173: Mechanism of insect resistance and effect of Controlled Atmospheric Storage (CAS) in stored millet grain/seed pest management	J. Stanley	2024-2027	Newly Approved

Sr. No	Project Title	Principal investigator	Duration	Remarks
37	IIMR/CP/2024-2027/174: Evaluation of pearl millet germplasm for downy mildew resistance in arid zone/ A1 zone	Gopi Kishan	2024-2027	Newly Approved
38	IIMR/CP/2024-2028/175: Genetic diversity, pathogenic variability, and development of differential host against pearl millet blast pathogen	G. Rajesha	2024-2028	Newly Approved
BASIC & STRATEGIC RESEARCH				
39	IIMR/CI/2021-2026/149: Generation of genomic resources and its application for the improvement of millets	P. Rajendra Kumar	2021-2026	Ongoing
40	IIMR/CI/2020-2025/124: Manipulating SbSERK gene(s) to understand their effect on generating apomixis components through CRISPR-Cas9 mediated gene editing technology	D. Balakrishna	2020-2025	Ongoing
41	IIMR/CI/2023-28/163: Identification of bioactive compounds in the grain and gene mining from millets	Jinu Jacob	2023-2028	Ongoing
42	IIMR/FF/2020-2025/127: High calcium accumulation in finger millet and its relationship to grain constituents	R. Venkateswarlu	2020-2024	Concluded
43	IIMR/CP/2023-27/168: Biochemical characterization of Iron and Zinc rich pearl millet genotypes and their relationship with rancidity, anti-nutrients and seed quality	R. Venkateswarlu	2023-2027	Ongoing
44	IIMR/FF/2021-2026/154: Nutritional composition, phenolic profile and bioactivities of sorghum, and foxtail,kodo and proso millet grains	V.M. Malathi	2021-2026	Ongoing
45	IIMR/FF/2021-2026/153: Biochemical characterization of millets and millet food products for nutraceuticals and health benefits	V.M. Malathi	2021-2026	Ongoing
EXTENSION RESEARCH				
46	IIMR/ER/2021-2026/156: Yield gap and constraints analysis of sorghum production in traditional area	R.R. Chapke	2021-2026	Ongoing
47	IIMR/ER/2022-2026/169: Development of advance information and communication technology (ICTs)- enabled communication and education tools for millets promotion	R.R. Chapke	2023-2026	Ongoing
48	IIMR/EVA/2020-2025/138: Livelihood security of millets stakeholders through production and processing technologies in NE region	Sangappa	2020-2024	Concluded
49	IIMR/ER/2022-2026/161: Adoption and Impact of Improved millets production technologies in India	A. Srinivas	2022-2026	Ongoing
50	IIMR/ER/2024-2027/176: Evaluating performance, impact, and sustainability of farmer producer organizations (FPOs) for strengthening millet value chain	Sangappa	2024-2027	Newly Approved
VALUE-ADDITIONS & SOCIO-ECONOMICS				
51	IIMR/VA/2021-2026/155: Development of millet based composite foods in collaboration with fishery, dairy, horticulture and meat commodities	B. Dayakar Rao	2021-2026	Ongoing
52	IIMR/EVA/2020-2025/136: Economic analysis of production, marketing, utilization and policy perspectives of sorghum, pearl millet and ragi in India	Anuradha Narala	2020-2025	Ongoing
53	IIMR/VA/2023-26/170: Development of novel products with different texture characteristics and biodegradable films for packaging of the different value added products made from millets	P. Hemashankari	2023-2026	Ongoing
54	IIMR/CP/2023-25/171: Development of online web applications for varietal database information management system	P. Mukesh	2023-2025	Ongoing
GLOBAL CENTRE OF EXCELLENCE				
55	IIMR/GC/2023-26/171A: Global centre of excellence on millets (Shree Anna)	Tara C Satyavathi	2023-2026	Ongoing

RAC, QRT and Other important meetings

Research Advisory Committee Meeting

The 25th Research Advisory Committee (RAC) meeting of ICAR-Indian Institute of Millets Research, Hyderabad was held during 19-20 September 2024 under the Chairmanship of Dr. Arvind Kumar, Former Deputy Director General, ICRISAT, Patancheru, to review the progress of institute's research during 2023-24. The Members of RAC present physically were- Dr. SR Maloo, Former Director of Research, MPUAT, Udaipur; Dr. ST Kajjidoni, Former Dean, College of Agriculture, UAS, Dharwad, Dr. A Nirmalakumari, Former Professor (Plant Breeding and Genetics), Centre of Excellence on Millets, TNAU, Athiyandal; Prof. Rajinder Singh Chauhan, Dean, School of Biosciences, Mahindra University, Hyderabad; Shri. G Vinod Kumar Rao (Farmer's Representative), Hyderabad; Dr. C Tara Satyavathi, Director, ICAR-IIMR, Hyderabad and Dr. P Rajendrakumar, Principal Scientist and Member-Secretary, RAC. The Special Invitees to attend the meeting were; Dr. Raj Kumar Bhandari, NTBN, Niti Aayog, Mumbai and Dr. R Madhusudhana, Project Coordinator (Sorghum and Millets), Hyderabad. Dr. SK Pradhan, ADG (FFC), ICAR, New Delhi joined the meeting through online mode. After the initial remarks of the RAC, Dr. P Rajendrakumar, Member Secretary, presented the Action Taken Report of the previous RAC meeting.



Dr. C Tara Satyavathi, Director, IIMR presented an Overview of Research and Development in Millets during 2023-24. She presented the crop-wise research groups and product profiles developed in all the millets for organized research. She briefed about institute's significant achievements under various research programs, seed production at IIMR, externally funded projects, publications, International Nutri-cereal Convention 5.0, business incubation, start-up facilities and processing in millets. She informed the establishment of Global Centre of Excellence on Millets at ICAR-IIMR, Hyderabad for catering to global research and development needs in millets. She also highlighted the infrastructure development under the Global Centre of Excellence on Millets and new initiatives undertaken such as whole genome sequencing, metabolome profiling. etc. She also emphasized the collaborative research taken-up under the Global CoE on Millets involving 15 ICAR Institutes for efficiently utilizing the expertise available. She informed about the establishment of a Regional Centre at Gudamalani, Barmer, Rajasthan focused on the pearl millet research.

The scientists representing different crop / thematic groups presented the progress, achievements and expected outcome from their projects. The RAC team also visited the field experiments and discussed the research outputs with the concerned scientists on 20 September, 2024. This was followed by visits to Gene Bank, Centre of Excellence on Millets, Primary and Secondary Processing Facilities and Nutrihub. The Chairman and members appreciated the efforts of scientists and other staff of the Institute for the excellent work. The Chairman and members gave valuable suggestions for the improvement of various projects. The recommendations as approved by the RAC and the Council are given below:

S No.	Recommendations of XXV RAC Meeting
1	RAC observed effective steps have been taken to implement almost all the recommendations suggested by RAC and approved by ICAR. RAC appreciates the efforts taken by the Director, ICAR-IIMR and the team in taking effective steps towards long term implementation of the recommendations of RAC. Formation of crop-based working groups and also crop-wise presentations is a welcome step. This will encourage people to work in team. The steps initiated by ICAR-IIMR to implement the 2023 RAC recommendations need to be continued with full efforts. RAC shall review the progress for 2024 implementation in 2025.
2	For ICAR-Global Centre of Excellence on Millets, a comprehensive plan on the lines of international centre and future needs of India and other countries growing millets need to be put in place. The comprehensive plan should take into account the emerging challenges on Climate change, deteriorating soil health, deteriorating water availability, efforts towards sustainability of agriculture as well as mechanization and digital tools application, and capacity development of its staff as well as of other centres across Globe.
3	ICAR-IIMR is at the centre of circle of managing project co-ordination for sorghum and millets, the current Indian Institute of Millet Research, Global Centre of Excellence on Millets as well as MAHARISHI- Secretariat. It is expected from the current set up to emerge to work as an International Centre including hiring of international talents, maintaining international collaborations. ICAR-IIMR needs to be provided with mechanism, empowerment and authority by ICAR to be able to work with the pace, especially for establishment of Global Centre and coordination of MAHARISHI activities at Global level. At the same time, RAC feels that at country level, in order to manage all the tasks at national and international levels, with the existing level of staff set up, project coordinator should work closely with Director, IIMR with all staff reporting coming to Director, IIMR. Bifurcation of staff between institute's Director and Project Co-ordinator at this stage of time will hamper development of Global Centre of Excellence on Millets and set up of MAHARISHI. RAC also recommends provision of additional funds to ICAR-IIMR to meet expected Global level requirement.
4	RAC recommends provision of additional staff to the centre in view of additional responsibilities and with establishment of a new regional research station on Pearl millet at Gudamalani, Barmer, Rajasthan. RAC further recommends AICRIP on Pearl millet be coordinated from Gudamalani under the guidance of Director, IIMR.
5	Concerted efforts towards Germplasm conservation are needed. Each year 500 new germplasm accessions in total should be added to the original accessions conserved either through collection or acquisition from international centres like ICRISAT, USDA or other centres. ICAR-IIMR has evaluated around 25,000 accessions of Sorghum for different morphological traits. At the same time, there are some genotypic data available with ICRISAT or NIPGR for a small set of these lines. It is suggested that IIMR collaborate with both the above-mentioned institutes and initiate genetics and genomics studies with involvement of molecular biologists from IIMR. Also, RAC recommends integration of metabolome data generated for different crops with transcriptome data for more meaningful comparison on nutritional significance of millets.
6	Sweet Sorghum work at IIMR is delivering good output. RAC recommends the team to make effective interaction with industry as well as different ministries to convince them the importance of Sweet Sorghum for biofuel.
7	RAC recommends to initiate more agronomic research on millets towards weed control using mechanized implements, weedicides as well as towards development of implements for sowing, processing of millets including small millets.
8	RAC appreciates the research undertaken by IIMR on gene editing. RAC further recommends IIMR to initiate blue sky research on enhancing the grain cooking quality of millets like rice and wheat.
9	RAC recommends ICAR-IIMR to take more steps on capacity development of its own staff including undertaking scientific exchange program with different international centres for sending ICAR-IIMR staff to work there for 2-4 months and bringing staff from other institutes at IIMR to work for 2-4 months.
10	RAC recommends ICAR-IIMR to attract private sector CSR funds and undertake industry/demand-based research similar to CSIR labs for attracting funds from the industry.

QRT meeting

The QRT team comprising of Dr. S.L. Mehta, Former Vice-Chancellor (Maharana Pratap University of Agriculture & Technology, Udaipur)-Chairman and the other members Dr. K. Ganesamurthy, Former Director, Centre for Plant Breeding and Genetics, TNAU, Coimbatore; Dr. O.P. Govila, Former Project Coordinator, AICRP on pearl millet; Dr. Prabhakar, Former Project Coordinator, AICRP on Small millets,

Bengaluru; Dr. S.S. Mane, Director of Instructions and Dean Faculty of Agriculture, Dr. PDKV, Akola and Dr. N.K. Bajpal, Director Extension, BUAT, Banda; Dr. N.K. Bajpal, Director Extension, BUAT, Banda visited IIMR on 23-24 September, 2024 and 6-8 November, 2024 to finalize the QRT reports of IIMR and three AICRPs (Pearl millet, sorghum and small millets). The team had formal interactions with Dr. C.

Tara Satyavathi, Director, IIMR, Dr R Madhusudhana, Project Coordinator (Sorghum and millets) and need based interactions with various scientists of IIMR. Dr. A.V. Umakanth, Principal Scientist, ICAR-IIMR and Member Secretary, QRT coordinated these meetings. Finally, all the QRT reports were submitted by Dr S L Mehta, Chairman-QRT to Hon`ble Director General, ICAR, Dr Himanshu Pathak on 31st December, 2024



at Board room of NASC, New Delhi. The chairman apprised the Hon`ble DG about the review and the major recommendations made by QRT for IIMR and AICRPs. ADG (Seed)-Dr D K Yadava, Director, ICAR-IIMR-Dr (Mrs) C. Tara Satyavathi, PC Sorghum and millets-Dr R Madhusudhana and QRT Member Secretary Dr AV Umakanth attended this meeting.



Institute Research Council (IRC) meeting

Institute Research Council (IRC) meeting was held at ICAR-IIMR, Hyderabad during 21 and 22 May, 2024 to review the progress and dialogue on ongoing institute projects. The meeting was chaired by Dr. C. Tara Satyavathi, Director IIMR and Chairperson IRC, and attended by the external experts - Dr. J.V. Patil, former Director, IIMR Hyderabad and Dr. A. Nirmalakumari, Officer In-charge (Retd.), AICRP on small Millets, Aathiyandalal, Tamil Nadu, Dr R Madhusudhana, Project coordinator, Sorghum and Millets, ICAR-IIMR Hyderabad and Dr. I.K. Das, Member Secretary-IRC, besides the scientists of the institute.



During deliberations a total of 49 ongoing projects were thoroughly reviewed and discussed. The RPPs were presented by the principal investigators. A total of 5 new project proposals were presented and discussed. Details about the presentations of the projects and comments and suggestions received during the meeting will be available in the proceedings of the meeting.

Before the formal IRC, Pre-IRC meeting was conducted on 22, 24, 26, 29 and 30 April, 2024 for in depth discussion on research priorities on each of the nine crops. The meeting was chaired by Dr. C Tara Satyavathi, Director, IIMR and chairperson IRC and co-chaired by Dr. R Madhusudhana, Project coordinator, Sorghum and Millets. Each crop had a separate session, which was attended by the crop-specific group of scientists. Major research gaps emerged during discussion are documented in the proceeding.

Participation in Meetings/ Seminars / Workshops / Conferences etc.

