Indian J. Plant Genet. Resour. 35(3): 8–12 (2022)
DOI 10.5958/0976-1926.2022.00032.8

Reorienting the Plant Genetic Resource Management for Enhanced Utilization

Trilochan Mohapatra[1*] and Sunil Archak[2]
[1]*President, National Academy of Agricultural Science, Pusa Campus, New Delhi-110012*
[2]*ICAR-National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012*

Context

Since mid-20th century, India transformed itself as a country that depended on food aid to a net food exporter, with nearly six-fold increase in food grain production from 50 million tonnes in 1950-51 to 314.51 million tonnes in 2021-22, due to the adoption of technologies. By 2050, India's population will reach 1.7 billion people, creating the most populated country in the world. Food demand will increase by 70 per cent. Globally, the demand for food is expected to rise by 50 per cent and yields may decline by 2050 in the absence of adequate climate action. Thus, India faces the formidable challenge of ensuring a guaranteed and adequate supply of nutritious and healthy food produced in an economically, culturally, socially and environmentally sustainable manner.

The United Nations' 2030 Development Agenda includes 17 for Sustainable Development Goals (SDGs) and those related to agriculture include: 1) No poverty, 2) Zero hunger 3) Good health and well-being for people 12) Responsible consumption and production, 13) Climate action, 14) Life below water, and 15) Life on land. However, addressing several of SDGs in an increasingly challenging environment and burgeoning population would be a formidable challenge. It is here that genetic resources play a crucial role.

Role of Genetic Resources

Genetic resources are the biological cornerstone of global food security. The agricultural diversity and genetic resources that support agriculture need to be used efficiently both to maintain current levels of food production and to confront future challenges. Adapting crop varieties to local ecological conditions can reduce risks induced by climate change. Thus, identifying adapted germplasm requires reoriented emphasis on augmentation, characterization and evaluation of germplasm in genebanks. In fact, conservation is the beginning of the solution in terms of trait-discovery (Fig. 1). Science-based interventions are required at various stages of genetic resources use.

Increasing yields of major food crops – or even maintaining them – in the face of climate change will depend on combining genetic traits found in materials of a wide range of origins, including wild species. Unfortunately, wild species are especially vulnerable to climate change because they do not receive management interventions that help them adapt to changing conditions. Narrowly adapted species and endemics are especially vulnerable to the direct effects of climate change. Some of the centres of landrace diversity exist in areas under

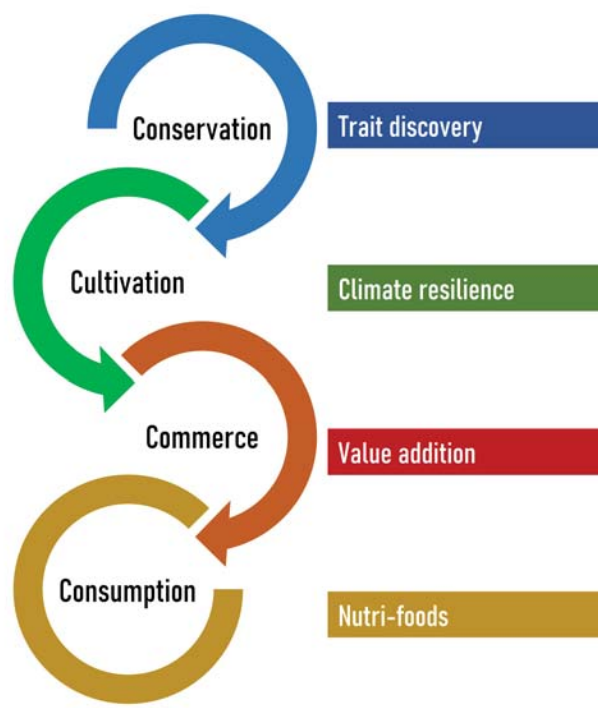

Fig. 1. Science-based interventions required at various stages of genetic resources use

*Author for Correspondence: Email-tmnrcpb@gmail.com

Prioritization of crop wild relatives

NBPGR shortlisted 861 Indian CWR taxa belonging to 769 species for 171 crops (of ICAR-mandate) falling under 14 crop groups (based on overall closeness with crop; potential use). Prioritisation resulted in 292 taxa (257 species) belonging to 85 crops (level of closeness to crop, economic traits or wide hybridisation work under progress and extent of distribution/ threat). Of 292 prioritised taxa, only 167 are conserved in the National Genebank. Conserved species lack representative samples from across a geographical and ecological range.

considerable climate risk, where diversity is valued for its resilience. It is, however, poorly understood how the increase of climate risk, and change in the climate baseline might impact the current diversity in landraces found in situ. Impacts are likely to be both positive and negative on landrace diversity depending on the region, but a priority for research and monitoring activities is to ensure that more diversity is not lost.

