Germplasm, conservation and its potential role in crop improvement

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ABSTRACT: *Genetic resources supply the basic mechanics that allow plants to convert soil, water, and sunlight into something useful for human consumption. One of the most sustainable approaches for conserving precious genetic resources in the long run is to use plant genetic resources in crop development, followed by adoption, cultivation, and consumption or marketing of improved cultivars by farmers. This review's goal is to describe the challenges surrounding the use of genetic resources in crop development. Crop genetic resources are the foundation of agricultural output, and their conservation and application have yielded major economic benefits. However, because crop genetic resources are essentially public assets, private incentives for conservation of genetic resources may fall short of meeting public goals. To effectively harness the existing resources in further valuable ways, a significantly greater characterization and knowledge of genetic diversity and its distribution is required. It's critical to plan collecting excursions and conservation operations efficiently. The value of diversity lies in its application. The most basic method of conservation is to combine multiple ex situ and in situ conservation strategies in a complimentary manner. Biotechnology provides us with a new set of tools for studying genetic resources, as well as conservation measures. The utilization of distantly related trait carriers as donors for the desired traits has become more possible thanks to gene technology. Given the restricted national plant breeding capacity, international germplasm exchanges will continue to be vital in influencing new climatic and climate conditions.*

KEYWORDS: Germplasm, Genetic Diversity, Crop Improvement, Conservation

INTRODUCTION

All materials available for improving a vascular plant species are sometimes referred to as genetic resources [6]. Plant genetic resources were defined as the entire generative and vegetative reproductive material of species with economic and/or social value, especially for the agriculture of this and future generations, with a special emphasis on nutritional plants, according to the FAO's revised International Undertaking 1983. Plant genetic resources were also characterized by Brockhaus and Oetmann [10] as "plant material with a current or potential value for food, agriculture, and forestry," which is similar to the description given by FAO [24]. Plant genetic resources, under this definition, inquire about the economic, scientific, or societal value of the heritable components found within and among species.

However, in traditional plant breeding, genetic resources can also be defined as materials that aren't immediately useful to the breeders since they haven't been selected for adaptation to the target environment [31].

Plant Genetic Resources (PGR) are germplasm or genetic diversity of actual or potential value found among individuals or groups of individuals belonging to a species [57]. PGR encompasses a wide range of collections, including those derived from centers of variety, centers of domestication, and breeding programs. Landraces, farmers' varieties, breeding material, genetic stocks, obsolete and current varieties, wild and weedy relatives of cultivated plants, and potential domesticates such as wild species are all included in PGR [21].

Plant Genetic Resources (PGR) serve as crucial materials for agricultural productivity research and improvement. They provide features and genes that are beneficial for food, feed, fiber, medicine, aesthetics, industry, and energy [53]. Globally threatened by human and environmental factors, their preservation is critical to humanity's prosperity and future. Plant germplasm is typically preserved as seeds or vegetable propagules such as roots, tubers, entire plants, or tissues. Germplasm is made up of both the genetic material that governs heredity and the tissues, organs, and organisms that exhibit genetic diversity naturally [22].

National Genetic resources in plants One area of research that is continuously being redefined and rejuvenated is conservation. Conservation aids in the preservation of the genetic foundation, which is necessary for breeding or the selection of superior crop types and strains for food, fuel, and medicine. Plant genetic resources offer the biological foundation for food security, and consequently support each person's livelihood. These materials are the most important material for plant breeders, and thus the most important input for farmers. As a result, they're critical to long-term agricultural production. Plant genetic resources are critical for agricultural development, including increased food production, poverty reduction, and economic growth [55].

Maintaining those species with high genetic diversity is therefore critical for long-term agriculture, particularly for resource-poor farmers working in marginal regions with modest inputs [3]. On-farm conservation of land races on peasant farms has proven to be a good conservation approach since it aids in the maintenance of evolutionary mechanisms that are responsible for the development of genetic variety [15]. The genetic variety of species is conserved in situ (in situ) or ex situ (in field gene banks) in a designated area within a natural environment. Large collections of many of the world's most important food crops have been gathered and stored in modern gene banks [39].