S. No.	Name of Employee	Title of the meeting / Workshop etc (If paper etc. presented mention the title)	Organized by	Venue / Place	Online / Physical	Dates
1	K. Hariprasanna Swarna Ronanki	International (India-Africa) exchange of experience sharing and capacity building program on Millets (W)	IIMR and FMFA, Germany	IIMR, Hyderabad	Online	8-11 Jan, 2024
2	Sangappa	Coop Millets Renaissance	National Cooperative Union of India	New Delhi	Online	9-10 Jan, 2024
3	Sangappa	Market-Driven Millets Production, Processing and Value Addition Technologies	MANAGE, Hyderabad	Hyderabad	Physical	16-18 Jan, 2024
4	C. Tara Satyavathi	Price Policy for <i>Kharif</i> Crops 2024-25 Marketing Season with concerned Organizations/Associations related to Rice, Maize, Millets	Commission for Agricultural Costs & Prices, New Delhi	New Delhi	Physical	18 Jan, 2024
5	C. Tara Satyavathi	Investment forum for advancing climate resilient agrifood systems.	Food and Agriculture Organization of the United Nations, New Delhi.	New Delhi	Physical	18-19 Jan, 2024
6	Sangappa	Engendering FPOs-Past, Present, Future	APMAS	Hyderabad	Physical	19 Jan, 2024
7	C. Tara Satyavathi	International Symposium on Gut Health & Lifestyle Disorders.	GUT Health, New Delhi	New Delhi	Physical	20 Jan, 2024
8	C. Tara Satyavathi	Performance review meeting of INSPIRE Faculty Fellow under the Life Sciences-Plant/Agri / Veterinary subject area	DST at Centre for Cellular and Molecular Biology	Hyderabad	Physical	29 Jan, 2024
9	Ch. Deepika	Oral presentation on Speed breeding to aid climate resilient agriculture In: International conference on Food & Nutritional Security through Agriculture Ecosystem	MANAGE, Hyderabad	Hyderabad	Physical	1-2 Feb, 2024
10	S. Srividhya	Oral presentation on Evaluation of Key adaptive traits in millets for drought tolerance. In: International conference on Food and Nutritional security through Agricultural ecosystem	MANAGE, Hyderabad	Hyderabad	Physical	1-2 Feb, 2024

S. No.	Name of Employee	Title of the meeting / Workshop etc (If paper etc. presented mention the title)	Organized by	Venue / Place	Online / Physical	Dates
11	C. Tara Satyavathi	Delivered Keynote address at International Conference 'Sanmantrana' on Innovations and Technological Interventions for Sustainability : Emerging Challenges	Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore	Indore	Physical	02 Feb, 2024
12	Rajendra R. Chapke	Regional Agriculture Fair	ICAR-IVRI Varanasi	Varanasi	Physical	3-5 Feb, 2024
13	C. Tara Satyavathi Rajendra R. Chapke	Regional Workshop on Training Need Assessment of Clientele States	Extension Education Institute, Hyderabad.	Hyderabad.	Physical	5 Feb, 2024
14	Sangappa	Market-driven millet production, processing, and value addition	ICAR-IIMR, Hyderabad & MANAGE, Hyderabad	Hyderabad	Physical	5-12 Feb, 2024
15	Rajendra R. Chapke	Regional Workshop on "Training Need Assessment of Clientel States to prepare Annual Training Calender for 2024-25"	EEI, Hyderabad	EEI, Hyderabad	Physical	6 Feb, 2024
16	C. Tara Satyavathi	Virtual meeting on International joint research project on millet between India and Japan from FY 2024.	ICAR, New Delhi		Online	7 Feb, 2024
17	C. Tara Satyavathi	Delivered virtual Keynote address on Millets for Climate Resilience and Nutritional Security: A Sustainable Approach during the International Conference on "Reviving Ancient Grains: Millets on the Global stage	University of Horticultural Sciences, Bagalkot, ICAR-Krishi Vigyan Kendra, Kolar.		Online	8 Feb, 2024
18	C. Tara Satyavathi	Workshop on "Diversification of Diet: Importance of Inclusion of Millets in the Diet Menu of ICDS, Mid-Day Meal Scheme and Urban Canteens	University of Hyderabad, Hyderabad	Hyderabad	Physical	16 Feb, 2024
19	C. Aruna K. Hariprasanna	28th meeting of the ICAR Regional Committee for Zone VIII (M)	CMFRI - Cochi		Online	16 Feb, 2024
20	C. Tara Satyavathi	7 th International Conference on Plant Genetics and Genomics	Glostem Pvt. Ltd., Chandigarh	Delhi	Physical	17 Feb, 2024
21	P. Hemasankari	Virtual workshop on Millets Primary Processing: Entrepreneurial Perspectives	ICAR-IIMR and MANAGE, Hyderabad	ICAR-IIMR, Hyderabad	Online	23 Feb, 2024
22	Sangappa	Millets Primary Processing Units, Millet Value Addition, Millet Value Chain and Government Initiatives to Aid FPOs promotion	ICAR-IIMR, Hyderabad & MANAGE, Hyderabad	Hyderabad	Online	23 Feb - 1 Mar, 2024
23	Baswaraj Raigond	State level Seminar cum Workshop on Biotechnology in the diagnosis and management of plant virus diseases	Lokmangal Science and Entrepreneurship College, Wadala, Solapur, MH	Wadala, Solapur, MH	Physical	26 Feb, 2024

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24	V. M. Malathi	Interactive meet on Conservation of Indigenous Millets and Ethnomedicine'	NCERT, New Delhi	NCERT, New Delhi	Physical	29 Feb, 2024
25	P. Mukesh	Meeting on "Spurious Pesticide Use in Agriculture - Labelling for Safety"	Plant Protection of India Society, Hyderabad		Online	5 Mar, 2024
26	C. Tara Satyavathi	Guest of Honour for International Women's Day 2024 celebrations	National Institute of Food Technology, Entrepreneurship and Management, Thanjavur		Online	6 Mar, 2024
27	C. Tara Satyavathi	International Conference on Responsible Production and Consumption (ICRPC): Agricultural Sustainability and Food Security	University of Hyderabad	Hyderabad	Physical	7 Mar, 2024
28	C. Tara Satyavathi	Meeting for certification of Technology Product Model in Agriculture Extension	ICAR, New Delhi		Online	11 Mar, 2024
29	N. Kannababu	Monitoring Workshop of SERB-DST	SERB-DST, Govt. of India	BHU, Varanasi	Physical	14-15 Mar, 2024
30	Baswaraj Raigond	ITMC meeting	ICAR-National Research Center on Pomegranate, Solapur, Maharashtra	Solapur, Maharashtra	Physical	15 Mar, 2024
31	C. Tara Satyavathi	IYM Closing event – "Roundtable discussion: Research and development for the millet sector"	Food and Agriculture Organization of the United Nations, Rome, Italy.		Online	15 Mar, 2024
32	P. Mukesh	Webinar on Intellectual Property Rights Filing Process	ICAR-National Institute of Biotic Stress Management, Raipur		Online	19 Mar, 2024
33	P. Hemasankari	CAT Exposure visit of oriya farmers to ICAR-IIMR, Hyderabad.	ICAR-IIMR, Hyderabad	ICAR-IIMR, Hyderabad	Physical	25-29 Mar, 2024
34	C. Tara Satyavathi	Global South Millet Convening for Shared Vision and Inclusive Action Beyond IYM 2023 at Dubai, UAE.	Organized by ICRISAT, at Dubai, UAE		Physical	25-26 Mar, 2024
35	C. Tara Satyavathi	Closing Ceremony of the International Year of Millets (IYM) 2023 at Rome, Italy.	Food and Agriculture Organization of the United Nations, Rome, Italy.	FAO, Rome, Italy	Physical	29 Mar, 2024
36	V. M. Malathi	Brainstorming workshop "Millets and other Neglected and Underutilised Species	Gitam University and Coventry University, UK	Gitam University, Hyderabad	Physical	26 Mar, 2024
37	C. Tara Satyavathi B. Venkatesh Bhat	Review meeting of the Task Force on Millets	DAFW	New Delhi	Physical	2 Apr, 2024
38	C. Tara Satyavathi	Review Meeting of SMDs.	Online	ICAR-New Delhi		05 Apr, 2024.

S. No.	Name of Employee	Title of the meeting / Workshop etc (If paper etc. presented mention the title)	Organized by	Venue / Place	Online / Physical	Dates
39	C. Tara Satyavathi	Eco-regional Working Group meeting	ICAR-New Delhi		Online	12 Apr, 2024
40	Swarna Ronanki	Webinar on millet processing and business opportunities	National Institute of Food Technology Entrepreneurship and Management	Virtual	Online	13 Apr, 2024
41	C. Tara Satyavathi	Selection Committee meeting at Union Public Service Commission.	UPSC, New Delhi		Physical	15 Apr, 2024
42	Sangappa	Millet Production, processing & Value Addition	District Training centre, Haveri and ICAR-IIMR, Hyderabad.	Hyderabad	Online	18 Apr, 2024
43	K. Hariprasanna	Meeting of the Committee for revision of AICRP testing fee (M)	IIMR, Ludhiana	-	Online	18 Apr, 2024
44	K. Hariprasanna	Workshop on Advances in Millets Production, Processing and Value Chain Development (W)	FAO & IIMR	-	Online	22 Apr - 1 May, 2024
45	C. Tara Satyavathi	Workshop on Promotion of Climate Resilient Crops / Varieties / Seeds (Climate Resilient / Smart Agriculture) & Panel Discussion on "Bringing Resilient Agri Food Systems during Vikasit Bharath".	ICAR-CRIDA, Hyderabad		Physical	23 Apr, 2024
46	C. Tara Satyavathi K. Hariprasanna	FAO-ICRISAT Millet Seed Exchange meeting	FAO of the United Nations		Online	24 Apr, 2024
47	P. Hemasankari	Research & Development for Resolving Gaps in scaling up of Millet Value Chain for Technical Back - stopping Micro-Units Under MoFPI-PMFME	ICAR-IIMR, Hyderabad	Conference Hall, Nutrihub	Physical	24 Apr, 2024
48	Rajendra R. Chapke	International workshop of FAO and ICAR-IIMR on Millet Value Chain under Asia-Africa South Cooperation on "Advances in Millets Production, Processing and Value Chain Development"	FAO, Bangkok	ICAR-IIMR, Hyderabad	online	30 Apr, 2024
49	C. Tara Satyavathi	Policy Round Table on Millets: "The Future Food" organized by the Indian Chamber of Food and Agriculture (ICFA), New Delhi and delivered Chief Guest address.	Indian Chamber of Food and Agriculture, New Delhi	New Delhi	Physical	2 May, 2024
50	B. Venkatesh Bhat	39 th AGM of AICRP on Seed (Crops) and 27 th Annual Breeder Seed review meeting	UAS, Bangalore	Bangalore	Physical	2-3 May, 2024

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51	Sangappa	Workshop on Road to Drupa Roadshow! Exclusively tailored for "Labels and Folding Carton Converters."	HP on packaging of food products	Hyderabad	Physical	4 May 2024
52	C. Tara Satyavathi	Review Meeting of the project entitled "Promotion of Climate Resilient Sweet Stalk Sorghum as Bioenergy crop"	DA&FW, New Delhi		Online	6 May, 2024
53	Baswaraj Raigond	Socially Aware Nominee	Institute Animal Ethics Committee (IAEC) of Jaypee University, Wanknaghat, Solan, H.P	Wanknaghat, Solan, H.P	online	10 May 2024
54	Swarna Ronanki	Workshop on Carbon Accounting for sustainable agrifood systems	Food and agriculture organization of the United Nations	Virtual	Online	13 May, 2024
55	Sangappa	Workshop on designing the MOOC course on Management of Farmer Producers Organizations	NAARM, Hyderabad	Hyderabad	Physical	16 May, 2024
56	P. Hemasankari	COHORT-VIII	RKVY-RAFTAAR Grant-in-Aid COHORT-VIII Pre-seed stage (NEST) & Seed stage (NGRAIN)	ICAR-IIMR, Hyderabad	Physical	21 May - 1 Jun, 2024
57	C. Tara Satyavathi	52nd meeting of Plant Germplasm Registration Committee (PGRC)	ICAR-NBPGR, New Delhi		Online	22 May, 2024
58	C. Tara Satyavathi	Seed Mela - Inaugural Program	PJTSAU, Hyderabad	Hyderabad	Physical	24 May, 2024
59	C. Tara Satyavathi	Attended Online Techno Commercial Assessment and Expert Committee meeting (TCAC) for CSH 43MF	Agrinnovate India Ltd., New Delhi		Online	24 May, 2024
60	C. Tara Satyavathi	Corpus Funds Proposal IARI - MEGA UNIVERSITY - HYD - HUB	ICAR-CRIDA, Hyderabad		Online	24 May, 2024
61	Sangappa	Grant-in-Aid program under RKVY-RAFTAAR project	Nutrihub-TBISC, ICAR-Indian Institute of Millets Research	Hyderabad	Physical	29 May 2024
62	C. Tara Satyavathi	Symposium - Millets: The Super food of Bharat	Ministry of Culture, Indira Gandhi National Centre for the Arts (IGNCA), New Delhi	New Delhi	Physical	1 Jun, 2024.
63	Mahesh Kumar	A Technical Hindi Workshop	TOLIC-Hyderabad-2 in joint auspicious with CSIR_IICT, Hyderabad	CSIR-IICT, Hyderabad	Physical	11 Jun, 2024
64	C. Tara Satyavathi	Meeting to discuss preparation of documents related to Policy Paper on Biofuels.	ICAR, New Delhi		Online	12 Jun, 2024