Status of PGR Management and Utilization

Germplasm augmentation: Climate change calls for change in priorities for action with respect to genetic resources. Today there is urgent need for consolidating Indian genebank collections of wild species, including crop wild relatives (CWR), due to increased likelihood of extinction for narrowly adapted and endemic species. Novel and increased demands on germplasm in genebanks for adapting agriculture to climate change, including the need to screening for different characters. By carrying out focused collecting missions, a total of 132 exploration and collecting missions during 2016-2021 resulted in collection of more than 9700 (Fig. 2). About 30% of the accessions belonged to the focus group of CWR. In the NEH region alone, as many as 28 explorations were conducted and more than 2000 accessions. Use of all modern tools viz. GIS, digital surface and soils maps, satellite imagery, etc. must be routine practice of exploration missions. Collecting, compiling and documenting ITKs related to PGR is also significant.

Plant quarantine: A systematic step-wise strategy followed for testing of each sample imported for presence of any unwanted pests and all samples found infested/ infected were salvaged and if they could not be salvaged, they were rejected and destroyed by suitable means.

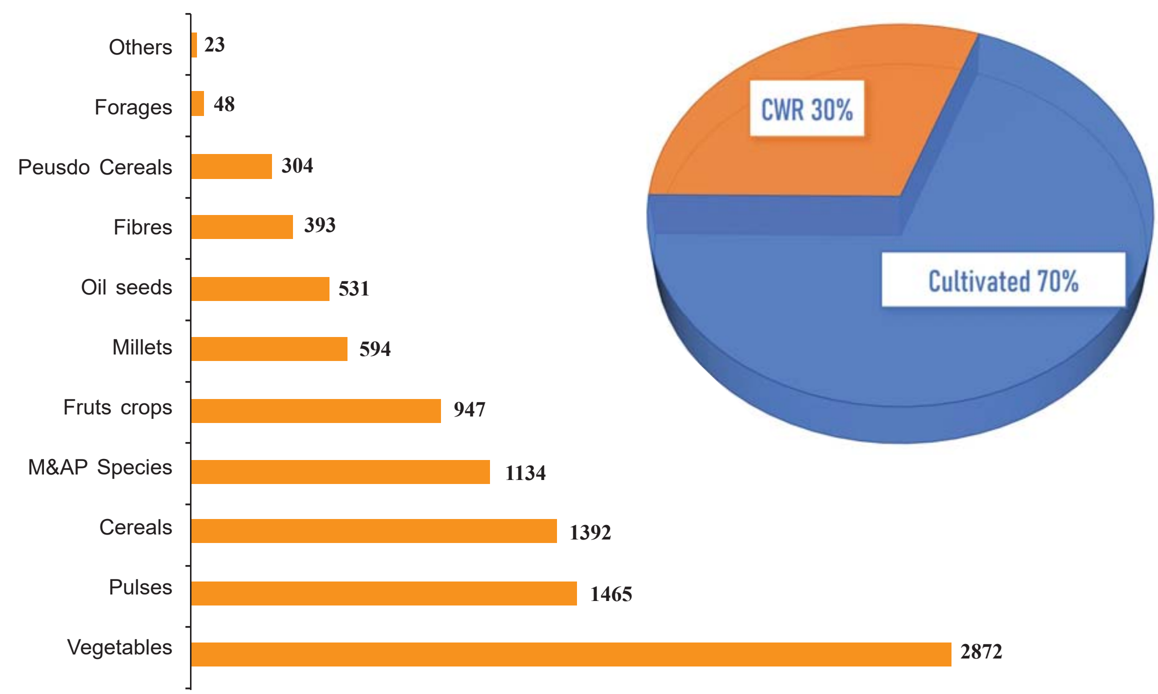

Fig. 2. Crop-group wise germplasm collected by NBPGR through targeted explorations during the period 2016-21

