FIELD GENE BANKS: THE LIVING REPOSITORIES OF PLANT GENETIC RESOURCES

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Abstract

Since plant breeding research and cultivar development are integral components of improving food production, availability of and access to diverse plant genetic resources is of utmost importance. Plant genetic resources for food and agriculture (PGRFA) encompass the diversity of genetic material of traditional varieties and modern cultivars, as well as crop wild relatives and other wild plant species used as food. Many important varieties of field, horticultural and forestry species are conserved as Field Gene Banks (FGB). FGBs provide easy and ready access to conserved material for research as well as for use. It is one of the options of a complementary strategy for the conservation of germplasm of many plant species. The conservation of germplasm in field gene bank involves the collecting of materials and planting in the orchard or field in another location. In this paper conservation of Plant Genetic Resources for Food and Agriculture (PGRFA) as field Gene Banks is discussed.

Keywords: *ex situ* conservation, perennial plants, PGR, Field gene banks (FGB), PGRFA

Introduction:

Plant genetic resources, is a non-renewable natural resource indispensable for the sustenance of human life on this earth. The disappearance of many plants species due to human activities is depleting the world's genetic resources and is putting man's heritage of biodiversity under serious threat [1]. There is therefore the urgent need to preserve genetic diversity including plant resources of known and unknown economic importance which will guarantee the availability of all potentials for use in the benefit of our children and grandchildren [2]. Conservation has been defined as the management of human use of the biosphere so that it may yield to the greatest sustainable benefit to present generations, while maintaining its potentials to meet the needs and aspirations of the future generations [3]. Thus, conservation embraces preservation, maintenance, sustainable utilization and restoration, and enhancement of the natural environment [4].

Plant genetic resources are a strategic resource at the heart of agricultural crop production. Plant breeders are in need of a continuous supply of diverse and novel genetic diversity to produce new crop varieties able to cope with the impacts of changing cultivation conditions and climate change [5, 6, 7]. The Convention on Biological Diversity

(CBD), which came into force on 29 December 1993, now provides the framework for acquisition and utilization of germplasm. Consistent with Article 15 of CBD, which recognizes the sovereign rights of nations over their biodiversity, collection and acquisition of germplasm are undertaken with prior informed consent, using material acquisition agreements on mutually agreed terms.

Plant genetic resources:

The term plant genetic resources implies that the germplasm has or can have economic or utilitarian value, whether current or future, the most important being that which contributes to food security [8]. The importance of plant genetic diversity is now being recognized as a specific area since exploding population with urbanization and decreasing cultivable lands are the critical factors contributing to food insecurity in developing world. Plant Genetic Resources (PGR), according to the Convention for Biological Diversity any living material of present and potential value for humans. Plant genetic resources are the total of all the combinations of genes resulting from the evolution of a species. Plant diversity can be captured and stored in the form of plant genetic resources (PGR), which is a bio-repository, which preserve genetic material for long period. Humans take advantage of plant genetic resources in as much as they are useful to us, which means that we must understand them, and know how to manage, maintain and use them rationally. International efforts aimed at collecting and conservation of plant genetic resources have been coordinated since 1974 by the International Board for Plant Genetic Resources (IBPGR).

There are broadly speaking two basic approaches to genetic resources conservation, namely, *in-situ* and *ex-situ* conservation. *In-situ* means the setting aside of natural reserves, where the species are allowed to remain in their ecosystems within a natural or properly managed ecological continuum. The natural biosphere reserve is a useful solution for species that are endangered and nearly on the point of extinction [9]. This method of conservation is of significance to the wild relatives of crop plants and a number of other crops, especially tree crops and forest species where there are limitations on the effectiveness of *ex-situ* methods of conservation. The crops of immediate interest for *in-situ* conservation are the perennials that are vegetatively propagated [10] and those with seeds that cannot survive cold storage [11, 12]. The *ex-situ* form of conservation includes, in a broad sense, the botanic gardens and storage of seed or vegetative material in genebanks. The field genebanks where clonal materials are maintained as living collections in a field/orchard or plantation also represent *ex-situ* form of conservation. Cryogenic preservation of vegetative material is another mode of *ex-situ* conservation and it holds promise, especially for base collections.

Plant genetic resources for food and agriculture (PGRFA):

Plant genetic resources are the part of biodiversity that nurtures people and is nurtured by people. Plant genetic resources are currently of great interest inasmuch as they are related to the satisfaction of man’s basic needs and to the solution of severe problems such as hunger and poverty. They include all those on the continuum from wild species with agricultural potential to cloned genes [13].

These are the biological basis of world food security and, directly or indirectly, support the livelihoods of every person on Earth. Plant genetic resources for food and agriculture (PGRFA) encompass the diversity of genetic material of traditional varieties and modern cultivars, as well as crop wild relatives and other wild plant species used as food. These resources serve as the plant breeder's most important raw material and the farmer's most essential input. They are also a reservoir of genetic adaptability to buffer against potentially harmful environmental and economic change. PGRFA could be conserved by various methods.

