NCPGRM

1st National Conference on Plant Genetic Resources Management

Proceedings and Recommendations

22-24 November 2022
New Delhi, India

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PROCEEDINGS AND RECOMMENDATIONS

of the

1st National Conference on Plant Genetic Resources Management

November 22-24, 2022
National Agricultural Science Centre (NASC)
New Delhi, India

Organized by

Indian Society of Plant Genetic Resources, New Delhi, India
Indian Council of Agricultural Research, New Delhi, India
ICAR-National Bureau of Plant Genetic Resources, New Delhi, India
Alliance of Bioversity International and CIAT, India Office, New Delhi, India
Protection of Plant Varieties and Farmers' Rights Authority, New Delhi, India

Co-Organized by

Trust for Advancement of Agricultural Sciences, New Delhi, India
International Maize and Wheat Improvement Center, India Office, New Delhi, India
International Center for Agricultural Research in the Dry Areas, India Office, New Delhi, India
International Council for Research in Agro-Forestry, India Office, New Delhi, India
International Crop Research Institute for Semi-Arid Tropics, Hyderabad, India
National Academy of Agricultural Sciences, New Delhi, India

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Citation
R.S. Paroda, A. Agrawal, R.K. Tyagi, S. Archak, M. Verma, J.C. Rana, and G.P. Singh (2023) Proceedings and Recommendations of the '1st National Conference on Plant Genetic Resources Management', New Delhi, India, Nov. 22-24, 2022. Indian Society of Plant Genetic Resources, New Delhi, 112 p.

ISBN: 978-81-950114-3-8

Published : July, 2023

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NCPGRM

Preface

The present proceedings-cum-recommendations emanate from the '1st National Conference on Plant Genetic Resources Management (NCPGRM 2022), which was held at National Agriculture Science Centre (NASC) Complex, New Delhi, during 22-24 November, 2022. Indian Society of Plant Genetic Resources (ISPGR), Alliance of Bioversity International and CIAT, Indian Council of Agricultural Research (ICAR), ICAR-National Bureau of Plant Genetic Resources (NBPGR), and Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) were the organizers. The Trust for Advancement of Agricultural Sciences (TAAS), International Maize and Wheat Improvement Center (CIMMYT), International Center for Agricultural Research in the Dry Areas (ICARDA), International Council for Research in Agro-Forestry (ICRAF), International Crop Research Institute for Semi-Arid Tropics (ICRISAT) and National Academy of Agricultural Sciences (NAAS) were the co-organizers.

The main aim of NCPGRM 2022 was to bring on board various stakeholders (officials from government departments, subject matter experts, scientists, researchers, farmers, representatives, and researchers of the private sector, etc.) related to management of plant genetic resources (PGR) to deliberate on numerous contemporary issues, based on their considered views and experience. The 3-day Conference comprised seven scientific sessions (a plenary, five technical sessions, and a panel discussion) covering specific areas of PGR management. In total, there were 7 keynote lectures, 21 invited lectures, 10 short lectures and 33 rapid oral presentations. Besides, there were 249 posters on topics covering the themes and sub-themes of various Technical Sessions. Both oral and poster presentations comprehensively captured current research being undertaken in various institutions within and in some of the other countries. More than 300 scientists, faculty members, post-graduate students, research scholars and other stakeholders in the PGR arena attended the conference. The NCPGRM 2022 platform provided an excellent opportunity for exchange of views among participants concerning collecting, augmentation, evaluation, documentation and use of PGR. The goal of the Conference was to formulate a Road Map for actions required for effective germplasm management for climate resilient and sustainable agriculture. Accordingly, recommendations emerging on major issues concerning PGR management have been synthesized and presented in this document.

The success of the NCPGRM 2022 is attributed to the efforts of the Core Organizing Committee, chaired by Padma Bhushan Dr R.S. Paroda, President, ISPGR and Chairman, TAAS. We place on record our deep appreciation to Dr Himanshu Pathak, Secretary, Department of Agricultural Research (DARE) and Director General (DG) ICAR, Dr K.V. Prabhu, Chairperson, PPV&FRA, Dr G.P. Singh, Director, ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), and Dr J.C. Rana, Country Director, Alliance for Bioversity International and CIAT, India, for the institutional support extended for organization of NCPGRM 2022. Thanks, are sincerely accorded to all the Chairs and Members of the National Advisory Committee, Technical Program Committee, Local Organizing Committees, staff of ISPGR, NBPGR, ICAR and TAAS, besides Co-organizers including, CIMMYT, ICARDA, ICRAF, ICRISAT and NAAS. Financial support from co-sponsors, namely, Federation of Seed Industry of India (FSII), Hytech Seed India Private Limited (Hytech), Maharashtra Hybrid Seeds Company Private Limited (MAHYCO), Kaveri Seeds, Rasi Seeds, National Seed Association of India (NSAI), Imperial Life Sciences (P) Limited, UD Associates and Sim Biochem, is sincerely acknowledged. Most importantly we thank all Delegates, Speakers, Co-Chairs and Convenors who contributed in making the NCPGRM 2022 a grand success to achieve the objectives.

The Editors immensely thank Drs P.L.Gautam, B.S. Dhillon, Bhag Mal, J.L. Karihaloo, and Umesh Srivastava for providing valuable and critical comments in the text of this manuscript. It is hoped that this document would be useful to all the stakeholders as systematic information and blueprint of management of PGR in the near future. It is also our expectation that the road map suggested would ultimately not only benefit the custodians and developers of PGR, especially the farmers, tribal communities, and the breeders, both in public and private sector, but also the policy-makers in achieving the common goal of sustainable agriculture.

Editors

Abbreviations and Acronyms

ABS	Access and Benefit Sharing
AICRP	All India Coordinated Research Project
APAARI	Asia-Pacific Association of Agricultural Research Institutes
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources
BCH	Biosafety Clearing House
BDA	Biological Diversity Act, 2002
BIORRAP	National Biological Research Regulatory Approval Portal
BMC	Biodiversity Management Committee
BSF	Benefit Sharing Fund
BSI	Botanical Survey of India
BTWC	Biological and Toxins Weapons Convention
CAZRI	Central Arid Zone Research Institute
CBD	Convention on Biological Diversity
CeHAB	Centre for High Altitude Biology
CGIAR	Consultative Group for International Agricultural Research
CHM	Clearing-House Mechanism
CIAT	International Centre for Tropical Agriculture (Centro Internacional de Agricultura Tropical)
CIFOR	Center for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Centre (Centro Internacional de Mejoramiento de Maíz y Trigo)
CIP	International Potato Centre (Centro International de la Papa)
COVID	Corona Virus Disease
CSA	Community Supported Agriculture
CSIR	Council of Scientific and Industrial Research
CWR	Crop Wild Relatives
DAC&FW	Department of Agriculture, Cooperation and Farmers' Welfare
DARE	Department of Agricultural Research and Education
DATAR	Diversity Assessment tool for Agrobiodiversity and Resilience
DSI	Digital Sequence Information
DST	Department of Science and Technology
FAO	Food and Agriculture Organization of the United Nations
FCM	Flow Cytometry
FGB	Field Genebank
FGR	Forest Genetic Resource
FPO	Farmer Producer Organization
FSII	Federation of Seed Industry of India
G-DIRT	Germplasm Federation of Seed Industry of India Identification and
GB9	Ninth Meeting of Governing Body of ITPGRFA
GBS	Genome-By-Sequencing
GCDT	Global Crop Diversity Trust
GEAC	Genetic Engineering Appraisal Committee
GEF	Global Environment Facility
GHS	GeneHyplotype Based Selection
GHU	Germplasm Handling Unit
GI	Glycaemic Index
GM	Genetically Modified

GoI	Government of India
GR	Green Revolution
HYV	High-Yielding Varieties
IAC	1st International Agrobiodiversity Congress
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRAF	International Center for Research in Agroforestry (World Agroforestry Centre)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICTV	International Committee of Taxonomy of Virus
IHBT	Institute of Himalayan Bioresource Technology
IITA	International Institute of Tropical Agriculture
IJPGR	Indian Journal of Plant Genetic Resources
IP	Intellectual Property
IPPC	International Plant Protection Convention
IPR	Intellectual Property Right
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition of Agri-biotech Applications
ISPGR	Indian Society of Plant Genetic Resources
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LMOs	Living Modified Organisms
LYCE	Lycopene Epsilon Cyclase
MABB	Marker Assisted Backcross Breeding
MAGIC	Multi-Parent Advanced Generation Inter-cross
MAHYCO	Maharashtra Hybrid Seed Company Private Limited
MAPS	Marker Assisted Pedigree Selection
MDM	Mid-Day Meal
MLS	Multilateral System of Exchange (under the ITPGRFA)
MoA&FW	Ministry of Agriculture and Farmers Welfare, Government of India
MoEF&CC	Ministry of Environment, Forest and Climate Change, Government of India
MOLPLAN	Molecular Diversity Panel
MTA	Material Transfer Agreement
MV	Mega Variety
NAAS	National Academy of Agricultural Sciences
NABI	National Agri-food Biotechnology Institute
NAHEP	National Agricultural Higher Education Project
NARS	National Agricultural Research System
NBA	National Biodiversity Authority
NBPGR	National Bureau of Plant Genetic Resources
NCPGRM	National Conference on Plant Genetic Resource Management
NE	North East
NEIST	North East Institute of Science and Technology
NGB	National Geneb ank
NICRA	National Innovations and Climate Resilient Agriculture
NGO	Non-Governmental Organization
NP	Nagoya Protocol
NSAI	National Seed Association of India
OP	Open Pollinated
PBR	Plant Breeders Rights
PC	Phytosanitary Certificate
PGR	Plant Genetic Resources

PGRFA	Plant Genetic Resources for Food and Agriculture
PPP	Public Private Partnership
PPV&FR	Protection of Plant Varieties and Farmers' Rights Act, 2001
PPV&FRA	Protection of Plant Varieties and Farmers' Rights Authority
PVP	Plant Variety Protection
R&D	Research and Development
RCA	Royal Commission on Agriculture
RCGM	Review Committee on Genetic Manipulation
RG	Rice Genome
RS	Remote Sensing
SBB	State Biodiversity Board
SDGs	Sustainable Development Goals
SMTA	Standard Material Transfer Agreement
SNP	Single Nucleotide Polymorphism
SoPs	Standard Operating Procedures
SPAD	Soil Plant analysis Development
TAAS	Trust for Advancement of Agricultural Sciences
TKDL	Traditional Knowledge Digital Library
TKRC	Traditional Knowledge Resource Classification
TOFI	Tree Outside Forests in India
TRIPs	Trade Related Intellectual Property Rights
UN	United Nations
UPOV	Union Protection of New varieties
USAID	US Agency for International development
V	Vitrification
WEPs	Wild Edible Plants
WTO	World Trade Organization
ZTM-BPD	Zonal Technology Management-Business Promotion Development

NCPGRM

Context and Rationale

Background

Plant genetic resources (PGR), related ecosystem services as well as the management practices employed by stakeholders are playing pivotal role in agriculture and an important component of biodiversity. PGR are the biological cornerstone of global food and nutrition security. Hence, PGR management has been an important scientific and socio-economic concern over the past half a century. It is paramount that coordinated efforts are needed to collect, conserve and sustainably utilize vulnerable PGR in view of the fast depletion of genetic diversity of agricultural crops occurring due to biotic, abiotic and anthropogenic factors. Further, in situ and on farm conservation in farmers' fields do require efficient scientific management for the much-needed genetic enhancement to meet emerging challenges for our food, nutrition, and environmental security.

Indian subcontinent is one of the Vavilovian Centres of Origin and is one of the 12 Mega Gene Centres of diversity in the world. It is endowed with rich biodiversity accounting for almost 12% of world flora in a wide range of ecosystems. North-West Himalayas, North-East India, Western Ghats, and the Andaman and Nicobar Islands are hot spots of biodiversity which have around 33% of country's endemic recorded flora. The tribal and traditional farming communities played a significant role in managing and conserving the valuable genetic resources in our country. Also, traditional varieties, landraces, wild progenitors, wild and weedy relatives of crop plants have been used in breeding or selected over generations for specific traits of economic importance.

The agricultural diversity and genetic resources that support crops, need to be used efficiently both to maintain current level of food production and to confront emerging new challenges. In the context of climate change, declining natural resources and increasing population, it is imperative that greater attention is now given to agrobiodiversity for our future sustainability. Fortunately, many valuable PGR do exist that would help in better adaptation to climate change by developing more stress tolerant varieties as well as to contribute towards attaining Sustainable Development Goals (SDGs). Adapting crop varieties to varying agro-ecological conditions can reduce risks induced by the climate change. Also, Covid-19 pandemic has taught the lesson that we need to diversify our food basket around the local food systems that are more adapted and sustainable. The UN Food Systems Summit, held during the UN General Assembly in New York in 2021, set the stage for global food systems transformation to achieve the SDGs by 2030, which called for renewed emphasis on enhanced use of local genetic resources of food crops. However, this would require concerted scientific efforts on collecting, characterization, evaluation, conservation, and effective use of existing germplasm.

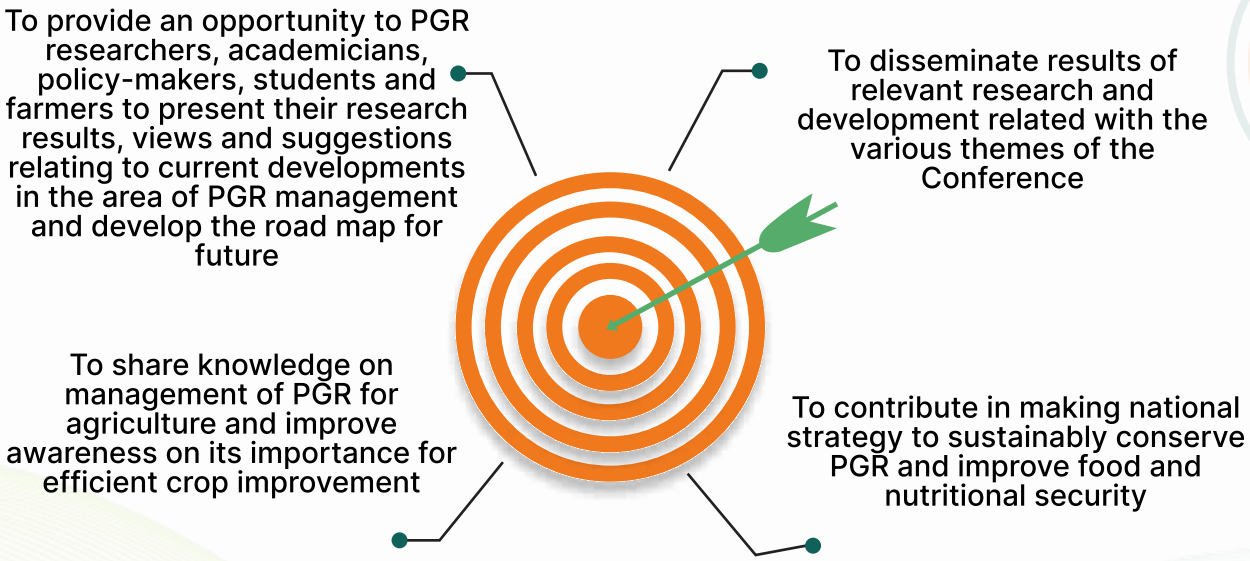
Rationale

Keeping in view the above background, it necessitated a scientific dialogue through a conference to deliberate the current status, available science-based technologies and innovations for more effective and efficient conservation through use of genetic resources. Also, review of existing constraints and challenges in PGR management approaches being followed and to be improved by both public and private institutions require critical assessment for needed improvement. In addition, a platform was also required for update on progress related to implementation of 'Delhi Declaration' endorsed by the 1st Agrobiodiversity Congress (IAC) held in November 2016 that was inaugurated by the Hon'ble Prime Minister Shri Narendra Modi and defined future strategy for long-term sustainable use of our PGR.

Accordingly, the Indian Society of Plant Genetic Resources (ISPGR), in collaboration with Indian Council of Agricultural Research (ICAR), ICAR-National Bureau of Plant Genetic Resources, Alliance of Biodiversity International and CIAT and Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), organized the **1st National Conference on Plant Genetic Resources Management (NCPGRM)** during **November 22-24, 2022**.

The co-organizers included Trust for Advancement of Agricultural Sciences (TAAS), International Maize and Wheat Improvement Centre (CIMMYT), International Centre for Agricultural Research in the Dry Areas (ICARDA), International Council for Research in Agro-Forestry (ICRAF), International Centre for Research in Semi-arid Tropics (ICRISAT) and National Academy of Agricultural Sciences (NAAS). The Co-sponsors of the Conference were Federation of Seed Industry of India (FSII), Hytech Seed India Private Limited (Hytech), Maharashtra Hybrid Seeds Company Private Limited (MAHYCO), Kaveri Seeds, Rasi Seeds, National Seed Association of India (NSAI), Imperial Life Sciences (P) Limited, UD Associates and Sim Biochem.

Objectives



Venue, Thematic Areas and Participants

Program

The NCPGRM 2022 was structured under five themes and 17 sub-themes, to cover the diverse areas of PGR management. The program comprised one Plenary Session, five Technical Sessions and a Panel Discussion (Annexure 1). Each session had keynote lectures delivered by the eminent experts in PGR management during each technical session, to create focal points of discussion with the delegates. Leading scientists presented comprehensive presentations covering sub-themes in each session. Young scientists were given an opportunity to share their research findings through 'Rapid Presentations' in each technical session. A poster session was also organized throughout the three days of conference to display the research of many of the delegates.

Thematic Sessions

The NCPGRM 2022 traversing three days comprised one plenary session, five technical sessions and one panel discussion related to following aspects of PGR management:

1. **Augmentation of Germplasm for Enhanced Utilization**
   (Sub-themes: Plant Exploration, Germplasm Exchange and Plant Quarantine)
2. **Trait Discovery, Gene Mining and Genome Editing**
   (Sub-themes: Germplasm Phenotyping, Genotyping and use of Biotechnology)
3. **Conservation for Posterity**
   (Sub-themes: Seed Gene Bank, Tissue Culture and Cryopreservation)
4. **Farmer-Centric PGR Management**
   (Sub-themes: In Situ/ On Farm, Community Genebank, Participatory Plant Breeding, Relevant Traditional Knowledge)
5. **Enabling Policy on PGR Management**
   (Sub-themes: IPR, Farmers & Breeders Rights, Access and Benefit-Sharing, General Policies)

There were 37 invited speakers and panelists, who delivered lectures and participated in panel discussion on topics across the conference themes. The details of various sessions are presented in ensuing pages.

Venue and Participants

The Conference was held in hybrid mode — virtually through an online platform and physically at Dr A.P. Shinde Hall, located in the National Agriculture Science Centre (NASC) Complex, Dev Prakash Shastri Marg, Pusa Campus, New Delhi, India. More than 300 delegates (Annexure 2) participated in the conference, that provided an arena for the delegates to share their research and knowledge on varied aspects of PGR management for sustainable use and conservation.

Inaugural Session

Inaugural Session

Lighting of the lamp by Dr. R.S. Paroda, President ISPGR

The Conference was inaugurated on November 22, 2022 by the Chief Guest, Dr Himanshu Pathak, Secretary, Department of Agricultural Research and Education (DARE) and Director General (DG), Indian Council of Agricultural Research (ICAR). The Inaugural Session was chaired by Padma Bhushan Dr R.S. Paroda, Chief Patron and Chair, Organizing Committee of the NCPGRM 2022. The other dignitaries on the dais were Dr K.V. Prabhu, Chairman, Protection of Plant Varieties and Farmers' Rights Authority (PPVFRA); Dr J.C. Rana, Country Director, Bioversity International, India & Vice President, Indian Society of Plant Genetic Resources (ISPGR); Dr G.P. Singh, Director, ICAR-National Bureau of Plant Genetic Resources (NBPGR) and Dr Anuradha Agrawal, National Coordinator, National Agricultural Higher Education Project (NAHEP), ICAR and General Secretary, ISPGR.

Welcome of the Chief Guest, Dr Himanshu Pathak, Secretary, DARE and DG, ICAR by Dr G.P. Singh, Director, ICAR-NBPGR

Welcome of Dr R.S. Paroda, Chief Patron and Chair of 1st NCPGRM, Chairman TAAS by Dr G.P. Singh, Director, ICAR-NBPGR

The inaugural function was attended by more than 350 invited guests from different scientific institutes located in Delhi, including ICAR Headquarters and its institutions, CGIAR Centers and various other institutions, and delegates from different parts of the country.

Dr GP Singh welcoming all delegates on behalf of ICAR-NBPGR

Dr G.P. Singh, Director, ICAR-NBPGR and Chair, Local Organizing Committee of the Conference, welcomed the dignitaries, distinguished invitees and delegates. He expressed his gratitude to Dr Himanshu Pathak, Secretary, DARE and DG, ICAR, as Chief Guest for gracing the occasion. During his welcome address, he emphasized on the role of PGR for sustainable agriculture in the face of burgeoning population. He said that the organization of this Conference was very appropriate post-COVID-19 pandemic to discuss some significant issues and to chart a road map for sustainable management and utilization of PGR.

Dr J.C. Rana, Alliance of Bioversity International and CIAT, Region Asia, India Office giving the welcome speech

Dr J.C. Rana, Country Director, Alliance of Bioversity International and CIAT, Region Asia, India Office, while welcoming the dignitaries and delegates informed that Bioversity International and its predecessors, International Board on Plant Genetic Resources (IBPGR) and IPGRI, through its regional offices, has been playing an important role in building institutional capacity, human resource development, and providing reorientation or technical upgradation training to country partners for the management of agro-biodiversity at the national, trans-boundary regional and global levels. He reiterated that holding the Conference was considered vital in the present perspective of diminishing diversity in agricultural crops as well as the advancements in the knowledge domain. He hoped and anticipated that several recommendations would emerge post from the Conference that may further stimulate the conservation of genetic resources and use of agricultural biodiversity for demand-driven, sustainable agricultural production.

Dr K V Prabhu sharing his views with the NCPGRM participants

Dr K.V. Prabhu, Chairman, PPV&FRA, expressed his pleasure that a large assembly of global experts from different parts of the world had joined the recently concluded Ninth Session of the Governing Body (GB9), International Treaty of Plant Genetic Resources for Food and Agriculture (ITPGRFA) and India is taking a lead in chalking out the roadmap for management of PGR through this national dialogue in the form of NCPGRM 2022. He spoke of India's agricultural heritage economy and highlighted the requirement to support exchange of all crop genetic resources and stressed the importance of conserving and utilizing farmers' varieties and landraces in conjunction with the crop wild relatives (CWR). Dr Prabhu expressed hope that the

Dr Himanshu Pathak, Secretary, DARE and Director General, ICAR and dignitaries releasing the publications of 1st NCPGRM

NCPGRM 2022 would advance the deliberations of GB9 of ITPGRFA to share scientific knowledge for PGR management at one platform to develop future strategies for research and community benefit programs for conservation and sustainable use of PGR.

The Chief Guest, Dr Himanshu Pathak, Secretary DARE and DG ICAR, and all the dignitaries on the dais released the following publications: (i) Souvenir, 1st NCPGRM, 2022; (ii) Abstract Book 1st NCPGRM 2022; (iii) Indian Journal of Plant genetic resources (IJPGR) Volume 35 (3), 2022; and (iv) 75 Unique Plant Germplasm Collections by ICAR-NBPGR.

Dr Himanshu Pathak, Secretary, DARE and DG, ICAR, addressing the gathering at 1st NCPGRM

Dr Himanshu Pathak, Secretary, DARE and DG, ICAR, delivered the inaugural address. He welcomed all the delegates including the international dignitaries participating on-line, in-person participants gathered from different states and organizations and expressed his contentment at the organization of such an event post-COVID-19 pandemic at the national level in India He expressed the view that serious dialogue and research on PGR management are imperative for food security and sustainable development and that the NCPGRM 2022 would pave way forward to manage the food and nutrition challenges posed by the climate change scenario and over-exploitation of genetic resources. He suggested that sustainable use of PGR could be realized by climate resilient agriculture. He affirmed that the rich PGR of India and diverse agro-climates will be consequential in long term sustainability of the national crop breeding and genetic engineering programs and providing relevant linkages among farmers, research system and agro-industry for technologies, products, and information to create newer win-win scenarios. He expressed his appreciation to Padma Bhushan Dr R.S. Paroda for his vision and guidance for organizing this event and encouraged the delegates of the NCPGRM 2022 to make best use of the platform for interaction and collaboration.

Dr R.S. Paroda addressing the 1st NCPGRM

Dr R.S. Paroda, President, ISPGR, Chairman, TAAS and Former Secretary, DARE and DG, ICAR, informed about the role of the ISPGR in promoting PGR activities at national and international levels, especially in organization of the 1st International Agrobiodiversity Congress (IAC) in 2016 which has become a rolling event as 2nd IAC was held in Rome in 2021 and the 3rd IAC is scheduled to be held in China. Similarly, the 1st NCPGRM 2022 has been planned such that it becomes event at national level. While recalling PGR stalwarts from India like Drs B.P. Pal, A.B. Joshi, Harbhajan Singh, M.S. Swaminathan, he said that research in PGR is not for oneself but for society at large. He noted that the challenge of ensuring sustainable crop genetic resources management is paramount in the face of burgeoning population, diminishing genetic diversity, biotic and abiotic stresses.

He said that COVID-19 had taught the importance of local food systems. The ICAR-led Indian national agricultural research system should have pride in having a robust genetic resources management system through its five bureaux of plants, animals, fishes, microbes, and insects, which is now require greater coordination. He urged that a Board for Agrobiodiversity Management had been established by ICAR with himself as Chair, which needs to be revived for harmonization of genetic resource management for food, nutrition, and agriculture. He informed that ISPGR had provided inputs in the revision of India's Biological Diversity Act, 2002 (BDA), among other points. He had strongly advocated that DARE/ICAR be delegated with regulatory powers related to agrobiodiversity exchange at national and international levels. We need more of germplasm exchange which is substantially decreased during last few years and greater partnership with the private sector for future utilization of genetic resources. Duplicate genebank facilities (like Svalbard Seed Vault) also need to be established for back up collections of germplasm conserved in National Genebank of ICAR-NBPGR. He also urged that action should be taken for establishment of Gene Fund to provide support for farmers and communities undertaking in situ conservation of PGR. He urged that registration of extant varieties be expedited by easing out of the process.

Dr Anuradha Agrawal, delivering vote of thanks

He also desired a mission to be created at national level for germplasm evaluation, as NBPGR alone cannot do this huge task. Finally, he emphasized on the need for greater partnership at international and national level including engagement of private sector also. The Inaugural Session was concluded by a formal vote of thanks by **Dr Anuradha Agrawal,** General Secretary, ISPGR, to the Chief Guest and other dignitaries on the dais, and to all the invited guests and delegates.