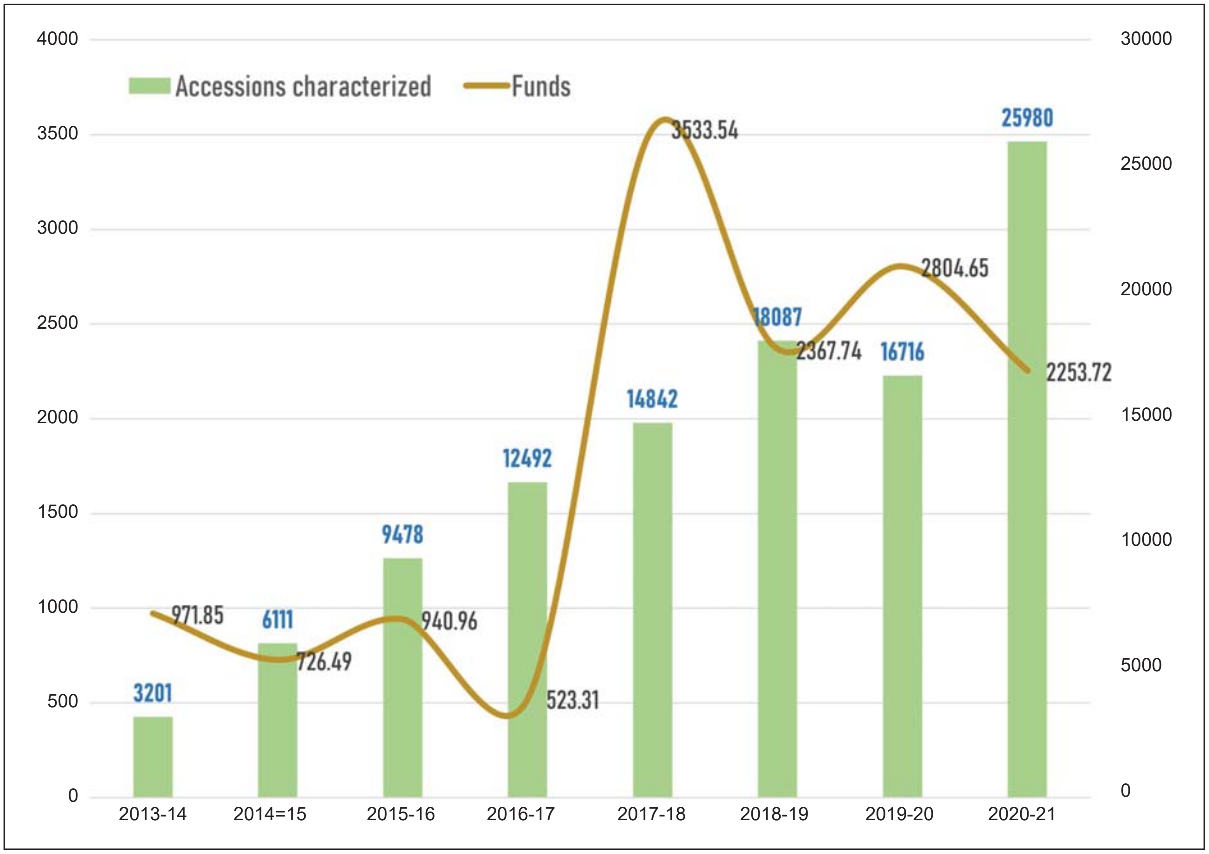

Fig. 3. Institutional funding (*line*, in lakh rupees) accelerating the characterization of germplasm (*bar*, number of accessions).

Estimated losses in India averted by interception of quarantine pests in introduced germplasm is estimated to be around Soybean (Rs.45 crore), Maize (Rs.47 crore), Rapeseed- mustard (Rs.39 crore) and Groundnut (Rs.33 crore). This calls for arming the quarantine set-up with modern tools and carrying out supportive research and documentation. Generation of awareness about importance of quarantine among public and policy makers is also essential.

***Conservation*:** Globally more than 7 million accessions are conserved *ex situ* (WIEWS data) and about the same number are in the safety back-up at the Svalbard Global Seed Vault. Data of only 2.5 million are available on Genesys-PGR portal. Indian genebank conserves about 0.45 million accessions collected from habitats within India (Table 1) or imported from other countries. Despite global holdings being redundant, enough scope of augmentation and enough room in the seed genebank exist. Number of accessions of CWR added to seed genebank has jumped from 17 per year to about 120 per year since 2014. NBPGR has the best of cryo and in vitro genebanks. But field genebanking of horticultural crops requires attention and coordination with institutes and universities. Working with custodian farmers has great advantage.