According to Brown [11], there were 300,000 species of higher plants in the earth at one time, but only around 3000 (1% of them) are used by humans now. Only 200 of them are cultivated, and only 30 of these provide nearly all of the food consumed by the human population. Only eight grain species offer about 75 percent of this nourishment (wheat, rice, maize, barley, oat, sorghum, millet and rye). The world's major advancements in agricultural productivity today are primarily dependent on having access to a good and broad variety of genetic resources.

According to Ghimiray and Vernooy, [27], no country in the world is self-sufficient in germplasm to meet its food needs. The majority of key agricultural crops emerged over thousands of years in emerging countries, which contain the most genetic variety. For food and agricultural development, many countries rely largely on non-indigenous crops and imported germplasm. Currently, all countries and areas are strongly interdependent. This interdependence is expected to grow further in order for countries to successfully respond to global climate change [29]. The purpose of this study is to provide an overview of germplasm, conservation, and agricultural improvement.

LITERATURE REVIEW

Origins of Crop Genetic Diversity

Human selection of plant varieties for desired features (such as taste, pest resistance, or seed size) dates back to the dawn of agriculture, according to Healy et al. [34]. Farmers have chosen, saved, and replanted varieties of crops that humans consume today for thousands of years. "Diversity centers" arose where crop variety intra-species diversity was particularly strong. The majority of variety hubs may be found where crops were first domesticated, which is mostly in today's developing countries. With the introduction of new breeding techniques that made it easier to pick certain desirable features, the rate of genetic progress accelerated. For all types of crops, breeders have crossed diverse parental material and selected features to achieve high yields and higher quality. Pest resistance, disease resistance, drought resistance, and other stress resistance have all been pursued by breeders. In fact, for numerous crops, resistance has become the primary breeding target [18].

There are five types of genetic resources in the context of crop genetic diversity:

1. Plants that have a common ancestor with a crop species but have not been domesticated are known as wild or weedy relatives. These can also provide resistance features, but they may be difficult to include into final cultivars [54].
2. Landraces are crops that have been improved over many generations by farmers without the use of modern breeding procedures. Because each is suited to a certain habitat, these variants are often quite different within species. They're sometimes employed for resistance qualities in modern breeding programs, and substantial efforts are usually necessary before their genes may be utilised in a final variety [61].
3. Improved germplasm is any material that has had one or more desirable features introduced into it by scientific selection or intentional crossing.
4. Advanced (or elite) germplasm consists of "cultivars," or cultivated variations, that farmers can plant, as well as advanced breeding material that breeders mix to create new cultivars [8].
5. Genetic stocks are mutants or other germplasm with chromosomal anomalies that plant breeders will use for selective breeding and fundamental research.

Table 1 Selected agricultural plants and therefore the geographic regions where they were domesticated

East Asia	Africa	Near east	Europe	North America	Pacific islands	South America
Rice Millet Buckwheat Soybean Adzuki beans Turnips Chinese radish Canola seed Apricot Peach Water chestnut Cucumber Sesame Tea	Sorghum Teff Pearl millet Foxtail millet Cow pea African rice Yams Oil palm Water melon Okra	Wheat Barley Peas Chickpeas Faba beans Lentils Carrots Beets Safflower Olive Fig Fenugreek Dates	Oats Rye Beets Hazelnut Plum Apple Cabbage Almond Pear Lettuce Carrot Onions Grape	Corn (maize) Common bean Lima bean Chili pepper Sweet potato Sunflower Papaya Pumpkin Tomato Mango Bottle gourd Squash	Breadfruit Sweet potato Taro Arrow root Coconut Yams Lemon Grapefruit Orange Mango Banana Clove Black pepper Eggplant Sugarcane	Quinoa Common bean Manioc Squash Tobacco Cacao Sweet potato Cotton Avocado Cashews Pineapple Papaya Peanut Chili pepper

Factors influencing plant genetic resources

Genetic diversity is a source of significant increases in agricultural output and, as a result, producer and consumer well-being. These advantages may provide incentives for conservation and efficient use of important resources, but in the case of genetic resources, these incentives are often subdued because the returns on their discovery and utilization aren't usually easily collected by individual farmers, corporations, or countries. In reality, genetic erosion, or the loss of genetic variety within a species, has been documented in a number of commercially significant crops [33], [59].