Plenary Session











Plenary Session

Dr Paroda delivered the plenary lecture on **'Managing our Agrobiodiversity'**, which accentuated the overall theme and set the tone for the 3-day deliberations of 1st NCPGRM 2022. He spoke on the enormity of species and genetic diversity on Earth, many of which remaining to be discovered. While distinguishing between biodiversity and agrobiodiversity, he exulted on the role of women in agriculture. He said that agrobiodiversity encompassing the variability of genetic resources for food and agriculture, as well as local knowledge and culture that aid in human survival, is pivotal in increasing agricultural productivity, food, and nutrition security through diversification. He informed that India was blessed with rich agrobiodiversity and an equally strong institutional network for collection, conservation, documentation and use of genetic resources. Dr Paroda mentioned that for effective management of agrobiodiversity, one must 'think globally but act locally'. He reflected on paradigm shifts in the past few decades at global and national level in exchange, conservation and use of agrobiodiversity, from free exchange of germplasm under the 'common heritage of mankind' of the 1970s, to the present day's regulatory regimes (*e.g.*, CBD, ITPGRFA, Nagoya Protocol *etc.*) leading to complexity in the policy, legal and regulatory issues in genetic resource management. As a consequence, several concerns have arisen on the use germplasm such as as insufficient data on genetic resources (passport, characterization, evaluation etc.), complacency in use of germplasm (especially crop wild rel science [*e.g.* genetic modification (GM), Information and Communication Technology (ICT), Data Analytics, Artificial Intelligence (AI), phenomics, genomics, *etc.*) are important for using genetic resources for solving challenges in agriculture. In this context, he emphasized for digitization of data and databases available in public domain related to genetic resources and related knowledge. While he appreciated the ICAR's strength in the form of institutional mechanisms of five bureaux for plants, animals, fishes, insects, and microbial genetic resources, which is unparalleled to any other country, however, he expressed his concern on the decrease in funding support to these organizations.

A view of the audience during the plenary session

Focussing on PGR, Dr Paroda recalled the contributions of great luminaries like Drs B.P. Pal, A.B. Joshi, M.S. Swaminathan, Harbhajan Singh, and R.K. Arora, among others, who shaped the policy that led to a systematic PGR management program in the country and contributed to the establishment of NBPGR. He appreciated the role of ex situ genebanks at national, international and global level, as also the fund in the form of Global Crop Diversity Trust (GCDT), although GCDT was only supporting global genebanks. He deliberated on the various issues on ITPGRFA such as expansion of Annex 1 list of crops, access, and benefit sharing (ABS), Standard Material transfer Agreement (SMTA), Farmers Rights, etc. He said that amendments to BDA should improve the ease of operation for exchange of genetic resources, especially of agrobiodiversity by delegation of powers to DARE/ICAR (under section 16 of BDA). He mentioned that for coordination and convergence of the various institutions working on genetic resources, a National Advisory Board had been established between 2011-14, which needs revival. Dr Paroda informed the audience about the genesis of the 1st IAC held in 2016 and asked that 'Delhi Declaration on Agrobiodiversity' be reviewed during this conference. He also wished that just like 2023 has been declared as 'International Year of Millets' by the United Nations, an 'International Year of Agrobiodiversity' should also be designated to draw global attention to this important subject. He concluded by giving a specific set of recommendations and anticipated a systematic blueprint to emerge out of the conference deliberations.

Technical Session 1



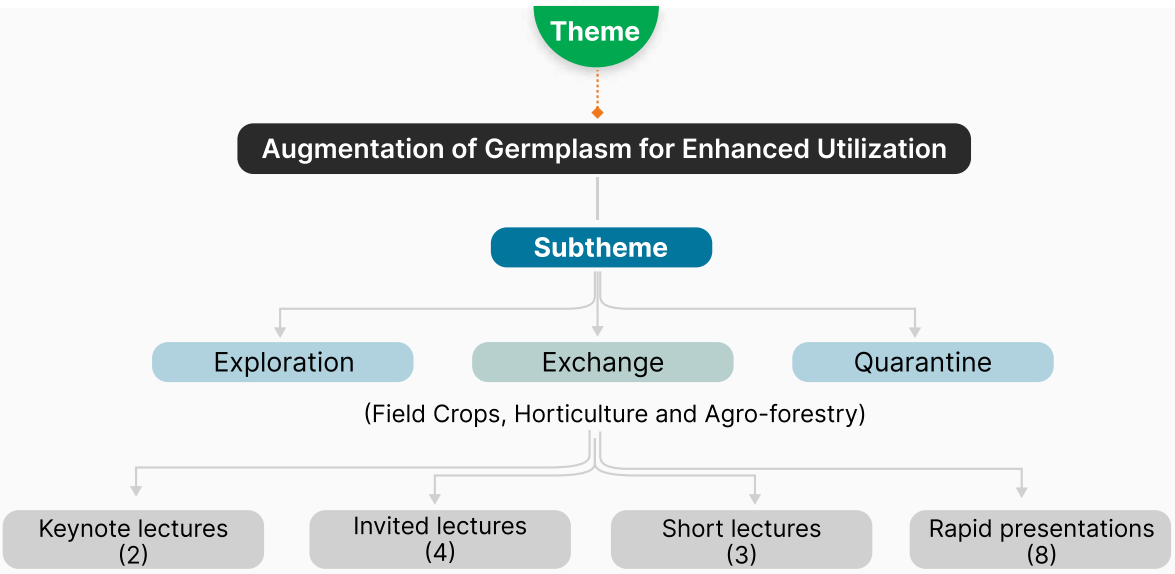


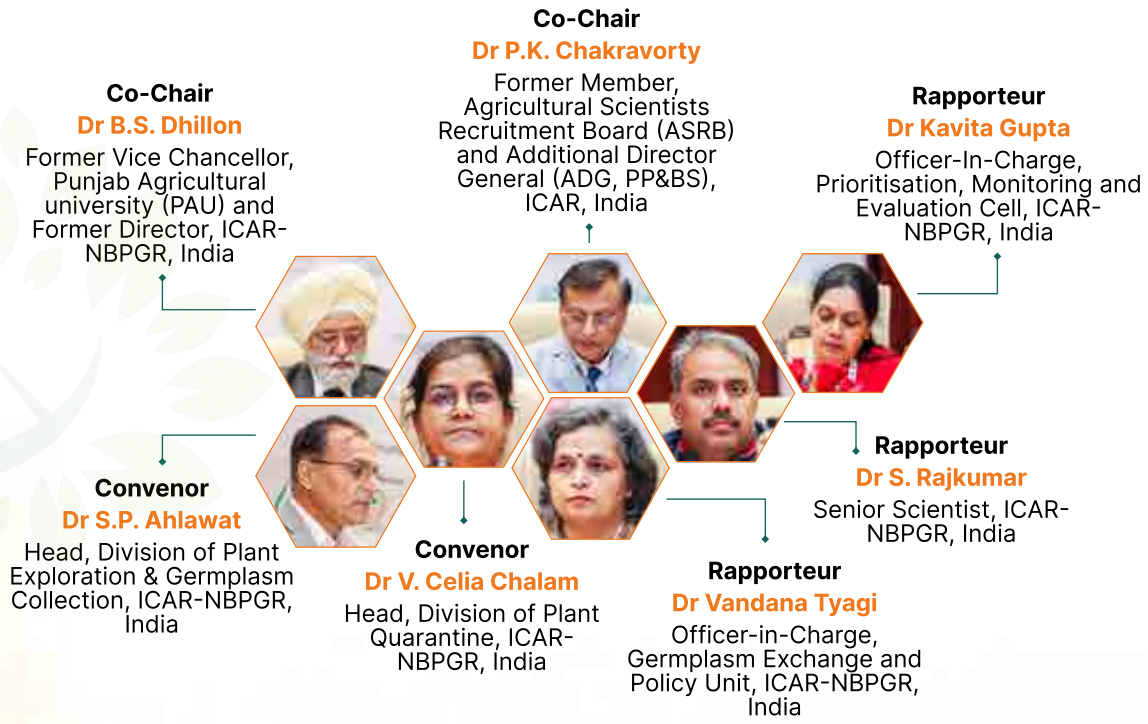






Technical Session 1





Keynote lectures were presented by **Dr G.P. Singh**, Director, ICAR-NBPGR, India and **Dr K.N. Ganeshaiah**, Professor (Retd.), & INSA Senior Scientist, Department of Plant Genetics and Breeding, University of Agricultural Sciences (UAS), Gandhi Krishi Vigyan Kendra (GKVK), Bengaluru, India. It was followed by invited lectures by **Dr P. Lava Kumar**, Head, Germplasm Health/Virology and Molecular Diagnostics, International Institute of Tropical Agriculture (IITA), Nigeria; **Dr S.C. Dubey**, Assistant Director General (ADG) (Plant Protection & Bio-safety), ICAR, India; **Dr Chandrashekhar Biradar**, Country Director, International Center for Research in Agroforestry (ICRAF), India; and **Dr S.S. Dash**, Scientist E, Botanical Survey of India (BSI), Kolkata, India. Thereafter Short Lectures were given by **Drs Vandana Tyagi**, **K.C. Bhat** and **V. Celia Chalam**, ICAR-NBPGR, India. Lastly, rapid presentations were made by **Drs N. Sivaraj**, **M.R. Rohini, Manoj Kumar, A.K. Srivastava, K.P. Mahapatra, K. Pradheep, Jameel Akhtar, Teju C.M.** and **Vikas V.K.**

Keynote Lectures

Dr K.N. Ganeshaiah gave a talk on *"Mapping Bioresources and Genetic Diversity"* which comprised (i) lessons learnt during his groups investigations, (ii) national program to map bioresources and (iii) a new model for conservation of agrobiodiversity. He said the global biodiversity hotspots of the world had caught the attention of the genetic resource collectors and scientists and a comparison between the two shows that there is considerable overlap between the two maps. The overlap areas harbor high endemicity for agriculturally relevant species and some areas have undergone heavy genetic erosion in cultivated crops. This leads to the need for earmark and conserve global agrobiodiversity hotspots, which are characterized by rich agrobiodiversity, high endemism and highly threatened. Dr Ganeshaiah also said that the range of agrobiodiversity is continually expanding (from crops to wild species to uncultivated and forest species) and suggested that it would be best to consider them as 'bioresources'. Thus, through a Department of Biotechnology (DBT) supported initiative, 'bioresource hotspots map' of India is underway for the last three decades. Inventory has been completed for Western Ghats, Eastern Ghats, Andaman and Nicobar Islands, North-East Himalayas and is currently underway in the Vindhyas range. This comprises most fine-scale data ever surveyed for bioresources; interestingly the data shows that genetic diversity is not uniformly distributed in the habitat of a species and there are certain hotspots of genetic diversity. *Ex situ* conservation in genebanks captures only temporal snapshots of evolution while in situ allows natural evolution. Taking the example of *Phyllanthus embilica*, he proposed a model for 'Forest Genebanks' (natural genebanks) wherein one nuclear sink population (with maximum genetic diversity) is further enriched by introducing material from peripheral donor populations.

Dr G.P. Singh delivered the keynote lecture on *"Role of NBPGR in PGR Conservation and Utilization in India"*. He gave a general overview of PGR status in the country and the various instruments to which India became signatory over the last three decades. He said producing enough food for world's population in 2050 will be easy. But doing it at an acceptable cost to the planet will require research into everything from high- tech seeds to low-tech input farming. For this, germplasm would be a key for meeting future challenges (*e.g.* climate change), and would be possible through enhanced use of genetic diversity through novel pre-breeding strategies and reinforcement of plant breeding chain. He gave the examples — in case of wheat and rice where novel sources of resistance genes derived from wild species have been incorporated in mainstream varieties. Thus, role of NBPGR becomes very important in germplasm and gene conservation, leading to sustainable food production. Besides the regular activities in service and research related to PGR, Dr Singh enumerated some of the recent impactful achievements of NBPGR including: (i) contribution in the GB9 meeting of the ITPGRA held in Delhi in September 2022, especially for Multilateral System (MLS) enhancement and Farmers' Rights; (ii) modernization of the Indian National Genebank (NGB) in 2021, the second largest in the world with ~4.7 lakh accessions; (iii) Initiation of projects on in situ conservation of CWR (rice); (iv) large scale characterization and mega-evaluation of national genebank collections of various crops including wheat (~27,000), barley (~7,000), lentil (~2,000), chickpea (20,800), *Vigna spp.* (10,000), pea (~3000), mustard (5,000), sesame (~7,000), soybean (10,000), *etc.* to develop core sets, mini-core sets and trait-specific reference sets under NICRA project, DBT funded Network project and in-house projects.; and (v) PGR genomics and informatics.

Dr S.C. Dubey made his presentation on *"Stringent Plant Quarantine System to Ensure National Biosecurity"*. He said that plant quarantine is a legislative measure by governments for introduction of planting materials, plant products, soil, living organisms etc. to prevent inadvertent introduction, establishment and further spread of exotic pests into the country to prevent severe economic and environmental losses. He distinguished the difference between 'pest' and 'quarantine pest', and also defined 'biosecurity'. He informed that Indian government had highlighted the threat from bioterrorism in 2019 at a meeting in Shanghai which requires a cross-sectoral approach (public health, international trade, environment protection and improved agricultural production) for preparedness and mitigation. Plant biosecurity also encompasses biosafety. In India several regulations such as Environment (Protection) Act, 1986; Biological Diversity Act 2002; Indian Wildlife (Protection) Act, 1972, Forest (Conservation) Act, 1980, Plant Quarantine (Regulation of Import into India) Order, 2003 and few others are related towards biosecurity, but are working independently and there is need for greater coherence. He cited examples of a few recent exotic pests, especially by locusts, fall armyworm etc. He elaborated on the organizational details and functionality of the plant quarantine system in India under the MoA&FW, including role of NBPGR. He also discussed role of domestic quarantine and challenges faced due to restrictions, such as breeder seed production. He informed that in 2013, an 'Agricultural Biosecurity Bill' was sought to set up an 'Agricultural Biosecurity Authority' covering animal health, plant health, marine organisms and agricultural important microbes, which is yet to be approved. India is signatory to the 'Biological and Toxins Weapons Convention (BTWC), 1972. He also informed that a recent initiative by Department of Agriculture and Farmers Welfare (DA&FW) was establishment of a portal for 'National Agricultural Biosecurity Board' and National Agricultural Biosecurity Council' and all quarantine data needs to be uploaded through this portal. Other new initiatives included the National Biological Research Regulatory Approval Portal (BioRRAP) by DBT for facilitating regulatory mechanism for research on microorganisms. He flagged several researchable issues such as accurate identification and classification (digitized biosystematics keys) including their perceived risk level; improved diagnostic and surveillance for invasive pests; models for risk analysis; and epidemiology in relation to climate change.

Dr P. Lava Kumar made a presentation in virtual mode on *"Phytosanitary aspects of germplasm, and its impact on conservation, distribution and use (A systems approach to germplasm health protection)"*. He mentioned that the CGIAR genebanks conserve over 770,000 germplasm accessions of the most important food, forage, and tree crops in 35 *ex situ* collections in nearly 20 countries and breeding programs located in multiple countries contribute to the development of improved varieties of rice, wheat, maize, cassava, yam, sweet potato, potato, food legumes, oilseeds, and forages. With respect to International Institute of Tropical agriculture (IITA), he said that out of the 34,775 accessions, 81.6% were available for distribution, being free from pests. Under the ITPGRFA, CGIAR centres are the largest distributors of germplasm, and the 11 centers contribute nearly 500 accessions to 100-140 centres globally every year.

More than one million diagnostic tests for germplasm health certification have been carried out. His presentation summarized transboundary pest risks to international germplasm distribution; procedures used by the germplasm health units (GHUs) to ensure the production and distribution of pest-free germplasm from the CGIAR programs. He illustrated some of the advanced molecular diagnostics like rapid virus diagnostics, HTS-Virus Diagnostics and multispectral imaging (non-invasive) analysis being applied for quick detection. He said that challenges in germplasm health activity is policy-dependent, and variable rules for exchange exist and there is no standardized approach. For this, CGIAR has adopted a 'Green Pass'

phytosanitary protocol, which has a systems approach to phytosanitary risk management that use robust health testing systems. He concluded by saying that current phytosanitary procedures are insufficient to address international germplasm distribution and there is need to establish standard methods for phytosanitation, through a system approach.

Dr Chandrashekhar Biradar spoke on *"Trees outside forests: untapped potential for germplasm conservation, landscape diversity, and climate resilience"*. He focused on the role of trees species outside the forest and called for adopting functional practices that combine production, consumption, conservation of forest diversity with significant co-benefits to people, culture, nature, and nations. He called for a 'systems approach' for transition to green deal for germplasm where diversity of crop, trees and animals is the source of regenerative system, synching ecology with economy so that producers, consumers, culture and nature, all are the beneficiaries. Yield-specific production has to shift diversity-based production, with local niche-based focus. Agroforestry based production systems offer this solution and underutilized species (*e.g.* millets, horse gram *etc.*) are good examples. He then elaborated on a recent program *i.e.* 'Tree outside Forests in India (TOFI)" supported by US Agency for International development (USAID), Ministry of Environment, Forestry and Climate Change (MoEF&CC), Centre for International Forestry Research (CIFOR) and World Agroforestry that aims to significantly expand the area under trees (2.8 m ha) while enhancing landscapes, livelihoods and ecosystem services. A key feature is the right trees for right species for the right purpose. For this global tree data and knowledge platform is being developed. He said that investments in restoring regenerative production systems are growing with the recognition of their role in nourishment, carbon-neutral, net zero, climate resilience ecologically sustainable and economically profitable. Agroforestry can return 8-13 times more profit than conventional agriculture.

Dr S.S. Dash gave a lecture on *"Plant exploration, germplasm collection: Challenges and opportunity in Indian Himalayan region"*. He informed that BSI and NBPGR had been collaborating in the recent past to collect genetic diversity and species diversity, respectively. He said that a large amount of biodiversity in Western and Eastern Ghats of India was threatened. The NW Himalayas had unique and endemic flora with varied habitat. Out of the 18,666 species of higher plants reported in India, the Indian Himalayan region alone has 11,157 species, dominated by Poaceae, Asteraceae, Orchidaceae, and Papilinoidae, *etc.* He appraised that Botanical survey of India (BSI) as an apex research organization on plant taxonomy, pursuing taxonomic research in the Himalayan region through its four Regional Centres (Shillong, Dehradun, Gangtok, Itanagar) and has collected huge number of botanically and horticulturally important plants, accumulated information on economically important plant species, gene pools of wild plants, wild relatives of crop plant, prioritized future collections for technology intervened research on crop development, drug development, food security and livelihood generation. He cautioned about habitat loss in Indian Himalayan as one of the major threats and climate change implication for biodiversity and germplasm conservation. He spoke of an urgent need to revamp *ex situ* plant conservation of CWRs, and commercialization of several underutilized fruit species. He informed that BSI has about 7,050 species conserved in its various botanic gardens. In the context of climate change and germplasm collecting, he suggested that future explorations should be targeted taxa of prioritized species such as medicinal plants, rare/threatened species, and superior plants, *etc.* He said that increasing restrictions imposed by the state governments on certain collecting areas which are rich in biodiversity (*e.g.* national parks and reserves) are a major challenge in plant exploration, and there is need for a consortium of like-minded institutes for exploration and collection of germplasm. Future explorations also should emphasize the collection of red list species.

Invited Lectures

Dr Vandana Tyagi gave a lecture on *"Germplasm exchange for sustainable food security"*. She said that global exchange of PGR is critical to widen the food basket, and is foundation to food security. She informed that out of the 4.26 lakh germplasm accessions in the NGB, 20% are of exotic origin, with recent new crops introductions of kiwi, dragon fruit and asafetida. Many crops of Indian origin like rice, cucumber had provided important genome for saving crops across the world from severe diseases. Plant breeders, molecular biologists, and agronomists, achieve greater gains in crop yields and quality in crop yields and quality in shorter times than in the past due to exchange of germplasm. However, recent policies emerging from international environmental negotiations are giving rise to restrictions that are limiting access and exchange of germplasm and threatening food security. She pointed out that implementation of Access and Benefit Sharing (ABS) systems through Convention on Biological Diversity (CBD), Nagoya Protocol (NP) has negatively affected the exchange of genetic resources. As per NBPGR study, an overall decrease in accessions imported by ICAR institutes (35%), Universities (10%) and other institutes (11.2%) had occurred during 2010-19 as compared to 1985-94, after ABS regulations. Only private institutes had an increase (56.3%) in germplasm exchange; however, CG centres could maintain same status as for as germplasm exchange is concerned. She mentioned that according to Article 10.2 of the ITPGRFA contracting parties agreed to establish MLS which provides for facilitated access to PGRFA for the crops covered under Annex I of ITPGRFA and share in Fair and Equitable way the benefits arriving from the utilization. As on July 2022, a total of 2,343,549 accessions are available for distribution under the MLS and under treaty 90,690 SMTAs have been agreed upon whereas under CBD, only 7,043 national records are available under the Clearing-House Mechanism (CHM), showing lower exchanges under the bilateral system. She informed that during the 9th Governing Body Meeting of the ITPGRFA, an *Ad Hoc* Open-ended Working Group was re-established to enhance the functioning of the MLS.

Dr K.C. Bhatt made a presentation on *"Unique plant germplasm collections from diverse agro-ecological regions of India"*, wherein he spoke on the urgency for collecting trait-specific and climate-resilient germplasm, besides other PGR in view of rapidly changing climatic conditions. He informed that since inception of ICAR-NBPGR in 1976, germplasm of over 2,200 taxa including over 10% notable/unique collections have been assembled. He also voiced the concern about gaps in representation of wild/less-cultivated taxa; areas unattended in some agro-ecological zones, research/study on different aspects like enrichment, validation of trait-specific germplasm and popularization of less-known potential germplasm. There are enormous number of wild plant species (861 CWR of 171 crops) identified at different climatic regions and used by locals. 'Potential plant species', known for rich micronutrients in their economic parts are grown in kitchen garden, or harvested from forests, both for household consumption and sold in local markets. These taxa are generally associated with the indigenous knowledge and such valuable germplasm needs to be conserved with its traditional knowledge. He elaborated on the methodology and examples of unique collections made by NBPGR in the recent past.

Dr V. Celia Chalam delivered a talk on *"Regulatory framework and quarantine for safe transboundary movement of transgenic germplasm"* and appraised about the import of genetically modified organisms/living modified organisms (GMOs/LMOs) in India is governed by the provisions of Environment Protection Act, 1986 and Rules 1989, and by Cartagena Protocol on Biosafety (CPB) of the CBD. She informed that Import Permit issued by the Director, ICAR-NBPGR, subject to import clearance issued by the Review Committee on Genetic Manipulation (RCGM), Ministry of Science and Technology, Government of India and Phytosanitary Certificate (PC) issued by the National Plant Protection Organization (NPPO) of the respective country of origin are a must with transgenic planting material consignment meant for contained use. She said that keeping in view the biosafety requirements, National Containment/Quarantine Facility at ICAR-NBPGR, New Delhi, ensures that no viable biological material/pollen/pathogen enters or leaves the facility during quarantine processing of transgenics. In addition, post-entry quarantine growing/inspection of the transgenics is also undertaken by ICAR-NBPGR to ascertain that regulated quarantine significance pests for India as per the Plant Quarantine (Regulation of Import into India) Order 2003 must be intercepted. She informed about the many capacity building training programs conducted by NBPGR. She concluded by saying that for import of germplasm, there is a need of revision of pest list of PQ Order 2003 (for pests already present in India, virus names not as per International Committee of Taxonomy of Virus (ICTV), crop inspection at the country of origin, lack of local pest database, Pest surveillance programs to identify new pests), requests for waive-off of additional declarations, free from pests for germplasm, post-entry quarantine inspection, Inspection Authorities — availability of funds for diagnostics, meeting the challenges in detection of pests especially viruses for bulk imports for commercial purpose, lack of capacity (bulk imports for commercial purpose) are major constraints. For exports challenges exist in testing of pests not reported from India for issuance of PC and identification of pest-free areas as per the International Plant Protection Convention (IPPC) norms.

Rapid Oral Presentations

Presenter	Dr N. Sivaraj
Title	Are sorghum landraces of Telangana climate resilient?
Key Findings	▸ Ecological niche models generated for sorghum landraces indicated that they are climate-resilient but there would be a shift in cultivating pockets in Telangana
	▸ However, by using advanced studies like high throughput precision phenotyping, multi-omics platforms, next-generation sequencing (NGS), gene mapping the models need to be validated
Presenter	Dr M.R. Rohini
Title	Species distribution, exploration, collection and conservation of Salacia species (high value antidiabetic plant) of Western Ghats
Key Findings	▸ A total of 50 variable accessions of eight species collected from Kerala and Karnataka, established in field genebank through seeds
	▸ Regeneration protocol for in vitro multiplication and conservation established of S. chinensis established, including pollen cryopreservation
	▸ Future studies to focus on bioprospecting for chemical diversity to identify elite species and elite accessions for promoting cultivation
Presenter	Dr Manoj Kumar
Title	Collection, conservation and multiplication of pearl millet landraces in Rajasthan
Key Findings	▸ An attempt was made to evaluate pearl millet landraces collected across 33 districts of Rajasthan as crowdsourcing trials, which included mother and baby trials during 2019-21
	▸ Seeds of selected seven landraces were assigned codes and the coded packets were given to farmers for sowing. The recorded data were fed in CLIMMOB APP for analysis of different parameters
	▸ All were found good for yield and variable nutritional parameters. DUS testing also carried out
Presenter	Dr A.K. Srivastava
Title	Conservation priority of Buchanania lanzan Spreng. (Chironji): A potential wild fruit tree of peninsula India
Key Findings	▸ Experiment on survey and collection of superior chironji genotypes through explorations in hotspot areas of UP, MP, Bihar and Chhattisgarh were conducted during the year 2020-21 and 2021-22
	▸ A total of 74 elite genotypes were collected based on the horticultural traits. Germplasm variability status was found as medium
	▸ On the basis of fruiting potential, precocity in bearing and fruit quality attributes, Genotypes BUAT- C- 30, 34, 40, 48, 49, 54, 70, 71 and 72 found promising

Presenter	**Dr K.P. Mohapatra**
Title	IoT based E-solution for safeguarding tree germplasm against physical damage, misidentification and mistracking in field genebanks
Key Findings	▸ For automation of data, a SMART-protection system (IoT based) comprising set of sensor tags, machine-learning components, making Wireless Sensor Network (WSN) with Gateway Device was applied for real time/RFID monitoring of data through mobile Apps
	▸ The technology has worked perfectly by networking 248 trees located at three different locations i.e. Delhi, Bengaluru and Jhansi
	▸ Software is user- and gender-friendly as it could be operated successfully by a person having any level of education from 10 ft distance
	▸ The technology can be tested in more stressed agroclimatic situations like deserts and high rainfall remote localities
Presenter	**Dr K. Pradheep**
Title	Survey and collection of plant genetic resources from Andaman & Nicobar Islands representing Indo-Burma and Sundaland biodiversity hotspots
Key Findings	▸ Some 34 taxa collected which are endemic to A&N and 354 accs. maintained in Field Genebanks (FGBs). Taxonomic authentication of collections and field keys developed
	▸ Rootstock suitability studies (across genera/families) undertaken in nutmeg, sapota, garcinia, biotic screening studies *e.g., Musa, Solanum*
	▸ Exploring usefulness as coastal bioshield, dining plates, ornamentals. *etc.*
Presenter	**Dr Jameel Akhtar**
Title	Large scale phenotyping of pea germplasm for discovery of resistant sources against powdery mildew *(Erysiphe polygoni)*
Key Findings	▸ Out of 4,680 accessions of pea in the NGB, 1,136 (IC and EC) accessions screened for powdery mildew in 2021
	▸ 25 accessions showed highly resistance. Out of these 4 accessions (IC220378, IC274040, IC345548 and IC424898) were highly resistant
	▸ However, there is need to confirm presence of resistant gene(s) er-1 (complete resistance) and er-2 (incomplete/leaf resistance) in the identified accessions
Presenter	**Dr Vikas V.K.**
Title	*Inter-specific hybridisation followed by mutation to improve the yield potential of cultivated emmer or Khapli wheat (Triticum dicoccum Schub. L.)*
Key Findings	▸ To develop semi-dwarf and high yielding line(s) from inter-specific derivatives of *T. dicoccum,* gamma rays and electron beam used
	▸ Electron beam as a potential mutagen for wheat as observed in M6 generation, for measured by plant morphotype, and biological yield
	▸ Multi-location evaluation of mutants required and if released, it would be the first electron beam mutant variety in wheat

The Co-Chairs summarized the work presented by all the speakers. They appreciated the conference organizers for providing the platform for both public and private sector organizations working in PGR area. **Dr P.K. Chakravorty** summarized the area of concerns in exploration, exchange and quarantine of PGR. Biotic sources (10-40%) are one of the important reasons for genetic diversity loss. He informed that nearly 74% of diseases in Indian crops were of alien origin. He said that after COVID-19 pandemic, a 'Bioterrorism Council' is being contemplated. He also endorsed the need to increase the stringent measures in the country for quarantine, especially in bulk import and travelers coming airports/seaports. He appreciated the work of NBPGR in quarantine interceptions and need to upgrade the technology for detection of pests (*e.g.* electronic noses for detection) which requires more research through inter-institutional collaboration. **Dr B.S. Dhillon** also summarized the PGR work done in the past for food and nutritional security. At global level, climate change, biotic stresses, and war are the current threats to genetic resources. This requires more policy issues and IPR awareness. He said a major challenge in collecting is the issue of duplication. He informed about the past efforts on mega-characterization of wheat, rice, chickpea, pigeon pea, *etc.* started by ICAR in 2002 in a network mode, which is now being supported by DBT and other funding agencies. This needs for more crops. He recalled the Citrus Gene Sanctuary identified by **Dr Bhag Singh**, which now is eroded. He said that we need to be more liberal for germplasm exchange. Talking about germplasm utilization he said pre-breeding needs to be given attention. He urged Director, ICAR-NBPGR, to facilitate ease of operation for germplasm registration and take necessary initiative to ensure better quarantine process at airports and sea ports, for which he must write to ICAR. He mentioned that trait–specific germplasm needs to be popularized for wider use by breeders.