***Germplasm characterization*:** Genebanks carry out characterization as a routine activity. However, large-scale phenotyping of the germplasm accessions in one-go can facilitate designation of core collections allowing increased use of germplasm. ICAR's initiatives in supporting the field characterization of several crops under an ambitious project "Consortia Research Platform on Agrobiodiversity" provided much needed funds that led to forming networks and carrying out multi-location experiments. The dedicated financial support gave an impetus to take out entire genebank collections of various crops for characterization (Fig. 3). A total of >280 crore rupees was invested by ICAR though mega projects like CRP-Agrobiodiversity and NICRA causing a dominion effect and attracting about 150 crore rupees as extra-mural grants. Advantages of such initiatives include: (i) involvement of plant breeders and specialists from the outset guaranteeing the use of identified trait specific resources and (ii) creation of an institutional as well as organic partnerships for long term associations. For instance, varieties as many as 78 vegetable, 29 spices, 26 millets, 24 pulses, 21 cereals, 17 forage, 13 oilseeds among others have been developed using the indigenous germplasm in the last decade (2011-2020).

***Germplasm sharing*:** India, though NBPGR and other partner institutions, has ensure that germplasm is available for research in the country. In fact, procedures are laid out for sharing germplasm with foreign researchers. It is important to ensure that germplasm is exchanged for research purpose without hurdles and also follow legal requirements nationally and compliance internationally. In collaboration with Kirkhouse Trust, India has shared >250 accessions of pulses with ten African countries.

***Use of modern technologies*:** India has the advantage of being endowed with high degree of genetic variability accessible from ex situ genebank. There is now need to lay greater emphasis on employing novel technologies including genomics for large scale genotyping and associating with phenotypic variations. Trait discovery, identification of best germplasm accessions with multiple trait advantage will ultimately lead to their use in developing climate resilient and nutri-rich varieties.

Action Points

Keeping in mind the changing climatic conditions, changing needs and advancements in technologies, it is essential to calibrate our PGR management procedures and prioritize the resources for enhanced utilization of PGR (Fig. 4). Some suggestions given below:

Efficient use of gene pool: Augmentation of CWRs by collecting or by importing; developing descriptors where not available and characterization; trait-specific screening; pre-breeding; genotyping and identification of loci. Effective use genomic tools for genotyping and associating the data with phenotypic trait and contributing the material/information to varietal development programmes.

Map R&D and PGR services onto visions and programmes: A number of significant activities are being carried out by NBPGR and partners. They need to be mapped onto the relevant SDGs and national vision documents to make the PGR activities look relevant and contemporary. Excellent activities can be planned and implemented under the aegis of national programmes aiming at farmers welfare as well as NEH/TSP specific activities.

Table 1. Germplasm accessions of various crops collected from different states and conserved in Indian genebank

State	Count
Andaman and Nicobar Islands	622
Andhra Pradesh	13765
Arunachal Pradesh	3573
Assam	6136
Bihar	5711
Chhattisgarh	14881
Delhi	6912
Goa	352
Gujarat	8476
Haryana	6049
Himachal Pradesh	8950
Jammu and Kashmir	3732
Jharkhand	4125
Karnataka	8246
Kerala	4653
Madhya Pradesh	14069
Maharashtra	17545
Manipur	1825
Meghalaya	1975
Mizoram	1585
Nagaland	1978
Odisha	10159
Others	45580
Punjab	4621
Rajasthan	10889
Sikkim	1239
Tamil Nadu	7204
Telangana	8290
Tripura	603
Unknown	70444
Uttar Pradesh	14817
Uttarakhand	12378
West Bengal	2753
Others	114

Documentation and awareness: Without an efficient information system, data on useful germplasm and traits cannot be accessed by researchers curtailing the utilization potential. In addition to the impactful research papers aiming at scientists, semi-technical and general publications must be brought out periodically. They will provide necessary information to policy makers and funding agencies about the ongoing programmes and success stories. PGR is localized and therefore leaflets and brochures in vernacular languages must be made available.