Genetic diversity may be a particular problem, according to the National Research Council [49], because more genetic homogeneity in crops can increase sensitivity to pests and diseases. In and of itself, genetic homogeneity does not imply that a particular variety is more susceptible to pests, illnesses, or abiotic challenges. In fact, newer types are frequently bred for increased resistance, which explains their popularity. Nonetheless, as pests and diseases evolve to overcome host plant resistance, genetic homogeneity raises the chances that a mutation may affect a crop in the future. The evolved pest or disease has a larger crop base that it can successfully attack, potentially increasing its severity. Instead of a specific disease affecting only a small percentage of a crop's production on limited land, the disease could now affect a larger percentage of a crop's production [18].

Habitat Loss

According to Day-Rubenstein et al. [18], the loss of untamed relatives is primarily due to habitat alteration for agricultural purposes. The loss of wild relatives of farmed crops is one element contributing to a fall in crop genetic diversity [49]. Plant, animal, and microbe populations often decline when forest and other wild habitats are removed, limiting genetic diversity. Habitat loss is particularly troublesome in developing countries, which are usually subjected to stronger demands for conversion of wild land than developed countries [38].
According to Day-Rubenstein et al. [18], the loss of untamed relatives is primarily due to habitat alteration for agricultural purposes. The loss of wild relatives of farmed crops is one element contributing to a fall in crop genetic diversity [49]. Plant, animal, and microbe populations often decline when forest and other wild habitats are removed, limiting genetic diversity. Habitat loss is particularly troublesome in developing countries, which are usually subjected to stronger demands for conversion of wild land than developed countries [38].

Despite the fact that many habitat reserves have been formed around the world, wild relatives of farmed species are frequently included only by accident. Habitat preserves frequently focus on places with a high diversity of species, such as wildlife or all plant species, rather than only crop species. These aren't always the locations with the most crop genetic diversity. Although much empirical research has concentrated on the loss of tropical forests, further agricultural expansion onto other areas is also foreseen, albeit at slower rates than previously predicted. The industrialized world has lower rates of agricultural land expansion than the developing world [36].

Displacement of Landraces by Scientifically Bred Varieties

Landraces are being superseded by scientifically developed modern types, reducing crop genetic diversity [43]. Traditional conservation methods and other conventions have been lost as traditional types have been replaced by contemporary ones in recent years. This is primarily due to the increased use of high-yielding species and varieties in commercial agriculture, as well as climatic factors, pests and diseases, ineffective agrarian policies and development activities, and poverty, all of which contribute to the migration of indigenous youth (with their traditional Andean agricultural knowledge, experience, and customs) [50]. The genetic foundation of kinds used in agricultural production is thought to have narrowed as a result of the ongoing selection process. This transition from landraces to contemporary varieties is seen to be exemplified by the proliferation of high-yielding "Green Revolution" varieties and concomitant improvements in crop management practices beginning in the 1960s. Landraces are planted on far less land today than they were a century ago [35].

Landraces may be being phased out in favor of scientifically developed types due to farmer preference. Farmers examine yield potential as well as other production and consumption characteristics when selecting varieties. Landraces can sometimes provide better yields or resilience to biotic and abiotic stressors, although this is not always the case. Landraces often have consumption features that are traditionally preferred over modern types (for example, maize that is better suited to tortillas), but this advantage isn't always absolute. While maintaining a diverse range of landrace varieties may be beneficial to current or future plant breeding, individual farmers do not immediately profit from these benefits, thus they have little incentive to take them into account when selecting seed for planting. If farmers stop planting and maintaining landraces, they will become extinct unless they are stored ex situ. Despite the fact that many landraces are maintained in gene banks, genetic diversity may be lower than if these landraces were planted by farmers since they are not subject to ongoing evolutionary pressure within the gene bank [26].

The rate of landrace replacement by scientifically developed cultivars varies by crop, world region, and habitat, according to Cabanilla et al. [13]. Commercialized crops, or those grown purely for the market rather than for personal consumption, are almost entirely made up of scientifically bred types in most industrialized countries, with the occasional usage of landraces. Genetic resource specialists in underdeveloped nations typically have knowledge concerning the status of crop landraces and, as a result, the rate at which they are being replaced by scientifically grown varieties, but accurate and aggregated public information is difficult to come by [19].