Technical Session 2



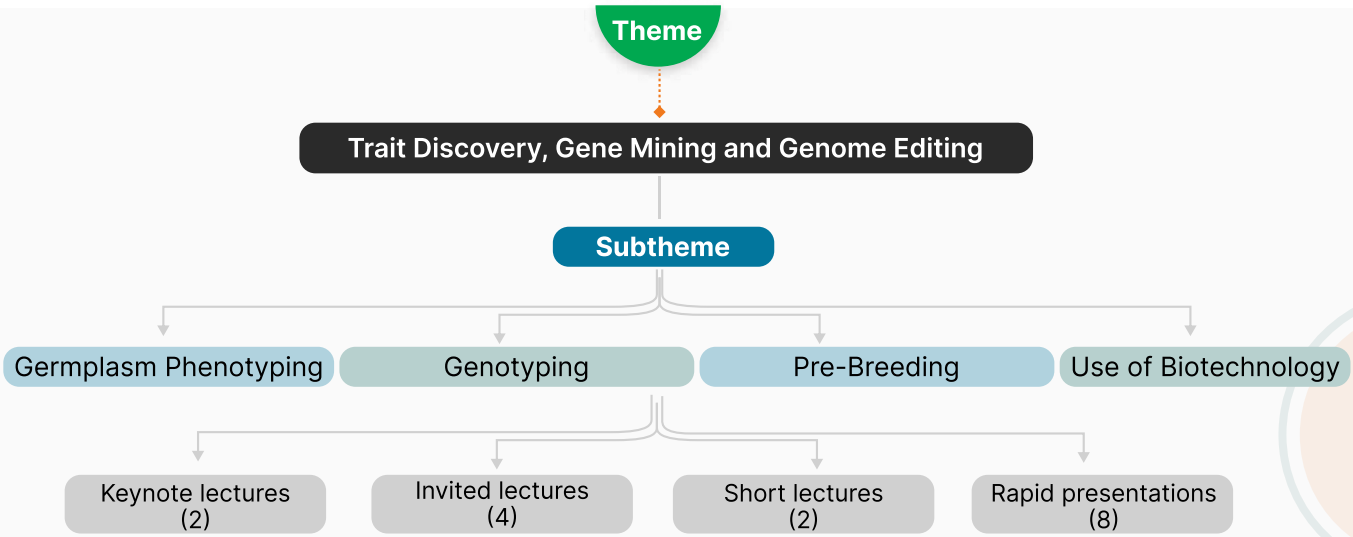


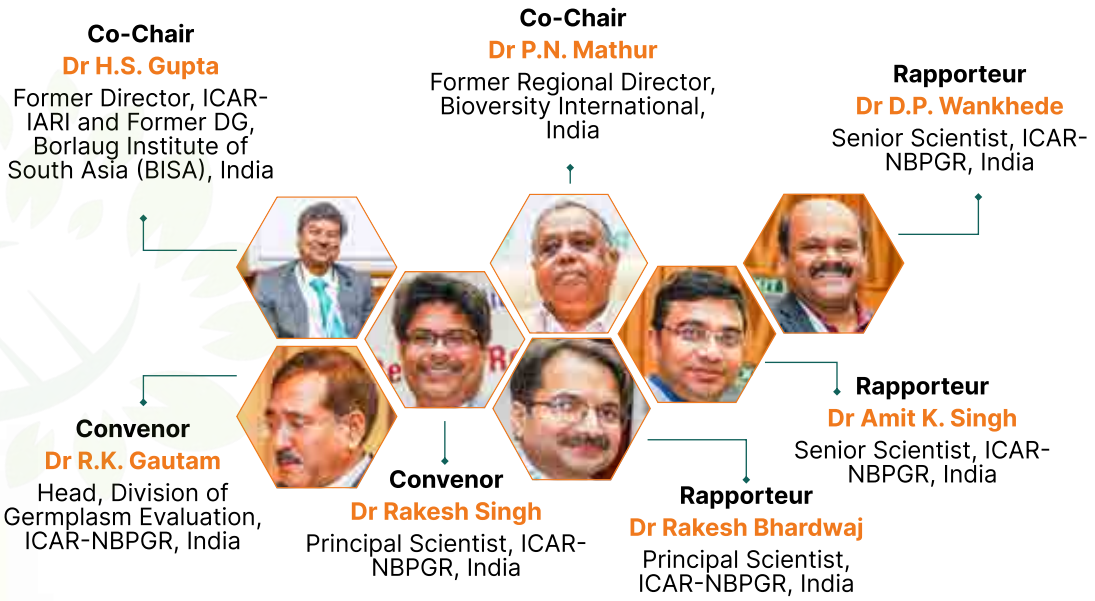






Technical Session 2





Keynote lectures were presented by **Dr Matthew Reynolds**, Distinguished Scientist and Head of Wheat Physiology, CIMMYT, Mexico and **Dr Rajeev Varshney**, Director, Centre for Crop & Food Innovation, Murdoch University, Australia. It was followed by four invited lectures by **Dr N.K. Singh**, National Professor, ICAR-National Institute for Plant Biotechnology, India; **Dr Joy K. Roy** & **Ashwani Pareek**, Executive Director, National Agri-Food Biotechnology Institute, Mohali, India; **Dr Shiv Kumar Agrawal**, Regional Coordinator, ICARDA, India and **Dr Bharat Char**, Chief Science Officer, Maharashtra Hybrid Seed Company Pvt. Ltd. (MAHYCO), India. This was followed by short Lectures by **Drs R.K.** and **M.C. Yadav**, ICAR-NBPGR, India. Thereafter, rapid presentations were made by speakers **Drs Vikender Kaur, Twahira Begum, Ashok Kumar, Rithesh BN, Gayacharan, Supriya Sachdeva, Shrawan Singh** and **Jyoti Kumari**.

Keynote Lectures

Dr Matthew Reynolds delivered a keynote lecture on *"Using genetic resources to stack and complement climate resilience traits"*. He described the pre-breeding value chain comprising crop design, genetic resources, phenotyping, genetic analysis, crossing and selection, evaluation of genetic gains and informatics. He informed that CIMMYT focuses on two main drought environments — (i) Mediterranean type that rains in early part of season then is dry, and (ii) post-monsoon typical of South Asia, where the crop survives on stored moisture. He showed a conceptual model of heat-adaptive traits wherein yield is influenced by genes governing light interception, efficient metabolism and photoreception. Similarly, he also explained drought adaptive traits for drought tolerance (osmotic budgeting, water budgeting, *etc.*), and drought avoidance (deep roots, evaporative cooling, *etc.*). He informed that since 2011, >60,000 accessions have been screened under drought and heat, at CIMMYT Mexico. Synthetic hexaploid hybrids expressed increased biomass, showing genes for tolerance, though not for yield. The same set was also DNA fingerprinted and a Molecular Diversity Panel (MOLPLAN) developed for heat stress. Breeder-friendly phenotyping underpins genetic resource screening, parental characterization, progeny selection and gene discovery. Advanced lines sown side by side but with different irrigation regimes, showed very little yield correlation despite same average mean yield, proving that distinct crossing and selection strategies are needed. Given the high associations between canopy temperature and root mass at depth under drought, the use of "less breeder-friendly" approaches for studying roots and moisture profiles are expected to become obsolete. Spike and leaf photosynthesis show independent genotypic variation, suggesting the traits could potentially be stacked to boost total canopy photosynthesis. Spike photosynthesis is especially important for drought tolerance, since spikes recycle respiratory CO_2. QTL have been identified for pedicellate spikes (PS). An array of remote sensing (RS) protocols is in place to screen the progeny of strategic crosses for many of the desired traits, and similar RS approaches were applied earlier in the pipeline to identifying candidates' parents from screening genetic resources. Results from international nurseries of the 8th SATYN nursery (targeted to hot environments), demonstrated that novel lines show up to 7% more yield than local checks under heat stress and 4% more yield than the best CIMMYT check Baj, averaged across 33 environments of varying stress levels. He concluded that translational research and pre-breeding could achieve a significant boost (*e.g. via* public-private partnerships) by linking to upstream discovery research that aims to fill significant knowledge gaps that currently limit a more comprehensive understanding of yield and climate resilience in most crops.

Dr Rajeev Varshney presented his keynote lecture on *"Genomics for improving germplasm management and utilization"*. At the outset, he gave a brief overview about the Centre for Crop and Food Innovation and the Western Australian State Agricultural Biotechnology Centre, where he is working as Director and focusing on fruit crops, . His presentation highlighted use of genomic and biotechnological tools for improvement of three important legumes, namely, chickpea, pigeonpea and groundnut, using germplasm from ICRISAT genebank, where he had worked for 17 years. He mentioned that availability of cutting-edge and affordable DNA sequencing and genotyping platforms have facilitated dense genetic profiling of large collections archived in genebanks worldwide. The use of genebank genomics as a tool for collection management was also highlighted, including identification of duplicates in both homogenous and heterogeneous populations. Pre-requite for using genomics as a tool for utilization of diversity for crop improvement include high quality reference genome, followed by democratization of sequencing technologies, high-throughput sequencing/ genotyping and phenotyping platforms and mining of superior haplotypes for important traits through pangenomics or genome-wide association studies (GWAS).

The pan-genomics approach in chickpea re-affirmed its centre of origin of as the Fertile Crescent, identified two paths of diffusion to the rest of the world, threw light in Cicer species divergence, identified mislabeled accessions in the collection, identify genomic regions for domestication and breeding bottlenecks. The ICRISAT group could map 20-50 traits in each of the three crops which could be used for translational genomics or genomics-assisted breeding approach (marker-assisted selection, backcrossing, recurrent selection) and haplotype-based breeding, genomic selection, promotion/removal of alleles though gene editing. He concluded saying that genomics is key for harnessing full potential of genebanks, and pan-genomics and precision phenotyping provide opportunities for undertaking fast-forward breeding approaches to expeditiously creating and incorporating superior genes/ haplotypes in crop improvement. He suggested that national genebanks should be joining with international programs to have unified approach of sequencing, phenotyping, data analyses and databases.

Invited lectures

Dr N.K. Singh gave a lecture on *"Genomics-assisted breeding of climate-resilient cultivars utilizing traditional varieties and wild rice genetic resources"*. He discussed the background on the definition and use of genomics tools such as (i) complete physical maps (for evolutionary and phylogenetic insights), (ii) high-density DNA fingerprints (for characterization and IPR protection), (iii) high resolution QTL mapping, gene discovery and allele mining for useful agronomic traits, (iv) Trait-linked and genome wide DNA markers as selection tools for accelerated plant breeding and (v) Designing guide RNA for genome editing. He discussed about one of the most popular mega varieties (MV) 'IR64' and is cultivated for decades due to its superior quality, yield stability and high adaptability as a result of recombination breeding. The MVs provide an ideal base for further improvement by introgression of validated genes and QTLs using marker-assisted selection for accelerated breeding. He discussed about the availability of rice genomic resources — genome sequence, pangenome, more than 18,000 type ISSR markers, a set of HvSSRs, various genes for biotic and abiotic stresses and yield traits and over 4 million single nucleotide polymorphisms (SNPs), high-density SNP chip arrays, for diversity analysis and breeding applications. He explained marker-assisted pedigree selection (MAPS) including gene haplotype-based selection (GHS), marker-assisted recurrent selection (MARS), marker-assisted backcross breeding (MABB), and genomic selection (GS); most of the MAS-derived rice varieties have been developed through MABB. He stated that more than 50 rice varieties developed through marker-assisted selection have already been notified for commercial cultivation in South and South-East Asia with IRRI and ICAR playing a pivotal role in marker development and sharing of advance breeding lines with the NARS partners *e.g.* Swarna-Sub1, Samba Mahsuri-Sub1, IR 64-Sub1, BR11-Sub1, Improved Pusa Basmati 1, Pusa 1847, *etc.* He also said that development of near-isogenic lines of mega varieties (MV-NILs) provides a core strategy for further enhancing the value of these already popular varieties. And parallel back-crossing programs for introgression of individual genes/QTLs in to the MVs appears to be the most efficient strategy. He emphasized that Green Revolution (GR) high-yielding varieties (HYV) carrying the *sd1* gene for semi-dwarf plant height need to combine with climate resilience. He showed that six consistent QTLs for grain yield under drought, namely, *qDTY1.1, qDTY2.1, qDTY2.2, qDTY3.1, qDTY3.2* and *qDTY12.1* have been transferred into flood-tolerant versions of Swarna, Samba Mahsuri and IR 64 to develop two-in-one drought- and flood-tolerant high yielding rice varieties. The SUB1QTL for submergence tolerance has also been transferred to nine regional rice MVs. He also emphasized the identification of new genes from wild rice for climate resilience and transferring these into the HYV-MV backgrounds and use of genome editing tool for high-speed precision breeding of new climate-resilient varieties of rice and other crops. He concluded by stating the need for (i) Conservation and high throughput evaluation of germplasm for the desired agronomic traits for novel gene discovery; (ii) Choosing plants of economic importance for sequencing with single molecule long read chemistry *e.g.* PacBio

HiFi platform to assemble high-quality Reference and Pan genomes; (iii) High-density genetic maps using SNP genotyping array platforms for anchoring of the genome; (iv) RNASeq for full length transcripts and alternate splicing information for the validation of gene annotation; (v) Plant Biology: study of spatial and temporal expression of genes at RNA, protein, metabolite, metal ion and phenotype levels; (vi) Marker-trait association, through GWAS and bi-parental QTL mapping and map-based cloning of genes using functional genomics tools.; (vii) Genomics-assisted breeding using foreground, recombinant, high-density background selection for pyramiding of multiple desirable genes.

Dr Joy K. Roy gave a lecture on behalf of Dr Ashwini Pareek, on *"Technologies and innovations contributing towards food and nutritional security in the era of climate change"*. At the outset, he spoke the tools and technologies being adopted to improve the yield and nutritional value in diverse crops at National Agri-food Biotechnology Institute (NABI). To improve grain quality in wheat to reduce glycemic index (GI) the ratio between amylose and amylopectin content was being altered. He mentioned that mutagenic approach (EMS) was adopted to improve the Indian wheat variety (C306) for high amylose content (resistant starch), as germplasm screened was lacking it. Two superior lines could be identified and private industries sought those for their low GI. QTLs were identified for the trait. Gene identification is underway. Dr Roy then described the genetic improvement of banana for nutrition enhancement by of gene overexpression and genome editing (CRISR-Cas9). In Banana *cv* Grand Naine, Lycopene Epsilon Cyclase (LYCE) gene editing (carotenoid biosynthesis pathway) was applied to obtain high carotenoid (6-fold high pro-vitamin A) bananas. Generation of transgene-free carotenoid cleavage dioxygenase 4 (CCD4) edited banana lines showed carotene content was increased from 1.4 to 2.7 times higher in leaves and roots of banana *cv* Rasthali. In rice, similarly, molecular breeding had been applied for improved grain quality. He revealed that the rice genome was being edited to make it lysine-rich and tolerant to abiotic stresses.

Dr Shiv Kumar Agrawal spoke on *"Trait discovery and deployment through mainstreaming landraces and crop wild relatives (CWR) in legume breeding programs"*. He presented an overview about legumes and status of their CWR and said that only limited genetic gains (0.6-0.8% per year) have been achieved in legumes with 3,500 varieties of major pulse crops cultivated globally out of which only 1,200 are in India. To meet the future demand of pulses, there is need to accelerate the annual genetic gain at 1.5%. He acknowledged the initiative by ICAR-NBPGR taken during 2011-15 for widening the genetic base of lentil and chickpeas through pre-breeding. Further strengthening by the Crop Trust during 2016-19 under a project on trait discovery and deployment through mainstreaming the wild gene pool in barley and grass pea breeding programs to adapt to climate change and another project on DIVA-PR dissemination of interspecific ICARDA varieties and elites through participatory research. He said that for continuous genetic improvement, we not only need to improve the trait value but also to maintain the genetic variance.

The narrow genetic base and extensive and repetitive use of a handful of germplasm as parents in hybridization has been identified for limited genetic gain in legumes. One option to widen the genetic base is to mainstream landraces and CWR in breeding schemes as these contain a wealth of novel traits/alleles due to their adaptation to diverse habitats. He informed that at ICARDA, three-pronged approach of 'core breeding (value-added traits), pre-breeding (future value-added traits) and discovery or wide hybridization (game changing traits) was being adopted for short- (3-5 years), medium- (5-8 years) and long-term (8-15 years) outputs.

He said that issues related to pre-breeding typically were lack of the information on the CWR and crossability, linkage drag and number of generations needed for exotic germplasm. He discussed about the pre-breeding work being undertaken at ICARDA in various crops (lentil and grasspea). He finally summarized stating that CWR are a great source of useful traits and their limited evaluation/collection was a major bottleneck. The strong crossing barriers in grass pea are being overcome by new age tools, though perception of inferiority and linkage drag remains. Pre-breeding is a long-term endeavor and requires concerted efforts. Most of the pre-breeding activities form the upstream research and no direct variety released in crops that he had described.

Dr Bharat Char made a presentation on *"Using new breeding techniques and digital tools for crop improvement"*. He addressed that multiple technology approaches are needed to sustain genetic gains achieved through plant breeding, and the major challenges associated with climate change as well as tolerance to biotic stress factors. He mentioned that incorporating single genes into crops that enable plants to withstand these stresses is a demonstrated approach but one which has faced increasing difficulty in gaining approvals or release. To aid the crop breeder, molecular marker and genomics approaches have been used successfully and now the focus is on predictive breeding models for making decisions in breeding programs thereby reducing time to develop a product as well as save on resources. Predictive breeding comprises a training set (with replicated data of lines and high-density marker data on lines), statistical modeling, target set [of new lines and unknown phenotypes and predictions (*in silico* based, of new lines and hybrids]. He also discussed that integration of doubled haploids has been a proven strategy for enhancing the breeding programs with several successes in commercial crops. More recently, digital agriculture has offered new methods of assessing crop performance. For instance, developing protocol for drone imaging using different sensors (Red, Green, Blue, multi spectral and thermal) and standardising and monitoring of different crops (cotton and Chili) for crop health attributes (disease and pest index/severity, Nitrogen and Chlorophyll status) and water stress. These include precise phenotyping and yield estimation using artificial intelligence and machine learning approaches. Finally, examples of new breeding techniques to introduce new traits in crop breeding programs along with outcomes and challenges were discussed.

Short lectures

Dr R.K. Gautam made a presentation on *"Towards harnessing soybean germplasm diversity in the National Genebank for summer season cultivation"*. He gave an overview of the various activities being carried out by the Division of Germplasm Evaluation at ICAR-NBPGR. Specifically for soybean, he said that India is importing edible oil worth more than ₹70,000 crores annually and discussed the potential of soybean to be exploited as a summer season crop intercropped with sugarcane in both Northern as well as Southern parts of India. He gave details on characterization and validation of 8,029 soybean accessions at ICAR-NBPGR, Issapur and selection of a set of 251 early maturing lines. He stated that 45 accessions identified as early and very early maturing would be tested over locations to serve directly or as donor to enhance soybean yield during summer season in conjunction with sugarcane inter-cropping system for crop diversification and additional income. The selected early maturing soybean accessions after multilocation testing and intercropping studies will be shared with NARS breeders. Dr Gautam said that utilization and cultivation of early maturity and photo-insensitive varieties as intercrop has potential to enhance soybean production in ~20 lakh ha sugarcane area. Enhanced soybean production without additional land area can result in diversification, soil enrichment and enhanced farmers' income.

Dr Mahesh C. Yadav gave a lecture on *"Development of pre-breeding genetic sources for trait discovery and gene mapping in bread wheat: Indian perspectives"*. He discussed the development of a 5-parental Multi-parent Advanced Generation Inter-Cross (MAGIC) and five bi-parental mapping populations in wheat using five founder parents selected based on component traits to create three F1 hybrids (Iepace Robe x NW1014, HD2864 x UP2338 and DL788-2 x HD2864) using HD2864 (founder line) as reciprocal parent. Each F1s were crossed in full diallel pattern to produce six double crosses and the two-way crosses were further hybridized in all possible combinations to reshuffle the genomes of founder lines. The MAGIC population was stabilized by natural self-pollination, and 4th cycle selfed seeds of 1930 MAGIC RILs and F8 seeds of 1090 RILs of five biparental populations harvested and then exposed to 35-38°C during grain development stage to screen for terminal heat-stress tolerance and to impart adaptation to elevated temperature under extremely late-sown conditions. He stated that the promising 510 RILs of 5-parental MAGIC population would be evaluated in multi-environment for fine-mapping of QTLs for heat-stress tolerance in bread wheat.

Rapid Oral Presentations

Presenter	**Dr Vikender Kaur**
Title	Characterization of linseed germplasm conserved at National Genebank of India and development of core set
Key Findings	▸ Wide range of variation was observed at two locations in 2800 accessions. Initially, five different core sets were derived using Core Hunter 3 software
	▸ The coefficient of variation and Shannon–Weaver diversity indices were increased in the core set as compared with the whole collection. Correlogram revealed that trait associations and their magnitude were conserved for most of the traits after sampling of the core set
Presenter	**Dr Twahira Begum**
Title	Assessment of molecular diversity of core collection of ginger germplasm from Northeast, India
Key Findings	▸ The 28 SSR primers produced a total of 70 bands in 150 accessions of ginger. The polymorphic information content ranged from 0.672-0.089 while the marker index ranged from 2.015-0.044 and resolving power ranged from 2.041-0.280. On the basis of the molecular analysis the primer RM125 was found to be the most efficient
	▸ The highest polymorphic population was found to be of Arunachal Pradesh (90.00%), followed by Assam (68.57%). The highest similarity was found between Meghalaya and Sikkim (0.9571) followed by Nagaland and Mizoram (0.9425) based on Nei's genetic identity while the lowest similarity was found between Nagaland and Meghalaya (0.7239)
Presenter	**Dr Ashok Kumar**
Title	Introduction and morphological characterization of 'heeng' (*Ferula assa-foetida*) accessions in cold deserts of Indian Himalayas
Key Findings	▸ Field trials of heeng have been laid out at farmer's fields in five districts (Lahaul & Spiti, Kinnaur, Mandi, Kullu and Chamba) of Himachal Pradesh to evaluate their performance
	▸ A significant variation was recorded for the morphological traits
	▸ DNA barcoding of seed samples was performed to confirm the authenticity of *heeng*
	▸ Country's first "Heeng Germplasm Resource Centre" has been established at CSIR-IHBT, Palampur
Presenter	**Mr Rithesh B.N.**
Title	Characterization of wild and cultivated Musa species of India based on Flow Cytometric Analysis of ploidy and nuclear DNA content
Key Findings	▸ Ploidy of 28 diploid *Musa* accessions and 3 triploid accessions were confirmed from *In Vitro* Gene Bank of NBPGR using flow cytometery
	▸ The genome size within the same genus varies greatly and different individuals within the same species had variable genome sizes

	▸ The nuclear DNA content of 8 wild species, namely, *Musa balbisiana var. andamanica, M. indandamanensis, M. saddlensis, M. sikkimensis, M. nagensium, M. paramjitiana, M. cheesmani, M. aurantiaca and triploid cultivars viz., Meitei-hei, Vaibalha* and *Champacolla* were first reported in the study with a wide range of variations
Presenter	**Dr Gayacharan**
Title	Characterization of entire ricebean collections of Indian National Genebank and development of core set for enhanced utilization
Key Findings	▸ A total of 1,760 accessions of ricebean germplasm (*Vigna umbellata*) characterized in two locations for two years to identify core set based on phenotypic data and passport information
	▸ Though species is known to have rich genetic diversity, morphological variability is poor (except for traits *viz.* grain colour, grain size, flowering and maturity period)
Presenter	**Dr Supriya Sachdeva**
Title	Genome-wide association study reveals novel QTLs/MTA for plant height in a subset of Rice Genome (RG) panel
Key Findings	▸ Among the subpopulation of 3,000 rice genome panel obtined from IRRI, the order of average plant height recorded was *intermediate type > aus/boro > indica > japonica* indicating that the source and natural environment affects plant height of rice considerably
	▸ Based on genomic studies, distribution of superior alleles in the different allelic groups showed that superior alleles for plant height are distributed in both whole population and indica subspecies
	▸ Haplotyping showed plants carrying qPH1-1, qPH3-1, qPH4-1 (117.6 cms) and qPH1-1, qPH3-1, qPH4-1 and qPH8-1 (115.14 cms) were shorter than the plants carrying qPH1-2, qPH1-3
	▸ Markers in vicinity of QTLs identified viz., qPH1-1, qPH3-1, qPH4-1 and qPH8-1 can be directly used in marker-assisted breeding to control plant height
Presenter	**Dr Shrawan Singh**
Title	Genetic diversity, population structure and trait characterization in Indian cauliflower
Key Findings	▸ 91 genotypes were phenotyped and genotyped (SSR and GBS) for grouping Indian cauliflower based on temperature requirement for curd formation and development
	▸ Cauliflower maturity groups follow temperature dependent curd formation pattern. Significant level of admixture was noticed through structure analysis using SSRs and GBS analysis
	▸ New germplasm with good traits identified for Delhi conditions
Presenter	**Dr Jyoti Kumari**
Title	Wheat genetic resource mining for trait discovery towards achieving Sustainable Development Goals for food and nutritional security
Key Findings	▸ Evaluation of large number of wheat germplasm accessions in the NGB collections undertaken to identify novel traits and donors, and use the same in plant breeding
	▸ At the outset, 22,416 accession characterized and composite core set developed

- Evaluation of composite sets for biotic stresses (yellow rust, brown rust, black rust, karnal bunt, loose smut, powdery mildew, spot blotch) and abiotic stresses (salinity, drought) and quality traits (protein content, sedimentation value) carried out at 11 locations, as per need

- Uni- and multi-trait germplasm identified which are being used in crossing programs, mapping population development and GWAS for gene/QTL identification

Dr H.S. Gupta concluded the session and mentioned that production and productivity has increased due to deployment of specific genes and genotypes (*e.g* SubA genes). Dr P.N. Mathur emphasized on 'conservation for use', biotechnology level yet to reach to grassroot level and also on orphan crops (*e.g.* grass pea) that have been remained neglected to greater extent.