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65	C. Tara Satyavathi	Inaugural session of the Regional Consultation on Science of Natural Farming organized by DA&FW, New Delhi	MANAGE, Hyderabad	Hyderabad	Physical	14 Jun, 2024.
66	C. Tara Satyavathi	Meeting on Insights from Australian Consumer Focus Groups on Indian Products	Agri-Science Queensland, Department of Agriculture and Fisheries, Brisbane.		Online	20 Jun, 2024.
67	C. Tara Satyavathi	GEFC meeting	ICAR-NBPGR, New Delhi		Online	24 Jun, 2024.
68	C. Tara Satyavathi	Online meeting on 100 Days Action Plan and Five Year Targets	ICAR, New Delhi		Online	1 Jul, 2024
69	C. Tara Satyavathi	Meeting to discuss TCP titled "Enhancing capacity on Sustainable value chain development of Millets for food and Nutrition security in Asia	Dept. of Agriculture and Farmers Welfare M/o Agriculture and Farmers Welfare, New Delhi		Online	4 Jul, 2024
70	Jinu Jacob	Guest lecture at Dept. of Plant Breeding and Genetics on 'Biochemical outlook of the genetics of carbohydrates, lipids and proteins'	College of Agriculture, Padanakkad, Kerala	College of Agriculture, Padanakkad, Kerala	Online	9 Jul, 2024
71	Sangappa	Workshop on promotion of millets	MANAGE, Hyderabad	Hyderabad	Online	9 Jul, 2024
72	S. Srividhya	Workshop on "Advanced Microscopy in Biological Sciences" on 11 th & 12 th July 2024	ICAR-IIMR	Hyderabad	Physical	11-12 Jul, 2024
73	C. Tara Satyavathi	Attended Technology Day of ICAR, and Received the Certificates for the 4 (four) Technologies of ICAR-Indian Institute of Millets Research, Hyderabad Certified by ICAR, New Delhi.	ICAR, New Delhi	New Delhi	Physical	16 Jul, 2024
74	C. Tara Satyavathi	Interaction meeting with South African Delegation for millets collaboration between India with Centre for Excellence in Indigenous Knowledge Systems, Durban, South Africa.	ICAR-IIMR, Hyderabad	Hyderabad	Physical	20 Jul, 2024
75	C. Tara Satyavathi	Meeting of Extant Variety Recommendation Committee (EVRC) as Committee Member (Subject Matter Specialist)	Protection of Plant Varieties and Farmers' Rights Authority		Physical	22 Jul, 2024
76	Mahesh Kumar	Meeting of Town Official Language Implementation Committee (Central Govt. Offices-2) organized by NIRDPR, Hyderabad	ICAR-NBPGR-RS, Hyderabad		Physical	24 Jul, 2024

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77	C. Tara Satyavathi	Online interaction meeting with Consul General of Mexico in Mumbai, Mr. Adolfo Garcia Estrada	Mexican Consulate, Mumbai		Online	25 Jul, 2024
78	K. Hariprasanna C. Aruna	92 nd Meeting of CVRC (M)	DAF&W	-	Online	2 Aug, 2024
79	C. Tara Satyavathi	Delivered Keynote address on "Reviving Millets in India: Crop Improvement perspective"	BIOFACH India, New Delhi.	New Delhi	Physical	3 Aug, 2024
80	Rajendra R. Chapke	FAO-sponsored project entitled "Enhancing capacity on sustainable value chain development of millets for food and nutrition security in India"	FAO, Bangkok	ICAR-IIMR, Hyderabad	online	6 Aug, 2024
81	Rajendra R. Chapke	Brainstorming Session on Resource Based & Location Specific S&T Interventions for SC & ST Communities	EFD, TCST, Hyderabad	The Hotel Plaza, Begumpet, Hyderabad	Physical	7 Aug, 2024
82	Sangappa	Entrepreneurship orientation program on medical and aromatic plants-9 (EOPMAP-9)	ICAR-DMAPR Hyderabad	Hyderabad	Physical	8 Aug, 2024
83	Sangappa	Value chain Extension	ICAR-IIHR, Bengaluru & MANAGE, Hyderabad		Online	9 Aug, 2024
84	K. Hariprasanna	1 st Quarter Review of AICRP-Sorghum & Small Millets centres (M)	AICRP-S&SM	-	Online	8 -16 Aug, 2024
85	Sangappa	Value chain Extension	ICAR-IIHR, Bengaluru & MANAGE, Hyderabad	Hyderabad	Online	9 Aug, 2024
86	C. Tara Satyavathi	Elemental Analysis Services Workshop for South Asia. Delivered talk on "Nutrition Breeding in Millets"	ICRISAT, Hyderabad	Hyderabad	Physical	12 Aug, 2024
87	K. Hariprasanna V. M. Malathi	Workshop on Elemental Analyses Services for South Asia CGIAR BRS Platform and Harvest Plus	CGIAR BRS Platform and Harvest Plus	ICRISAT, Hyderabad	Physical	12-14 Aug, 2024
88	Baswaraj Raigond	Agri Entrepreneurship Development in Plant Protection	NCIPM, New Delhi	New Delhi	Physical	20-23 Aug, 2024
89	Swarna Ronanki	Hands-on Training on Statistical Analysis and Exploring the Role of Agriculture in Industry Domains	The Indian Society of Agronomy, IARI		Online	22-08-2024
90	B. Venkatesh Bhat	XXVII Meeting of ICAR Regional Committee (Zone II)	NRRI, Cuttack, Odisha	Cuttack, Odisha	Physical	23 Aug, 2024
91	C. Tara Satyavathi	Attended QRT cluster meeting on Pearl millet at AU, Jodhpur	Agril. University, Jodhpur	Jodhpur	Physical	28 Aug, 2024
92	Swarna Ronanki	Integrated weed management strategies under changing Agricultural Scenario	Directorate of Weed Research, Jabalpur		Online	28 Aug, 2024

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93	V. M. Malathi	Capacity Building Workshop on Mainstreaming Nutrition in OCOP for Healthy Diets	FAO and the Institute of Nutrition Mahidol University		Online	28-30 Aug, 2024
94	C. Tara Satyavathi	Delivered Plenary lecture on “Millets for Food & Nutritional Security in Asian & African Continents”	Royal Global University, Guwahati.		Physical	9 Sep, 2024
95	Sangappa	Barnyard Seed Production Field Day	ICAR-IIMR, Hyderabad	Hyderabad	Physical	12 Sep, 2024
96	C. Tara Satyavathi	Informational Webinar on Synthetic Biology: Technological Developments and Policy discussions	Biotech Consortium India Ltd., New Delhi		Online	13 Sep, 2024
97	Sangappa	Virtual Buyer Seller meet	ICAR-IIMR, Hyderabad	Hyderabad	Online	13 Sep, 2024
98	Sangappa	Meeting on millet value chain development	ICAR-IIMR, Hyderabad in collaboration with FAME	Hyderabad	Online	17 Sep, 2024
99	Baswaraj Raigond	Special guest on “20 th Foundation Day of ICAR-NRC on Pomegranate, Solapur	ICAR-NRC on Pomegranate, Solapur	Kegaon, Solapur	Physical	25 Sep, 2024
100	C. Tara Satyavathi, B. Venkatesh Bhat, Sangappa	National Conference on Food Systems for Sustainability & Profitability of Millets Conference	Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh	Jhansi, Uttar Pradesh	Physical	5-6 Oct, 2024
101	C. Aruna	Webinar on “Dynamic Digital Presence” as part of the Vigilance Awareness Campaign (S)	ICAR-NAARM, Hyderabad		Online	7 Oct, 2024
102	C. Tara Satyavathi	As Indian collaborator made presentation in the First Research Coordination Meeting on Accelerated Genetic Improvement of Key Dryland Millets for Climate Change Adaptation	Secretariats of the FAO and the IAEA		Online	8 Oct, 2024
103	C. Tara Satyavathi K. Srinivas Babu, Sangappa, K.N. Ganapathy Sooganna	International Symposium on “Shree Anna and Forgotten Foods (ISSFF)” at Bhubaneshwar, Odisha	Department of Agriculture and Farmers’ Empowerment, Govt. of Odisha	Odisha	Physical	10 Oct, 2024
104	K. Hariprasanna K.N.Ganapathy, B. Amasiddha and K. Venkatesh	ICRISAT Genebank Small Millets Field Day	ICRISAT Patancheru	ICRISAT Patancheru	Physical	11 Oct, 2024

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105	B. Venkatesh Bhat, Rajendra R. Chapke	Regional training cum workshop on "Millet participatory varietal selection, associated best management practices, and value chain"	FAO, Bangkok	ICRISAT, Hyderabad	Physical	14-16 Oct, 2024
106	Sangappa	Workshop on strengthening the capacity of Farmer Producer Organizations (FPOs) for improved performance and sustainability	ICAR-IIMR Hyderabad, Central University of Karnataka and ICAR-KVK Kalaburgi	Karnataka	Physical	23 Oct, 2024
107	Sangappa	National Conference on Building Sustainable Agriculture Startups	NAARM, Hyderabad	Hyderabad	Physical	12-13 Nov, 2024
108	P. Hemasankari	58 th Annual Convention of Indian Society of Agricultural Engineers (ISAE) "Engineering Innovations for Next gen Digital Agriculture and International Symposium on Agricultural Engineering Education for Aspiring youth in Transforming Agriculture"	Indian Society of Agricultural Engineers (ISAE) and Vasant Rao Naik Marathwada Krishi Vidyapeeth, Maharashtra	Parbhani, Maharashtra	Physical	12-14 Nov, 2024
109	C. Tara Satyavathi	Chaired Panel-5 on "Nurturing Growth: Support system for sustainable Agri-Startups.	NAARM, Hyderabad	Hyderabad	Physical	13 Nov, 2024
110	C. Tara Satyavathi	Attended Virtual meeting regarding discussion on settling up Nutrihub in Northeastern region under MOVCDNER scheme	Ministry of Agri. & Farmers Welfare, DA&FW, New Delhi.		Online	14 Nov, 2024
111	C. Tara Satyavathi	Attended virtual meeting called by Agrinnovate India on Licensing of Fodder Sorghum CSH 43 MF	Agrinnovate India		Online	20 Nov, 2024
112	Jinu Jacob	International conference on biotechnology - Way forward. Delivered a talk on 'The glorious journey of millets-From traditional grains to Nutraceuticals' as an invited speaker.	University of Kerala		Online	20-22 Nov, 2024
113	C. Tara Satyavathi	Inaugurated Food processing unit of FPOs and delivered inaugural address	FPO, Lambasingi		Physical	23 Nov, 2024
114	B. Venkatesh Bhat	National Seed Congress	ISARC & NSRTC	Varanasi, Uttar Pradesh	Physical	28-30 Nov, 2024
115	C. Tara Satyavathi	Chaired the meeting of SCSP and TSP committee of Global CoE with Directors of ATARI, & KVKs	ICAR-IIMR, Hyderabad		Online	23 Dec, 2024

Meetings, Field Days and Exhibitions

International Nutri-Cereal Convention 6.0

The **INCC 6.0** (International Nutri-Cereal Convention) was a significant three-day mega event organized by Nutrihub, ICAR-IIMR during October 17 to 19, 2024. The event, brought together a distinguished gathering of policymakers, researchers, and industry experts to discuss the future of millets. This convention served as a vital platform for stakeholders in the millet sector, including government officials, industry leaders, researchers, and start-ups, to converge and discuss the future of millets in agriculture and nutrition. The event was marked by a series of technical sessions, exhibitions, and networking opportunities aimed at promoting millets as a sustainable and healthy alternative.



The R&D convention was inaugurated by the esteemed Shri. P. Prasad, the Hon'ble Agriculture Minister of Kerala, who graced the occasion as the Chief Guest. Dr. T.R. Sharma, DDG (Crop Science), joined as the Guest of Honor. Dr. Ch. Srinivasa Rao, Director of ICAR-NAARM, presided over the function. Other dignitaries, including Dr. Sagar Hanuman Singh, DG NIPHM, Dr. Raj Bhandari, Member NTBN, Dr. Venkatesh Bhat, Principal Scientist and Director of Nutrihub at ICAR-IIMR, Dr. B Dayakar Rao, CEO of Nutrihub and National Convenor, and Dr. Sangappa, Scientist at ICAR-IIMR and Organizing Secretary, were also

present. The session was moderated by Dr. S. Srividya and Dr. V.M. Malathi, Scientists, ICAR-IIMR.



DDG Visit

Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi, visited Indian Institute of Millets Research (IIMR) on 10 May, 2024. He was accompanied by Dr. D.K. Yadava, ADG (Seed). Dr. Sharma was apprised about the ongoing research work and progress by Dr. C. Tara Satyavathi, Director, IIMR. During the interactive session of IIMR Scientists with DDG, Dr. Tara Satyavathi, made a brief presentation on the achievements of ICAR-IIMR and progress of construction work of Global Centre of Excellence facility. Dr. T.R. Sharma emphasized India's contribution of millets as



Nutritional and health food to the world and urged the scientists to demonstrate millets to the Global market through more value addition and varietal technologies.

Deputy Director General (CS) visits IIMR

On November 29th, 2024, the Deputy Director General (Crop Science) of ICAR visited the Indian Institute of Millets Research (IIMR), Hyderabad, to review the progress of ongoing activities under the Global Centre of Excellence on Millets (Shree Anna). The Central



Public Works Department (CPWD) team has explained the progress of the GCoE building, field research complex, and farm shed construction activities to the DDG (CS). He also visited the state-of-the-art genomics and molecular breeding research facilities developed at IIMR and discussed the ongoing experiments with the scientists. The Director of IIMR delivered a detailed presentation to the DDG, outlining the progress of the seven key components and activities of the GCoE on millets (Shree Anna).

Visit of Dr. Rakesh C Agrawal, DDG (Education), ICAR

Dr. R.C. Agrawal Hon'ble DDG (Education), ICAR visited ICAR- IIMR, Hyderabad on 21 August 2024 who was welcomed by the director Dr. C. Tara Satyavathi and other scientists. He was taken to the millet demo field, Common Facility Centre, Centre of Excellence on Millet Value Addition and Nutrihub. Hon'ble DDG had a meeting with the Director and the scientist on development of millet certificate course one each on millet production, processing and entrepreneurship development and also on the development of millet curriculum for students.