Genetic Uniformity in Scientifically Bred Varieties

Crop genetic diversity can be reduced in situations where most or all landraces are replaced by scientifically bred varieties due to (1) reductions in total number of varieties, (2) concentration of area planted in a few favored varieties, or (3) reductions in the genetic distance between these varieties. The National Research Council [49] stated that in developing nations, little attention has been made to genetic uniformity of scientifically bred species, possibly because the focus has been on habitat modification and landrace displacement. However, one important study looked at changes in modern spring bread wheat planted in developing countries, both in terms of genetic diversity of varieties released and types planted in farmers' fields [20].

Regardless of genetic diversity trends, the genetic homogeneity of many crops has sparked fears that crop yields and output would become increasingly inconsistent from season to season [58]. Individual farmers, like other drivers of genetic erosion, have limited incentives to consider the broader potential effects of genetic uniformity, and may view the advantages of uniform varieties to be greater when deciding which kinds to plant. Farmers may also be ready to incur the risk of increased variability in exchange for higher average yields. Plant breeders' ability to keep ahead of emerging pests and diseases through temporal diversity is directly dependent on the quality and accessibility of germplasm collections held by public gene banks and private breeders. Because many of the benefits of raw germplasm cannot be seized, private breeders collaborate with the public sector to define and improve genetic materials before making them available for personal use [5].

Alien invasive species (IAS)

Invasive alien species (IAS) are also known as aliens, exotics, or nonindigenous organisms. IAS are species that are native to at least one location or region that have colonized or invaded a neighborhood outside of their original distribution, either accidentally or deliberately, posing a threat to biological diversity, ecosystems and habitats, and human well-being. The threat presented by IAS to biodiversity is ranked second only to habitat loss in terms of importance [14]. On small islands, habitat loss has replaced pollution as the leading source of biodiversity loss. Invasive species may outcompete native species, repressing or excluding them, and thereby altering the environment fundamentally. They'll change the way nutrients are cycled through the ecosystem, which will have an indirect impact on the ecosystem's structure and species composition [45].

Diseases

Human activities have put pressure on natural resources, particularly plant genetic resources, to varying degrees. The immune system of the affected people will be weakened as a result of this stress. Plant genetic resources, in particular, are now vulnerable to a variety of novel diseases that were not present in the original population. Vulnerability rises when the gene pool shrinks. Chemical disease management is costly and has the potential to harm natural eco-systems, whereas genetically based resistance provides effective and environmentally sound disease control [56].

Global climate change

Climate change has a significant detrimental impact on the environment and plant genetic resources, frequently causing disruptions such as drought, flood, and disease. Crop yields are projected to be reduced in many locations due to changes in rainfall patterns and harsh weather events. Moreover, rising water levels result in agricultural depletion by generating coastal land loss and saline water intrusion [52]. This could have an effect on the distribution of plant genetic resources, as well as their physiognomy.

Population growth and Urbanization

As the human population expands, new machinery is developed to alter the natural environment to meet his needs, resulting in a strangling pressure on ashore and other natural resources for food, industry, shelter, and agriculture, ultimately leading to habitat destruction and the loss of plant genetic resources [60]. According to Malik and Singh [44], grain demand by 2020 is expected to be over 250 million tonnes, implying that an extra 72 million tonnes of food grains will be required. As happened during the revolution, this could lead to overexploitation of plant genetic resources. Social upheavals, such as wars, and poverty, constitute a constant threat to genetic extinction since they are linked to a significant reliance on natural resources, which frequently leads to overexploitation and destruction of wild plant genetic resources.

2.3 Genetic vulnerability and erosion

As a result of its genotype, a widely planted crop becomes consistently vulnerable to a pest, pathogen, or environmental hazard, potentially resulting in widespread crop losses. In some crops and regions, this phenomenon continues to pose a serious concern (for example hybrid rice in China supported one male sterile source). The emergence and continuous spread of the Ug99 race of wheat stem rust, to which the vast majority of extant varieties are vulnerable [23], is a good example of the impact of genetic vulnerability. The creation and maintenance of crop diversity and variety in production systems can help to reduce susceptibility and may have an impact on ecosystem stability. In line with this, crop plant genetic improvement is based on the selection of genotypes with favorable alleles/genes influencing desirable agronomic traits. The amount of genetic variety is reduced as a result of this process. Because the majority of today's trendy genotypes descend from a small number of landraces, the genes influencing significant features have less diversity than the gene pool of landraces and wild relatives [46].