Technical Session 3

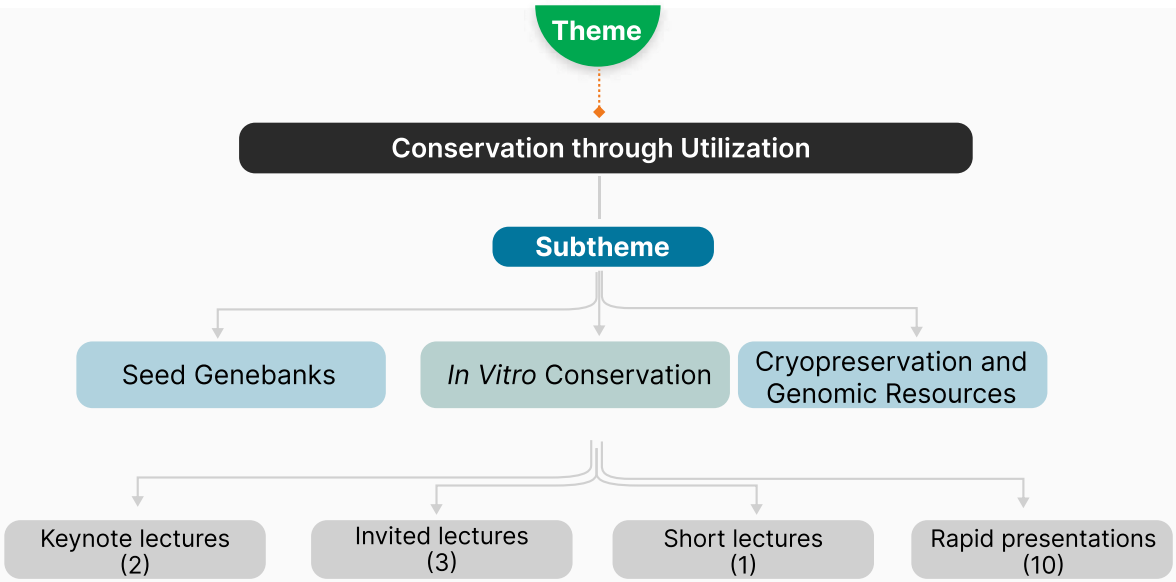


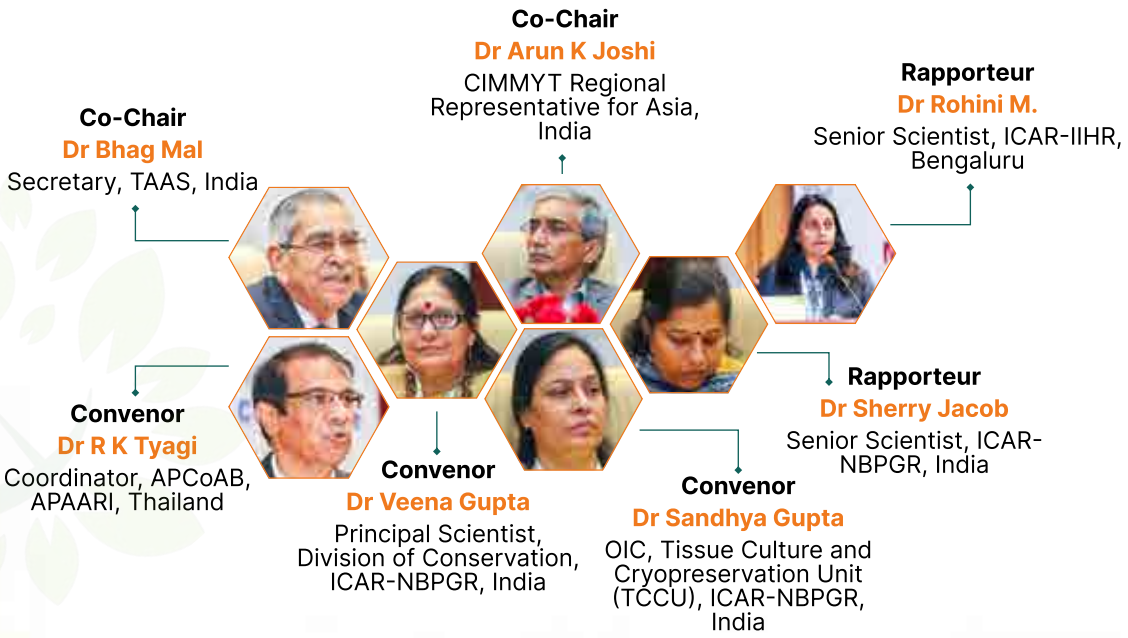






Technical Session 3





Keynote lectures were presented by **Dr S.K. Vasal**, Distinguished Scientist, CIMMYT, Mexico and **Dr Hari D. Upadhyay**, Former Director, Genebank, ICRISAT, India. It was followed by invited lectures by **Dr Venuprasad Ramaiah**, Genebank Manager, International rice Research Institute (IRRI), Philippines, **Dr Bart Panis**, Plant Cryobiologist, Alliance of Bioversity International and CIAT, Belgium and **Dr Sunil Archak**, National Fellow, ICAR-NBPGR, India. A Short Lecture was presented by **Dr Mohan Lal**, Principal Scientist, CSIR-North East Institute of Science and Technology (CSIR-NEIST), Jorhat. Thereafter, rapid presentations were made by delegates **Drs Gowthami R., Padmavati Gore, Anil Kumar, Tanmita Gupta, Vartika Srivastava, Bhargav Kiran, Era Vaidya Malhotra, Manish Kumar Vijay, Badal Singh** and **Amit Kumar Singh**.

Keynote Lectures

Dr S.K. Vasal delivered keynote lecture on *"Designing germplasm management systems to maximize use of maize genetic resources"*. He explained that maize offers numerous options for cultivar development, breeding methodologies, seed production practices, and several specialty corn types. He summarized the work done on exploration and collection of traditional maize types and identification of landraces for further improvement to develop open-pollinated varieties (OPVs), hybrids or both. He shared strategies to manage genebank systems and heterotic models used by maize scientists to maximize use of existing genetic resources. He shared his experience in maize to design germplasm management system(s) with multiple tiers involving materials with different level of performance such as useful accessions, gene pools and populations as attempted by CIMMYT. He developed Thai Composite maize by recombining 46 accessions from Mexico which later, with the inclusion of downy mildew resistance, was named as Suwan-1 and mentioned that it has been widely used across the globe in different ecologies as it is an excellent combiner. He stated that the development of a two-tier germplasm management system of backup pools and advanced populations at CIMMYT, resulted in 28 populations and 34 gene pools meeting germplasm needs of varied adaptation ecologies and the studies on combining ability of these materials through international collaboration to establish heterotic patterns. He also described the development of new heterotic pools, hybrid-oriented source germplasm, trait-specific populations, synthetics as well as heterotic groupings and patterns of materials being handled at CIMMYT.

Dr Hari D. Upadhyay presented his keynote lecture on *"Strategies for enhancing use of germplasm collections in crop improvement for sustainable conservation."* He expressed his concerns on vulnerability of agriculture to global warming, depletion of natural resources and low risk absorbing capacity of the farmers in South Asia and sub-Saharan Africa. He suggested to develop high-yielding climate-resilient cultivars with a broad genetic base and judicious management of natural resources as an important way to address global food and nutritional security. He mentioned that globally 7.4 million accessions are conserved in more than 1,750 genebanks but less than 1% of assembled germplasm is used in breeding programs leading to narrow genetic bases of crop gene pools. He emphasized that the requirement of reliable data on traits of economic importance, development of core sets and mini core sets is the need of the hour in all crops for variation in multiple traits.

Systematic evaluation of mini core collections has resulted in identification of a number of germplasm lines with agronomically and nutritionally beneficial traits in chickpea, groundnut and sorghum. He reminisced that use of diverse germplasm lines identified from a groundnut mini core resulted in developing exceptionally high oil (up to 63%, compared to ~48% in control cultivar) and high-yielding breeding lines, indicating that new germplasm sources contribute to enhance the genetic gains. He also stated that systematic and sustained efforts to infuse diversity from wild relatives are required. In groundnut TXAG 6, an amphiploid has been successfully used to enhance 100-seed weight (up to 87 g, cultivated parent ~ 40 g), pod yield (up to 27% more than cultivated) and traits related to drought tolerance such as specific leaf area and soil plant analysis development (SPAD) chlorophyll meter reading. Similarly, in sorghum, recombinant inbred lines of *S. bicolor x S. propinquum* crossed as pollen parents with four cultivars, Teshale, Macia, Lata and BTx623 showed rich variation for important traits. He highlighted the availability of genotypic data for large numbers of germplasm accessions aids in understanding of crop genomes and their diversity which can be used by other researchers.

Dr Venuprasad Ramaiah made a presentation on *"Conserving and utilizing plant genetic resources – role of IRRI genebank"*. He said that CGIAR genebanks are an essential component of a global system for conservation and use of PGR for food and agriculture (PGRFA). He explained that the 11 CGIAR genebanks conserve 30 crops and collections includes both cultivated, and wild and related species. These germ-germplasm accessions and the associated data are made available to researchers around the world and a cornerstone of crop improvement across the world. He presented several examples to show the value of the rice collection at IRRI in attaining food and nutritional security and in adapting to climate change. He opined that despite such examples, wealth of diversity in IRRI genebank remains largely untapped and their utilization would remain the focus in the coming years.

Dr Bart Panis gave a lecture on *"Application of plant cryopreservation for the conservation of plant genetic resources, production, virus eradication and as a tool for modern breeding techniques"*. He discussed efficient cryopreservation methods were developed for a wide range of plant species for diverse tissue types - pollen, meristems, calli, zygotic as well as somatic embryos, seeds and dormant buds and most used cryopreservation protocols applied to plant tissues are the classical slow freezing protocol, droplet vitrification, encapsulation dehydration and dormant bud cryopreservation. He mentioned, currently, between 20,000 to 25,000 accessions are safely preserved in liquid nitrogen and more initiatives to increase these numbers are being taken. Crops with more than 1000 accessions cryopreserved are apple, banana, mulberry, cassava, garlic and potato. It is estimated that worldwide between 1,00,000 and 1,50,000 unique accessions of vegetatively propagated and recalcitrant seed crops are currently held in field-, *in vitro*- and cryo-genebanks. He also focused on the importance of establishment of a 'safety cryopreservation back up facility' like the Svalbard Global Seed Vault.

He also mentioned that cryopreservation can also be applied to store cell lines with specific characteristics for the long-term and its use for the eradication of pathogens such as viruses, phytoplasmas and bacteria from the plants. Finally, he stated that cryopreservation can be applied in *in vitro* plant production companies for "clean," true-to-type back-up in case of problems of contamination, hyper-hydricity and somaclonal variation.

Dr Sunil Archak delivered a lecture on *"PGR informatics for efficient conservation and use"*. He stressed on the importance of the availability of trait-specific PGR for varietal development programs and mentioned that PGR utilization, in turn, depends upon the availability of reliable information. He explained the significance of PGR Informatics and PGR Portal for efficient utilization of valuable genetic resources. He stated that effective PGR Informatics can be built upon sound scientific grounds to encompass genetic, taxonomic, geo-informatic, bioinformatic and genomic linkages. He said that a user-centric approach is needed that includes growth, scalability, capacity, and visibility; through development of a powerful and user-friendly data portal, nodes, thematic portals, and rich internet applications. Research and development in PGR analytics will accelerate cognitive decisions that facilitate PGR utilization. NBPGR, being the nodal organization for PGR management in India, holds the responsibility of research and development in PGR Informatics. He discussed that in the past two decades, three seminal changes have shaped PGR informatics — technology change in computers, policy change from open access to regulated access and objective change from

conservation-centric to utilization-centric management; and, the need of the genebanks to build and manage their PGR information systems. He expressed his dismay that all the gene-rich countries lack informatics facilities. He informed about number of tools and algorithms have been developed in the field of informatics applicable in other sciences, however, customizing available algorithms for PGR Informatics continues to remain a challenge, as they are non-canonical problem-solving computer operations with rules set by biology.

He appraised critical gaps in PGR informatics and a general lack of emphasis on PGR Analytics to facilitate cognitive decisions. He said that ICAR-NBPGR has digitalized and documented germplasm, starting in 1997 with computerized allotment of IC numbers and massive efforts to digitize data began in 2002. With a decade long incessant efforts, PGR databases were developed by 2010-11 and "PGR Portal" was launched in 2012 as an open access information portal on PGR conserved in the National Genebank of NBPGR. He also enumerated several applications developed at NBPGR including PGR Map, PGR Clam, GRIS, E-Herbarium, CWR, Genebank dashboard, G2G, Gap analysis tool etc. All the applications can be accessed at http://pgrinformatics.nbpgr.ernet.in. He stated that future lies in providing a comprehensive system of seamless access to genetic and genomic data and their analyses; building dashboards to enable flawless reporting facilitating planning, resource allocation and collaborations.

Short Lecture

Dr Mohan Lal gave a lecture on *"Genetic resources of MAPs conserved at CSIR-NEIST, Jorhat for trait-specific breeding with special reference to NE India"*. He presented the germplasm conservation status of CSIR-NEIST which is more than >2,807 germplasm of different MAP species like Java citronella (72), Lemongrass (534), *Kaempferia galanga (143), (143), Kaempferia parviflora (42), Kaempferia rotundas (21), Acorus calamus* (230), *Zingiber zerumbet* (124), *Clerodendron colebrookianum* (42), *Capsicum chinense* (>274), *Solanum khasianum* (286), *Patchouli* (83), *Curcuma caesia* (136), *Curcuma longa* (>350), *Curcuma zedoaria* (86), *Zingiber officinale* (>590), *Bixa orellana* (42), *Homalomena aromatica* (126) *and Cannabis sativa* (43), out of these, some are rare, endangered plant species. He stated that this repository is the largest ex situ genebank of medicinal and aromatic plants in the entire Northeast India which includes Solanum khasianum, Kaempferia galanga, lemon grass, Java citronella and Patchouli. So far, a total of 21 trait-specific germplasm were identified/ developed from this repository using various breeding techniques like selection or mutation breeding. These elite germplasms are high performing at commercial scale owing to which 43 technologies have been transferred so far generating high revenue as well.

Rapid Oral Presentations

Presenter	**Dr Gowthami R.**
Title	Cryoconservation of shoot tips of *Swertia chirayita* (Roxb.) H.Karst., a critically endangered medicinal plant of India
Key Findings	▸ Shoot tips (1.0-1.5 mm) excised from 4-wk-old stock cultures of two accessions of *S. chirayita* were cryopreserved using vitrification (V) and doplet vitrification (DV) techniques
	▸ Survival and regrowth were highest for shoot tips dehydrated for 20 min in PVS2 (20% survival and 15% regrowth). No shoot tips survived cryopreservation without PVS2 treatment
	▸ Pregrowth of donor plants on high sucrose media (0.3 M sucrose) doubled the post-thaw regrowth to ~44 % in comparison to 15% when pregrown on multiplication media (3 % sucrose)
	▸ Using DV technique, significant improvement in post-thaw regrowth (44%), as compared to V was observed (~ 21.67 %)
Presenter	**Dr Padmavati Gore**
Title	Genetic resources of pigeonpea: conservation for utilization
Key Findings	▸ Out of 11,940 accessions from NGB, trait-specific accessions identified for agronomic (13), cytoplasmic male sterile (21), fertility restorer (10) and biotic (10) and abiotic (1) traits
	▸ Under Consortium Research Platform on Agrobiodiversity, 9,500 accessions characterized by using 29 agro-morphological descriptors
	▸ Several released varieties developed from germplasm through selection
Presenter	**Dr Anil Kumar**
Title	Makhana (*Euryale ferox* Salish.) genetic resources and utilization
Key Findings	▸ One selection out of 242 accessions, Sabour Makhana-1 variety adoption has potential to overall increase in utilization of wetlands, leading to enhanced income and self-employment, especially to small and marginal farmers
	▸ The net return from selling of *Makhana* seeds is ₹1, 60,000 to ₹1, 70,000/ha with B:C ratio 3.7:1. The net return based on pop selling is maximum in Sabour Makhana-1 *i.e.* ₹3, 04,800/ ha with B:C ratio 4.95:1 as compared to landraces
	▸ The standardized *Makhana* production technology provides the way for better utilization and to get maximum net return from underutilized and neglected waterlogged areas without eroding the natural resources
Presenter	**Dr Vartika Srivastava**
Title	In vitro mass multiplication and field acclimatization of spine gourd (*Momordica dioica* Roxb.)
Key Findings	▸ As the traditional methods of spine gourd propagation have several limitations, efficient clonal propagation to aid in production of disease-free, high-quality planting material in genotype (RMDSG/2020-2) was developed using the tubers

	▸ Multiplication of *Momordica dioica* shoots in vitro achieved on a modified MS media supplemented with 2.22 µM BA
	▸ Shoot explants derived from male and female plantlets may be conserved for medium- and long-term basis using cryopreservation protocols in future
Presenter	**Mr S. Bhargav Kiran**
Title	In vitro regeneration protocol standardization of cultivated genotypes and wild species of okra
Key Findings	▸ Out of 54 possible combinations tested, each for 5 cultivated okra genotypes *via* epicotyl culture, 0.5, 0.5 + 1mg/l NAA, IBA + kinetin showed maximum shoot length (5.23 cm) and early flowering (59 days) in Pusa Bhindi 5
	▸ In the case of embryo culture ,0.5, 1, 1mg/l NAA, IBA + kinetin showed maximum shoot length (5.3 cm) in Pusa Sawani and early flowering (47 days) with1.5, 5,0.5 mg/l NAA, IBA + kinetin in Pusa Bhindi 5.
	▸ Among the two wild species, 0.5, 0.5, 1mg/l of NAA, IBA + kinetin showed maximum shoot length 4.3 cm and early flowering of 147 days *via embryo culture in A. moschata*
Presenter	**Dr Era Vaidya Malhotra**
Title	Long term conservation of *Vanilla planifolia* Andrews using droplet vitrification based cryopreservation technique
Key Findings	▸ Droplet vitrification, V-Plate and D-Plate cryotechniques attempted in *V. planifolia*, with 10-20% survival
	▸ Genetic stability assessed using 20 ISSR markers
	▸ The protocol can be further refined to use it for cryobanking of *V. planifolia* germplasm
Presenter	**Manish Kumar Vijay**
Title	Preservation of central India's forest genetic resources through the establishment of a seed gene bank at Tropical Forest Research Institute, Jabalpur, Madhya Pradesh
Key Findings	▸ 65 priority species (mostly RET) for FGR finalized as part of project at the Tropical Forest Research Institute, Jabalpur
	▸ FGR collected by identification of natural population, provenance/ seed sources and delineation for creation of maps; Tree selection, seed germplasm collection and conservation strategy; collection of field data, and individual tree passport data
Presenter	**Dr Amit Kumar Singh**
Title	G-DIRT: *a web server for identification and removal of duplicate germplasms using SNP genotyping data*
Key Findings	▸ G-DIRT (Germplasm Identification and Removal Tool) is a user-friendly web server-based tool for germplasm duplicate identification based on genotypic data (SNP genotyping)
	▸ The tool is developed based on a two-tier architecture using R, PHP, HTML, CSS, and JavaScript

	▸ The web server also allows data pre-processing based on the parameters like Minor allele frequency; Missing genotype data; Linkage disequilibrium pruning; Hardy Weinberg's equilibrium; Marker heterozygosity; Monomorphic SNPs, *etc.*
	▸ G-DIRT will help enable the genebank curators and researchers in maintaining non-redundant germplasms and also pre-process genotypic data for carrying out GWAS analysis for trait discovery
Presenter	**Dr Badal Singh**
Title	Elucidating the seed storage behavior of Makhana (*Euryale ferox* Salisb.)
Key Findings	▸ Best seed germination method was submergence method which significantly reduces germination time and enhances germination percentage
	▸ Makhana seeds can tolerate desiccation level of 6-7 % with storage condition of -18°C which indicates its orthodox storage behavior. Seed histological study revealed no significant changes in tissue integrity under desiccated condition
	▸ There is a need to standardize seed sampling method with respect to harvesting time and maturity to get uniformly vigorous seeds to have conclusive understanding of seed biology

Technical Session 4



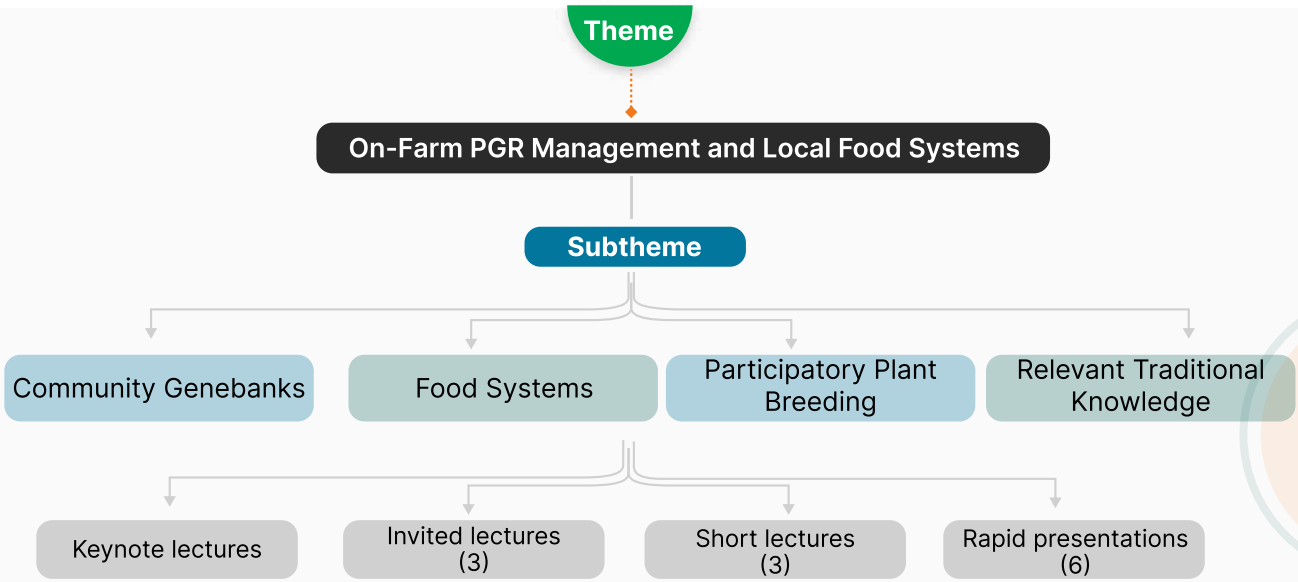


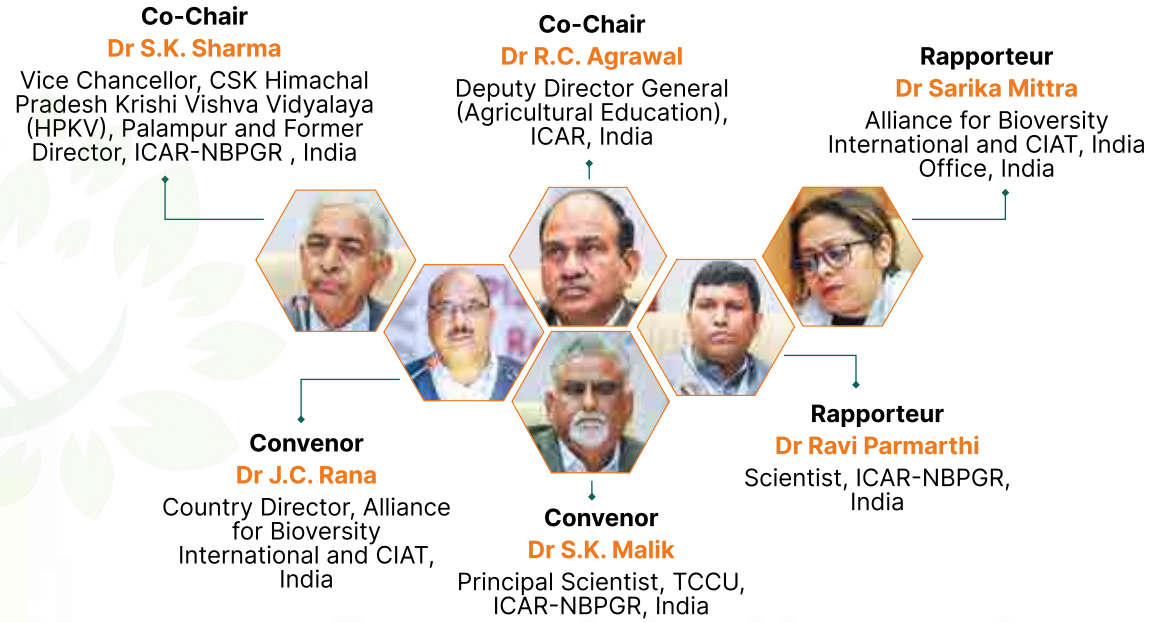






Technical Session 4





Keynote lecture was presented by **Dr Anil Gupta**, Chair, Honeybee Network and Former Professor, IIM, India. It was followed by three invited lectures by **Dr Paola De Santis**, Scientist II, Alliance of Bioversity International and CIAT, Italy; **Dr I.S. Bisht**, Consultant, Alliance Bioversity and CIAT, India; **Dr Viswajanani J. Sattigeri**, Head, CSIR-Traditional Knowledge Digital Library Unit, India. This was followed by Short Lectures by **Dr S. Rajan, Dr S.P. Ahlawat, Dr Umesh Srivastava** and **Dr Sudhir Kochhar**. Thereafter, rapid presentations were made by delegates **Drs Rajkumari Sanayaima Devi, Veerendra Kumar Verma, Parvaze A. Safi, Lal Singh, Subhas Chandra Roy** and **Adheena Ram A**.

Keynote Lectures

Dr Anil K. Gupta gave the keynote lecture on *"In situ conservation, characterization, commercialization: incentivizing communities"*. Dr Gupta informed about his 40-year-study undertaken in three villages of Faizabad district in eastern Uttar Pradesh, regarding monitoring of PGR use in villages. He suggested that students (masters and PhD) be involved in monitoring certain sites and different microclimates over long term to document, so that climate adaptation, as also look for plants that survive after extreme weather events such as tsunami, where highly salt-tolerant species would have grown. ISPGR or other organizations should send multidisciplinary team to survey sites of extreme heat or cold to providing us the resilience species that we need.