Field Day and Seed Distribution Program to Transfer the Improved Technologies to Farmers

On 3rd June 2024, ICAR-Indian Institute of Millets Research Hyderabad, promoted Bettada Basaweshwara

Farmer Producers Company, organized millet seed distribution program in Jakkaldinni village of Raichur district, Karnataka. Farmers received free millet seeds of Barnyard (CBYMV-1, DHBM 93-2), Little (CLMV-1), and Multicut Fodder Sorghum (CSH 24MF) from ICAR-IIMR scientists Drs. Sangappa and Amasiddha. During



the program, Dr. Sangappa emphasized the benefits of millet value addition, health and importance of creating marketing linkages via Farmer Producer Organizations (FPOs). Further, Dr. Amasiddha elaborated on the best cultivation techniques and strategies for establishing a sustainable millet seed bank of millets. More than 50 farmers participated in the event. The initiative was expected to boost millet production, ensure food security and promote the economic well-being of FPO farmers in Raichur district.

Field day cum Training on Small Ruminants and Poultry rearing

A one day field demonstration entitled "Sheep, Goat and Poultry production for sustainable livelihood" was organized on 13th June, 2024 at Hulsoor, Karnataka under ICAR-IIMR SCSP project by Dr. Sangappa and FPO-NEST team. The demonstration was collaboratively organised by Veterinary College, Bidar (KVAFSU, Bidar), ICAR-IIMR, Hyderabad and Hulsoor Mahila Kisan Millets Producer Company Limited. A total of 50 farmers participated in the program from Basavakalayan, Bhalki, Bidar and Humnabad blocks of Bidar district of Karnataka state. ICAR-IIMR, FPO NEST team briefed the trainees about the purpose and importance of the training programme. At the outset, Dr. Chikkagoudar Kotresh Prasad delivered a lecture on management of sheep and goats in the stall-feeding system. An overview on backyard poultry



production system was given by Dr. Vidyasagar. In an interactive session with farmers Dr. Waghmore, Dr. Ambika, Mr. Ashok Sajjan. Mr. Kailashnath Korishetty and Mr. Abbuseth participated and clarified the doubts of the participants. As a part of the program free fodder seeds and animal feeds were distributed to eligible SC participants. The participants were more interested to know the importance of scientific rearing of poultry and small ruminants. Further, farmers expressed their satisfaction and showed interest to replicate the improved technologies learnt in training for enhancing their production.

Field day on Crop Cultivation Ration Card to FPO farmers of Skota FPO

On July 6, 2024, S. Kota Rythu Bharat FPO, promoted by ICAR-IIMR organized field day on Crop Cultivation Ration Card (CCRC) campaign to the FPO farmers of Timidi village at SKota block with the help of agriculture and revenue departments and NABARD officials. During the field day, Agricultural Officers and Revenue Department officials highlighted the



importance of Rythu Bharosa and PM Kisan schemes and demonstrated the procedures on how to access and utilize these schemes for ensuring farmer welfare.

The event also included sessions on best practices in crop cultivation, emphasizing sustainable agricultural techniques. Farmers were encouraged to adopt these methods to improve yield and income. Approximately 45 farmers attended the meeting in Timidi village. The event concluded with a feedback session where farmers expressed their appreciation and suggested areas for future training and support. Dr. Sangappa organized this field day with the help of Sri. Nagarjuna DDM Vizianagaram.

Field Day at ICAR-IIMR, Hyderabad along with South African Delegates

Mr. Venkataiah, Mr. Vishnuvas Reddy, Mr. Naresh and Dr. Muralidhar Reddy from Dhundubi FPO participated in field day and interacted with IIMR team and scientists of South African country at ICAR-IIMR, Hyderabad on 20th July, 2024. The field day was aimed to strengthen research collaborations between IIMR and South African countries. During the visit, farmers toured various research facilities, experimental farm areas, gene bank, Nutrihub and production plants of ICAR-IIMR. They observed cutting-edge research and advancements in millet cultivation, processing, and value addition. The interaction with South African scientists provided valuable insights into global research practices and potential collaborative opportunities.



Farmer Scientist Interaction and Farmers Field Day at Tekmal FPO promoted by IIMR

FPO-NEST team and Agriculture Drone Project team of ICAR-IIMR, Hyderabad organized Farmers Scientist interactive meet and Drone Spraying Field Day at Kusangi Village of Tekmal Mandal, Medak district with the help of Tekmal Mandal Farmer Cooperative Society on 21st August, 2024. Dr. C Tara Satyavathi, Director,



ICAR-IIMR acted as chief guest of the Program and addressed the importance of technology adoption in agriculture and utilization of drones for effective spraying in cotton and paddy fields. Further she applauded the Tekmal FPO activities and efforts in adopting new technology. Dr. Gangaiah, Principal Scientist explained the operational procedures of Drone and Dr. Sangappa, Scientist, highlighted the importance of FPO in effective utilization of ADP program.

Farmers' Field Day on advanced agricultural mechanization

Sh. K. Srinivasa Babu, Drs. Sangappa, and Rafi from ICAR-IIMR, Hyderabad along with Lamabsingi FPO participated in Farmers Field Day on theme "Advanced Agricultural Mechanization" on 29th August, 2024 at ARS, Ragolu, Srikakulam. The purpose of this visit was to



introduce modern agricultural machinery, such as seed drills, precision planters, harvesters, and threshers, to enhance farming efficiency and productivity. The event also provided stall for FPOs and provided hands-on experience to farmers in adopting these innovations for more efficient and sustainable farming practices. Further Lambasingi FPO also showcased their value added products in the stall and made a business transaction of 12000.

Millet Field Day to Farmers at Tekmal FPO Promoted by ICAR-IIMR

Dr. Sangappa and FPO-NEST team of IIMR, Hyderabad along with Sh. Veer Shetty, Millet Man of Telangana conducted millet field day to millet growers in Dadaypalle village of Tekmal Mandal



on 29th August, 2024. The field day was organized in the fields of millet farmers who took free seed distributed by ICAR-IIMR through Tekmal FPO. Mr. Veer Shetty demonstrated key harvesting techniques by examining millet panicles, and shared information on millet processing methods that helps farmers to improve their practices. A total of 45 farmers attended the field day program.

Barnyard Seed Production Field Day at Bettada Basaveshwar FPCL promoted by ICAR-IIMR, Hyderabad

Drs. Sangappa and Amasiddha Scientists from ICAR-IIMR, Hyderabad organized Barnyard seed production farmers field day at Bettada Basaveshwar Farmer Producer Company, promoted by ICAR-IIMR Hyderabad on 12th September, 2024. Dr. Amasiddha, provided in-depth explanation on millet varieties, significance of cultivation and harvesting techniques.



Dr. Sangappa, suggested developing Jakkaladinni village into a millet seed production hub. Mr. Anil Rachmalla, a millet entrepreneur from Hyderabad appreciated the efforts of FPO for contributing to millet seed production.

Farmers Field day on Crop Diversification through Millets & Value Addition of Millets at Tekmal Farmers Producer Cooperative Society

ICAR-IIMR, Hyderabad, ESAF Foundation and Tekmal FPCS, promoted by ICAR-IIMR had jointly organized a farmers' field day program on "Crop Diversification through millets and Value Addition of Millets on 24th September, 2024" at Palvancha Village of Tekmal Mandal, Medak District. Cultivation



practices, health benefits, nutritional properties of millets were clearly explained by Mr. Veer Shetty, Millet Man of Telangana and Scientists of IIMR. Farmer's field day was conducted where all the farmers were taken to foxtail millet fields of Chakali Sai and Puli Subash in Palvancha village and showed the harvesting practices of foxtail millet. With the help of thresher and dehuller given by IIMR, Mr. Veershetty showed practical exposure to farmers by running the machines. Further from dehulled grains atta was prepared and the same was used in preparing value added products by engaging women members of FPO. A total of 110 farmers attended the training. Dr. Sangappa and Mr. K. Ramakiran coordinated this field day.

Field day by Thandava Valley and Sri Alluri FPOs of ICAR-IIMR

Thandava Valley Horticulture & Agriculture FPMACS Ltd. and Sri Alluri FPO MACS Ltd., promoted by ICAR-IIMR Hyderabad, organized field day on October 2024 to engage farmers in sustainable farming practices and organic cultivation techniques. Thandava Valley FPO hosted its program on 22nd October at Kesavaram and Rajavaram villages in Payakaraopeta block, where Mandal Agriculture Officer Mr. Adinarayana advised farmers on managing pest infestations in paddy fields and recommended organic sprays for the tillering stage to support crop growth. Similarly, on 30th October, Sri Alluri FPO held a polambadi session at Podhi village in Hukumpeta block for millet harvesting and post-harvest guidance. Mandal Agriculture Officer and Horticulture Officer demonstrated on using Ghana Jeevamrutham in millet fields for improving soil health and crop yields. A total of 140 farmers participated in this polambadi program organized by Dr. Sangappa & FPO-NEST of ICAR-IIMR, Hyderabad.



S. No.	Name	Affiliation	Date
1	P. Prasad	Minister for Agriculture, Government of Kerala	3 Feb, 2024
2	B. Ashok	APC, Kerala	3 Feb, 2024
3	B. Meena Kumari	Former DDG (FS) ICAR & Former Chairperson, National Biodiversity Authority Cochin	6 Feb, 2024
4	Vincent Vadez	IRD-France, ex-ICRISAT	21 Mar, 2024
5	Alexander Grondin	IRD-France	21 Mar, 2024
6	R.C. Agarwal	DDG (Ag. Edu), ICAR	21 Mar, 2024
7	H.S. Gupta	Chairman, Assam Agriculture Commission	1 Oct, 2024
8	L. Madan Kumar Reddy	Dy CEO (South Zone), KUIC	18 Dec, 2024

Dr. Rajeev Varshney, Director, Centre for Crops and Food Innovation, Murdoch University, Australia visited ICAR-IIMR on 4 January, 2024. Dr. C Tara Satyavathi, Director and other scientific fraternity of IIMR felicitated



him for attaining the prestigious position and his contributions in genomics, genetics, molecular breeding research. Dr. Varshney had a detailed dialogue with IIMR team on issues of mutual interest. He also visited Centre on Excellence, Technology Business Incubator and other millet processing facilities.

Dr. PB Kirti, Agri Biotech Foundation, Hyderabad and Former Professor of Plant Sciences, University of Hyderabad visited IIMR on 16 January, 2024. Dr. C Tara Satyavathi explained him the recent activities of IIMR.



He interacted with the IIMR Scientists.

Mr. Neeraj Prajapathi, the campaigner of Millets, who is traveling from Kashmir to Kanyakumari (4200 km) on bicycle visited IIMR on 17 January, 2024. Dr. C Tara Satyavathi, Director - IIMR felicitated him for his inimitable efforts to popularize millets across the nation.



Visit of Hon'ble Agriculture Minister of Kerala

Shri P. Prasad, Hon'ble Minister for Agriculture, Government of Kerala visited the ICAR-Indian Institute of Millets Research, Hyderabad on 3 February, 2024.



Dr. C Tara Satyavathi, Director, IIMR apprised him about the ongoing R&D activities at IIMR including health benefits of consuming millets to overcome lifestyle diseases. The dignitary was shown all millet processing facilities including CoE and Nutri Hub at IIMR by Dr. B Dayakar Rao. The minister emphasized about the need for more work on promotion of millets based value-added products in urban and peri-urban areas with better marketing linkages through formation of FPOs, SHGs, and other agencies. He also suggested the deployment of processing machinery right in the villages where millets produced are processed through farm gate processing programme to ensure better returns to farmers.

Visit of Dr. (Mrs.) Neeraja Prabhakar, VC of SKLTSHU, Telangana State on the eve of International Women's Day celebration

ICAR-Indian Institute of Millets Research celebrated the "International Women's Day-2024" on 8th March



under the theme of 'Invest in Women, Accelerate progress'. Chief guest Dr. (Mrs.) Neeraja Prabhakar, VC of SKLTSHU, Telangana State interacted with the staff of IIMR and delivered a special lecture on the significance of empowering women through education and life skills for the betterment of the society. She also shared her memories of millet foods and importance of including millets in the daily diet. Director, IIMR also addressed the staff of IIMR and shared her words of encouragement.

Visit of Perumal Ramasamy, Kansas State University, USA.

Dr. Perumal Ramasamy, Professor - Sorghum and Millet Breeding, Kansas State University, USA visited the Institute on 4th March, 2024 to understand the research activities, millet processing and value-addition, business incubation, entrepreneurship



and training programmes undertaken for the promotion of millets. In the presence of the Director, he had discussions with the scientists on possible collaborations in the future as ICAR-IIMR, Hyderabad has to cater to global needs. He also suggested for collaboration in the Ph.D. student programmes for enhancing the quality of research. Dr. Karnam Venkatesh, Senior Scientist explained the activities of the Genebank and the details of the millet germplasm collections. He also visited the Centre of Excellence, Nutri-Hub and Processing Units to understand the activities undertaken. The diverse millet food products and processing technologies that are developed and standardized for commercialization were showcased to him. Dr. P Rajendrakumar, Principal Scientist (Biotechnology) coordinated the visit.

Visit of UP Minister

A visit was made by Sri Surya Pratap Shahi, the Hon'ble Agricultural Minister of Uttar Pradesh and Sri Baldev Singh Aulakh, the Hon'ble Agricultural Minister of State,



to the Indian Institute of Millets Research (IIMR) on 28 August, 2024. They were welcomed by Dr. Dayakar, the Director In-charge. During the visit, the dignitaries toured the millets germplasm unit and observed a millet field demonstration, showcasing advancements in millet cultivation. They also visited the seed processing unit, where various processing techniques were demonstrated. The event concluded with Sri Surya Pratap Shahi addressing the IIMR scientists, emphasizing the importance of millets in sustainable agriculture and innovation.

Visit of International participants from Asian and African countries to ICAR-IIMR, Hyderabad as a part of International ITEC Training Program

Centre for ICT, MANAGE, Hyderabad organized an International ITEC Training Program on "Applications of ICTs in Agriculture" at MANAGE, Hyderabad, from 4th to 17th December, 2024. The program brought together 30 international participants from Asian and African countries to explore the transformative role of ICTs in agriculture. As part of the training, the participants visited ICAR-Indian Institute of Millets Research (ICAR-IIMR), Hyderabad, on 11th December, 2024 to gain insights into the integration of ICT in millet cultivation and promotion.