Collaboration and networking: Every activity of PGR management is multi-disciplinary. Inter-institutional collaborations within India have shown good results in

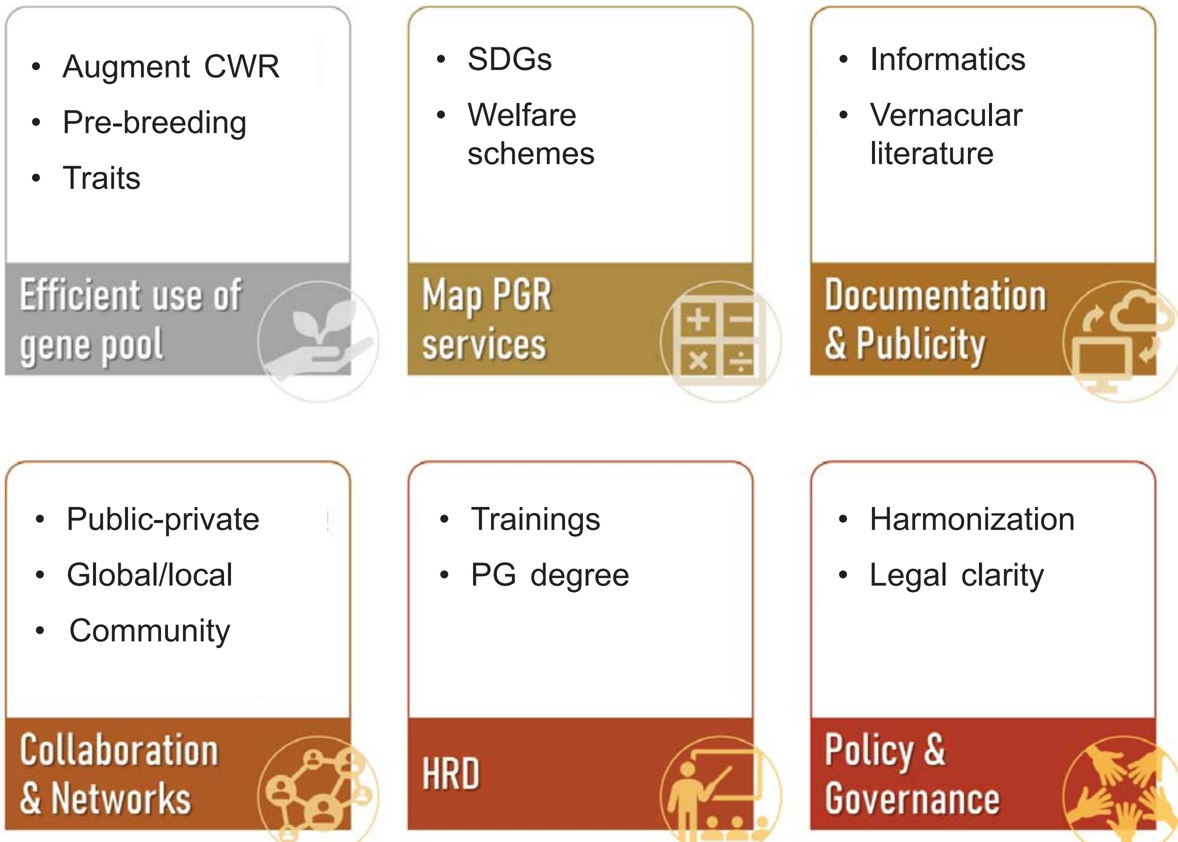

Fig. 4. Five action areas for the future of genetic resources utilization

phenotyping and genotyping. International collaborations, particularly in screening for biotic and abiotic stress factors will save valuable years in preparation. Public-Private partnerships are woefully less and needs strategic planning. Working with custodian farmers and conserving communities will provide not only practical lessons but also access to hitherto uncollected populations of lesser-known crops.

Capacity building and HRD: PGR management requires specialized skills and therefore training programmes to various stakeholders must be a regular activity. Topic-specific trainings in taxonomy, genotyping, quarantine, informatics, etc. are required for upgradation of skills. It is important to generate human resource that will be well-prepared to continue PGR programmes in future through post-graduate programmes.

Acknowledgement

Information has been drawn from various reports of ICAR-NBPGR and thanks are due to all the researchers of the Bureau and network partners.