Indian J. Plant Genet. Resour. 35(3): 107–109 (2022)
DOI 10.5958/0976-1926.2022.00051.1

Contribution of Technology in Enhancing and Preserving PGR

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Agriculture begins with seed and most improvements in agriculture employ plant genetic diversity. Agricultural trait improvement and genetic gain rely on germplasm diversity and associated information. Given the pace of germplasm loss, technology is critical in germplasm management and preservation. Traits that improve crop productivity and quality of produce also indirectly contribute towards germplasm conservation. Digital information can also help to monitor and conserve genetic diversity.

Introduction

Plants form the basis for all other life on our planet. They balance the various ecosystems and provide food, fibre and fuel for the growing human population. as well as habitat for most other organisms. Human intervention with their growing number, urbanization and industrialization have led to plant ecosystems being disturbed resulting in loss of plant biodiversity. Plant scientists have been working to preserve and conserve the diversity of plant genetic resources across the globe. Conservation efforts have been taken up both locally as well as globally with contributions from communities and nations. The diversity of plants needs to be preserved as it is the only way forward for upgrading marginal or degraded regions and for ecological sustainability. Technology and agriculture are interfused with and make use of diversity of germplasm and can also contribute to its preservation.

Efforts so Far are Still not Adequate

The largest seed bank for long term storage of seeds was established in 2008 near arctic circle, the Svalbard Global Seed Vault. India is home to the second largest gene bank set up by National Bureau of Plant Genetic Resources (NBPGR) in 2021. Most of the countries and CGIAR institutions have their own banks for plant genetic resources. However, these efforts are inadequate, given the immense diversity of the plant varieties and races spread across the globe in varied environments. In India, NBPGR and National Biodiversity Authority (NBA) are the authorities that manage germplasm conservation and access.

Modern Technology Provides Solutions

In the era of genome sequencing and genomics, physical access to germplasm is not the only way to utilize and benefit from the diversity, the sequence data associated with the germplasm is also a treasure trove of knowledge that may be used for better understanding a trait, improving it or modifying it with all the new available breeding tools. Therefore, we need to invest in generating gene sequence or protein data for the available accessions in seed banks and devise a mechanism to manage the access for such data. Promoting open exchange of Digital Sequence Information (DSI) will support conservation, fosters research into technological solutions to tackle societal challenges and benefit the global population as a whole. Germplasm or DSI access is a necessity for scientific advancement and technological development. Any barriers to the sharing and use of DSI would discourage innovation and scientific research. The benefits of open access and sharing were demonstrated well in case of tracking and monitoring of SARS-CoV-2 across the globe, that helped in containment, management of the spread and vaccine development for the virus.

Global and Local Approaches Needed

International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) was adopted by FAO in 2001 and focuses on sustainable use of all plant genetic resources for food and agriculture. India is a signatory of this treaty as well as Convention on Biological Diversity (CBD). These treaties recognize the contribution of farmers to the diversity of crops while establishing a global system for access and benefit sharing. The open

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access and monitoring of benefit sharing will require use of digital technologies across the globe, with cross access across databases, so that duplication of efforts in data monitoring is avoided. This will reduce costs and ensure fair monitoring.

GM and Gene Edited Crops

Developers of GM and gene edited crops rely on germplasm diversity and allelic variation for trait improvement. Without ample sequence information and study of variants and wild species, none of the biotechnology tools would be effective. The cultivation of the improved crops positively impacts associated ecosystems as well as field resources. It is well documented that GM cultivation has reduced land conversion and reduced environmental impact of agriculture. For instance, if crop biotechnology had not been available to farmers in 2018, maintaining global production levels that year would have required the planting of an additional 14 percent of the arable land in the United States, or roughly 38 percent of the arable land in Brazil or 16 percent of the cropping area in China. These technologies utilize plant genetic resources and also contribute towards their conservation and improvement.

Policy Imperatives

Continuous crop improvement is an imperative to meet growing demand for food, feed and fuel. Governments in each country, while trying to protect their own native germplasm, have to adopt facilitating policies which allow cross border exchange of germplasm, open access to germplasm by both public and private sector players and conservation of local germplasm by communities. Private sector has a crucial role to play in the crop improvement programs of different countries. It is very important to clearly define the parameters of access and benefit sharing for germplasm. Biodiversity conservation efforts of different organizations and communities should be rewarded and encouraged. Private industry may be encouraged to help local communities to conserve their genetic resources through professional management of local seed banks. Harmonization of policies across nations for conservation and exchange of plant genetic material through global treaties is very important and they should be put in place sooner than later. Farmers who conserve natural resources including soil and biodiversity should be rewarded on the basis of clearly defined and measurable parameters. Short term and long-term storage infrastructure for germplasm may be created in remote areas of the countries by the governments. Professional cataloguing along with gene sequence and protein data of all the germplasm stored in such facilities needs to be facilitated by the government.

Sustainable Future Scenario

We are moving from productivity centric agriculture to sustainable agriculture that requires diversity in food crops and promoting local germplasms. Though plant breeders have multiple modern tools available with them, they all rely heavily on the historic records and genetic sequence information. Be it MAS, GWAS or gene editing they all can improve the breeding process but need genetic sequence information about breeding population or allelic variants. Breeding for climate resilience and de-novo domestication will not only require access to available diversity but will also contribute to germplasm diversity for various crops adapted to local environments.

Plant genetic resources preservation entails intense, long-term investment and is spearheaded by national governments or multi-nation consortia. But the resources, be it seed or DSI is accessed by researchers, plant breeders and trait developers from universities, public institutions and private industry and in many cases, they collaborate and contribute towards enhancing the preservation and conservation efforts. An equitable germplasm benefit sharing system can further support conservation or efforts of a community. Open access to plant genetic resources and collaboration between various stakeholders will support plant breeding for global food and nutritional security and maintain the diverse niche farming systems. Local seed banks are needed for better preservation and access to germplasm as well as involvement of the local community and stakeholders. Infrastructure development or upgradation is critical for these efforts and it can be supported by stakeholders accessing the germplasm from the seed bank

Global acceptance of policies and harmonization across nation is also critical for adequate plant genetic resource management, besides the use of digital technologies, infrastructure development and use of new breeding tools.

Indiscriminate destruction and misuse of natural resources can be balanced by re-planting degraded areas and conserving existing habitats in view of climate change in a sustainable manner. This can only be achieved if diverse germplasm is preserved and are available for use across the globe.

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