Dr Gupta informed how his organization was giving voice, visibility and velocity to creative and innovative people in formal and informal sectors. He gave the example of mustard variety with 43.5% oil content, as compared to 41% of released varieties, which were also drought tolerant. Such farmers varieties are highly resilient, and need to be recognized and such breeding by farmers be mainstreamed, and annually events should be organized in form of a competition. He narrated the importance of conducting innovation fairs for grassroot workers through his organization (GIAN) wherein innovations from deep tech sector and grassroot levels are brought together.

Dr Gupta then flagged the issue about how to disconnect the link between regions of high biodiversity and poverty. He said that a debate was triggered in early nineties that one could not conserve biodiversity by keeping people poor. The fear that with economic development, erosion of biodiversity takes place is often true empirically. But is it inevitable? Can we not design portfolio if such incentives which make conservation and economic development compatible. He suggested that market consumers should be made to pay extra for bio-products derived from diverse contexts. The emerging market of organic food and minor millets indicate changes emerging in market place. But we have not used block chain technology yet to show to a consumer how much diversity exists in the regions from where a crop or its products are being sourced and why they should pay for sustaining it keeping traceability, trust and transparency in mind.

It was urged by Dr Gupta that NBPGR redesigns and revisit the descriptors of various crops (especially of landraces) to include the dimensions of: i) climate resilient parameters such storability of grain/seeds; ii) suitability of crops for food processing or as functional foods. Knowledge mapping by students (under MNREGA or REWA) would help in recording the fast disappearing information on landraces to link with functional foods. The Functional food industry is growing into a billion-dollar global market and the proper application of analytical chemistry, physiology and other applied sciences will help in incentivizing consumer to trigger traction for traditional varieties. This could motivate the food and beverage industry to become a stakeholder in the conservation of biodiversity. The drought and flood prone region, some of the traditional varieties may have unique functional advantage for human and livestock health, for example recently, three paddy varieties were found to have anti-cancer properties. The example of flax seed is very illustrative in this regard. From around Rs 70 for 1000 g, flax seed fetches same amount for just 100 g. The characterization by the scientists validating tradition al knowledge added this value.

Recent studies in Eastern Uttar Pradesh, UT of J&K, Sikkim and Nagaland besides Gujarat and other regions including Andaman islands have shown that women's knowledge about edible weeds, wild plants and local crop/horticultural varieties can be a very powerful driver of bio-enterprises through *in situ* value addition and augmentation of family income besides meeting conservation goal.

Local communities have known unique functional and ecological properties of wild relatives of crops for millennia. However, there is an urgent need for a nation/worldwide coordinated program for developing protocols for sustainable extraction of bioresources from the wild. There exists a strong case for reinvestigation of functional and agro-ecolgical features of wild relatives for seeking genes of future relevance including for climate resilience by building upon the local knowledge. Studies have shown that vitamin C,E,A in some of the land races are double of the ones found in cultivated crops.

Knowledge of labourers, not just farmers, also matters In a study in Mali, it was found that migrants labourers from Timbuktu knew more about such properties of *O longistaminata* than farmers, for whom it was a weed and who wanted to remove it. Knowledge of workers/ labourers has been neglected almost all over even when farmer's knowledge has been drawn upon to a limited extent. Several by-products of crops which are almost completely neglected for high value medicinal purposes such as silk of corn and industrial material purposes such as hulled cobs. Stone of mango of local varieties, larger in size and with lesser pulp is thrown away when it has so many rich ayurvedic and industrial applications. There is a need for a whole new branch of agricultural science to emerge (by-product science) to reinvestigate the value addition local communities can get from in industrial applications of local biodiversity. This might enhance the incentives for in *situ* conservation.

Long-term monitoring of in *situ* plot-wise agrobiodiversity is a dire need to understand under what conditions for some local varieties or selection thereof still survive while most others have already disappeared. Also there is a need for a network of mobile and fixed distributed labs to support community efforts in characterizing local biodiversity and use STI to empower communities in recognizing the market potential of the resources they may have neglected so far. The contribution of local communities in the conservation, characterization and possible commercialization or DIY bioproducts has not been adequately recognized and rewarded as an inalienable process of modern cataloguing of germplasm and breeding. Dr Gupta urged that a new ethical and professional guidelines be developed to correct this asymmetry. This will invigorate the partnership between formal and informal actors in PGR value chain. Honey Bee Network and its collaborative institutions are ever willing partners in this exchange.

Invited Lectures

Dr I.S. Bisht made a presentation on *"Small-holder farming and the role of youth in food system transformation for sustainable development".* At the outset he gave the salient achievements of GEF project on 'Mainstreaming agricultural biodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability in India' currently operative and located in four distinct regions (Rajasthan, Uttarakhand, Assam and Madhya Pradesh). These include (i) greater diversity deployed in production landscapes, lost diversity repatriated; (ii) Community level informal seed system strengthened (29 community seed banks at 17 project sites established, conserving >3,000 farmer landraces); (iii) 4,278 farmer varieties tested in PVS trials and 233 improved genotypes selected by farmers for better yield and other desired traits in 20 crops; (iv) Value chain developed for improved products being promoted by 160 self-help groups closely working with 25 farmer producer groups and 23 private companies.

Dr Bisht defined small-holder farmers. Globally family farms constitute over 98% of all farms, and work on 53% of agricultural land. India has 87.2% small-holder farmers in 47.3% arable land, with an average size of 0.6 ha. India's over 126 million small-holder farmers collectively possess around 74.4 million ha of land. Across distinct contexts, family farming plays a critical role for global food production. Use of farmers varieties or traditional varieties is 80% by small-holder farmers.

Diversity is a necessity not choice for small-holder farmers. His study has shown that only 7% youth plan to pursue agriculture as their liveleihood. The challenges of engaging rural youth in farming and food systems include (i) poor and inadequate education; (ii) limited access to land; (iii) inadequate access to financial services; (iv) poor emplyability at community level; (v) limited access to market (vi) limited invovlemnt in policy dialogues. He opined that a system is needed where we help small-holder farmers sell their farm products locally within their communities that benefits consumers and farmers alike. He proposed applying the concepts of the circular economy to agriculture to increase its capacity for regeneration, build a more diverse and robust food system, protect the integrity of the environment, and promote rural livelihoods and incomes.

He proposed four marketing interventions as better initiatives towards infusing sustainability into traditional farming systems across the country: (i) Promoting community-supported agriculture (CSA) initiatives; (ii) Linking small-holder farming to the midday meal (MDM) school feeding programs; (iii) Enhancing market access and value chain development for local plant food resources; and (iv) Enhancing off-farm employment opportunities for rural youth at the community level. He also suggested critical role of young people in transforming food systems making food systems more sustainable, resilient, and effective. Probable areas/ sectors where job opportunities for youth occur at community level could be Organic farming, Agri-ecotourism, Women-centric jobs, viz. embroidery, tailoring, weaving, patchwork, applique, handicraft, etc.; Management of common property resources (CPRs)/ agroforestry species/community forests.

In conclusion Dr Bisht said that agroecology is a truly sustainable alternative. There is an urgent need to promote inclusiveness in the production of food, to ensure that the food system is sustainable and reduces the nutrition inequity gap so that everyone can access healthy and nutritious food easily. Shorter food circuits strengthen better producer - consumer linkages. Blind adherence to increasing food production without considering trade-offs or synergies with other outcomes is now being challenged, enabling us to envision alternative futures that address the needs of farmers, society, and nature. He said that changing food systems is an intergenerational challenge that requires an intergenerational approach, and we must empower youth to be in the driver's seat.

Dr Vishwajanani J. Sattigeri presented her lecture on *"Genetic resources and traditional knowledge and cultural expressions — Protection, preservation and promotion"*. She began by informing that a WIPO study had predicted that by 2050, the global population is expected to reach 8.9 billion and average per capita food consumption would rise above 3,100 kcal per day,with increased consumption of livestock products. This anticipated 40% increase in global population will require a 70% increase in agricultural productivity, with a further expansion in crop production to support the increased demand for livestock products. Contrary to the preduction the world population had alleady reached 8 billion in 2022, and 2050 it is expected to be 9.7 billion. She suggested that socio-economic growth and development can be strengthened when we grow on the strong foundations of our traditional knowledge, in form of defensive and positive protection. She presented the challenges associated with protecting our traditional knowledge from misappropriation and biopiracy giving examples of patents revoked and amended for turmeric (1998), Basmati (2002) and Neem (2005). With this background, she mentioned that an important initiative from the government of India after several instances of misappropriation was the birth of the Traditional Knowledge Digital Library (TKDL).

India's TKDL is a first of its kind globally to address the rising challenges of protecting a nation's TK from vested interests. The TKDL was set up in 2001 as a prior-art database, which is based on the evidences and by using such TK, patent applications are revoked, amended, withdrawn or at times abandoned. About 4.33 lakh formulations have been documented so far. She informed that the Indian patent act 1970 under debars patenting an invention which in effect, is traditional knowledge or which is an aggregation or duplication of known properties of traditionally known component or components under section 3(p). Other legal instruments that directly or indirectly protect TK are (i) Geographical Indications (GI) of Goods (Registration and Protection) Act, 1999; (ii) The Design Act, 2000; (iii) The Protection of Plant Varieties and Farmer's Rights Act, 2001; (iv) Biological Diversity Act, 2002 and (v) The Scheduled Tribes And Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. The Traditional Knowledge Resource Classification (TKRC) classification system is yet again a unique and important aspect of the TKDL to facilitate ease of search by patent examiners. She informed that TKDL would be opened for all users as approved by the Cabinet and modalities are under development.

Dr Paola De Santis delivered her lecture on *"Genetic diversity for improving production systems, landscape restoration and adaptation to climate change"*, virtually. She stated that farmers have domesticated plant species and created the crops and traditional varieties, maintained and modified the genetic diversity. Traditional varieties and inter=specific diversity help in productivity in stress environment, climate fluctuations, growing consumer demand and interest of communities for control of their foods. She described a heuristic framework for identifying multiple ways of supporting the conservation and use of traditional crop varieties within agricultural production systems. She showed data on how traditional varieties had greater resilience to biotic stresses. She then presented a model of 'Portfolio Options Approach (POA)' wherein various varieties are made available to be cultivated together, at different levels and scenarios (in contrast to promotion of varieties in isolation), strategically picking varieties that complement each other. For this detailed study on traits need to be provided. Giving the examples of study in Sri Lanka, China and Nepal for POA, she showed that mixture of varieties, gave greater sustainability to the farmers. She presented the Diversity Assessment Tool for Agrobiodiversity and Resilience (DATAR), which was created to facilitate the assessment of diversity in farmers' fields.

The tool also provides information on the genetic material provider, allows to assess management, market, policy and institutional constraints and provides the heuristic decision-making framework with goals and constraints and offers a portfolio of diversity-related interventions to support the improvement of local communities' livelihoods and benefits from the use of their local intra-specific diversity and restore ecosystem health.

Short Lectures

Dr S. Rajan spoke on *"A paradigm change in on-farm conservation of mango genetic resources and the development of new varieties"*. He said that India has excellent mango diversity, conserved in field gene banks or orchards maintained by custodian farmers around the country. One cause for the abundance of genetic resources is the planting of mango orchards from seedlings and the crop's highly heterozygous nature. He informed that CISH worked on mango diversity in four villages near Malihabad, UP, since the last 10 years. He said that farmers grew about 12-19% non-commercial varieties in their orchards, as a hobby and for personal use. Thereafter 12 custodian farmers were identified in these villages who together grew 564 varieties in these four villages, with enormous genetic diversity. The major drivers for on-farm conservation of mango were heritage orchards, multivariety orchards, seedling orchards in marginal lands, informal graft exchange system, and homestead gardens. Nevertheless, the number of custodian farmers is rapidly declining, and the next generation has less incentive to maintain these variations. No new orchard is planted with seedlings, and growers attempt to grow commercially popular types. As a result, the chances of getting a new type via seedling variability are diminishing. Nurserymen also promote commercial mango variety cultivation and prepare grafts based on demand. They have lost the collection of heirloom varieties that was formerly an indicator of a good nursery. Rare kinds are no longer propagated in nurseries since there is no market for them. The quantity of seedling populations is decreasing in the changing scenario, large multivariety old orchards are becoming rare, and grafted plants are replacing seedling trees. The variety in the seeding population had already been used to search for commercially viable types. As a result, the remaining seedling population has a limited likelihood of producing a new variety. Farmers in many areas are removing traditional orchards and replacing them with high-return crops/varieties. The current research showed the significance of existing traditional types, their on-farm conservation, and ways to increase the returns from these varieties. Mango seedlings must be planted along the highway, roads, and public land that is not utilised for cultivation. The seedling population developed in this area will act as a new population with the potential for new variations to evolve. Diversity fairs of non-traditional varieties are one way forward, besides germplasm registration, branding and marketing.

Dr S.P. Ahlawat delivered lecture on *"Community Seed Banks: Challenges and prospects to conserve agrobiodiversity, improve nutrition and livelihood security"*. He said that Community Seed Banks (CSBs) comprise informal institutions, governed and managed locally by the farmers. Their core function is to supply seeds (landraces and farmers' varieties) for local use and cater seed demand of small area or group of villages. CSBs store the seed on short term (usually annual basis) and function like a bank that provide seed on loan and in return take back the seed upon harvest of crops at no or very low cost. Thus, they are a dynamic conservation system for maintenance of indigenous local genetic diversity on-farm, involving farming community participation, for local landraces. Under a GEF project attempts were made to link NGB and CSB with a farmers as a bridge (repatriation and augmentation), and four case studies were presented. CSB's therefore, play a vital role in ensuring seed security and improving farmers' access to seeds, conserving agricultural biodiversity and the associated traditional knowledge, providing options for adapting to climate change, as well as

can contribute to the realization of Farmers' Rights. Those CSBs managed by NGOs and developed FPOs for source of income, are doing well. However, CSBs do not have regular income, support of institutions, and proper facilities for seed testing, grading, containers for storage and are facing difficulty to manage and sustain them. Hence, regular income is essential to run CSBs, but legislation does not permit business of unlabeled and unbranded seed. Seed standards of landraces, FVs and underutilized crops for labeling and business are scanty. Introduction of diversity, new varieties and training on PPB (participatory plant breeding) and seed production, storage are essential. CSBs requires co-financing, corpus fund, policy support and strengthen linkage with public institutions (KVKs, Crop based Instt., SAUs) to function smoothly. Rich diversity of local crops and associated traditional knowledge is unrecognized, underutilized and are under pressure of erosion from the farmers field and natural habitat. Dr Ahlawat concluded by stating that CSB is the only solution to promote on-farm conservation, increase access to quality seeds, planting materials to farmers for food security, protect farmers' rights and from exploitation of seed companies, and to cope up with climate change. He said many local varieties can be registered/released through simple selection or improvement process, to legally produce, sell and distribute the seed through CSB. He urged that DAC, MoA&FW should include FVs in Seed Act, should support CSBs through schemes like seed village and recognize, incentivize the Custodian farmers as "Conservator of Agro-biodiversity for Future Generations". Custodian farmers should lead these CSBs and diversify their portfolio including seed production, branding and sale of products through FPO's.

Dr Sudhir Kochhar gave lecture on *"Vista of opportunity for On-farm conservation of native crop diversity: on a cutting edge knowledge perspective"*. He opened the discussion by recalling a recommendation from the Delhi Declaration on Agrobiodiversity (2016) related to "..complementary strategies to conserve agrobiodiversity use by ensuring a continuum between *ex situ, in situ,* on-farm, community-based and other conservation methods with much greater and equal emphasis on each". He said agriculture being the basis of human survival, should not allow the realization that we are either on the verge of losing biodiversity or have actually lost it, to come very late. Therefore, to ignore a dynamic harnessing of the conventional agricultural vertical, particularly the disruptive on-farm management of a protectable, resilient, profitable, protected, and branded mix; could be too late. Options to promote organised in-situ/ on farm conservation of native agricultural biodiversity, for availing a long-term benefit of its dynamic, evolutionary state remains lesser studied or under-prioritized. Some old experiments (1984-1989) on upland paddy and bamboo germplasm conducted at Basar (District West Siang), Arunachal Pradesh had led to suggesting a preliminary model for on-farm conservation of diversity of local rice and bamboos in the state. A few prominent, conventional/historical on-farm conservation practices in rice-based cropping systems across the country include, Zero Valley of Apatani Plateau, Arunachal Pradesh, Jaypore Tract of Orissa, Wynad District of Kerala, etc., which need systematic promotion and opportunity based replication too. The then proposed on-farm conservation model for Arunachal Pradesh suggested to; (i) earmark few superior local varieties having good farmer' preference, productivity, and local adaptability traits vis-a-vis premium value, (ii) encourage farmers to increase cultivated area under such elite varieties, covering 2/3rd to 3/4th of their holdings; to get more yield and higher produce/ incomes, (iii) farmers must not ignore rest of their conventionally grown varieties, and must grow them in at least 1/3rd to 1/4th of their cultivated area, and (iv) seasonal, multi-crop and varietal mosaics may have to be an essential feature of all such on-farm conservation practices to help foster resilience and endurance. A state-wide adoption of such on-farm conservation model could be dynamic, evolution-friendly, farmer-friendly, and competitive at a basic economic/ business level. Similarly, on-farm conservation of local bamboo diversity through use as agroforestry species

assumes significance since bamboo is already de-notified from regulatory control of forest laws. Farmers may openly adopt, conserve, and fetch higher income from bamboos. A drastic change in the regulatory and farmer' welfare regimes over the time as well as an increasing complexity in farmers' coping up due to lack of awareness on empowerment could constrain and complicate holistic promotion of on-farm conservation/ management model(s), which needs to be addressed.

Dr Umesh Srivastava spoke on *"Plant diversity, indigenous traditional knowledge and local food system in achieving food and nutritional security, sustainability and resilience"*. He commenced his talk by defining ITK as the information gained over a period of time, passed on from generation to generation by the word of mouth. Genetic diversity preserved by indigenous people and its practices provides a valuable resource for improving food security and adapting to climate change. It reduces agricultural risks and increases resilience to climate change. Even the IPPC highlighted the importance of ITK in adaptation, climate change monitoring and mitigation. Traditional practices have helped better adaptation such as (i) raising of short duration drought hardy and heat tolerant crops on marginal lands; (ii) conserving the seeds and use of local landraces with adaptive characteristics over generations; (iii) having knowledge for alternative food, feed, fibre, medicinal resources, etc. available locally in the forest or wild areas to rely when crops fail; (iv) practicing traditional farming to conserve natural resources for better resilience and adaptation; and (v) using traditional knowledge to predict and forecast the extreme events and take precautionary steps to survive extreme vagaries of nature. Despite ubiquitous talk about diversity and inclusion in agricultural development, indigenous food systems remain poorly understood, undervalued, in practice. Treating ITK as an equal in scientific and policy debates is critical in enabling sustainable and just transformations of our food systems. Indigenous food systems are disappearing at an alarming rate, pushed by the very agricultural systems humanity is desperately trying to make sustainable and resilient. Particular attention on scientific and policy institutions is needed to create public awareness about crops in local food system, their potential role and contributions of these traditional foods in health and nutrition, sustaining ecosystems and cultural knowledge. Dr Srivastava concluded by saying in situ conservation plans for halting the genetic erosion need priority. Package of practices for semi-domesticated and domesticated wild edible plants need to be developed to ensure their commercial production while ensuring sustainability and maintaining socio-ecological resilience of the traditional food systems. Particular attention on scientific and policy institutions is needed to create public awareness about crops in local food system, their potential role and contributions of these traditional foods in health and nutrition, sustaining ecosystems and cultural knowledge.

Rapid Oral Presentations

Presenter	**Dr Rajkumari Sanayaima Devi**
Title	Local vegetables and wild edible plants (WEPs) of Manipur: Bioprospecting aspects and need for germplasm conservation
Key Findings	▸ Manipur's traditional local vegetables and WEPs have enormous opportunity to be utilized at commercial scale and can be introduced to other states subjected to suitable policy considerations
	▸ Local and tribal people must be educated for skilled and sustainable collection, cultivation and harvesting of WEPs
	▸ Younger generation need to be educated and made aware about local vegetables. This will ensure safeguarding and disseminating indigenous knowledge systems and conserving WEPs in the future.
Presenter	**Dr V. K. Verma**
Title	Assessment of ethnobotanical uses, household and regional genetic diversity of aroid species in Northeastern India
Key Findings	▸ Based on the aroid species population study in Jhum land, accession Rengma dominated with 47% of the total population followed by Tamachonkham (36%) and Tasakrek (12%)
	▸ The observed average heterozygosity (0.24) was less than expected heterozygosity (0.69)
	▸ The identified superior accessions *i.e.*, Tamachokgkham, Rengama-2, Rongrem, Rengama-1 collections from Garo hills and popular cultivar Panchmukhi and C-3 (all bunda type) and White Gauriya and SJ-1 (both arvi type) for yield and related traits can be promoted for commercial production
Presenter	**Dr Lal Singh**
Title	Mainstreaming of mountain native crops for nutritional and livelihood security in Himachal Pradesh
Key Findings	▸ Local landraces of red rice (*cv* Annan), barley, kidney bean (*cvs*. Chitra, Peuli, Saphed), amaranth (cvs Bithu, Jhuli Bithu), buckwheat (*cvs* Bharesa and Kathu) and rice bean (*cv* Dhangru) were mainstreamed to replace the cash crops in the locality
	▸ Capacity building and awareness programs conducted with 178 household
	▸ Crowdsourcing and multiplication trials conducted in farmers' fields and entire value chain developed for target crop
Presenter	**Dr Subhas Chandra Roy**
Title	Origin of black rice from wild rice *(Oryza rufipogon)* of India — A pre-breeding approach
Key Findings	▸ Research findings indicate that relatively black pericarp colour is a recently acquired trait of the cultivated rice and confirms that wild rice of India has contributed some of its genomic region(s) in the genetic background of local cultivars *i.e., Badshabhog, and Chenga*, which are highly compatible to recognize the genomic region from *O. rufipogon* by crossing introgression and gene-flow in such a way that progeny lines acquired neo-functionalization with gain-of-function mutation mainly linked to anthocyanin biosynthesis genes (Kala 1, 3 & 4 alleles) through recombinational and insertional (LINE1) rearrangement

	▸ Wild rice gene pool of Raiganj, District Uttar Dinajpur, West Bengal, India, needs immediate attention by the CGIAR (Bioversity International/IRRI/CIAT/AfricaRice), to conserve it for sustainable agriculture; otherwise this unique genotype (AA genome) will be lost from the wild rice gene pool diversity
Presenter	**Dr Adheena Ram A.**
Title	**Intellectual property protection and conservation of unique goods from crop genetic resources in Kerala**
Key Findings	▸ In Kerala, 34 unique goods registered as GI, out of which 17 are agricultural products
	▸ The unique medicinal rice *'Navara'* was the first to be registered as GI under the agricultural product in Kerala. The red kernelled rice varieties known as, *Palakkadan Matta* with high nutrient content also got GI tags. *Pokkali* rice varieties are internationally accepted salt tolerant gene donors. *Wayanad Gandhakasala* and *Wayanad Jeerakasala* are the popular unique traditional scented rice cultivars of Kerala having characteristic fragrance and aroma
	▸ The medicinal Tirur betel leaf, unique hand made ball jaggery *Marayoor Sharkara*, malty and chocolaty flavoured Wayanad Robusta Coffee, golden brown sweeter crystalline Central Travancore Jaggery and golden yellow crispy *Vazhakulam* pineapple are some among them. *Kuttiattoor* mango and *Edayur chilli* have recently been registered as GIs

Dr R.C. Agrawal appreciated all the presentations which gave lot of new recommendations. He gave the example of how young student innovators are using crop wastes for producing useful products such as mazie cob peat as replacement of cocopeat, as cheaper costs. Dr R.S. Paroda suggested that a national program by formulated to document traditional knowledge and ICAR-NBPGR and Bio-diversity International should formulate a project, and a separate brainstorming be organized for this with guidance from Dr Anil Gupta. Value addition of produce is also important. Dr S.K. Sharma also agreed and said that Dr Anil Gupta gave important recommendations with actionable points. He said on-farm conservations need lot of attention.

Technical Session 5

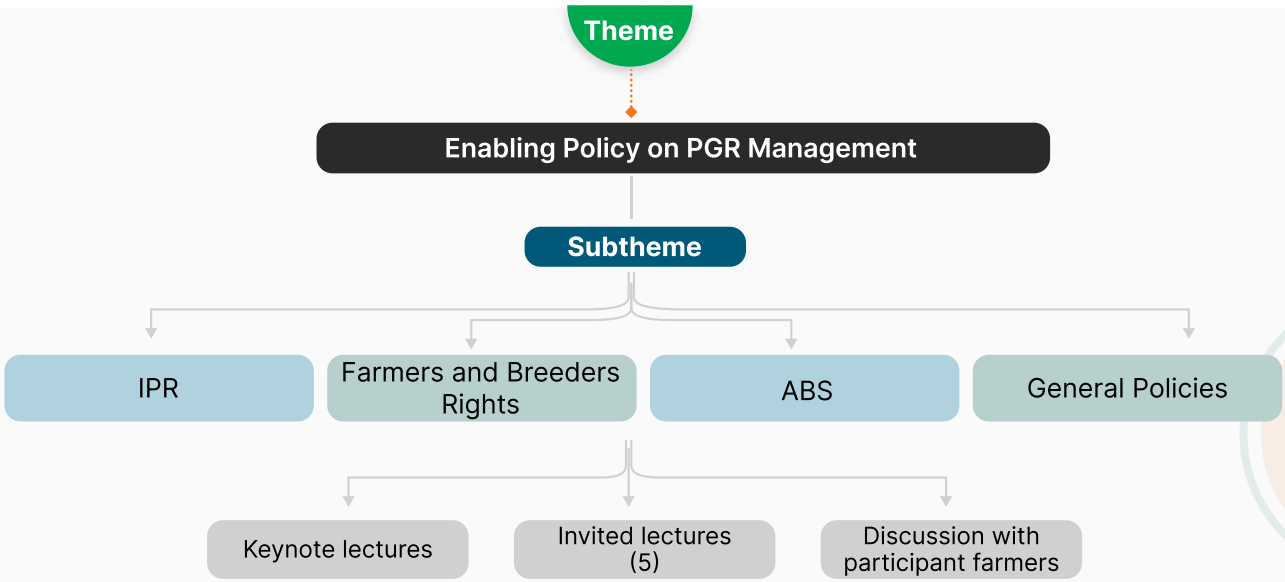









Technical Session 5



Keynote lecture was presented by **Dr K. Vinod Prabhu**, Chairman, PPV&FRA, India. It was followed by five invited lectures by **Dr Aysegul Sirakaya**, Post-Doc Fellow & Researcher, Lund University, Sweden; **Dr Dinesh Kumar Agarwal**, Registrar General, PPV&FRA, India; **Dr J. Justin Mohan**, Secretary, National Biodiversity Authority, India; **Dr K.K. Narayanan**, Founder and Director, Sthhayika Seeds Pvt Ltd, and Foundation for Advanced Policies Training in Plant Breeding, India and **Dr Neeru Bhooshan**, CEO & Principal Scientist, Zonal Technology Management-Business promotion Development (ZTM-BPD) Unit, ICAR-IARI, India.

This was followed by discussion engaging farmers also on "Access and direct benefit sharing with the PGR conserver farmer/community under PPVFRA: Some Examples".