Dr. Sangappa Scientist, ICAR-IIMR, Hyderabad detailed about the overview of millet value chain, role of Farmer Producer Organizations (FPOs), and various initiatives undertaken by ICAR-IIMR to promote millets and support farmers. Drs. KN Ganapathy, S Avinash, and K Venkatesh Scientists,



ICAR-IIMR shared valuable insights on the nutritional and economic aspects of millets. The participants were taken to Gene Bank and highlighted the IIMR's efforts in preserving genetic diversity for future agricultural advancements. The visit also included discussions on modern agricultural practices, a field visit to observe millet cultivation techniques.

Secretary (Agriculture and Farmers Welfare) and Joint Secretary INM, DG MANAGE visited ICAR-IIMR

The hon'ble Secretary (Agriculture and Farmers Welfare), DA&FW Dr. Devesh Chaturvedi, IAS and Hon'ble Joint Secretary (INM) and DG MANAGE Dr. Yogita Rana, IAS visited ICAR-IIMR on 29 September, 2024. They were welcomed by the Director after a brief review on Global CoE and MAHARISHI projects. They visited demo field, Common Facility Centre, Nutrihub and CoE on Millet Value Addition. They were appraised of the facilities and the work done to promote entrepreneurship at ICAR-IIMR. The Joint Secretary proposed to have Nutrihub like facility in North Eastern State under Mission Organic Value Chain Development in North Eastern Region.

Students and Farmers Visits

S. No.	Date	From	Total No. of visitors
STUDENTS			
1	17 January, 2024	Kendriya Vidyalaya, Hyderabad	250
2	17 January, 2024	Kerala Agriculture University, Vellanikkara, Kerala	100
3	8 January, 2024	Students from SRM University, College of agriculture, Chennai	80
4	10 February, 2024	Final year B.Sc., students from the College of Agriculture, Kalaburgi	60
5	27 February, 2024	University of Agricultural Sciences, Dharwad, Karnataka	62
6	28 February, 2024	KL University, Hyderabad	37
7	27 February, 2024	Bijapur, Karnataka	85
8	28 February, 2024	Engineering students from Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad	30
9	7 March, 2024	Students of M.Sc. from PC Jabin Science College, Hubballi, Karnataka	30
10	7 March, 2024	Final year B.Sc. Agriculture students from SRS college of Agriculture and Technology Vendasandur, Agaram, Tamil Nadu	225
11	11 March, 2024	Tamil Nadu Agriculture University, Coimbatore	109
12	3 April, 2024	Nammazhvar College of Agriculture and Technology, Kamudi, Tamil Nadu	80
13	18 April, 2024	KSNUAHS, Shivamogga, Karnataka	
14	10 July, 2024	SCSPA, College of Agriculture, Ashti, Beed and Latur of Maharashtra	88
15	27 August, 2024	College of Agriculture, Pune, Maharashtra	23
16	14 August, 2024	Shramshakti College of Food Technology	60
17	6 September, 2024	BBA students from St. Mary's College, Hyderabad	30
18	19 September 2024	Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (KSNUAHS), Shivamogga, Karnataka	55
19	21 October, 2024	Lokmangal College of Agricultural Biotechnology, Wadala, Sholapur	20
20	7 November, 2024	Postgraduate nutrition students from St. Ann's College for Women, Mehdipatnam	95
21	16 December, 2024	Phoenix Global School, Rajahmundry, Andhra Pradesh	70
22	17 December, 2024	Rani Laxmi Bhai Central Agriculture University	45
FARMERS			
1	4 January, 2024	Farmers from Tamil Nadu	21

S. No.	Date	From	Total No. of visitors
2	8 January, 2024	Farmers from Etah District of Uttar Pradesh	25
3	16 January, 2024	Farmers from Bhusawal, Maharashtra	9
4	22 January, 2024	Farmers from Urban Rural Agrofly Farmer Producer Company Limited, Maharashtra	
5	29 January, 2024	Farmers from Agriculture Department, Gazipur, Uttar Pradesh	10
6	25 January, 2024	Farmers from Vikarabad District of Telangana	25
7	5-6 February, 2024	Farmers from Tamil Nadu visited ICAR-IIMR, Hyderabad	60
8	7 February, 2024	Farmers from Dindori, MP visited ICAR-IIMR	31
9	08 February, 2024	Farmers from Thane and Palghar, Maharashtra	14
10	21 February, 2024	Farmers from Salem and Tirunelveli, Villupuram districts of Tamil Nadu	20
11	22 February, 2024	Farmers of Rashtriya Asahaya Sevashram Parishad, Prayagraj, Uttar Pradesh	35
12	23 February, 2024	Farmers from Dindori district of Madhya Pradesh	35
13	6 March, 2024	Farmers of Kanpur dehat, Uttar Pradesh	35
14	6 March, 2024	25 Farmers from Madhya Pradesh	25
15	14 March, 2024	Farmers (30) from Koraput, Odisha	30
16	4 July, 2024	Farmers from Nashik, Maharashtra through Agriculture Technology Management Agency (ATMA), Nashik	40
17	1 July, 2024	Farmers from Tiruvannamalai, Tamil Nadu	25
18	30 July, 2024	Farmers from Tirunelveli, Tamil Nadu	25
19	5 September, 2024	Tribal farmers from Adilabad district	
20	10 September, 2024	Farmers from Bihar	30
21	24 September, 2024	Farmers from Virudhunagar, Tamil Nadu	20
22	9 October, 2024	Farmers from ATMA, Ramanathapuram, Tamil Nadu	20
23	23 October, 2024	Farmers from Tirupur, Tamil Nadu	30
24	19-20 November, 2024	Farmers from Agricultural Technology Management Agency (ATMA), Tamil Nadu	40
25	4 December, 2024	Farmers from Assam	15

As on 31 December, 2024

Dr. C. Tara Satyavathi,
Director

Scientific Staff

S. No.	Name	Designation	Discipline
1	Dr. B. Dayakar Rao	Principal Scientist	Agril. Economics
2	Dr. G. Shyam Prasad	Principal Scientist	Agril. Entomology
3	Dr. C. Aruna Reddy	Principal Scientist	Plant Breeding
4	Dr. B. Venkatesh Bhat	Principal Scientist	Genetics & Cytogenetics
5	Dr. B. Gangaiah	Principal Scientist	Agronomy
6	Dr. N. Kannababu	Principal Scientist	Seed Technology
7	Dr. A.V. Umakanth	Principal Scientist	Plant Breeding
8	Dr. I.K. Das	Principal Scientist	Plant Pathology
9	Dr. P.G. Padmaja	Principal Scientist	Agril. Entomology
10	Dr. B. Subbarayudu	Principal Scientist	Agril. Entomology
11	Dr. K. Hariprasanna	Principal Scientist	Plant Breeding
12	Dr. P. Rajendrakumar	Principal Scientist	Biotechnology
13	Dr. Rajendra R Chapke	Principal Scientist	Agril. Extension
14	Dr. A. Kalaisekar	Principal Scientist	Agril. Entomology
15	Dr. D. Balakrishna	Principal Scientist	Biotechnology
16	Dr. T. Napoleon	Principal Scientist	Genetics
17	Dr. P. Sanjana Reddy	Principal Scientist	Plant Breeding
18	Dr. K.N. Ganapathy	Principal Scientist	Plant Breeding
19	Dr. J. Stanley	Principal Scientist	Agril. Entomology
20	Dr. R. Venkateswarlu	Sr. Scientist	Biochemistry
21	Dr. Anuradha Narala	Sr. Scientist	Agril. Economics
22	Dr. Avinash Singode	Sr. Scientist	Plant Breeding
23	Dr. Venkatesh Karanam	Sr. Scientist	Genetics & Plant Breeding
24	Dr. D. Seva Nayak	Sr. Scientist	Physiology
25	Sh. K. Srinivasa Babu	Scientist (SS)	Agril. Entomology
26	Dr. P. Mukesh	Scientist (SS)	Computer Applications
27	Ms. Hemasankari	Scientist	Agril. Engineering
28	Dr. G. Rajesha	Scientist	Plant Breeding
29	Dr. Jinu Jacob	Scientist	Biotechnology
30	Dr. Sangappa Chillarge	Scientist	Agril. Extension
31	Dr. Amasiddha Bellundagi	Scientist	Plant Breeding

S. No.	Name	Designation	Discipline
32	Dr. A. Srinivas	Scientist	Agri. Extension
33	Dr. Sooganna	Scientist	Seed Science & Technology
34	Dr. Deepika Cheruku	Scientist	Plant Breeding
35	Dr. Swarna Ronanki	Scientist	Agronomy
36	Dr. S. Srividhya	Scientist	Plant Physiology
37	Dr. V.M. Malathi	Scientist	Biochemistry
CRS, Solapur			
38	Dr. Baswaraj Raigond	Sr. Scientist & O/I	Pathology
39	Dr. Parashuram Patroti	Scientist (SS)	Plant Breeding
RRS-Pearl Millet, Gudamalani, Barmer, Rajasthan			
40	Dr. Shailendra Nath Saxena	Principal Scientist & Head	Plant Physiology
41	Dr. Gopi Kishan	Scientist	Plant Pathology
AICRP on Pearl Millet, PC Unit, Jodhpur			
42	Dr. Vikas Khandelwal	Sr. Scientist	Plant Breeding

Technical Staff

Name	Designation
Sh. H.S. Gawali	Chief Technical Officer
Ms. D. Revati	Chief Technical Officer
Sh. D.M. Bahadure	Assistant Chief Technical Officer
Dr. Mahesh Kumar	Assistant Chief Technical Officer
Sh. S. Narendar	Technical Officer-Electrician
Dr. V. Ravi Kumar	Technical Officer-Computers
Sh. Raghunath Kulkarni	Technical Officer - Field / Farm
Sh. Aghav Vilas Dnyanoba	Technical Officer-Farm Superintendent
Dr. P V Rajappa	Technical Officer-Field / Farm
Sh. Surabhi Naresh	Sr. Technical Assistant
Ms. Usha R Satija	Sr. Technical Assistant
Sh. Prashant Bhusari	Sr. Technical Assistant
Sh. J. Bhagavantam	Technical Assistant
Sh. C. Bikshapathi	Sr. Technician
Sh. Sai Karthik	Sr. Technician
Sh. Manthri Kumara Swamy	Sr. Technician
Sh. G. Chimanlal	Technician
Sh. Rahul Pandey	Technician
Sh. Sumit Kumar	Technician
Sh. Shaik Abdul Gani	Technician
Sh. Sumit Kumar (Tyagi)	Technician
CRS, Solpaur	
Sh. A.R. Limbore	Assistant Chief Technical Officer
Sh. R.M. Patil	Sr. Technical Assistant
Sri Y.S. Kshirsagar	Sr. Technician
Sh. Kanhaiya Lal Athya	Technician

Administrative Staff

Name	Designation
Ms. Ritu Dalal	Senior Administrative Officer
Sh. Shaik Rukman	Finance & Accounts Officer
Sh. Shivaprasad Perumalla	Administrative Officer
Ms. V.S.G .Parvathi	Assistant Administrative Officer
Ms. G. Saraswathi	Assistant Administrative Officer
Sh. D. Rambabu	Assistant Administrative Officer
Ms. N Kanaka Durga	Private Secretary
Ms. A. Usha Rani	Private Secretary
Sh. S. Rama Murthy	Private Secretary
Sh. M. J. Nadaf	Assistant
Sh. K. Suresh Kumar	Assistant
Sh. Md. Inayatuddin	Assistant
Mr. Abhijeet	Assistant
Ms. M Susmitha	Assistant
Mr. Babloo Kumar	Assistant
Mr. Mohammad Shadab	Assistant
Ms. Amandeep Kaur	Assistant

Skilled Supporting Staff

Name	Designation
Sh. J. Narsimha	SSS
Smt. G. Prameela	SSS
Smt. Parvathamma	SSS
Sh. Amruth Raj Santosh	SSS
CRS, Solapur	
Sh. J.V. Chatre	SSS
Sh. Malik Dharma Nanware	SSS

Personnel Joined IIMR

Name	Designation	Joined on
Mr. Sumit Kumar	T-1	6 May 2024
Mr. Rahul Pandey	T-1	6 May 2024
Mr. Kanhaiya Lal Athya	T-1	6 May 2024
Mr. Shaik Abdul Gani	T-1	9 May 2024
Mr. Abhijeet	Assistant	26 Aug 2024
Ms. M Susmitha	Assistant	10 Sep 2024
Mr. Babloo Kumar	Assistant	9 Sep 2024
Mr. Mohammad Shadab	Assistant	23 Sep 2024
Ms. Amandeep Kaur	Assistant	30 Sep 2024
Sh. Sumit Kumar (Tyagi)	T-1	5 Nov 2024
Sh. Shivaprasad Perumalla	Administrative Officer	21 Nov 2024

Personnel Promoted

Name	From	To
Dr. K.N. Ganapathy	Senior Scientist	Principal Scientist
Dr. J. Stanley	Senior Scientist	Principal Scientist
Dr. D. Seva Nayak	Scientist	Senior Scientist
Ms. D. Revati	ACTO	CTO
Smt. Usha Satija	Technical Assistant	Sr. Technical Assistant
Sh. Prashanth Bhusari	Technical Assistant	Sr. Technical Assistant
Sh. S. Naresh	Technical Assistant	Sr. Technical Assistant
Sh. Manthri Kumara Swamy	Technician	Sr. Technician

Personnel Superannuated

Name	Designation	Retired on
Dr. K.B.R.S. Visarada	Principal Scientist (Genetics & Cytogenetics)	31 May 2024
Dr. K.V. Raghavendra Rao	Chief Technical Officer	31 August 2024
Sh. O.V. Ramana	Chief Technical Officer	31 August 2024

Sad Demise

Name	Designation	Date
Sh. G. Samaiah	SSS	23 January 2024

75th Republic Day celebrated

The Nation's 75th Republic Day was celebrated with patriotism, enthusiasm and unity at Indian Institute of Millets Research on 26 January, 2024. Dr. C Tara Satyavathi, Director, IIMR unfurled the national flag and addressed the staff. On this occasion, Director mentioned about the collective effort of all the IIMR staff in successful celebration of International Year of Millets-2023 and praised the contribution of individuals in this great achievement. Director also expressed the need of dedication to meet the challenges of food and nutritional security in the nation and extension of enthusiastic participation, coordination and collective group works in future. She stressed on the need to repeat the productive performance of 2023 in the coming years with higher deliverables. The IIMR staff and children of IIMR staff also actively participated in the celebrations. The institute reverberated with patriotic fever and enthusiasm ending with the prize distribution. Dr. B Amasiddha, Scientist and Sh. J Bhagavantham, Technical Assistant (Farm Section) and his team were the coordinators of the event.