The International Treaty on Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture was created to address issues left unresolved by the CBD, with the goals of (1) mandating plant genetic resource conservation, (2) ensuring equitable sharing of the benefits created by using these resources, and (3) establishing a multilateral system to facilitate access. In June 2004, the International Treaty came into effect (the U.S. has signed, but not yet ratified the treaty). The pact has a total of 66 signatories. The treaty regulates international germplasm exchange and can cover up to 35 crops, including major cereals such as rice, wheat, and maize, but not soybeans, peanuts, or other essential crops. "Recipients shall not claim any property or other rights that limit facilitated access to plant genetic resources for food and agriculture, [or their genetic parts or components,] [in the form] obtained through the Multilateral System," according to the treaty. This section has a lot of different interpretations, especially when it comes to whether or not isolated molecules like genes can be patented [48].

On a number of aspects, the pact is ambiguous. There are still disagreements on how to implement benefit sharing and, as a result, how to develop a standard Material Transfer Agreement (MTA). The quality MTA is intended to set the terms of access to plant genetic resources, and this standard MTA will control all germplasm exchanges under the new international system (rather than the bilateral approach suggested by the CBD). The benefits of commercializing germplasm obtained under the multilateral system will be shared through four mechanisms: (1) data exchange, (2) technology access and transfer, (3) capacity building, and (4) monetary and other commercialization benefits sharing [18].

Given the benefits of crop genetic resources to the general public, funding their conservation remains a concern. Resources available under present and near-term strategies may not be sufficient to conserve the resources required by agriculture. Though MTAs and, by extension, the expansion of IPR are meant to be self-sustaining conservation policies, proposals to emphasize in situ and ex situ conservation, as well as the transfer of technology and skills, would necessitate extra public money. Various attempts have been made to assess the true costs of gene banks, in-place preservation, and technological transfer [12].

Genetic resources as sources of latest ideas in plant improvement

Bidinger [7] describes genetic resource collections as containing unique phenotypes that are normally present in low frequencies and are occasionally non-competitive or unproductive, such as a dwarf or extremely early angiosperm among tall, strong, later flowering angiosperm. Plant scientists can use such phenotypes to generate and test hypotheses regarding the function of the traits that distinguish them, as well as adapt these traits to new agricultural applications. It might be argued that genetics originated in this manner: Mendel was fascinated by the diverse ratios of different bloom colors within the pea plants in the monastery garden.

Conservation of Plant Genetic Resources

Conservation of plant genetic resources is defined by Hammer and Teklu as "the process of actively retaining the range of the gene pool with an eye to actual or potential usage." Human exploitation of genetic variety is referred to as use. Conservation aims to collect and maintain adaptable gene complexes for use now and in the future. Genetic resource protection and utilization is as old as agriculture itself. Farmers have been saving seed for future planting, domesticating wild plants, and selecting and breeding species to fit their individual needs and conditions for over 12,000 years. Breeders can find the raw materials they need to generate new kinds, and farmers can switch crops in response to changing environments and markets, thanks to the conservation of genetic resources [31].

The necessity for Conservation

Many species and kinds are becoming extinct, and many more are endangered or vulnerable. Conservation of genetic diversity may be a vital concern in conservation and evolutionary biology to reverse this uninterrupted gene degradation, as genetic variation is the staple for evolutionary change within populations. Human exploitation of genetic variety is referred to as use. Conservation aims to collect and protect adaptable gene combinations. Collection is frequently seen as a topic in its title, however it is not discussed here. In this regard, a primary review on one of the Vavilov gene centers was recently published [16].

Plant diversity conservation is critical because of the direct benefits to humanity that will result from its use in improved agricultural and horticultural crops, the potential for developing cutting-edge medicinal and other products, and the pivotal role that plants play in the functioning of all natural ecosystems. A wide variety of plants is required to keep the various natural ecosystems running smoothly. No creature exists in isolation; they all rely on a slew of interactions to keep them connected, such as pollination, and they all rely on a slew of interactions to keep them connected. There's no doubt that primitive and wild gene pools will continue to be key suppliers of genes for parasite resistance, as well as for other traits that are suggested by developments in science or technology, or by changing customer needs. It's critical to have a broad genetic base in the case of species that are already used by citizens as crops, so that existing genotypes can be improved when necessary [4].