Keynote Lectures

Dr K. Vinod Prabhu delivered keynote lecture on "*Science-led policies in plant variety registration under PPV&FRA (2001)*". He briefly discussed the historical perspective on Trade-Related Intellectual Property Rights (TRIPs), World Trade Organization (WTO) and PBR. In this perspective, plant variety [PGR attached with value for cultivation and use (VCU)] became most vital entity of global trade. No country without PBR provisions was allowed to remain a member of WTO. He said that the implementation of the PPVFR Act integrates uniquely, a balance between plant breeders' rights and farmers' rights unlike followed by 78 member countries of the International Union for the Protection of New Varieties of Plants (UPOV).

The Convention on Biological Diversity (CBD) (1993) brought genetic resources under the jurisdiction and sovereignty of national governments with recognition of the necessity of movement of PGR across countries and importance of the conservation by native communities to enable such movement, a fundamental need for crop improvement through plant breeding. However, under the International Undertaking on Plant Genetic Resources for Food and Agriculture (IUPGRFA), 1983, PGRs are treated as common heritage of humanity. Members being common, CBD a necessary binding for sustainable agriculture and environment, the IUPGRFA was renegotiated in harmony with the CBD for developing it as ITPGRFA in 1994. The Treaty after ratification, acceptance, approval or accession entered into force on 29 June 2004.

He further delved into the objectives of the PPVFR Act wherein the definition of plant variety, scientific principles to distinguish between farmers' and plant breeders' varieties and protection of a plant variety as an intellectual property right of the breeder (who could be an individual, farmer, community of farmers, institution or a government). Dr Prabhu clarified the registration process that considers the difference between farmer's variety as clearly distinguishable from a plant breeder's variety and provides legal *bona fide* certification from the Director (Research) of the State Agricultural University or any Central or State Government established commodity plant species research centre to the effect that the material being applied under farmers' variety category is indeed without human plant breeding intervention through artificially created variability. A farmer will be violating Farmer's Rights or infringing the Breeder's Rights on a variety if (s)he sells seed in branded form (packs, labels), adopts any practice that can be described as processing or beyond what is described as "farm produce, produced on contract on behalf of any agency, multiplies seedlings, propagules under protected cultivation systems, nurseries, *etc.*, for selling, claims rights of 39(2) on "illegitimately obtained unbranded/unauthenticated seed", sells the seed with variety denomination using 39 (1)(iv) of PPVFR Act from his farm produce if the seed is not true-to-type.

Invited Lectures

Dr Ayse Gul Sirakaya delivered a lecture on *"ABS, Nagoya Protocol and biodiversity conservation"* in which she discussed the impact of biodiversity loss on our everyday lives, the consequences of biodiversity loss due to over-exploitation of natural resources and results of failing to restore biodiversity in terms of emergence of global pandemics. She explained that we need to realize the full potential of all the international legal instruments including Access and Benefit-Sharing (ABS) on creating incentives for biodiversity conservation. She also elucidated the identification of commonly used regulatory mechanisms of ABS under provider countries' ABS legislation and analyses of these regulatory mechanisms to attain international ABS goals. Lastly, she explored the adopted text of the Nagoya Protocol that does not intrinsically lead to channel the benefits into conservation.

Dr S. Raj Ganesh on behalf of Dr Dinesh Kumar Agarwal gave the presentation on *"Comparison of provisions in Seed Act 1966 & Draft Seed Bill 2019 vis-a-vis IPR protection environment of plant varieties"*. He stated that seed is a vehicle for delivery of improved technologies and offers to integrate production, protection and quality enhancement in a cost-effective way. Just by use of quality seeds alone, 15-20% productivity increase can be achieved. He put forth the importance of seed from the Vedic period to more organized activities in India starting with 1925 constitution of "Royal Commission on Agriculture (RCA)" for spread of improved varieties and progress of seed distribution. He further discussed formation of "All India Seed Grower, Merchants and Nurserymen's Association" in 1946 in Quetta. Thereafter, he recalled the formation of "Grow More Food Enquiry Committee" and "Expert Standing Committee" of ICAR way back in 1952 to stress the need for improved seed with pre-requisite purity that resulted in setting up of several seed farms. In 1957, institutionalized programs for varietal improvement and testing began with the formulation of All India Coordinated Crop Improvement Project (AICCIP) on maize, followed by sorghum in 1960 and pearl millet in 1961. He stated that 1961 holds a prominent place for seed sector in India as the first seed testing lab was established at IARI, New Delhi. These beginnings led to the promulgation of first Seed Act of India in 1966 and ensuing *"The Seeds Rules"* in 1968 which laid foundation for organized seed sector in India. Maharashtra was first state to establish official seed certification agency under Department of Agriculture in 1970. Thereafter, National Seed Policy was rolled out in 2002. Currently, some 600 organized seed companies exist in India. He informed that from a predominantly public sector producing varieties suited for food production in the 1960's, the Indian seed industry has evolved into a multi-faceted industry with a large involvement of private firms (70-76%) and increasing emphasis on research and development. One third of these companies have a global technology and financial partners.

Talking specifically about the relevance of Seed Bill 2019, he said it would almost repeal the Seed Act 1966. The Seed Act covered only 'notified varieties of seeds' (foundation and certified seed) that were mostly bred under the National agricultural research Systems (NARS). The 'truthfully labelled' seeds emanating from private seed companies would now get covered under the Seed Bill, 2019. Compulsory registration of seed varieties based on VCU, evaluation and licensing of seed producers and processors. This would assure seed and planting material quality. The Seed Bill, 2019 is effectively a tool (license) to produce and market quality seeds whereas IPR only would be granted under PPV&FR. Also, under PPV&FR Act, re-registration of seeds after validity period is not allowed whereas under Seed Bill, seed companies can re-register seeds many times after the validity period (evergreening of varieties). However, farmers need to seek compensation from Consumer Court for non-performance of varieties under the Seed Bill, 2019.

Dr J. Justin Mohan presented his lecture on *"Realization of Access and Benefit Sharing (ABS) in India"*. He said that three groups of stakeholders are involved in biological resources — (i) Users (people, companies, research institutions); (ii) Source (forests, farmland, research institutes), and (iii) Providers (farmers, tribal communities, and researchers). He discussed the enactment Biological Diversity Act in India in 2002, which is aimed at conserving our biological resources, sustainable use of resources and fair and equitable sharing of benefits that arise from the use of these biological resources between the users and providers of such biological resources and associated traditional knowledge. He clarified that Indian scientists who access biological resources for research purposes do not require approval from National Biodiversity Authority (NBA).

Researchers depositing microorganisms in repositories outside India for claiming novel species need to intimate NBA in Form C (online), and are obliged to inform designated repositories not to provide such microorganisms for research or commercial purpose without approval of NBA. In cases where scientists sending research material outside India for non-commercial research, require approval from NBA in Form B, and the foreign recipient must provide a declaration that they will use the resources only for the purpose for which approval was granted. When obtaining patent on any product or process applicant is required to take approval from NBA in Form III, at fees of Rs 500. No approval is required if applicant has obtained IPR for bioresource like seed from PPVFRA. For transfer of results (data only, no biological material *per se*) of research/technology to a company covered under Section 3(2) of the BDA, approval is required in Form II, with a fee of Rs 5,000. If biological resource is to be exchanged, the recipient company must approach NBA. For research institutions involved in commercial production of biological resources for sale, Approval is required to be sought from State Biodiversity Board (SBB). In case of foreign collaboration for research, if project is approved by government, no approval is required from NBA.

He discussed the benefit sharing obligations based on either the purchase price of the raw material or on the annual gross ex-factory sale value of the product based on mutually agreed terms. He also informed that ABS funds at NBA help to improve the livelihood of farmers, tribal communities and fishermen and can also be used for management of Biodiversity Heritage Sites which are notified by the State Governments under Section 37 of the Biological Diversity Act, 2002. So far, 54 ICAR institutes have been beneficiary by receiving ABS amount from NBA.

Dr K.K. Narayanan talked on *"Genomics-led PGR management and utilization — Practical considerations under current policies"*. He began by defining 'genetic resources; as germplasm, improved varieties/hybrids, tools, and other resources as well as skills and methods. He said IP protection incentivises investment and efforts needed to improve crop varieties to meet the needs and challenges of today and in future. He focussed on flagging certain issues that were not fulfilled by PPV&FR Act , especially from the perspectives of private seed sector. He gave a historical overview of global IP protection regimes in seeds, including farmers privilege and breeders exemption . He said that the farmers' rights to "save, use, re-sow, exchange or sell his/her farm produce of protected seeds" has led to hesitation by private seed companies to come out fully for participation in PPV&FR registration, especially since definition of 'farmers' in India is still ambiguous. Also, the provision of compensation for failure of expected performance of a registered variety is not only dictated by genetics but also how it was 'nurtured.' Similarly, innocent infringement is also subjective. Tighter definitions of all terms those defined ambiguously are required in the Act. In his opinion, real time tracking of application for registration of varieties would also be helpful. With respect to benefit sharing clauses, better was of recording and documenting 'traditional knowledge'. Dr Narayanan advocated that incongruities between PPV&FR Act, Patent Act, BDA and Seed Act need to be harmonized. In private sector, germplasm is general coded and hybrids are more common than OPVs. Molecular and biochemical IDs are also need to be maintained.

Dr Neeru Bhooshan made a presentation on *"IPR based commercialization of plant varieties under public research systems"* and talked about IP Management and Technology Transfer and Commercialization of the plant varieties of ICAR-IARI to bridge the gap between lab and land. She said that first step was to nurture IP culture followed by public private partnership (PPP), and 3-tier IPR Management System supported by ICAR. She informed that ZTM & BPD Unit has successfully commercialized 200+ technologies to 500+ agro-based companies and took ICAR research outcome to field and farmers

with the active help of industry partners, thus, creating many different viable models of PPP. Dr Bhooshan told that the Unit is actively engaged in the process of protection of IPRs on the technologies generated by the research team of IARI and the process has been streamlined, which includes IP disclosure form along with inventors' interviews to fasten the process. The plant varieties developed at the Pusa institute by the Divisions of Genetics, Floriculture and Landscaping and Vegetable Science are very popular with the farmers and seed companies and they are protected under the PPVFR Act, 2001. She elucidated an example of large-scale marketing operations of promising wheat variety, HD 3086 through around 213+ seed companies in first three year of its release – a first in the history of ICAR at such a large scale. She also presented different models of Research-Farmer-Market, Research-Enterprise-Farmer-Processing and Market Linkage.

Discussion with Farmers

Mr Sundaram Verma, Padma Shree Awardee from Rajasthan, shared his experience on agrobiodiversity conservation. He said that all new challenges arising in agriculture can be faced with available rich agrobiodiversity. He appreciated the recognition bestowed by ICAR and PPVFRA to him, which not only benefitted him individually, but the entire farming community. He gave several examples from his own collections, which out-performed the popular varieties in situations of heavy rainfall, drought, pest-infested conditions that led to variety development through selection. Further, due to close interaction with scientists, he could identify unique traits in different crops in his own multi-crop collections. He asked for financial support for characterization and conservation and maintenance for agrobiodiversity in general and particularly on his farm.

Mr Sanjay Prakash Chaudhury, collaborated with Indira Gandhi Krishi Vishv Vidyalaya (IGKV), Raipur and is a good example of benefit sharing. He has a large collection of diverse rice germplasm maintained at his field, including 'Dubraj' rice. He realized the medicinal property of the variety analysed through GC-MS, which had anti-diabetic and inflammatory properties. He expressed his desire to expand his business to share his superior varieties with other interested stakeholders.

Mr N. Panache, is a native progressive farmer of Kodagu district (Karnataka), who was awarded Plant Genome Saviour Award (2019-20) for his efforts to save indigenous 'Adi-pepper'. He is the owner of Adi Pepper Demo Farm and Research Center in Garvale, where he is actively engaged in discovering natural crops in the district that have the capacity to become commercial crops while inflicting minimal environmental impact. He received the prize for his research, conservation, and promotion of the 'Adi Pepper,' an indigenous kind of pepper mainly grown across the natural habitat of Garvale village borders in Kodagu, India. He undertook the responsibility at the research centre to obtain this species of pepper registered under PPV&FRA, and in 2015, this high-quality pepper was recognised as a farmer's variety of pepper. This is the only pepper species that has passed biochemical testing, and it is regarded as the best of the seven pepper species growing in Kodagu. Since that particular form of pepper (once known as forest pepper) was mainly used for domestic purposes by the

people, it has recently reached a brand value of ₹3500/kg, generating more than six times the earnings of the other black pepper species sold in the district. This is also the first product in India with PPVFRA logo, and farmers variety that was registered without notification of species *(Piper elatum*).

The Adarsh Mahilla Cooperative from Chhattisgarh commercialized three green varieties of rice, and high iron content rice. The latter is given to pregnant women for all the gestation period, for helping in normal delivery. IGKV, Raipur and PPVFRA are facilizing this activity. The University has purified this variety. PPVFRA awarded the community with ₹10 lakhs.

The Rohru Red Rice Farmers' Society in the state Himachal Pradesh, who have also been were conferred with the Plant Genome Saviuor Award for conserving and multiplying 'Chhohartu' rice. This variety is categorized under 'Japonica Red Rice.' It is cultivated in villages such as *Peja, Maslin, Jangli, Daboli, Kaloti,* in an area ~1000 hectares and at an altitude from 1300 m to 2100 m (in Himachal Pradesh) and is free from pesticides and herbicides.

The women farmers expressed their happiness on being present in such large platform. The Chhohartu rice is considered to be rich in zinc and iron, along with elements of vitamins. The locals believe that the excess water that is poured off after cooking the rice (micro-nutrient rich) is extremely beneficial for pregnant women.

Technical Session 6







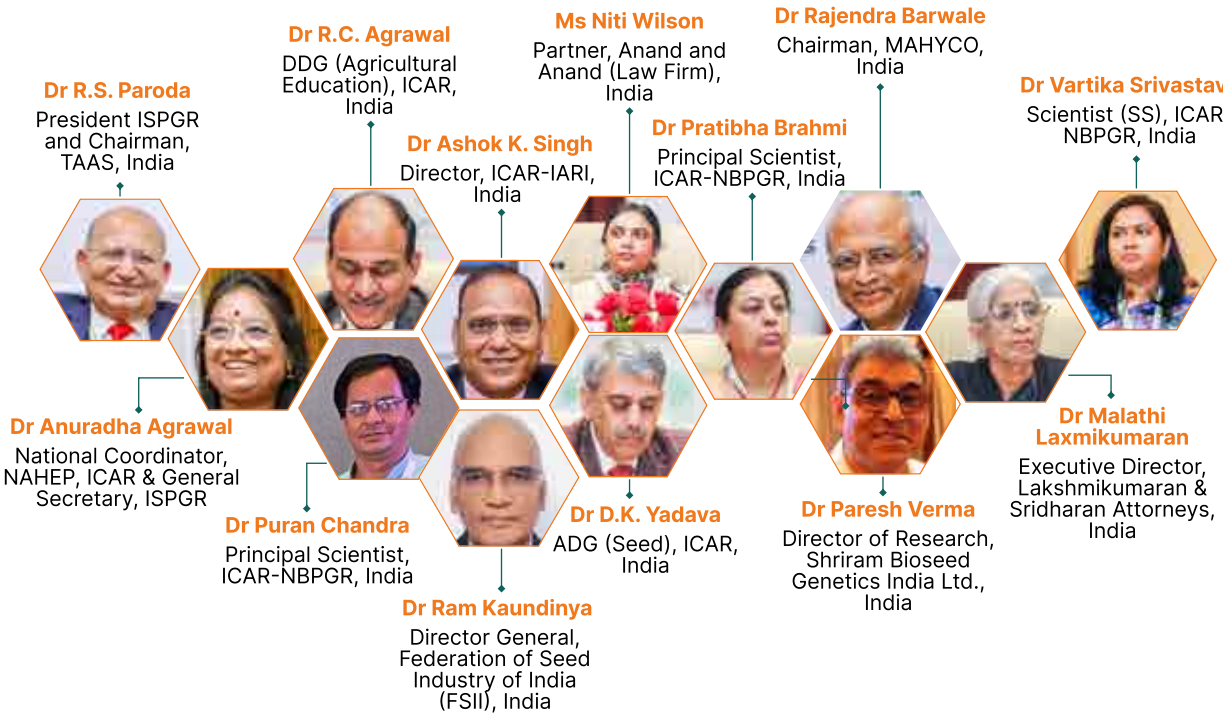




Technical Session 6

Theme

Public-Private Partnership (PPP) on PGR Management



The session opened by an overview presented by **Dr Ram Kaundinya**, who joined online. He said the PPP needs to be actualized by adequate policy support and intent. He introduced his organization (FSII) as being a 42-member-led association committed to increase investment in seed research to bring better products to farmers for improving farm productivity and income, contributing to 70% of research investment in R&D of seed sector in the country. He said that there is need to think 'out-of-box' on PGR Management. So far PPP had not worked well due to lack of trust and inadequate processes. The role of private industry is to be recognized and respected towards plant breeding as well as PGR management. Further, we also need to look how technology is transforming access —DSI will reduce the need for physical access of resources; the MLS of ITPGRFA will need to look at physical access as well as DSI. He also said that genetic resources are of no use unless they are used to produce plant varieties that create an impact on farmers lives. According to him conservation is a global phenomenon and cannot be accomplished in isolation. While briefly talking about the ITPGRFA, he informed that FSII had donated ₹20 lakhs to the ABS fund of ITPGRFA which will promote PGR conservation. He pointed out that of the 35 food crops and 29 forage crops in Annex 1 of the Treaty, most vegetable crops had not been included. Also, India had only opened 26,563 accessions of nine crops to the MLS, so far, which needs urgent action on enlargement of portfolio.

Mr Kaundinya suggested a few steps for way forward on PPP: (i) Build trust through confidence building measures. This requires collaborative group including private breeders, private companies, cold infrastructure and others in conservation efforts along with public sector; (ii) build sustainable and transparent models for sharing of germplasm in public gene banks with private sector by putting in place processes for easy, safe and predictable access and private sector should work towards getting proper ABS that would benefit conservation of PGR. For instance, if PPV&FRA encourages more registrations through a fair process would lead to greater varieties entering the gene banks for conservation. Also, the ₹3,000/accession charge by NBA is another bottleneck and can be modified by any other suitable ABS model; (iii) ICAR may collaborate with important seed industry players on agreed areas, including joint PGR management programs between public and private sector. For this clear IP policies between two partners, enforcing IP of both public and private and exclusive access to investing companies need to be considered.

Dr Kaundiniya suggested a few PPP models that require discussion:

1	**Consortium based approach** Urgent problems such as Fall Army Worm (FAW) in maize, pink bollworm in cotton, planting material improvement for horticultural crops, sharing germplasm and pre-breeding material with consortium members.
2	**Select OP crops for improvement (e.g. pulses, oilseeds and wheat)** Using biotech tools, identification of national partners for OP crops improvement, model to allow industries to recover a decent return on their investment.
3	**Institutional mechanism for market-driven sharing of PGR and research programs** Select a group of companies who have good investment capabilities in PGR and biotech and build relationship between ICAR and that group of companies for defined crop. Annual interactions with that group to bridge the gap between market need and research objectives will bring out the varieties needed by farmers in different regions.
4	**Using CSR funds of industry** To fund seed and PGR conservation efforts of rural and tribal communities in collaboration with public institutions.

Dr A.K. Singh was asked about his opinion on what would be the advantages and/or benefits to the public sector research in agriculture, in an ecosystem that encourages greater PPP particularly in plant breeding, and what are the potential areas for PPP in plant variety development and germplasm use. Dr Singh mentioned that there is a need for greater discussion on the contentious issue of deposition of propriety parental lines used for developing hybrids that are to be registered in PPV&FRA. Also, since food security in the country comes from public sector bred varieties and research, and contribution of private sector lesser, a balance needs to be created for farmers' rights and investment made by private sector in OP crops. He gave the example of HT soybean seeds, where farmers who have not purchased the seed from private company and must pay surcharge at the time of selling his produce, in case (s)he has used her/his saved seeds. Additionally, the HRD was one area where private sector involvement was very important in institutional capacity building though student and faculty exchange, industry sponsored fellowship, consortia research platform, contract research, collaborative research for development of parental lines and hybrids, precision phenotyping, licensing varieties on non-exclusive basis, and trait licensing.

Dr D.K. Yadava was asked to comment on the vision of ICAR with respect PPP in several transformative ideas for the way forward for agricultural research (especially plant breeding), education and extension for the next 25 years (*Amrit Kal*). He stated that four major areas being stressed were (i) accelerated crop improvement programs; (ii) green chemistry; (iii) precision farming; and (iv) regenerative agriculture. He said with respect to PPP already action was initiated, for example, to facilitate germplasm exchange for private sector, MTAs had been refined and implemented. He endorsed the idea of consortium platform mentioned by previous speakers. He informed that ICAR had developed last year the guidelines for CSR funding support. With respect to the New Seed Bill, he said an accreditation body would be put in place for certification. For enhanced trust building, Dr Yadava suggested that public sector scientists should be invited for field days/visits to private seed company to showcase their germplasm, as is done by all public institutes.

Dr Pratibha Brahmi was asked to comment about the status of cooperation with private sector in PGR exchange/access and what policies/protocols can be helpful for effective PPP in PGR management. She acknowledged the fact that it was due to the guidance of the National Advisory Board on Management of Genetic Resources (Chaired by Dr R.S. Paroda) in 2011, due to which MTAs were formulated and implemented (in 2017) to particularly facilitate exchange of germplasm by the private sector within and outside the country. So companies which have recognized R&D and are wholly Indian, have been facilitated in sharing >2,500 germplasm accessions since 2017, for research purpose, especially in vegetables. She also endorsed exchange of scientists among PPP for looking at each other germplasm and providing feedback to each other in a transparent manner.

Mr Rajendra Barwale, as Chairman of a leading seed company that mainly responsible to get Bt cotton in India, was asked to comment on how practical and successful is the PPP in India in agricultural research, so far? Conversely, is PPP is required at all for crop variety development? Should the public and private sector continue to work in silos? He said that his father, Late Sh B.R. Barwale subscribed greatly to the idea of partnership, and in fact MAHYCO itself was the outcome of PPP between his father as an entrepreneur and Late Dr H.B. Singh from IARI who shared okra variety Pusa Sawani with him. CMS in cotton was also a result of partnership from University of Georgia. Mr Barwale said that new varieties need to reach farmers. He appreciated the invitation from DG, ICAR inviting PPP from basic research onwards to develop new varieties. He greatly emphasized on the need for IP protection of new plant varieties, to sustain private companies, for which enforcement of law was much required. Mr Barwale said that policy support was very important in ABS, as also timely execution of permissions. Confidence building is required for assuring private sector about timely and effective enforcement of law surrounding ABS and seed sector. He also urged that time frame for registration should be well defined and adhered to by the implementing authorities. He called for greater engagement and dialogue between public and private sectors, especially for marketing.

Dr Paresh Verma was asked to comment about the changes he expected in the policies on procedure to speed up plant breeding and whether public-funded research in the seed sector should be phased out in a country like India? Dr Verma endorsed the public-funded research in the seed sector and said that in fact it needed to be funded more. Ecosystem of regulatory framework for PPP though in existence for >50 years, is now restricted to only technology transfer. True partnership would be now required for co-development, using biotech tools, molecular biology and data analytics and also co-investment by public and private sectors. This PPP model, therefore, needs greater evolvement, with greater complementarity of roles and strengths. There are many seed companies having strong research strength. The government is focused in increasing presence of private sector in all fields, including agriculture. Challenges being faced are more clarity in terms of ownership and benefit sharing.

Dr Malathi Lakshmikumaran was asked to elaborate on her expectations of private sector in PPPs with respect to plant varieties and germplasm management and what legal regime for IP to be taken care of. She said that from an IP perspective, the difference between agriculture versus engineering/pharma was that products of later were 'traceable'. Agriculture is different that seed can be replicated anywhere, where tracing and protection is more complicated. She said that the Biological Diversity Act 2002 was also a major impediment in MTAs, especially in defining section 3(2) a companies. She said that all 64 crops of ITPGRFA to be dealt with DARE/ICAR and not go the NBA for approval. She advocated for simplification of procedures for import, quarantine and DUS testing.

Dr Neeti Wilson was posed with a question that what laws and policies in India are helpful in PPPs in agricultural research and development and what are the impediments for practical implementation of PPP models in PGR sector. She said many issues have come up for the BDA which NBA needs to review. She said law evolves with time, when stakeholders present their perspective. In India, agriculture is dominated by public sector, but they need to have business like mindstate. For any Act, guidelines need to be made through frequent stakeholders' meetings for awareness.

Dr R.S. Paroda, in his concluding remarks, mentioned that the purpose of the session was to deliberate for further strengthening the PPP in PGR management and to understand what are the options available and the way forward, considering the discussion about PPP had been going on since long, and had not fully materialized due to trust issues. He recommended to have a follow-up brainstorming meeting on these issues engaging public and private sector representatives. He further emphasized that NBPGR needs to have legal division to comprehend the legal issues related to PGR access and benefit sharing and provide necessary inputs to ICAR for enabling policy development for ABS and other PGR-related issues.

Poster Session










Poster Session

There were total 249 posters in the Conference representing various ICAR and CSIR Institutes, State Agricultural Universities and Traditional Universities from different states of India. These were compiled and edited in the Abstract Book of the NCPGRM 2022. The posters presented research in the management of PGR offering a representative and in depth view of the ongoing research work in varied NARS and other organizations in India. The posters were displayed for all three days during the Conference.

There were total 37 posters in the Technical Session 1 focused on augmentation and quarantine of germplasm. Topics of the posters included germplasm exploration from various unexplored areas in India, exchange and quarantine of multifarious horticulture and agroforestry crops for enhanced utilization. There was a total of 148 posters in the Technical Session 2, mainly focused on germplasm phenotyping, genotyping and pre-breeding. This session also had posters on use of bioinformatics tools for trait discovery especially genome wide association mapping and genome editing. A total of 39 posters were presented in the Technical Session 3 with main focus on seed genebanks, in vitro conservation and cryopreservation for posterity and utilization of germplasm. Some 20 posters were displayed in the Technical Session 4 representing on-farm PGR management and local food systems. Topics of the posters also included work on community genebanks, food systems and participatory plant breeding. There were five posters in the Technical Session 5 mainly focused on general policies on PGR management including ABS.

A jury, comprising of experts in PGR management, examined all the rapid oral presentations and posters critically and adjudged the best posters in each session for 'Best Poster Awards'.

Gaps Identified , Recommendation and Way Forward











Gaps and Concerns Identified for PGR Management

Specific gaps concerning PGR Management in India identified during the 1st NCPGRM as:

Concerning General Issues

Lack of awareness and funding:
In general, there is considerable lack of awareness among farmers, policy makers, and the public about importance of conserving PGR. This is an obvious reason for lack of funding for PGR conservation related initiatives.

Climate change:
Climate change is a significant challenge to PGR management. It can limit the ability for proper testing and adaptation of PGR.

Biodiversity loss:
India has one of the highest rates of biodiversity loss in the world, which puts many plant species at risk of extinction. This loss of biodiversity can reduce the genetic diversity of crop plants, especially in view of vulnerability to pests, diseases, and environmental stresses.

Inadequate infrastructure:
Required facilities and infrastructure for in situ management of PGR are inadequate, including field genebanks, national facility for conservation for 'Safety Duplicates' (preferably in permafrost region), off-shore quarantine and supporting research facilities.