IIMR Foundation Day celebrated

The ICAR-Indian Institute of Millets Research, Hyderabad celebrated its "9th Foundation Day" on 9 February, 2024. Dr. Tamilisai Soundararajan, Hon'ble Governor of Telangana and the Lieutenant Governor of Puducherry was the Chief Guest. Dr. SL Mehta, Former DDG (Edu.), ICAR, Former VC, MPUAT, Udaipur and Dr. Jacqueline d'Arros Hughes, DG, ICRISAT were the Guest of Honors. Directors from various ICAR Institutes located at Hyderabad, former Director of IIMR Dr. N Seetharama and former Director (Acting) Dr. CV Ratnavathi graced the occasion.



At the outset, in her welcome address, Dr. C Tara Satyavathi, Director, ICAR-IIMR, Hyderabad emphasized on the Institute's role in the past and future. She also briefed the activities taken-up during International Year of Millets in 2023 and roadmap of the forthcoming Global Centre of Excellence on Millets.

In her address, the Chief Guest, Dr. Tamilisai Soundararajan, Hon'ble Governor of Telangana highlighted the importance of Millets as health foods in daily life and Government of India's support for the Millets promotion. She felicitated Dr. SL Mehta for his support to millets research at IIMR as Chairman of QRT and member of RAC. The dignitaries distributed the awards and mementos to the best FPOs supported by IIMR, millet seed production farmers, Millet entrepreneurs and certificates of appreciation and mementos to the best staff of IIMR; Prior to this programme, the Governor also visited all the millet processing units, Centre of Excellence on Millets, Startup and incubation facilities at Nutrihub of IIMR.

Dr. Jacqueline d'Arros Hughes in her address discussed about the way forward to strengthen the collaboration between the ICAR-IIMR and ICRISAT for maximizing the revenue of the millions of Millets farmers with minimum input. Dr. SL Mehta, Former DDG (Edu.), ICAR, Former VC, MPUAT, Udaipur specified a brief address on millets research in India.

To mark the occasion, three books entitled “Shree Anna Activities by ICAR-IIMR during the International Year of Millets-2023”, “Millet Improvement in India” and “Registered Genetic Stock of Millets in India” were released. Later, research fellows, students and staff of IIMR presented some Cultural events.

National Science Day Celebration-2024

ICAR-Indian Institute of Millets Research, Hyderabad, celebrated National Science Day on 28 February, 2024, by conducting an awareness programme at Springfield High School, Rajendranagar. The theme of this year's Science Day was 'Indigenous technologies for viksit bharat'. The scientists from ICAR-IIMR spoke to around 50 students from VII and VIII standard on the importance of the science day. As millets are one of the most valuable indigenous technologies in our country, the scientists talked about the importance of millets, types of millets and their health benefits. They encouraged students and teachers to include millets in their daily diet. Millet specimens were displayed and explained. Students were curious throughout the lecture and they interacted enthusiastically. They were given millet snacks to taste. The programme was organised by Drs. Jinu Jacob and Deepika C.

International Women's Day celebration

ICAR-Indian Institute of Millets Research celebrated the “International Women's Day-2024” on 8th March under the theme of 'Invest in Women, Accelerate progress'. Dr. KBRS Visarada, PS, IIMR delivered the welcome address and introduced the chief guest of her significant



contributions. Chief guest Dr. (Mrs.) Neeraja Prabhakar, VC of SKLTSHU, Telangana State interacted with the staff of IIMR and delivered a special lecture on the

significance of empowering women through education and life skills for the betterment of the society. She also shared her memories of millet foods and importance of including millets in the daily diet. Director, IIMR also addressed the staff of IIMR and shared her words of encouragement. All the staff members of IIMR enthusiastically participated in the session and expressed their views on celebrating women's day. The meeting ended with vote thanks by Dr. Srividhya, Scientist, IIMR.

'World IP day' observed

ICAR-Indian Institute of Millets Research, Hyderabad organized a “World IP day- 2024” program on 30th April, 2024. Dr. SK Soam, Head-ICM division, NAARM, was the chief guest and delivered the lecture related



to the IP day theme “IP and the SDGs: Building our common future with innovation and creativity”. All the staff of IIMR-Hyderabad including project staff attended the program, Dr. Amasidha, Scientist, IIMR was the coordinator of this event.

Combined Annual Group Meetings of AICRP on Sorghum & AICRP on Small Millets

The combined Annual Group Meetings of AICRP on Pearl millet, 54th Annual Group Meetings of AICRP on sorghum and 35th Annual Group Meetings of AICRP on Small millets were held at Regional Agricultural Research Station, ANGRAU, Tirupati, Andhra Pradesh during 27-28 June, 2024. The meeting was inaugurated by Dr. TR Sharma, DDG (CS), ICAR, New Delhi. The three-day group meeting was attended by about 500 delegates including Directors of ICAR institutes, scientists from AICRP on Pearl millet, Sorghum and Small millets centres, ICRISAT, Private sector,

ICAR-Indian Institute of Millets Research (IIMR), Hyderabad and other stakeholders.

The inaugural session of workshop commenced 27th June, 2024 with lighting of the lamp by dignitaries followed by ICAR song and ANGRAU song. Dr. TR Sharma, DDG (CS), ICAR was the Chief guest. The other dignitaries on the dais were: Dr. R Sarada Jayalakshmi Devi, VC, ANGRAU (Distinguished guest), Dr. SK Pradhan, ADG (FFC) (Guest of honour), Dr. C Tara Satyavathi, Director-IIMR & PC- Pearl millet, Dr. R Madhusudhana, PC-Sorghum & Small millets, Dr. PV Satyanarayana, Director of Research-ANGRAU, and Dr. V Sumathi. Associate Director of Research, RARS, Tirupati.

At the outset, Dr. V Sumathi welcomed the dignitaries and participants to the AGM. Dr. PV Satyanarayana gave opening remarks. Dr. C Tara Satyavathi presented the research highlights of pearl millet and Dr. R Madhusudhana presented the research highlights of sorghum and small millets. Dr. SK Pradhan gave inaugural address. He mentioned that though food grain sufficiency is attained, nutritional sufficiency is yet to be achieved for which millets are most viable option. Productivity has to be increased in millets to make their cultivation profitable. Dr. Sarada Jayalakshmi Devi, V.C., ANGRAU felt that introduction of millets in Public Distribution System enhances millets production and consumption. Incentives need to be provided to millet farmers.

Dr. T.R. Sharma, DDG-ICAR gave his inputs for overall improvement and popularisation of millets. He mentioned that pearl millet is a major millet crop, with



more than 50% of millet production and food for 90 million people in the world. Identification and use of new male-sterile system for hybrid development should be targeted in pearl millet. AICRP centers should work

on identification of resistant sources for biotic stresses and they should be involved in breeding programs for development of resistant cultivars.

During the inaugural session 4 books, 15 technical bulletins and pamphlets were released. Superannuating scientists were honoured during the occasion. In the subsequent sessions, the Principal Investigators (PIs) of different disciplines of both Sorghum and small millets presented the progress reports. On the second day - One special guest lecture was delivered on "Root and Rhizosphere Engineering for Developing Climate - Resilient Crops" by Dr. Eswar Rami Reddy, IISER, Tirupati. Later, Dr. TR Sharma, DDG-ICAR, Dr. SK Pradhan, ADG (FFC) and Dr. SS Mane, Member, PAMC given their remarks on the projects. In conclusion, V Sumathi, ADR, RARS, Tirupati presented the Vote of thanks. This event was coordinated from IIMR side by Dr. IK Das, and Sh. K Srinivasa Babu along with various committee members under the management of Project coordinators.

Varietal Identification Committee meeting

The Varietal Identification Committee meeting was held on 27th June, 2024 in hybrid mode under the Chairmanship of Dr. TR Sharma, Deputy Director (CS). Dr. SK Pradhan, Assistant Director General (FFC) was the Co-Chairman. The other members attended the meeting were: Dr. R Sarada Jayalakshmi Devi, VC, ANGRAU, (Special Invitee); Dr. DK Yadava, Assistant Director General (Seeds); Dr. Sanjay Kumar, Director, ICAR-IISS, Mau; Dr. P V Satyanarayana, Director of Research, ANGRAU, Sh A Britto, The Regional Manager, NSC, Secunderabad; Sh. N Sampath Kumar, District Manager, APSSDC Ltd., Vijayawada; Dr. Prabhakar, Former PC, AICRP on Small millets, Dr. C Aruna (Sorghum Breeding), Dr. B Gangaiah (Sorghum Agronomy and Physiology), Dr. IK Das (Sorghum Pathology), Dr. AV Umakanth (Sweets Sorghum Breeding); Dr. B. Venkatesh Bhat (Forage Sorghum Breeding); Dr. K Hariprasanna (Small millet - Breeding); Dr. TS Sukanya (Small millet - Agronomy); Dr. Palanna (Small millet - Pathology); Dr. Prabhu C Ganiger (Small millet-Entomology); Dr. Vikas Khandelwal, ICAR-AICRP on Pearl millet and Member Secretaries: Dr. C Tara Satyavathi, Director, IIMR and

PC-AICRP-Pearl Millet; and Dr. R Madhusudhana, PC-AICRP-Sorghum & Millets. A total of 22 proposals (Pearl Millet- 2, Sorghum-13 and Small Millets-7) were received. The committee critically examined proposals of Pearl Millet, Sorghum, Small Millets for different zones / states and 14 proposals were identified (Pearl Millet - 2, Sorghum - 6 and Small Millets - 6).

Centre-wise review of research progress and scientific audit

Prior to this event, as part of AGM 2024 the centre-wise review of research progress, scientific audit and work plan was held during 5-7 June 2024 on virtual mode under the Chairmanship of Dr. SK Pradhan, ADG (FFC) ICAR. Dr. C Tara Satyavathi, Director-IIMR & PC- Pearl millet and Dr. R Madhusudhana, PC-Sorghum and Millets welcomed the Chairman and expert Members of Project Advisory and Monitoring Committee, Dr. OP Yadav,



Dr. MVC Gowda, and Dr. SS Mane (Plant Pathology), and all the Officer In-Charge and participants from AICRP centers and Scientists of ICAR-IIMR. Dr. SK Pradhan in his opening remarks mentioned about the small millets and their importance as nutritional foods. The Officers in-charge of AICRP centres presented the brief account on the research undertaken, thrust areas, outcomes, shortfalls and strategies for future research. The technical programmes for 2024-25 were finalized through elaborate discussions within the disciplinary groups, PIs, respective PCs and Director, IIMR.

Brain storming session on “Developing Strategies for improving sorghum area and production”

As per the recommendation of Research Advisory Committee a brain storming session on “Developing

strategies for improving sorghum area and production” was held at ICAR-IIMR, Hyderabad on 19th June, 2024 in online mode. The agenda was to discuss on main reasons for decline in sorghum area and to come out with corrective measures. QRT and RAC members and eminent scientists including sorghum researchers from public sector, private sector and international institutes were invited for the meeting.

Dr C. Tara Satyavathi, Director, ICAR-IIMR, welcomed all the participants for the session and explained the purpose of the meeting indicating the concern on reduction in sorghum area. In spite of all the research efforts from public and private, the area has come down drastically. Now it is time to introspect to understand the reasons for the decline and to come out with strategies to increase area, production and productivity of sorghum. This is followed by presentations on different aspects of sorghum cultivation. Dr. B. Dayakar Rao made an elaborate presentation on “A case of strengthening R&D on sorghum production, consumption and utilization”.



Dr. C. Aruna presented on research opportunities in *kharif* sorghum. She presented the present status of the *kharif* sorghum research at IIMR and the possibilities to work for non-food uses of produce. Dr. B. Venkatesh Bhat made a presentation on opportunities in forage sorghum research. Dr. A.V. Umakanth presented the overview of sweet sorghum research and the opportunities for improving area under sweet sorghum. Dr. R. Madhusudhana, PC-Sorghum and Millets presented status of *rabi* sorghum research and opportunities. He explained the recent effort on *rabi* hybrid breeding by working on plant stature. Dr. Ephrem, Sorghum breeder from ICRISAT presented the international perspective. of increasing sorghum area and production. During deliberations suggestions and comments on various

issues in sorghum cultivation and strategy to address them were made by various experts' viz. Dr. O.P. Yadav, Director, CAZRI, Jodhpur, Dr. Prabhakar, former PC small millets, Bangalore and IIMR-RAC members, other experts from ICRISAT etc. were recorded.

Hindi Workshop

A one-day Hindi workshop was organized on 24 June, 2024 at ICAR-Indian Institute of Millets Research, Hyderabad. Shri Jaishankar Prasad Tiwari, former In-charge and Deputy Director, Central Hindi Training Sub-Institute, Department of Official Language, Ministry of Home Affairs, Government of India was a resource person. At the outset, Dr. Jinu Jacob, Scientist and In-charge, Hindi Cell welcomed the guest speaker and the participants. Dr. C Tara Satyavati, Director, IIMR, in her presidential address said that the Official Language implementation is running smoothly at IIMR, Hyderabad and we should take full advantage of such workshops to take the Official Language implementation forward at a faster pace. Smt. Ritu Dalal, Senior Administrative Officer, highlighted the official language implementation activities at the institute, and said that organizing such workshops will accelerate the official language implementation. Shri Tiwari gave a guest lecture and hands on training on "Standard Hindi and Noting & Drafting in Hindi".