In situ conservation

"In situ conservation" is defined as "the conservation of ecosystems and natural habitats, and thus the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, within the surroundings where they need to develop their distinctive properties," according to the Convention on Biological Diversity. Protected areas cover approximately 926 million hectares of the earth's surface and number 9,800 worldwide. Several countries have already designated over 10% of their land as Protected Areas. As a result, conservation of indigenous wild species of agricultural relevance occurs as a hit-or-miss result of nature protection [9].

On the farm Farmers' protection of landraces and traditional crop varieties differs from in-place conservation of uncontrolled material in several ways. On and near farms, maintaining, using, and developing plant genetic resources provides numerous chances to combine genetic conservation and agricultural development. Farmers in most nations have practiced landrace conservation as part of their farming system for hundreds of years. In Europe, agrobiodiversity conservation in place and on-farm is being considered by a number of countries in response to government and public interest in "greening" agriculture through the use of more conventional, organic, and integrated agricultural practices. Farmers' selection and management approaches could also be well fitted to agricultural systems that require little external inputs, but their output is typically insufficient to provide household food security [25].

Ex situ conservation

Apart from work on forest genetic resources, most conservation initiatives have focused on ex situ conservation, particularly seed gene banks. Plant gathering and ex situ conservation, particularly in botanical gardens, have a long history spanning several centuries. It is estimated that there are around 6 million accessions in existing global ex situ collections. Many working collections of plant breeders are included, as well as collections created particularly for long-term conservation. 600,000 ex situ accessions are kept in the Consultative Group on International Agricultural Research (CGIAR) system, leaving 5.5 million accessions to be housed in regional or national gene banks. Approximately 45 percent of the germplasm accessions kept in national collections are held by twelve countries [32].

Seed gene banks, field gene banks, and in vitro collections are all examples of ex situ collections. Seed gene banks are used to preserve orthodox seeds, while the latter two approaches are mostly employed for vegetatively propagated crops and species with refractory seeds that can't be dried and stored for long periods of time under cold temperatures. Perennial species that produce modest amounts of seed (such as some fodder species) and species with extensive life cycles (such as trees) are also maintained in this manner. Cryopreservation, pollen and embryo storage are examples of other types of conservation. It is estimated that 527,000 accessions are stored in field gene banks around the world, but only 38,000 are conserved in vitro. Seed storage is the most common method of preserving plant genetic resources, accounting for over 90% of all ex situ accessions. Many countries recognize the need for more collecting, with a focus on indigenous landraces, minor crops, and other underutilized species, particularly crop wild relatives, which are underrepresented in current collections [41].

Molecular Approaches to Utilization of Genetic Resources

Plant breeding has been greatly influenced by molecular genetics. It enables routine genetic analysis of practically any desired feature. As these features become well-understood, the underlying genes are frequently extracted and matched to a large number of genetic resources. The introduction of new PCR-based marker systems (amplified fragment length polymorphisms and microsatellites) has allowed researchers to investigate the vast majority of plant genomes. Linkage maps for various species are created, and they are occasionally paired with phenotypic data to identify genomic areas containing genes that code for specific traits of interest. In breeding programs, many of those locations are further described (e.g., by map-based cloning) and even altered (through gene splicing and marker-assisted selection) [40]. These efforts will undoubtedly continue, and newer molecular approaches such as DNA arrays and automation can even help. DNA markers have even been used to characterize germplasm, a technique known as fingerprinting, to determine genetic links among accessions (genetic diversity) and provide vital information in the fields of ecology, population genetics, and evolution [37].

Genetic Resources and their Potential Impacts on agriculture

Agriculture before the 18th century totally trusted landraces for fresh spanking new types, according to paper [51]. Agriculture's nature and practice were irrevocably changed during the economic revolution. Landraces and traditional varieties are being displaced by contemporary cultivars and hybrids that are less varied [2].

Our efforts to improve agricultural output will rely heavily on genetic resources. These resources, which are thankfully kept in gene banks all across the world, evolved a variety of alleles required for resistance and tolerance to diseases, pests, and harsh circumstances present in their natural surroundings. Instead of being guided, the use of genetic resources in cereal enhancement has been exceedingly limited and somewhat fortuitous. To make genetic resources a real consideration in plant improvement, new methods for analyzing and transferring them into improved varieties must be developed. Hopefully, biotechnology will soon be able to overcome the challenges of transferring desired genes into their appropriate hosts. Genetics can improve the resolution of any species' genome, allowing for more exact gene identification prior to attempted transfers [37].