Fragmented governance of genetic resources management system:
India has a complex governance structure for PGR management with different institutions and ministries involved. This creates difficulties in effective management of PGR. Further, there is inadequate coordination amongst the genetic resource bureaux i.e., NBPGR, NBAGR, NBFGR, NBAIM and NBAII and Private Sector for effective management of genetic resources in the country. The 'National Advisory Board on Management of Genetic Resources' needs to be revived quickly to provide guidance and oversight.

Concerning Legal Framework

The legal and policy framework for PGR management in India is primarily governed by the following Acts and policies, that lack effective coordination and convergence:

Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001:
This Act provides for the establishment of a national-level authority for the registration of plant varieties and the protection of plant breeders' rights. However, the Act has not been able to adequately protect the rights of farmers being the custodians of traditional crop varieties, and not registered the large number of extant varieties that have been released and notified by the State/Central Governments.

Seed Act, 1966:
Climate change is a significant challenge to PGR management. This Act regulates the quality of seeds sold in the country, including PGR. The Act is under revision for almost two decades and the revised Seed Bill, 2019 is yet to be approved by the Parliament.

Biological Diversity Act (BDA), 2002:
The BDA provides for the conservation and sustainable use of biological resources, including PGR, and the sharing of benefits arising from their utilization. However, the Act has not been able to effectively address the issue of ABS of PGR and same is being considered for revision to overcome existing gaps.

Theme-wise Recommendations

Germplasm Augmentation, Exchange and Quarantine

- There is an urgent need to develop agrobiodiversity hotspot maps similar to 'biodiversity hotspots' at the global and regional level, particularly for the regions with endemic agrobiodiversity and high risk of agrobiodiversity loss, so as to sustainably manage gene pool of important indigenous species.

- A mission-mode program needs to be initiated for exploration and collection of landraces, crop wild relatives and perennial horticultural crops from remote and inaccessible areas on priority. It should also include tree species to bridge the gap in agrobiodiversity using global tree data knowledge platform and deal with threat of climate change.

- Expedite explorations and collection of germplasm based on the gap analyses of existing collections in the genebank, particularly in climate-sensitive regions. Genetic diversity maps for each crop group need to be developed to sustainably manage the gene pool of important species. Emphasis needs to be given for importing the germplasm of national interest to widen the scope of cultivation of new crops.

- Development of a 'Systems Approach' to mitigate phytosanitary risk with clear cut 'go' and 'no go' procedures for safe and quick exchange of germplasm will be highly desirable. For this, the development of 'Green Pass' protocol for transparent biosecurity administration is needed.

- A 'National Integrated Biosecurity System', a 'National Plant Pests Diagnostic Network', standard phytosanitation methods for germplasm exchange, and also post-entry quarantine growing procedures must be established. This will ensure that new pests are not introduced especially while dealing with vegetatively propagated material. It will also help to develop new diagnostic techniques such as electronic noses using digital sensor-based technology for quick and accurate diagnosis of pest and diseases of germplasm.

- There is an urgency to create off-shore quarantine facility and strengthen entry-points quarantine as well as the biosafety/biosecurity system. Also, capacity building programs in the area of biosafety and GM detection need to be organized.

Trait Discovery, Gene Mining and Genome Editing

- A national program on pre-breeding and genetic base broadening involving CWRs and diverse germplasm in major and orphan crops should be established.

- There is requirement for inclusion of additional plant variety descriptors useful to consumers, producers, and industry, to shift focus from "evaluation" to "valuation" of PGR.

- There is need to deploy remote sensing and drone technologies for rapid phenotyping for traits related to biotic and abiotic stresses.

- Resequencing the germplasm accessions for construction of pan-genomes and super-pangenomes is highly desirable, for functional and evolutionary studies of genes across germplasm of different species, in a comprehensive manner.

- Identification of new genes and QTLs from landraces and CWRs, and transfer to mega-varieties (as successfully done in Swarna Sub-1 rice variety) needs to be replicated in more crops.

- Mutagenesis methodology should be used to induce additional useful variability in major economically important crops.

- The existing 'National Genomic Resources Repository' at ICAR-NBPGR should be strengthened with dedicated manpower and resources, to facilitate easy access by researchers.

- There is an urgent need to accelerate the efforts for discovery of new traits, genes and their deployment in crop varieties using emerging technologies such as genome editing, GM technologies, bioinformatics, artificial intelligence, phenomics, genomics, *etc.* for enhanced utilization of PGR.

- Protocols for the sustainable extraction of commercial products from bio-resources should be established. Additional plant variety descriptors can be included for characterization and evaluation of germplasm which are useful for consumers, producers and industry. Creation of mobile labs to characterize PGR in the field should be envisioned for supporting on-farm conservation programs.

Germplasm Conservation

Ex Situ Conservation

- Mission-mode network project on trait-specific germplasm evaluation being undertaken under 'CRP on Agrobiodiversity' by ICAR-NBPGR needs to be continued and further strengthened with assured financial and trained human resources, until all the germplasm holdings in the National Genebank are evaluated. This would help in development of core/ mini core collections in the important species for enhanced germplasm utilization.

- For cost-effective management of large genebank collections and for better utilisation, there is need to carry-out redundancy screening, heterotic grouping of source populations and evaluation of inbred lines.

- Establishment of 'Safety Duplicate Genebank' with assured financial resources based on recommendations already made by an expert committee and submitted to ICAR, needs to be accelerated.

In situ/On-Farm Conservation

- Sites with indigenous crop diversity need to be identified where *in situ*/on-farm conservation can be carried out with the involvement of non-governmental organizations (NGOs), self-help groups, farmers, and post-graduate students, etc. Also, a 'Portfolio Options Approach' should be adopted to allow farmers to select suitable plant varieties (crops and wild relatives) and livestock for on-farm conservation.

- For forest and tree species, the concept of 'natural genebanks' (forest genebanks) needs to be established which would facilitate evolution as well as use of conserved species.

- Farmers contributing significantly towards on-farm conservation and community seed genebanks should be recognised and incentivised in a sustainable manner.

- Coordination among different Ministries/ Departments/ Councils/ Institutions/ Universities under the State and the Central Governments need strengthening for managing *in situ* conservation.

IPR and Traditional Knowledge

- The rich indigenous traditional knowledge (ITK) on agrobiodiversity available with farmers, women, and migrant workers should be systematically documented (with due acknowledgement to individual/community sources), like CSIR's Traditional Knowledge Digital Library (TKDL). ICAR-NBPGR and Alliance of Bioversity International-CIAT may jointly develop such a project.

- Institutes/SAUs in NARS to scientifically validate claims for farmers' varieties/landraces need to be identified and given required support for the activity.

- Guidelines for Germplasm Registration by ICAR-NBPGR to be revisited to simplify the process and widen the scope of its availability to the breeders for utilisation in varietal development programs. Also, the outcome/benefit of germplasm registration process so far, needs to be assessed.

- Registration of extant varieties of crops not covered so far should be done by PPV&FRA on a priority consideration. ICAR/NARS should facilitate the process of identification of such crops of especially of local importance *vis-à-vis* having high relevance for indigenous food systems in climate change context. It should also be made public that extant variety registration and protection must be availed in time (until its notification is in active state) since it cannot be taken up infinitely.

- Revision of the rules for PPV&FR Act, 2001 need to be considered in the context of contemporary developments, and support for Gene Fund be ensured for conservation and benefit sharing.

- An effective IP protection landscape with adequate financial support is the need of the hour. Enhanced budgetary support for IP protection is required in the public sector, as also effective enforcement of the existing legal framework against IP violation and strong action is required to be taken against any infringement.

Public-Private Partnership

- For a successful public-private partnership (PPP) in PGR management, there is need to build mutual trust and implement clear policies on (i) IP sharing between partners, (ii) consortium-based R&D, (iii) market-driven joint evaluation/breeding programs particularly crop wild relatives (iv) formation of consultative groups for developing sustainable and transparent models of germplasm and benefit sharing. (v) the use of corporate research funds for PGR management.

- Increased investment in R&D with technology-driven PPP ensuring role and strength complementarities; a successful partnership requires joint investments as well as clarity of roles (who will do what?) and ownership (who will own what?).

- There is need to build capacity and increase awareness on the regulatory procedures for acquiring the germplasm from ICAR-NBPGR and through NBA.

- Effective and balanced mechanism of PPP for commercialization of plant varieties protected under PPV&FR Act, 2001, need to be developed. The existing model for PPP developed by ICAR-IARI may be adopted by other public sector institutes.

- Models for strengthening farmer participatory engagements and PPP need to be developed in germplasm use and conservation.

Enabling Policies

- The existing 'National Action Plan on PGR Management' should be re-visited in view of the new and emerging challenges including climate change.

- National Advisory Board on Management of Genetic Resources to be revived to provide guidance and oversight for coordination amongst the genetic resource bureaux i.e., NBPGR, NBAGR, NBFGR, NBAIM and NBAII and Private Sector for effective management of PGR.

- The authority for managing national and international exchange of agrobiodiversity should be delegated to DARE/ICAR. For this NBA and DARE/ICAR need to deliberate and take necessary steps to facilitate the process.

- Awareness among the stakeholders to be created about sharing the genetic resources and related information under the provisions in National Biological Diversity Act (2002) and varieties registered under PPVFR Act (2001).

- Harmonization required between the proposed Seed Bill (2019) and PPV&FR Act, in terms of provisions for infringements, compensation of legal rights, etc. where PPVFR Act, (2001) has overriding provisions under Section 92 Seed sector and PPVFRA are required to deliberate regarding the interpretations and practices of different provisions under PPVFR Act, (2001).

- Evidence-based ABS system to be developed to strengthen trust between providers and users of plant genetic resources; Address the issue of adding commercial value to PGR and strengthen PGR information systems.

- Societies like ISPGR should (i) work as "Independent Think Tank" and provide unbiased and independent views on science policy; (ii) nurture and motivate the youth as well as tap.

Way Forward for PGR Management

The PGR management is critical for the country's sustainable agricultural development. Hence, the PGR management strategies need to be compatible with the needs of all stakeholders, including breeders, farmers and indigenous communities. Obviously, effective and efficient management of PGR requires significant investment in R&D. The most important recommendations related to PGR management emerging from the conference were:

- **Strengthening policy and legal framework:** India presently has required laws in place for the conservation and sustainable use of PGR. However, there is need to strengthen and harmonize these, including framing of associated rules, regulations and SOPs to ensure their speedy implementation for sustainable use, equitable sharing of benefits, and protection of the rights of farmers and indigenous communities. Towards this end:
  - A comprehensive 'National Policy on PGR Management' that addresses issues related to exploration, conservation, sustainable use, access, and benefit-sharing is recommended to be developed under the guidance of National Advisory Board on Genetic Resources. This Board under the ICAR could serve a single window system on all matters related to agrobiodiversity involving all five bureaux (plant, animal, fish, microbes, and insects).
  - The authority for managing and exchange of agrobiodiversity at the national and international level must be delegated immediately by the National Biodiversity Authority (NBA) to DARE/ICAR in the best interest of our country.
  - Harmonize the proposed Seed Bill, 2019 and PPV&FR Act, 2001 in terms of provisions for infringements, compensation of legal rights, etc. where PPV&FR Act has overriding provisions under Section 92. For this, the seed sector and PPV&FRA are required to deliberate on the interpretations and practices of different provisions under PPVFR Act, 2001 and resolve the concerns, if any.
- **Building public-private partnership:** There is an urgent need to encourage close collaboration among the stakeholders to promote innovation and required genetic enhancement. PPP combines the resources and expertise of both sectors to achieve common goals. The challenges associated with PPP in genetic resources management, includes: issues related to intellectual property rights, equity, trust and access to genetic resources. Additionally, there is a need for a transparent and accountable governance system to protect the interests of all stakeholders, including smallholder farmers and indigenous communities. For this, there is need to have a relook at PPV&FR Act 2001, to ensure that the rights of farmers are adequately protected and such provisions are not deterrent for the applicants to register their unique varieties.
- **Strengthening infrastructure:** It was felt that we need to invest and strengthen further the existing infrastructure for PGR management, such as field and working genebanks at crop improvement institutes. Also, we urgently need a National Repository for the conservation of safety duplicates and an off-shore quarantine facility for screening and safe exchange of germplasm.
- **Building National Database on PGR:** The NBPGR need to develop and implement a comprehensive national database on PGR which provides all relevant information concerning availability, trait-value, IP rights, *etc.* to facilitate an easy access to information and effective collaboration with all concerned stakeholders.
- **Promoting in situ (on farm) and *ex situ* conservation:** *In situ* conservation involves conserving genetic resources in their natural habitats, and this can be an effective way to conserve endangered species and local landraces. India needs to promote *in situ* conservation and empower local communities to take charge of the conservation and utilization process. ICAR-NBPGR and Biodiversity International need to develop *in situ* conservation models that are most suited in the Indian context. *Ex situ* conservation

of genetic resources outside their natural habitats through genebanks, including *in vitro*-, cryo- and field-genebanks require modern facilities, especially in areas prone to natural disasters and climate change. Also, urgent efforts are needed to identify and eliminate the duplicate accessions in the National Genebank as a matter of priority.

- **Identification of trait-specific germplasm:** A mission-mode time bound program on trait-specific germplasm evaluation of available accessions in the national genebank must be initiated on priority involving multi-institutional and inter-disciplinary approach. For this, additional allocation of funds by ICAR to initiate immediately this Mission project will help in harnessing valuable genes for future food, nutrition and environmental security.

- **Enhanced use of PGR:** Sustainable use of genetic resources both for the present and future generations would require access to both germplasm and information in the public domain without restriction if exchanged under standard material transfer agreement (SMTA), This has to be in a participatory mode involving PPP and through inter-institutional as well as international collaboration. Beside these, farmers' participatory plant breeding, through their capacity building and the partnership with private sector using new science such as phenotyping, marker assisted selection (MAS), genome editing using CRISPER-Cas 9, and genetic modification through transgenic approaches would help in accelerating the process of genetic enhancement significantly. In fact, acceleration of plant breeding is critical for genetic resource enhancement and, therefore, major focus be now to accelerate use of genetic resources in the national crop breeding programs to develope improved varieties that are resilient to climate change, and have in-built resistance to pests and diseases as well as to abiotic stresses (drought, heat, cold, salinity, flooding, *etc.*).

- **Capacity building and public awareness:** Capacity building and awareness creation at all levels can help in active involvement of stakeholders for PGR conservation and its effective use. In this context, India needs to invest more in capacity building and awareness creation among all stakeholders for efficient management of PGR and their sustainable use both for the present and posterity.

- **Ensuring benefit sharing:** As the farmers are primary custodian of PGR, their active participation is crucial for the sustainable management and use. Hence, future programs should involve farmers in collection, conservation, and utilization of genetic resources. Also, the revisit of Biological Diversity Act, 2002 would ensure proper access and benefit-sharing of PGR.

- **Promoting local food systems:** In view of natural resource degradation, climate change and other natural threats such as COVID-19 pandemic, we now need to give greater attention on research needs and improve the local food systems for better household food and nutrition security.

- **Role of academic societies:** Scientific society like Indian Society of Plant Genetic Resources (ISPGR) must now assume greater role as an *"Independent Think Tank"* to provide unbiased independent opinion on science policy and public awareness, while also nurturing and motivating the youth (including women) to play a proactive role in PGR management. ISPGR has also an important role to promote PGR science so as to remain globally competitive and relevant.

The 1st NCPGRM resolved that by implementing above strategies and recommendations, Indian PGR Management System will not only get strengthened but shall help accelerate agricultural growth being so critical for our food, nutrition and environmental security.

Technical Program

Day 1: November 22, 2022 (Tuesday)		
08:30-09:30	**Registration**	
INAUGURAL SESSION		
Chair	**R. S. Paroda,** President ISPGR and Chairman, TAAS, India	
Chief Guest	**Himanshu Pathak,** Secretary, DARE and DG, ICAR, India	
Convener	**Anuradha Agrawal,** General Secretary, ISPGR, India	
Rapporteur	**Sonal Dsouza,** Alliance Bioversity and CIAT, India	
09:30-09:35	**Arrival of Dignitaries and Lighting of Lamp**	
09:35-09:40	**Welcome and Introduction about 1st NCPGRM**	**G. P. Singh** Director ICAR-NBPGR, India
09:40-09.55	**Brief Remarks from Co-Organizers**	**J.C. Rana** Country Director, Alliance for Bioversity International and CIAT, India **K. V. Prabhu** Chairperson, PPV&FRA, India
09:55-10:00	**Release of Publications**	
10:00-10:20	**Inaugural Address by Chief Guest**	**Himanshu Pathak** Secretary, DARE and DG, ICAR, India
10:20-10:30	**Chairperson Remarks**	**R.S. Paroda** President, ISPGR and Chairman, TAAS, India
10:30-10:35	**Vote of Thanks**	**Anuradha Agrawal**
10:35-11:00	**Group Photo and Tea/Coffee**	Posters for all sessions to be displayed
PLENARY SESSION		
Co-Chairs	**S. K. Vasal,** World Food Laureate, India **R. K. Tyagi,** Vice President, ISPGR, India	
Convener	**Manjusha Verma,** Organizing Secretary, NCPGRM, India	
Rapporteur	**Monika Singh,** Senior Scientist, ICAR-NBPGR, India **Padmavati Gore,** Scientist, ICAR-NBPGR, India	
11:00-11:05	**Introduction of Speaker**	**R.K. Tyagi**
11:05-11:50	**Plenary Lecture** *Managing Our Agrobiodiversity*	**R.S. Paroda** President, ISPGR and Chairman, TAAS, India
11:50-12:00	**Chairperson Remarks**	**S.K. Vasal**
12:00-12:05	**Vote of Thanks**	**Manjusha Verma**
TECHNICAL SESSION I **Augmentation Of Germplasm For Enhanced Utilization** (Sub-Themes: Exploration, Exchange And Quarantine – Crops, Horticulture, Agro-Forestry)		
Co-Chairs	**B. S. Dhillon,** Former Director, ICAR-NBPGR and Ex VC, PAU, Ludhiana, India **P.K. Chakraborty,** Former Member, ASRB and ADG, PP&BS, ICAR, India	
Convener	**S. P. Ahlawat,** Head, Division of Plant Exploration & Germplasm Collection, ICAR-NBPGR, India **V. Celia Chalam,** Head, Division of Plant Quarantine, ICAR-NBPGR, India **Vandana Tyagi,** OIC, Germplasm Exchange and Policy Unit, ICAR-NBPGR, India	
Rapporteur	**Kavita Gupta,** OIC, PME, ICAR-NBPGR, India **S. Rajkumar,** Senior Scientist, ICAR-NBPGR, India	

12:05-12:10	**Welcome**	**S. P. Ahlawat**
12:10-12:35	**Keynote Lecture 1** *Management of PGR in the national context*	**G. P. Singh** Director, ICAR-NBPGR, India
12:35-13:00	***Keynote Lecture 2*** *Mapping bio-resources and genetic diversity of wild crops for conservation and utilization*	**K. N. Ganeshaiah** Professor (Retd.), Dept. of Forestry and Environmental Sciences, UAS, GKVK, India
13:00-14:00	**Lunch**	
14.00-14.15	**Invited Lectures** *Phytosanitary aspects of germplasm and its impact on conservation, distribution, and use*	**P. Lavakumar *** Head, Germplasm Health Unit, IITA, Nigeria
14:15-14:30	*Stringent plant quarantine system for national bio-security*	**S. C. Dubey** ADG (Plant Protection & Bio-safety), ICAR, India
14:30-14:45	*Trees outside forests: untapped potential for germplasm conservation, landscape diversity, and climate resilience*	**Chandrashekhar Biradar** Country Director, ICRAF, India
14:45-15:00	*Plant exploration, germplasm collection: challenges and opportunity in India*	**S.S. Dash*** Scientist E, BSI, Kolkata, India
15:00-15:15	**Tea/Coffee**	
15:15-17:00	**Short Lectures** (7 min each)	**Vandana Tyagi** (Coordination)
	Germplasm exchange for sustainable food security (#SL-189)	**Vandana Tyagi**
	Unique plant germplasm collections from diverse agro-ecological regions of India (#SL-127)	**K.C. Bhatt**
	Regulatory framework and quarantine for safe transboundary movement of transgenic germplasm (#SL-226)	**V. Celia Chalam**
	Rapid Oral Presentations *(5 min. each)*	
	Are sorghum landraces of Telangana climate resilient? (#0-175)	**N. Sivaraj**
	Species distribution, exploration, collection, and conservation of Salacia species (high value anti-diabetic plant) of Western Ghats (#0-205)	**M.R. Rohini**
	Collection, conservation and multiplication of pearl millet landraces in Rajasthan (#0-202)	**Manoj Kumar**
	Conservation priority of Buchanania lanzan Spreng. (Chironji): A potential wild fruit tree of peninsula India (#0-297)	**A.K. Srivastava**

	IoT based E-solution for safeguarding tree germplasm against physical damage, misidentification and mistracking in field genebanks (#0-306)	**K.P. Mohapatra**
	Survey and collection of plant genetic resources from Andaman & Nicobar Islands representing Indo-Burma and Sundaland Biodiversity hotspots (#0-139)	**K. Pradheep**
	Large scale phenotyping of pea germplasm for discovery of resistant sources against powdery mildew (Erysiphe polygoni) (#-0-336)	**Jameel Akhtar**
	Exploration of diversity in pungent chilli genotypes from Arunachal Pradesh (#-0-283)	**Teju C.M.**
	Inter-specific hybridisation followed by mutation to improve the yield potential of cultivated emmer of Khapli wheat (Triticum dicoccum Schub. L.) (#-0-119)	**Vikas V.K.**
17.00-17.25	**Discussion & Co-Chairs Remarks**	
17.25-17.30	**Vote of Thanks**	**V. Celia Chalam**
17:30-18:30	**Poster Session (all themes)** and Tea & Coffee	
	CULTURAL PROGRAM AND WELCOME DINNER	
Convenor	**Veena Gupta, Professor (PGR), ICAR-NBPGR, India**	
18:30-19:30 19:30-21:00	**Cultural Program** **Welcome Dinner**	**Veena Gupta (Coordination)**

Day 2: November 23, 2022 (Wednesday)

TECHNICAL SESSION II

Trait Discovery, Gene Mining And Genome Editing

(Sub-Themes: Germplasm Phenotyping, Genotyping, Pre-Breeding And Use Of Biotechnology)

Co-Chairs	**H. S. Gupta,** Former Director, ICAR-IARI, and Former DG, BISA, India **P.N. Mathur,** Former Regional Director, Bioversity International, India
Conveners	**R.K. Gautam,** Head, Division of Germplasm Evaluation (DGE), ICAR-NBPGR, India **Rakesh Singh,** Principal Scientist, ICAR-NBPGR, India **Rakesh Bhardwaj,** Principal Scientist, ICAR-NBPGR, India **Amit K. Singh,** Senior Scientist, ICAR-NBPGR, India
Rapporteurs	**D.P. Wankhede,** Senior Scientist, ICAR-NBPGR, India

09.30-09.35	**Welcome**	**R.K. Gautam**
09.35-10.05	**Keynote Lecture** *Using genetic resources to stack and complement climate resilience traits*	**Matthew Reynolds*** Distinguished Scientist and Head of Wheat Physiology, CIMMYT, Mexico

10.05-10.20	**Invited Lectures** *Genomics for improving germplasm management and utilization*	**Rajeev Varshney*** Director, Centre for Crop & Food Innovation, Murdoch University, Australia
10.20-10.35	*Genomics-assisted breeding of climate-resilient cultivars utilizing traditional varieties and wild rice genetic resources*	**N. K. Singh** National Professor, ICAR-National Institute for Plant Biotechnology, India
10.35-10.50	*Technologies and innovations contributing towards food and nutritional security in era of climate change*	**Joy K. Roy & Ashwani Pareek** Executive Director, National Agri-Food Biotechnology Institute, Mohali, India
10.50-11.05	*Trait discovery and deployment through mainstreaming landraces and crop wild relatives in legumes breeding programme*	**Shiv Kumar Agrawal** Regional Coordinator, ICARDA, India
11.05-11.20	**Tea/Coffee**	
11.20-11.35	**Using new breeding techniques and digital tools for crop improvement**	**Bharat Char** Chief Science Officer, MAHYCO, India
11.35-12.35	**Short Lectures** (7 min each)	**Rakesh Singh** (Coordination)
	Towards harnessing soybean germplasm diversity in the National Genebank for summer season cultivation (#SL-308)	**R.K. Gautam**
	Development of pre-breeding genetic resources for trait discovery and gene mapping in bread wheat: Indian perspectives (#SL-273)	**Mahesh C. Yadav**
	Rapid Oral Presentations (5 min each) *Characterization of linseed germplasm conserved at National Genebank of India and Development of core set (#0-158)*	**Vikender Kaur**
	Assessment of molecular diversity of core collection of ginger germplasm from Northeast India (#0-183)	**Twahira Gegum**
	Introduction and morphological characterization of Heeng (Ferula assa-foetida) accessions in cold deserts of Indian Himalayas (#0-204)	**Ashok Kumar**
	Characterization of wild and cultivated Musa species of India based on flow cytometric analysis of ploidy and nuclear DNA content (#0-223)	**Rithesh BN**
	Characterization of entire ricebean collections of Indian National Genebank and development of core set for enhanced utilization (#0-243)	**Gayacharan**
	Genome-Wide Association Study Reveals QTLs for Plant height in a subset of 3K Rice Genome (RG) Panel (#0-156)	**Supriya Sachdeva**

	Genetic diversity, population structure and trait characterization for Indian cauliflower germplasm (#0-284)	**Shrawan Singh**
	Wheat genetic resource mining for trait discovery towards achieving the sustainable development goal of food and nutritional security (#0-235)	**Jyoti Kumari**
12.35-12.55	**Discussion & Co-Chairs Remarks**	
	Vote of Thanks	**Rakesh Bhardwaj**
13.00-14.00	**Lunch**	

TECHNICAL SESSION III

Conservation Through Utilization

(Sub-Themes: Seed Genebanks, In Vitro Conservation, Cryopreservation And Genomic Resources)

Co-Chairs	**Bhag Mal, Secretary,** TAAS, India **Arun K. Joshi,** CIMMYT Regional Representative for Asia, India
Conveners	**R.K. Tyagi, Coordinator,** APCoAB, APAARI, Thailand **Veena Gupta,** Principal Scientist, Division of Conservation, ICAR-NBPGR, India **Sandhya Gupta,** OIC, TCCU, ICAR-NBPGR, India
Rapporteurs	**Sherry Jacob,** Senior Scientist, ICAR-NBPGR, India **Rohini M.,** Senior Scientist, ICAR-IIHR, Bengaluru, India

14.00-14.05	**Welcome**	**R. K. Tyagi**
14.05-14.35	**Keynote Lecture 1** *Designing germplasm management systems to maximize use of maize genetic resources*	**S.K. Vasal,** Distinguished Scientist, CIMMYT
14.35-15.05	**Keynote Lecture 2** *Strategies for enhancing use of germplasm collections in crop improvement for sustainable conservation*	**Hari D. Upadhyay*** Former Director, Genebank, ICRISAT, India
15:05-15:20	**Invited Lectures** *Conserving and utilizing plant genetic resources-role of IRRI genebank*	**Venuprasad Ramaiah*** Genebank Manager, IRRI, Philippines
15:20-15:35	*Application of plant cryopreservation for the conservation of plant genetic resources, production, virus eradication and as a tool for modern breeding techniques*	**Bart Panis *** Plant Cryobiologist, Alliance of Bioversity International and CIAT, Belgium
15:35-15:50	**Tea/Coffee**	
15.50-16.05	**PGR informatics tools for efficient conservation and use**	**Sunil Archak** National Fellow, ICAR-NBPGR, India
16.05-17.05	**Short Lectures** (7 min each)	**Veena Gupta** (Coordination)
	Genetic resources of MAPs conserved at CSIR-NEIST, Jorhat for trait specific breeding with special reference of NE India (#S-200)	**Mohal Lal**