He provided information about the Standard Hindi and its benefits. Apart from this, he explained the easy way of using Hindi in the noting and drafting used in the office and resolved the problems faced in the Official Language implementation. The workshop concluded with the vote of thanks by Dr. Mahesh Kumar, Assistant Chief Technical Officer (Official

Language). A total of 35 participants from all cadres including scientific, administrative and technical participated in the workshop. The entire workshop was coordinated and conducted by Dr. Jinu Jacob and Dr. Mahesh Kumar under the guidance of Dr. C Tara Satyavati.

International Yoga Day Observed

The ICAR-Indian Institute of Millets Research observed the "International Day of Yoga" on 21st June, 2024. On this occasion Dr. KBRS Visarada, Former Principal



Scientist, IIMR was invited as a special guest. The theme of this year's Yoga day celebration was "Yoga for Self and Society." Dr. C Tara Satyavathi, Director, IIMR welcomed the staff and said that, Yoga helps us to become strong which in turn, leads to enhancing personal well-being and fostering a more positive and harmonious society. Dr. Visarada explained the staff on the benefits of yogasanas along with the demonstration. She enlightened as to how yoga also enhances teamwork and communication power in day to day office work. Staff of IIMR including RAs, SRFs and contractual persons enthusiastically participated in this event. Mr. OV Ramana, CTO coordinated and arranged the event on this International Yoga Day.

Field Day at ICAR-IIMR, Hyderabad

Mr. Venkataiah, Mr. Vishnuvas Reddy, Mr. Naresh and Dr. Muralidhar Reddy from Dhundubi FPO participated in field day and interacted with IIMR team and scientists of South African country at ICAR-IIMR, Hyderabad on 20th July 2024. The field day was aimed to strengthen research collaborations between IIMR and South African countries. During the visit, farmers toured various research facilities, experimental farm areas, gene bank,

Nutrihub and production plants of ICAR-IIMR. They observed cutting-edge research and advancements in millet cultivation, processing, and value addition. The interaction with South African scientists provided valuable insights into global research practices and potential collaborative opportunities. Drs. Sangappa and Rafi coordinated this visit.



Hindi Chetana Maas Celebration

Hindi Chetna Maas Samaroh was inaugurated on September 2024 with lighting a lamp by Dr. C Tara Satyavathi, Director at ICAR-Indian Institute of Agricultural Research, Hyderabad. Dr. Jinu Jacob Scientist and I/c, Hindi Cell welcomed the officials and said that such ceremonies are mainly organized to attract everyone towards Hindi. Thereafter, Dr. C Tara Satyavathi administered the Rajbhasha Pledge to all the personnel.

On this occasion, Smt. Ritu Dalal, Senior Administrative Officer read out the message of Shri Shivraj Singh Chauhan, Honorable Union Minister of Agriculture and Farmers Welfare and Dr. Mahesh Kumar, ACTO (OL) read out the appeal of Dr. Himanshu Pathak, Secretary, DARE and Director General, ICAR. Apart from this, Dr. Mahesh Kumar, while highlighting the importance of Hindi Diwas, said that 75 years have been completed by giving the status of official language to Hindi, hence this year is being celebrated as Diamond Jubilee celebration. Apart from this, he provided information about various competitions being organized during Hindi Chetna Maas and Signature Campaign in Hindi.

Dr. C Tara Satyavathi in her address said that language is the main means of communication and Hindi preserves the unity in diversity of India.



Apart from this, she said that today Shri Anna (Millets) are going from local to global and only Hindi and local languages can support us for a long time for their promotion. The Inauguration programme concluded with a vote of thanks by Dr. Mahesh Kumar & national anthem. In the series of Hindi Chetana Maas celebration Extempore, Noting & Drafting, Translation competitions in Hindi were organized. All the staff including scientists, technicals, administrative, Research scholars participated enthusiastically. The entire program was coordinated and conducted by Dr. Jinu Jacob and Dr. Mahesh Kumar under the guidance of Dr. C Tara Satyavathi.

Swachhata Hi Seva campaign 2024

FPO Nest, ICAR-Indian Institute of Millets Research, Hyderabad organized a Swachhata Hi Seva program with the theme “**Swabhav Swachhata-Sanskaar Swachhata**” on 22nd September, 2024 with the objective to promote awareness on cleanliness and environmental responsibility through collective citizen involvement in public and institutional working areas.



The drive organized by IIMR involved in cleaning, waste collection, segregation and proper disposal in the institute's premises, public areas, main roads, common toilets and open free spaces. Through

this activity, ICAR-IIMR demonstrated the power of collaboration and the significance of cleanliness in both rural and urban settings. Additionally, the program mobilized 50 citizens, including FPO-NEST staff and local citizens. Dr. Sangappa, Scientist & Dr. Rafi, ICAR-IIMR, Hyderabad organised and coordinated the event.

Round Table Discussion - Research and Development Strategy for the Future of Millets in India and Globally

A roundtable discussion was organized to discuss the “Future of Millets in India and Globally”. The round table discussion opened with Dr. Raj Bhandari, Member NTBN emphasizing millets’ importance for climate resilience and global food security. Dr. Dayakar Rao, CEO Nutrihub and Dr. Shaik N. Meera, Director, ICAR-ATARI, Hyderabad spoke about the key R&D priorities. Dr. Rao stressed the importance of comprehensive research addressing health impacts and stakeholder needs, while highlighting practical challenges faced by farmers. Dr. Meera discussed millets’ nutraceutical potential and proposed technological innovations like automation and blockchain for crop monitoring and traceability.

Various participants from across the country discussed about market development expanding millet cultivation, improving value addition for better farmer income, and identifying effective cropping systems. Special attention was given to developing carbon footprint assessment methodologies and integrating millets with other high-value food products to enhance nutritional profiles. The discussion concluded with the vote of thanks to the Chair and participants were taken to a guided tour to the Centre of Excellence (CoE), Common Facility Centre (CFC) and Nutrihub at ICAR-Indian Institute of Millets Research.

Cookery Show

Chef Vikas Chawla, Founder of Core Hospitality Solutions, hosted an engaging live cookery show focused on innovative millet recipes. The session emphasized the nutritional benefits of millets and showcased how incorporating them into daily diets can lead to positive health outcomes.

The INCC 6.0 “Start-up Convention” commenced with

an opening address by Dr. B Dayakar Rao, CEO of Nutrihub, ICAR-IIMR, and National Convener, who welcomed participants and emphasized the significance of millets in nutrition and sustainable agriculture. The convention featured insights from key government



officials, including Dr. Ashok Dalwai, IAS, former CEO of NRAA, Dr. G Narendra Kumar, IAS, DG NIRDPR, Mr. Sanjay Agarwal, IAS Former Secretary of DA&FW, Prof. VP Sharma, Chairman of CACP, were the Guests of Honor with Mr. P Prasad, Hon’ble Minister for Agriculture, Govt. of Kerala being the Special Guest along with Shri Ganesh Joshi, Hon’ble Minister for Agriculture Govt. of Uttarakhand as the Chief Guest of the Start-up Convention.

Start-up Exhibition

The event attracted over 100 start-ups, reflecting the growing interest in the millet sector. Among these, approximately 55 start-ups supported by Nutrihub showcased their innovative products and services at dedicated exhibition booths. The participation of these start-ups not only highlighted the entrepreneurial spirit within the sector but also provided them with valuable exposure to potential investors and partners.

Vigilance Awareness Week 2024

As per the directions of Central Vigilance Commission (CVC) and ICAR, Vigilance Awareness Week (CAW) at ICAR-IIMR was organized during 28th October to 3rd November, 2024. The theme of VAW 2024 is “Culture of integrity for Nation’s prosperity”. It commenced with taking of integrity pledge on 28th October, 2024 at 11:00 AM. Similarly, pledge was taken at the regional stations, CRS Solapur and Gudamalani also. Different competitions were held during VAW to bring in more awareness and sense of responsibility among the staff.

The topic for essay writing competition was “Culture of integrity for Nation’s prosperity”. Elocution competition was conducted on the topic “Corruption free India- For a developed Nation”. Quiz competition was organized with questions related to Vigilance. Another competition was poster presentation where the participants were asked to make posters on the topics related to vigilance and making India corruption free. Besides the programs at office, vigilance awareness programs were conducted in school and gram sabhas also. An awareness programme cum essay competition was organized on “Corruption free India for a developed nation” on 29th October, 2024, to the students of Adarsha Vidyalaya High School, Rajendranagar. The scientists of IIMR, created awareness on the importance of celebrating vigilance awareness week, measures to eradicate corruption and the need for vigilant citizens for a developed nation. ICAR-IIMR Hyderabad and Hulsoor Mahila Kisan Millets Producer Company (FPO), Bidar Jointly conducted Vigilance Awareness Program on 3rd November, 2024 at Halhalli Village, Hulsoor Taluka, Bidar district of Karnataka. The program was organized to promote awareness about the importance of vigilance and ethical conduct among the FPOs employees, directors, and Shareholder farmers. The valedictory program of VAW 2024 was conducted on 4th November, 2024. Director, ICAR-IIMR has addressed the employees and briefed different measures taken to bring in more transparency in the system and emphasized the need for discipline and transparency in working.

Visit of Army, Navy and Air force officials to ICAR-IIMR, Hyderabad as a part of Jai Jawan Kisan program

On 8th November, 2024, 47 officials from the Army, Navy, and Air Force visited ICAR-IIMR, Hyderabad, as part of the Jai Jawan Kisan program organized by MANAGE and Directorate General Resettlement, Ministry of Defence. Dr. Sangappa delivered a detailed lecture on business opportunities in millets and discussed about the activities of IIMR FPOs. Further he shared insights on Karnataka, Telangana and AP FPOs by displaying the existing commodities of FPOs. This visit inspired and guided defence personnel to consider agri-based enterprises as a post-retirement livelihood. The program

was coordinated by Dr. Sangappa and Ms. Chandhini from ICAR-IIMR, Hyderabad.

Swachhata Pakhwada drive at ICAR-IIMR from 16-31 Dec 2024

Swachhata Pakhwada programme was initiated at ICAR-Indian Institute of Millets Research, Hyderabad on 16th December, 2024 with Swachhata pledge administered under the supervision of Director, ICAR-IIMR, Dr. C Tara Satyavathi. All the staff participated in the two-week long activities. As a part of the drive in the IIMR office premises, stock taking of digitization of office records and e-office implementation, weeding out of old records, furniture and junk materials, cleanliness drive including cleaning of offices, corridors, lab and field areas, and institute premises was undertaken. Awareness was created in the rural adopted villages of the institute by promoting cleanliness, hygiene and eliminating open defecation. Cleaning activities were taken up involving rural people.

In residential colonies, awareness was created on waste management, utilization of organic wastes/ generation of wealth from waste, benefits of going polythene free. Organic farming practices in kitchen gardens was demonstrated. Cleaning of urban localities were organized involving residents.

A special talk on “Personal Hygiene and Swachhata” by Dr. Hima Bindu, Medical officer, Health center ICAR-NAARM, Hyderabad on 17 December, 2024 at



ICAR-Indian Institute of Millets Research, Hyderabad, aimed at fostering health awareness and promoting cleanliness practices in our workspace and beyond.

Infrastructure Development

Institute acquired latest high-end equipments for genomics, functional genomics, molecular breeding, nutrient analysis, processing and value addition research.

Genomics, Functional Genomics, Molecular Breeding Research

Nanopore- Promethion Genome Sequencer



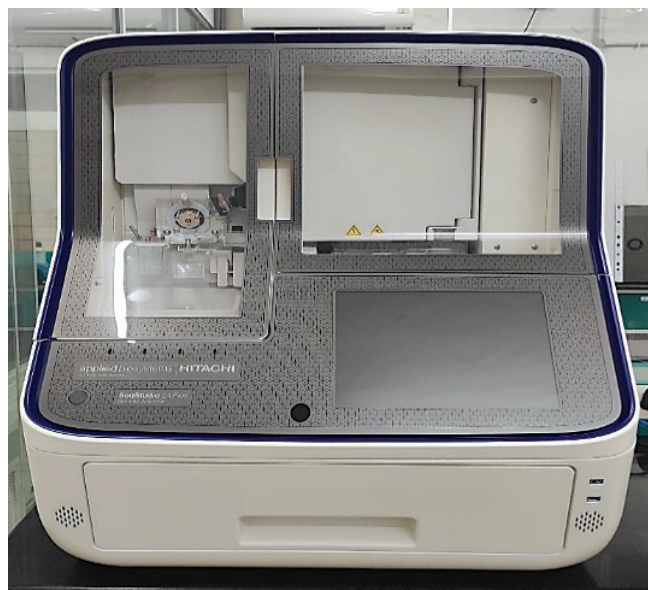
Digital PCR



Q PCR



Genetic Analyzer



Nutrient Analysis

Automatic Dietary fiber analyzer



Microwave Digestive system



Microwave Ashing system



Advanced Microscopy

Cryo Ultra Microtome



Fully automated fluorescence Stereo Microscope



Post - Harvest Machinery

Multi Millet Thresher



Panicle thresher



Processing and Value Addition

De husker



Pulverizer



Dehuller



Mixograph



FT-NIR



Fully Automatic cold extrusion line



- **Global Center of Excellence on Millets (Shree Anna) Research Complex:** Creation of world class molecular laboratories and international training facilities under Global Center of Excellence has been initiated during the year and progressing in a rapid pace
- **OTC-Polycarbonate Open Top Structure:** New facility created to screen the millet crops for heat and drought tolerance.
- **500 KVA DG set with acoustic enclosure:** Continuous power supply to the campus during power failures
- **Recarpeting of BT road:** New road laid in the arboretum and terrace field area of IIMR for proper movement of farm vehicles and also for farm operations
- **Farm Facilities:** New facility created for proper storage of farm material and equipment required for farm operations and also campus maintenance
- **Field Research Complex with HPCC Structure:** Creation of best field screening facilities (drought, speed breeding and genome editing) under one roof
- **Barbed wire fencing:** Creation of fencing to the land allocated for IIMR Regional Station on Pearl Millet at Gudamalani, Barmer, Rajasthan
- **Administrative cum Laboratory Building:** Creation of new building for IIMR Regional Station on Pearl Millet at Gudamalani, Barmer, Rajasthan

Fully Automatic bread line



Pre-cleaner cum grader cum aspirator



Official Language Implementation

Hindi Chetana Maas Celebration

Hindi Chetana Maas was celebrated during 14 September - 13 October, 2024 at ICAR-Indian Institute of Millets Research, Hyderabad. Dr. C Tara Satyavathi, Director, IIMR inaugurated Hindi Chetana Maas celebration on 18 September, 2024 by lighting a lamp. Dr. C Tara Satyavathi administered the Rajbhasha Pledge to all the personnel. Extempore, Noting & Drafting, Translation, Antyakshari & Poster Presentation competitions were held during the Hindi Chetana Maas. Scientists, Technical, Administrative personnel, RAs, SRFs, JRFs etc. of the institute participated in the above competitions with great enthusiasm. Besides, there was a signature campaign in Hindi during the month, in which all the officers and employees signed their official documents in Hindi.