Genetic resources help to keep the main agricultural species' yields increasing at a steady pace. Self-pollinating organisms have lower levels of molecular diversity, according to molecular genetic studies (as measured by the extent of molecular polymorphism). Although studies with maize reveal that molecular diversity is favorably and strongly connected with yield [47], there is still debate over the precise relationship between molecular diversity and yield potential. Measures of molecular diversity may be used to find novel germplasm sources that, when crossed with current types, result in increased yields, according to these studies. The work done at CIMMYT with synthetic wheat shows that this method has a lot of potential.

Characterization and Evaluation of genetic resources

The description of a single accession is characterized and evaluated in the broad sense and within the framework of genetic resources. It encompasses the complete range of actions, from the curator's receipt of new samples to their growth for seed increase, characterization, and preliminary evaluation, as well as more extensive examination and documentation. The most common goals of germplasm characterization are to describe accessions and establish diagnostic characteristics, classify accessions into groups using sound means, assess interrelationships between accessions or between traits and geographic groups of accessions, estimate the extent of variation within the gene bank collection, and identify duplicates during a collection [30].

Characterization of germplasm entails the identification and recording of highly heritable features that are displayed in a variety of contexts; as a result, it is frequently carried out in a single habitat. Characterization should begin during the first stages of germplasm acquisition and be completed in a suitable environment, particularly at a site close to where the germplasm was collected or under similar agro-climatic circumstances [42]. Where descriptors and descriptor states aren't available, germplasm curators should establish them in collaboration with crop advisory committees and agricultural experts for each crop species. Even the biological status of the germplasm should be known ahead of time in order to plan the characterisation strategy. The use of molecular and biochemical markers is becoming more common as technology advances. Amplified Fragment Length Polymorphisms (AFLPs), Simple Sequence Repeats (SSRs), and Single Nucleotide Polymorphisms (SNPs) are highly repeatable molecular markers that should be employed for characterization [62].

The agronomic description of the fabric during a gene bank, for features that are normally essential to breeders and crop improvement research, is referred to as germplasm evaluation. Germplasm evaluation involves determining an accession's agronomic potential, as well as quality metrics and sensitivity to various abiotic and biotic challenges. It is required to identify suitable germplasm with a target trait for further use. For increasing agricultural output, genetic resources are vital sources of variety. Evaluation should be carried out on germplasm accessions that have already been characterized and where sufficient planting material is available. Standardized and calibrated measuring formats should be informed by them. Germplasm evaluation can be a multi-disciplinary process, and it should be done collaboratively with germplasm curators, plant breeders, physiologists, pathologists, entomologists, biochemists, and others [28].

CONCLUSION

Crop genetic resources are the concept that underpins all crop production. However, habitat degradation, the dominance of scientifically cultivated variants over farmer-developed variety, and genetic homogeneity all pose dangers to diversity's survival. To maintain productivity increase, plant breeders require a diversified germplasm. International agreements are aimed to foster the preservation of genetic variety and promote the exchange of germplasm in order to delay or prevent the loss of crop genetic diversity around the world. Factors like as habitat degradation, conversion from landraces (farmer-developed variations) to scientifically bred varieties, and genetic homogeneity in scientifically bred varieties all contribute to the loss of genetic diversity.

During the last l00 years, there has been a significant loss of genetic variety, and as a result, the process of gene erosion has continued. Not only are genetic resources threatened by genetic erosion, but so is indigenous knowledge on how to choose, use, and conserve these materials, which has been collected through thousands of years. Genetic erosion of crop genetic resources could pose a serious threat to global food security in the future, as genetic variation reduces a species' ability to adapt to abiotic and biotic environmental change, as well as a population's ability to deal with short-term threats such as pathogens and herbivores.

In general, the world's population is rapidly expanding, yet productivity is declining due to a number of industrial issues. As a result, plant genetic resources must be utilized and conserved in order to address food security concerns. Crop variety must be preserved both in situ and ex situ, as these two approaches are complementary. Future progress in crop improvement is heavily reliant on the immediate protection of genetic resources to ensure their effective and long-term use. Genetic conservation and use in breeding of the great genetic variation seen in populations of wild progenitors and landraces of cultivated plants is universally agreed upon as the initial answer to crop germplasm genetic depletion.

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