	Rapid Oral Presentations (5 min each)	**Gowthami R.**
	Cryoconservation of shoot tips of Swertia chirayita (Roxb.) H. Karst., a critically endangered medicinal plant of India (#0-142)	**Padmavati Gore**
	Genetic resources of pigeon pea: Conservation for utilization (#0-188) Makhana (Euryale ferox Salisb.) Genetic Resources and Utilization (#0-176)	**Anil Kumar**
	In vitro approach for generation of Homalomena aromatica Schott an endangered medicinal plant of NE India (#0-185)	**Tanmita Gupta**
	In vitro mass multiplication and field acclimatization of spine gourd (Momordica dioica Roxb.) (#0-191)	**Vartika Srivastava**
	In vitro regeneration protocol standardization of cultivated and wild species of okra (#0-213)	**Bhargav Kiran**
	Long term conservation of Vanila planifolia 'Andrews' using droplet vitrification-based cryopreservation technique (#0-167)	**Era Vaidya Malhotra**
	Preservation of Central India's forest genetic resources through the establishment of a seed genebank at Tropical Forest Research Institute, Jabalpur, Madhya Pradesh (#0-107)	**Manish Kumar Vijay**
	G-DIRT: A germplasm duplicate identification tool based on identity-by-state analysis using SNP genotyping data (#0-140)	**Amit Kumar Singh**
	Elucidating the seed storage behaviour of makhana (Euryale ferox Salisb) (#0-140)	**Badal Singh**
17.05-17.25	**Discussion & Co-Chairs Remarks**	
17.25-17.30	**Vote of Thanks**	**Sandhya Gupta**

Day 3: November 24, 2022 (Thursday)

TECHNICAL SESSION IV

On-Farm PGR Management and Local Food Systems

(Sub-Themes: Community Genebank, Food Systems, Participatory Plant Breeding, Relevant Traditional Knowledge)

Co-Chairs	**S.K. Sharma,** Former Director, ICAR-NBPGR & VC, CSKHPKV, Palampur, India
	Rakesh Chandra Agrawal, Deputy Director General (Agric. Education), ICAR, India
Conveners	**J.C. Rana, Country Director,** Alliance for Bioversity International and CIAT, India
	Surendra Kumar Malik, Principal Scientist, TCCU, ICAR-NBPGR, India
Rapporteurs	**Ravi Parmarthi,** Scientist (SS), ICAR-NBPGR, India
	Sarika Mittra, Alliance for Bioversity International and CIAT, India Office, India

09:00-09:05	**Welcome**	**J.C. Rana**
09:05-09:35	**Keynote Lecture** *In situ conservation, characterization, commercialization: Incentivizing communities*	**Anil Gupta** Chair, Honeybee Network and Former Professor, IIM, India
09:35-09:50	**Invited Lectures** *Genetic diversity for improving production systems, landscape restoration, and adaptation to climate change*	**Paola De Santis*** Scientist II, Alliance of Bioversity International and CIAT, Italy
09:50-10:05	*Smallholder farming and the role of youth in food system transformation for sustainable development*	**Ishwar S. Bisht** Consultant, Alliance Bioversity and CIAT, India
10:05-10:20	*Genetic Resources, Traditional Knowledge and Cultural Expressions: Protection, Preservation and Promotion*	**Viswajanani J. Sattigeri** Head, CSIR-Traditional Knowledge Digital Library Unit, India
10:20-10:35	**Tea/Coffee**	
10:35-10:50	**Valuation of Ecosystem Services**	**Reuben Gergan** Biodiversity Consultant, UN Environment Programme
10:50-11.40	**Short Lectures** (7 min each)	**S. K. Malik** (Coordination)
	A paradigm change in on-farm conservation of mango genetic resources and the development of new varieties (#SL-285)	**Shailendra Rajan**
	Community Seed Banks: Challenges and prospects to conserve agrobiodiversity, improve nutrition and livelihood security (#SL-168)	**Sudhir P. Ahlawat**
	Vista of opportunity for on-farm conservation of native crop diversity: On a cutting edge knowledge perspective (#SL-337)	**Sudhir Kochhar**
	Plant diversity, indigenous traditional knowledge and local food system in achieving food and nutritional security, sustainability and resilience (#SL-338)	**Umesh Srivastava**
	Rapid Oral Presentations (5 min each)	
	Local vegetables of Manipur: bioprospecting aspects and need for germplasm conservation (#0-138)	**Rajkumari Sanayaima Devi**
	Assessment of ethnobotanical uses, household and regional genetic diversity of edible Aroid species grown in Northeastern India (#0-177)	**Veerendra Kumar Verma**

	Harnessing diversity of genus Phaseolus in Western Himalayan Kashmir: The journey of 15 years of breeding for yield, quality and resilience (#0-286)	**Parvaze A. Sofi**
	Mainstreaming of mountain native crops for nutritional and livelihood security in Himachal Pradesh (#0-255)	**Lal Singh**
	Origin of black rice from wild rice (Oryza rufipogon) of India- A pre-breeding approach (#0-157)	**Subhas Chandra Roy**
	Intellectual property protection and conservation of unique goods from crop genetic resources in Kerala (#0-255)	**Adheena Ram A.***
11.40-11.55	**Discussion & Co-Chairs Remarks**	
11.55-12.00	**Vote of Thanks**	**S. K. Malik**
TECHNICAL SESSION V **Enabling Policy On PGR Management** (Sub Themes: IPR, Farmers & Breeders Rights, ABS, General Policies)		
Co-Chairs Conveners Rapporteurs	**K. Vinod Prabhu,** Chairperson, PPV&FRA, India **G.P. Singh,** ICAR-NBPGR, New Delhi **Pratibha Brahmi,** Principal Scientist, GEPU, ICAR-NBPGR, India **Pragya, Principal Scientist,** ICAR-NBPGR, India **Dipal Roy Chaudhury,** Registrar, PPV&FRA, India	
12.00-12.05	**Welcome**	**Pratibha Brahmi**
12.05-12.35	**Keynote Lecture** *Science led legal decision-making policies in Plant Varieties Protection through Plant Breeder's & Farmer's Rights in India*	**K. V. Prabhu**
12.35-12.50	**Invited Lectures** *ABS, Nagoya Protocol and Biodiversity Conservation*	**Ayesgül Sirikaya*** Post-Doc Fellow & Researcher, Lund University, Sweden
12.50-13.05	*Balancing Seed Act 1966 & Seed Bill 2021 in the IPR protection environment of plant varieties*	**Dinesh Kumar Agarwal** Registrar General, PPV&FRA, India
13.05-14.00	**Lunch**	
14.00-14.15	**Realization of ABS in India**	**J. Justin Mohan*** Secretary, National Biodiversity Authority, India
14.15-14.30	*Genomics-led PGR management and utilization, practical considerations under current policies*	**Narayanan K. K.*** CEO Agrigenome Labs Pvt. Ltd; Director, Foundation for Advanced Training in Plant Breeding, India
14.30-14.45	*IPR based commercialization of plant varieties under public research systems*	**Neeru Bhooshan** CEO & Principal Scientist, Pusa Krishi Incubator, ZTM & BPD Unit, ICAR-IARI, India

14.45-14.55	Access and Direct Benefit Sharing with the PGR conserver farmer/community under PPVFRA: Some Examples	
14.55-15.10	**Discussion & Co-Chairs Remarks**	
15.10-15.15	**Vote of Thanks**	**Kavita Gupta**
15.15-15.30	**Tea/Coffee**	

PANEL DISCUSSION
(Public-Private Partnership In PGR Management) and
VALEDICTORY SESSION

Co-Chairs	**R. S. Paroda,** President, ISPGR and Chairman, TAAS, India **R.C. Agrawal,** DDG (Agric. Education), ICAR, New Delhi, India
Conveners	**Anuradha Agrawal,** General Secretary, ISPGR, and National Coordinator, ICAR-NAHEP, India
Rapporteurs	**Puran Chand,** Principal Scientist, ICAR-NBPGR, India **Vartika Srivastava,** Scientist (SS), ICAR-NBPGR, India

Panel Discussion on Public-Private Partnership in PGR Management

15.30-15.40	*Overview on the status of public-private partnership (PPP) in PGR management*	**Ram Kaundinya** Director General, Federation of Seed Industry of India
15.40-16.15	**Panelists Views** *Public sector perspective on PPP for germplasm sharing and variety development*	**Ashok K. Singh, Director,** ICAR-IARI, India **D. K. Yadava,** ADG (Seed), ICAR, India **Pratibha Brahmi, Principal** Scientist, ICAR-NBPGR, India
	Expectations of private seed sector for improved PPP in changing policy and climate scenario	**Rajendra Barwale,** Chairman, MAHYCO, India **Paresh Verma,** Director of Research. Shriram Bioseed Genetics India Ltd., India
	Legal and policy impediments in seamless implementation of successful PPP in the PGR sector in India	**Malathi Laxmikumaran,** Executive Director, Lakshmikumaran & Sridharan Attorneys **Niti Wilson,** Partner, Anand and Anand (Law Firm)
16.15-16.30	**Open Floor Discussion**	

Valedictory Session

16.30-16.45	**Summary of Major Recommendations of the 1st NCPGRM**	**R.K. Tyagi**
16.45-17.00	**Award Distribution** (For Best Rapid Oral Presentations and Best Posters)	
17.00-17.35	**Remarks by Organizers of 1st NCPGRM** Alliance for Bioversity and CIAT PPV&FRA	 **Jai. C. Rana** **K.V. Prabhu**
17.00-17.35	**Co-Chairs Remarks**	**R.C. Agrawal** **R.S. Paroda**
17.55-18:00	**Vote of Thanks**	**Anuradha Agrawal**

Awards for Rapid Oral Presentations and Posters

Best Oral Presentations

S.No.	Abstract No.	Title of Poster	Authors	Affiliation of presenting author
Theme 1: Augmentation of germplasm for enhanced utilization				
1.	O-139 (O-06)	Survey and collection of plant genetic resources from Andaman & Nicobar Islands representing Indo-Burma and Sundaland biodiversity hotspots	**K Pradheep,** Joseph John K, I Jaisankar, VA Muhammed Nissar, BA Jerard and SP Ahlawat	ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), Regional Station, Thrissur 680 656, Kerala
2.	O-336 (O-07)	Large scale phenotyping of pea germplasm for discovery of resistant sources against powdery mildew (Erysiphe polygoni)	Aditya Kumar, Bharat Raj Meena, Kuldeep Tripathi, Swati Tripathi, Gayacharan, Vinod Kumar Sharma, **Jameel Akhtar,** Ashok Kumar and VC Chalam	Division of Plant Quarantine, ICAR-National Bureau of Plant Genetic Resources, New Delhi-110012
3.	O-297 (O-04)	Conservation priority of Buchanania lanzan Spreng. (Chironji): A potential wild fruit tree of peninsula India	**AK Srivastava,** Dinesh Gupta, Chandra Kant Tiwari, BS Rajput, CM Singh, Ashutosh Rai, SV Dwivedi, Pradeep Kumar and Siddarth Kumar	Banda University of Agriculture and Technology, Banda – 210001 Uttar Pradesh
Theme 2: Trait discovery, gene mining and genome editing				
4.	O-284 (O-16)	Genetic diversity, population structure and trait characterization of Indian cauliflower germplasm	**Shrawan Singh,** Rakshita KN, Bhagchand Shivran and Vinay Verma	Division of Vegetable Science, ICAR-Indian Agricultural Research Institute, New Delhi -110012
5.	O-204 (O-12)	Introduction and morphological characterization of Heeng (Ferula assa-foetida) accessionsin cold deserts of Indian Himalayas	**Ashok Kumar,** Sanatsujat Singh, Satbeer Singh, Ramesh Chauhan, Ram Kumar Sharma and Sanjay Kumar	Agrotechnology Division, Council of Scientific and Industrial Research - Institute of Himalayan Bioresource Technology, Palampur - 176061 Himachal Pradesh
6	O-156 (O-15)	Genome-Wide Association study reveals QTLs for plant height in a subset of 3K Rice Genome (RG) panel	**Supriya Sachdeva**, Rakesh Singh, VK Singh and UM Singh	Division of Genomic Resources, ICAR-NBPGR, New Delhi
Theme 3: Conservation through utilization				
7.	O-140 (O-26)	G-DIRT: A germplasm duplicate identification tool based on identity-by-state analysis using SNP genotyping data	TK Sahu, **Amit Kumar Singh,** Shikha Mittal, SK Jha, Sundeep Kumar, SR Jacob, Kuldeep Singh	ICAR-National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012
8.	O-167 (O-24)	Long term conservation of *Vanilla planifolia* 'Andrews' using droplet vitrification based cryopreservation technique using droplet vitrification based cryopreservation technique	**Era Vaidya Malhotra,** Deepshikha Gupta, Sangita Bansal and Sandhya Gupta	Tissue Culture and Cryopreservation Unit, ICAR-National Bureau of Plant Genetic Resources, New Delhi-110012, INDIA

9.	O-107 (O-25)	Preservation of central India's forest genetic resources through the establishment of a seed gene bank at Tropical Forest Research Institute, Jabalpur, Madhya Pradesh	**Manish Kumar Vijay,** Maitryee Kundu, Nanita Berry and Neelu Singh	Tropical Forest Research Institute, Jabalpur, Madhya Pradesh
Theme 4: On farm PGR management and local food system				
10.	O-171 (O-31)	Mainstreaming of mountain native crops for Nutritional and Livelihood security in Himachal Pradesh	**Lal Singh,** MS Thakur, Rakesh Chahota, MJ Kaur and DK Thakur	Himalayan Research Group (HRG) Umesh Bhavan Chotta Shimla, Shimla-171002, H.P.
11.	O-138 (O-28)	Local vegetables of Manipur: bioprospecting aspects and need for germplasm conservation	**Rajkumari Sanayaima Devi,** Pallavi Dhal, Sachchidan and Tripathi	Department of Botany, DeenDayal Upadhyaya College, University of Delhi, Sector-3, Dwarka, New Delhi-110078
12.	O-177 (O-29)	Assessment of ethnobotanical uses, household and regional genetic diversity of edible aroid species grown in Northeastern India	**Virendra Kumar Verma,** Amit Kumar, Heiplanmi Rymbai and VK Mishra	ICAR Research Complex for NEH Region, Umroi Road, Umiam-793103, Meghalaya

Best Poster Presentations

S.No.	Abstract No.	Title of Poster	Authors	Affiliation of presenting author
Theme 1: Augmentation of germplasm for enhanced utilization				
1.	P-121	Introduction and establishment of nine Wild species of Gossypium from USDA, USA	**Vinita Gotmare,** Rachna Pandey, Neelkanth Hiremani, HB Kumbhalkar and YG Prasad	ICAR-Central Institute for Cotton Research, Nagpur,
2.	P-208	Introducing true cinnamon (Cinnamomum verum) in non-traditional areas of Himachal Pradesh	Ramesh Chauhan, Sanatsujat Singh, Ashok Kumar, **Satbeer Singh**	Division of Agrotechnology, Council of Scientific and Industrial Research - Institute of Himalayan Bioresource Technology, Palampur- 176 061, Himachal Pradesh
3.	P-128	Genetic resources of wild edible plants in high altitude of Chamoli district of Uttarakhand	**KM Rai,** Mamta Arya and Veena Gupta	ICAR-National Bureau of Plant Genetic Resources, Regional Station, Bhowali, Nainital,-263132, Uttarakhand-
4.	P-173	Access and utilization of cucurbit genetic resources for nutritional security	**Pragya,** CD Pandey, Vandana Tyagi, Pratibha Brahmi, SK Yadav, SP Singh and Surender Singh	ICAR-National Bureau of Plant Genetic Resources, New Delhi 110012
Theme 2: Trait discovery, gene mining and genome editing				
5.	P-314	Introgression of the genes governing resilience for climatic change into Brassica juncea from Sinapis alba	**Preetesh Kumari,** Kaushal Pratap Singh and Devender Kumar Yadava	ICAR- Indian Agricultural Research Institute, New Delhi-110012

6.	P-339	Screening of Luffa germplasm against ToLCNDV and identification of ToLCNDV resistant lines	**Monika Jha,** S Chauhan, A Ghosh, Pragya, CD Pandey, L Arya, S Archak and M Verma	PG School, ICAR-IARI, ICAR-National Bureau of Plant Genetic Resources, New Delhi-110012
7.	P-159	Characterization of rice landraces using high density rice 80K SNP array	**Akshay Singh,** Sabina Rana, Avantika Maurya, AK Singh and Rakesh Singh	Division of Genomic Resources, ICAR-National Bureau of Plant Genetic Resources, New Delhi 110012
8.	P-212	Identification of diagnostic keys for selected wild genetic resources of grasses in southern India	**Nagaraju Siddabathula**	Botanical Survey of India, Kolkata – 7000 064, West Bengal
9.	P-215	Mapping and mining of major genomic regions conferring resistance to Bruchine (Callosobruchus maculatus) in blackgram (Vigna mungo (L.) Hepper)	**Ragul. S,** Manivannan. N , Iyanar, K, Ganapathy, N and Karthikeyan G	Centre for Plant Breeding and Genetics, TNAU, Coimbatore – 641003, Tamil Nadu
10.	P-136	Genetic dissection of test seed seight (TSW) in linseed (Linumusitatissimum L.) using multi-locus genome wide association study	**DP Wankhede,** Ankit Saroha, Vikender Kaur, Deepa Pal, SS Gomashe, S Rajkumar, J Aravind and Ashok Kumar	ICAR-National Bureau of Plant Genetic Resources, New Delhi 110012
11.	P-343	Genome editing vis-a-vis conservation of plant genetic resources	**Divyansh Rana** and MK Rana	Amity Institute of Biotechnology, Amity University, Sector 125, Noida, Uttar Pradesh
12.	P-340	Characterization of grasspea (Lathyrus sativus) germplasm for agro-morphological traits along with protein content	**Ramya KR,** K Tripathi, R Bhardwaj, S Barpete and A Pandey	Division of Plant Genetic Resources, ICAR- Indian Agricultural Research Institute, New Delhi 110012
Theme 3: Conservation through utilization				
13.	P-262	High oil yield in sesame (Sesamum indicum) is shaped through sustained gene expression during seed development	**Ajay Kumar** and Parimalan Rangan	Division of Genomic Resources, ICAR-National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012
14.	P-250	Vegetable genetic resources: conservation and use	**Chithra Devi Pandey** and Sushil Pandey	Division of Germplasm Conservation, ICAR-National Bureau of Plant Genetic Resources, New Delhi 110012
15.	P-334	Standardization of long-term pollen cryopreservation of Lathyrus sativus to facilitate wide hybridization	**M Shankar,** R Gowthami, Kuldeep Tripathi and Anuradha Agrawal	Division of Plant Genetic Resources, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India
16.	P-347	Studies on seed morphometry and desiccation-freezing tolerance in Indian Madder (Rubia cordifolia)	**Sangita Bansal,** Era V Malhotra, Anang Pal Singh and S K Malik	
17.	P-341	Assessment of Cryo-fitness for Bitter gourd seeds	**Sharmila M,** S Ganeshram and V Thiruvengadam	

Theme 4: On farm PGR management and local food system				
18.	P-113	On-farm crop diversity management in rainfed agro-ecosystem of Jaunsar-Bawar, Jaunpur and Ranwain areas of Uttarakhand, India: a case study	**RS Rathi,** KC Bhatt, Anjula Pandey, DP Semwal, PK Malav, NS Panwar and SP Ahlawat	ICAR-National Bureau of Plant Genetic Resources, New Delhi-110012
19.	P-313	Kiwifruit- potential for fruit diversification and nutritional security	**Narender** Negi, Ram Chander, Rahul Chandora, Badal Singh, Krishan Madhav Rai, Dayal Singh and Mohar Singh	Regional Station, ICAR-National Bureau of Plant Genetic Resources, Phagli, Shimla
20.	P-324	On-farm conservation of traditional biodiversity in Central Western Ghats of India	**Puneeth GM,** Sunil Archak, Kailash Chandra Bhatt, Vimala Devi and Veena Gupta	ICAR-National Bureau of Plant Genetic Resources, New Delhi-110012
21.	P-152	Digitization of ICAR-NBPGR Plant diversity using Mobile App with QR code	**Ankur Tomar,** Anjula Pandey, NS Panwar and SP Ahlawat	ICAR-National Bureau of Plant Genetic Resources , New Delhi-110012

NCPGRM

List of Participants

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NCPGRM

About the Organizers

Indian Society of Plant Genetic Resources (ISPGR): The Society was founded in 1987 as a multidisciplinary scientific body involved in various issues of plant genetic resources (PGR) and related fields. The genesis of the Society was from the initiative taken by the scientists at the National Bureau of Plant Genetic Resources (NBPGR), New Delhi, under the leadership of Dr R S Paroda, the then Director of NBPGR and presently President, ISPGR and Chairman, TAAS. The primary objective of the Society is to provide a forum to those interested in the field of PGR for expressing their views, publishing their findings and interacting with different stakeholders. Membership of the ISPGR is open to all persons involved in PGR in India and abroad.

Indian Council of Agricultural Research (ICAR): ICAR is an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India. The Council is the apex body for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With 111 ICAR institutes and 71 agricultural universities spread across the country this is one of the largest national agricultural systems in the world. The ICAR has played a pioneering role in ushering Green Revolution and subsequent developments in agriculture in India through its research and technology development making a visible impact on the national food and nutritional security. It has played a major role in promoting excellence in higher education in agriculture. It is engaged in cutting edge areas of science and technology development and its scientists are internationally acknowledged in their fields.

National Bureau of Plant Genetic Resources (NBPGR): Indian Council of Agricultural Research (ICAR) established The ICAR-National Bureau of Plant Genetic Resources, (ICAR-NBPGR) in 1976 with its headquarters at New Delhi. The Bureau is the nodal organization in India with the national mandate to plan, conduct, promote and coordinate all activities concerning plant exploration and collection, characterization and also for safe conservation and distribution of both indigenous and introduced genetic variability in crop plants and their wild relatives. It is also vested with the authority to issue Import Permit and Phytosanitary Certificate and conduct quarantine checks on all seed materials and plant propagules introduced from abroad or exported for research purpose (including transgenic material). The Bureau has a network of 10 RS / BCs to fulfill the mandate of PGR management across different agro-ecological conditions of the nation.

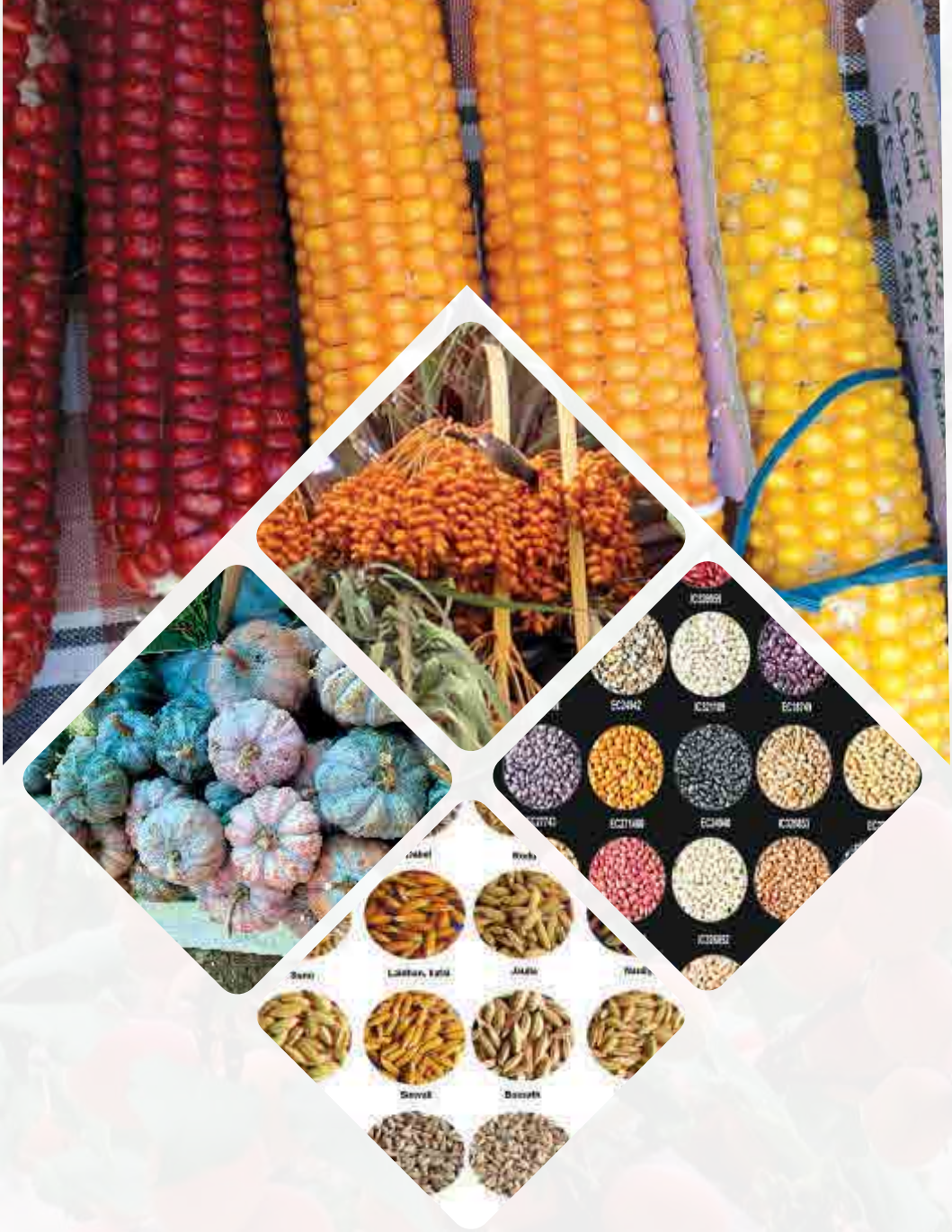
Alliance of Bioversity International and CIAT: It is a global research-for-development organization. Its vision is that agricultural biodiversity nourishes people and sustains the planet. It delivers scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity to attain sustainable global food and nutrition security. Bioversity International works with partners in low-income countries in different regions where agricultural and tree biodiversity can contribute in improving nutrition, resilience, productivity and climate change adaption. Bioversity International is a CGIAR research centre. CGIAR is a global research partnership for a food-secure future.

Protection of Plant Varieties and Farmers' Right Authority (PPV&FRA): In order to provide for the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants it has been considered necessary to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of the new plant varieties. Moreover to accelerate agricultural development, it is necessary to protect plants breeders' rights to stimulate investment for research and development for the development of new plant varieties. Such protection is likely to facilitate the growth of the seed industry which will ensure the availability of high-quality seeds and planting material to the farmers. India having ratified the Agreement on Trade Related Aspects of the Intellectual Property Rights has to make provision for giving effect to Agreement. To give effect to the aforesaid objectives the Protection of Plant Varieties and Farmers' Rights Act, 2001 has been enacted in India and Protection of Plant Varieties and Farmers' Rights Authority was established.

Photo Gallery

Photo Gallery


1st National Conference
on
Plant Genetic Resources
Management



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