Prize distribution ceremony was organized on 15 October, 2024. The programme started with ICAR song. At the outset, Dr. Jinu Jacob, Scientist & OIC Hindi Cell welcomed the delegates and participants and presented the report on official language implementation at IIMR during 2023-2024. Dr. Mahesh Kumar, Assistant Chief Technical Officer (Official Language) presented the report on various programs organized during Hindi Chetana Maas and expressed his gratitude to all the participants and judges for making the program successful.

Dr. C Tara Satyavathi presented cash prizes & citation to Smt. Ritu Dalal, SAO & Smt. G Saraswati, DDO as an incentive to promote official Language in routine official

work. She distributed cash prizes and certificates to the winners of various competitions and gave away the consolation prizes and certificates to all participants. She honored the organizer, judges and facilitators of the various competitions organized during Hindi Chetana Maas by presenting them Mementos & certificates.

Dr. Tara Satyavathi expressed immense pleasure on seeing the enthusiasm and zeal of the newly appointed personnel. In her address, she said that the progress of any institution is possible only with team spirit, so everyone should help each other and provide new dimensions to the official language implementation. Hindi is the only pillar that binds India together, which is full of diverse cultures, languages, emotions, cuisines, behavior, etc. It is the duty of every officer that without hesitation of mistakes, speed up the official language implementation at IIMR, Hyderabad. Finally, the ceremony concluded with a vote of thanks by Dr. Mahesh Kumar and the national anthem. The entire programs of the Hindi Chetana Maas celebration was conducted and coordinated by Dr. Jinu Jacob and Dr. Mahesh Kumar under the guidance of Dr. C Tara Satyavathi.

Hindi Workshops

Indian Institute of Millets Research, Hyderabad organized Four Hindi workshops on 8th March, 24th June, 26th September and 19th December, 2024. Shri Jaishankar Prasad Tiwari, former In-charge and Deputy Director, Central Hindi Training Sub-Institute, Department of Official Language, Ministry of Home Affairs, Government of India Smt. Ritu Dalal, Senior Administrative Officer and Dr. Mahesh Kumar, Assistant Chief Technical Officer (OL), ICAR-IIMR, Hyderabad delivered the lectures on the various aspects of Official Language Implementation & provided hands on trainings to the participants. The above workshops were coordinated by Dr. Jinu Jacob and Dr. Mahesh Kumar under the guidance of Dr. C Tara Satyavathi, Director, IIMR.

Official Language Implementation activities done at IIMR

Official Language Implementation of IIMR in Highlights: “Hindi Milap”, “Swatantra Vaartha”, “Shubha Labha”, “The South India Times”, “Andhra Jyothi”, “Rajbhasha Alok” etc. published the news regarding different activities related to Official Language Hindi & other programme organized at IIMR, Hyderabad.

Official Language Implementation Committee (OLIC) Meetings: The meetings of the OLIC were held during every quarter i.e. on 15th February, 14th June, 21st August and 19th December, 2024. The committee reviewed the progress made in Official Language Implementation at IIMR and discussed the ways to improve it according to Department of Official Language targets.

Quarterly Progress Report of Official Language Hindi: The quarterly progress report of IIMR regarding progressive use of official language Hindi is being sent to the Regional Implementation Office (South), Dept. of Official Language, Bangalore, ICAR, New Delhi and TOLIC-Hyderabad-Secunderabad.

Hindi Edition of Annual Report: The IIMR Annual Report 2023 published in Hindi version also.

Publishing of IIMR News Letter in Hindi: IIMR Newsletter is published in Hindi version also.

IIMR Advertisement in Hindi: On the occasion of Science Day & Hindi Divas two advertisements in Hindi were published in daily Hindi newspaper “Swatantra Vaartha” & “Shubh labh” on 28th February, 2024 & “Hindi Milap”, “Swatantra Vaartha” & “Shubh labh” on 14th September, 2024.

Bilingual forms: The official forms used for various purposes in the IIMR were prepared in bilingual (Hindi and English) & uploaded on IIMR Server.

Hindi Roster: A roster was prepared on ‘Hindi knowledge’ of IIMR officers and employees and it is being updated regularly.

Hindi Learning Board: Daily one Hindi word, its pronunciation in English and its equivalent English word was displayed on Hindi Learning Digital Board at IIMR premises and compiled. It was found very useful for increasing the Hindi vocabulary of IIMR staff.



Memorandum of Agreement / Understandings

(January to December 2024)

The MoUs/ MoAs signed during 2024 for collaborative research and promotion in millets and licensing of millet cultivars and millet value added products are as follows

S. No.	Date of Agreement	Second Party/ Licensee	Purpose of MoA/MoU	Signatory of Licensee/Second party	Witnessed by
1	09.02.24	Krishi Vikas Sahakari Samiti, Rajasthan	Licensing of CSH 24MF	Mr. Heeralal Sharma, MD	Drs. Venkatesh Bhat and J. Stanley
2	13.02.24	BAIF Development Research Foundation, Maharashtra	Collaborative Research	Mr. B. Shivadrudrappa	Drs. Sangappa and B. Amasiddha
3	19.02.24	ATS Gene Tech Pvt Ltd	Licensing of 4K SNP Panel	Mr. Srinivas Udumudy, CEO	Drs. T. Nepolean and J. Stanley
4	23.02.24	CSIR-Indian Institute of Petroleum, Dehradun	Collaborative Research	Dr. Atul Ranjan, Head	Drs. A.V. Umakanth and J. Stanley
5	06.03.24	Directorate of Tribal Welfare, Government of Tamil Nadu	Collaborative Project and Promotion	Mr. Thiru S. Annadurai, Director	Drs. T. Nepolean and K. Srinivasa Babu
6	16.03.24	Directorate of Agriculture and Farmers Welfare, Government of Odisha	Promotion of Millets	Dr. Prem Chandra Chaudhary, Director	K. Srinivasa Babu
7	04.04.24	Rasi Seeds (P) Ltd., Tamil Nadu	Licensing of CSH 24 MF	Mr. N. Saravanan, Business Head	Drs. J. Stanley and Avinash Singode
8	15.04.24	Loyola Academy, Secunderabad, Telangana	Students Research	Dr. L. Joji Reddy SJ, Principal	Drs. J. Stanley and P. Sanjana
9	26.04.24	Gold Dust Kitchen, Madhya Pradesh	Licensing of 6-millet value added products	Mr. Nilay Jain, Proprietor	Dr. J. Stanley
10	26.04.24	SR University, School of Agriculture, Warangal	Students Research	Dr. R. Archana Reddy, Registrar	Drs. J. Stanley and Swarna Ronanki
11	01.05.24	Vaishnavi Agro Foods, Andhra Pradesh	Licensing of 2-millet value added products	Mr. A. Shivakumar Proprietor	Dr. J. Stanley
12	20.05.24	Arogya Millets Company Limited, Andhra Pradesh	Licensing of 8 Millet value added products	Mrs. M. Saraswati, CEO	Dr. J. Stanley
13	28.05.24	Tashvika India Pvt Ltd., New Delhi	Licensing of 15 Millet value added products	Mrs. Sadhvi, CEO	Dr. J. Stanley
14	20.06.24	Avani Agro Food Products, Andhra Pradesh	Licensing of 6 Millet value added products	Mr. Radhakrishnaiah, Marketing Manager	Dr. J. Stanley

S. No.	Date of Agreement	Second Party/ Licensee	Purpose of MoA/MoU	Signatory of Licensee/Second party	Witnessed by
15	05.07.24	Paani Foundation, Mumbai	Dissemination of sweet sorghum and its value added technologies to the farmers (Collaborative Research)	Mr. Satyajit Bhatkal, CEO	Dr. A.V. Umakanth
16	12.07.24	Shri Vaishnav Vidyapeeth Viswavidyalaya, Madhya Pradesh	Collaborative Research & millet promotion	Dr. KN Guruprasad, Director	Drs. Venkatesh Bhat & P. Sanjana
17	20.07.24	MILEATS, Hyderabad	Licensing of Multi-millet bread	Mr. Pidishetty Pranav Kumar, Partner	Dr. J. Stanley
18	12.08.24	Manga Srinivas Foods Int. Ltd, Hyderabad	Licensing of Multi-millet instant idli mix	Mr. Kavali Mandeep, MD	Dr. J. Stanley
19	18.09.24	Kathirava Naturals Pvt Ltd., Hyderabad	Licensing of 3 millets value added products	Aishwarya Samala, MD	Dr. J. Stanley
20	18.09.24	Ajeet Seeds Private Limited, Hyderabad	Licensing of CSH 24MF	Mr. Sameer P. Mulay, MD	Dr. J. Stanley
21	21.09.24	Maangaani Foods Pvt Ltd., Hyderabad	Licensing of 3 millets value added products	Mr. K. Runith, CEO	Dr. J. Stanley
22	23.09.24	Vivekananda Trust	Collaborative Research & millet promotion	Dr. Balu	Dr. Kalaisekhar
23	30.09.24	Bhadra Agro Services, Ballari	Licensing of Sorghum fodder hybrid, CSH 24MF	Ms. K. Sujatha, Proprietor	Dr. J. Stanley
24	30.09.24	Malleswara Agro Agencies, Ballari	Licensing of Sorghum fodder hybrid, CSH 24MF	Mr. K. Ravi Kumar Reddy, Proprietor	Dr. J. Stanley
25	30.09.24	Foragen Seeds, Karnataka	Licensing of Sorghum fodder hybrid, CSH 24MF	Mr. K. Anil Kumar Reddy, MD	Dr. J. Stanley
26	03.10.24	Sri Surya Organics, Hyderabad	Licensing of 6 millet value added products	Mr. Lokeshwar Raju Konduri, MD	Dr. J. Stanley
27	08.10.24	Wholesome, Hyderabad	Licensing of 6 millet value added products	Ms. Ireni Indira, Proprietor	Dr. J. Stanley
28	15.10.24	Career Point University, Hamirpur, HP	Collaborative research and on health benefits, processing, value addition and promotion of millets	Dr. Sanjeev Kumar Sharma, VC	Drs. Sanjana Reddy and J. Stanley
29	29.10.24	Sri Satya Sai University for Human Excellence, Sri Aatya Sai Annapoorna Trust, ICMR-National Institute of Nutrition	Collaborative Research and promotion of millets	Dr. DHR Naidu, Registrar, SSUHE Dr. Anand Kumar Kadali, CEO AAAAT Dr. B.P Reddy, ICAR-NIN	Dr. R. Venkateshwarlu
30	05.12.24	Millet Growers, Hyderabad	Licensing of 6-millets value added products	Mrs. Gayatri Vemuri, Managing Partner	Dr. J. Stanley
31	06.12.24	Mavy Nutrition Pvt Ltd, Andhra Pradesh	Licensing of 6-millets value added products	Mrs. Hadassah Manthri, CEO	Dr. J. Stanley



**MoU with CSIR-Indian Institute of Petroleum,
Dehradun**



MoU with Rasi Seeds (P) Ltd., Tamil Nadu



MoU with Tashvika India Pvt Ltd., New Delhi



MoU with Paani Foundation, Mumbai



**MoU with BAIF Development Research Foundation,
Pune**



MoU with Wholesome, Hyderabad

Varieties Identified for Release



Sweet Sorghum Variety - SPV 2890

Fresh stalk Yield : 48-50 t/ha

Juice Yield : 17000-18000 L/ha

Brix (%) : 15.7

Days to Maturity : 130-133 days

Salient features : High fresh stalk yield, juice yield, thick stalks, tolerance to leaf diseases

Recommended for : Maharashtra, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu, Punjab, Uttar Pradesh, Madhya Pradesh & Gujarat

Varieties Identified for Release



Single cut Forage Sorghum Variety - SPV 2884

Green Fodder Yield : 440-480 q/ha

Dry Fodder Yield : 180-200 q/ha

Days to cut : 75-77 days

Salient features : High green & dry fodder yields, tolerance to leaf blight, rust, anthracnose, zonate leaf spot & downy mildew

Recommended for : Maharashtra, Tamil Nadu & Karnataka

Varieties Identified for Release



Foxtail Millet Variety - FXV 647

- Grain Yield : 28 q/ha
- Fodder Yield : 58 q/ha
- Days to cut : 85-88 days
- Salient features : A sturdy non lodging growth habit, high number of productive tillers, compact panicles, large seed size.
- Recommended for : Karnataka, Maharashtra & Madhya Pradesh under rainfed *kharif* & irrigated summer conditions



Global South Millet Convening for Shared Vision and Inclusive Action Beyond IYM 2023 at Dubai, UAE.



Dr. C Tara Satyavathi, Director, IIMR presenting an Overview of Research and Development in Millets to the Research Advisory Committee



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किसानों का हमसफर
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