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA—the Treaty) is a legally binding instrument with the objectives of facilitating conservation and sustainable use of PGRFA and the fair and equitable sharing of benefits derived from their use, in harmony with the Convention on Biological Diversity (CBD) in 1992. The Treaty defines PGRFA as "any genetic material of plant origin of actual or potential value for food and agriculture", genetic material being "any material of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity". PGRFA include cultivated varieties of plant species (landraces and modern cultivars), wild plant species with potential as trait donors to crops (crop wild relatives—CWR), wild-harvested species used for human and animal food, and plant breeders' material—advanced lines, élite varieties and DNA.

Conservation of PGRFA

Conserved PGR must be utilized for crop improvement in order to meet future global challenges in relation to food and nutritional security. For PGRFA to be available for sustainable use, they have to be actively conserved. The two basic types of conservation, namely *ex situ* and *in situ,* should not be viewed as alternatives or in opposition to one another, but rather as being complementary. Maintaining PGRFA in genebanks is often termed '*ex situ* conservation' – defined as 'the conservation of components of biodiversity outside their natural habitats' during CBD, 1992. Whereas *in situ* conservation is maintenance of viable population in their natural surroundings – a dynamic system which allows the biological resources to evolve and change over time through natural selection processes. Both concepts are therefore fundamentally different but are complementary.

Ex situ conservation of plant genetic resources can be achieved through different methods such as seed banks, field genebanks, in vitro storage methods, pollen banks and DNA banks. Detailed and well documented information about the available genetic material together with a broad, well maintained varietal diversity are essential for breeding efforts. This should also include local varieties [14], which may have a low market, but high breeding value.

A vast pool of this diversity exists in nature, in production systems and in genebanks, and the Plant Genetic Resources for Food and Agriculture (PGRFA) community has the knowledge, tools, techniques and rapidly evolving technology to conserve and use these genetic resources wisely to sustain crop production. *Ex-situ* conservation of crop diversity is a global concern, and the development of an efficient and sustainable conservation system is a historic priority recognized in international law and policy.

Genebanks

A gene bank is an *ex situ* means of conservation. Gene bank refers to a place or organisation where germplasm can be conserved in living state. Gene banks are also known as germplasm banks. The germplasm is stored in the form of seeds, pollen or in vitro cultures, or in the case of a field gene bank, as plants growing in the field. Maintaining viability, genetic integrity and quality of seed samples in genebanks and making them available for use is the ultimate aim of genebank management. Gene banks are mainly of two types, viz: 1) Seed Gene Banks, and 2) Field Gene Banks.

Gene Banks involves collection of seeds and other plant reproductive material, primarily of cultivated plants and their wild relatives. These collections represent as far as possible the gene pools of our crop plants, that is, the genetic basis of agriculture and horticulture. The mandate of a gene bank is to secure the conservation of these collected plant genetic resources and provide access to them. a gene bank is responsible for registering, studying, describing, and documenting its collection, and making both information and plant material available to researchers and other interested users. All these activities are increasingly important and challenging. They are labour intensive, require specialist knowledge and equipment (e.g. computer systems), and involve upgrading from earlier recording systems. They have to meet modern demands for openness, user-friendliness, and greater access to knowledge and information – including cultural and historical information.

Genebanks therefore are managed so as

1. to maintain the genetic integrity of its accessions.
2. Make the accessions easily available to users of germplasm.
3. Provide the raw material for plant breeding and basic biological research – Accessions of crop wild relatives are particularly valuable as sources of gene providers.
4. Provide germplasm for restoration of lost crops after natural or man-made catastrophes

Well-managed Gene Banks help to preserve genetic diversity and make it available to breeders and other scientists, who can then use it to develop and share improved varieties, including those adapted to particular agro-ecological conditions. Gene Banks help bridge the past and the future by ensuring the continued availability of plant genetic resources for research and for breeding new varieties that meet the consumer needs.

The most common and most economic method to conserve PGRFA is to store as seed. However, not all plant germplasm can be stored conveniently in the seed form. Field genebanks or living collections are the main conservation strategy for long-lived perennials, recalcitrant species and vegetatively propagated species. Their main limitation is that they take a great deal of space and are difficult to maintain and protect from natural disasters. They are susceptible to the spread of diseases and may suffer from neglect.

Field Gene Bank

Field gene bank conservation involves the collecting of materials from farmers' fields and gardens, or even from wild locations, and transferring them to a second site where they can be planted and monitored. In Field Gene Banks (FGB) the plant genetic resources are kept as live plants that undergo continuous growth and require continuous maintenance. A Field Gene Bank (FGB) is a facility established primarily for the *ex situ* storage and maintenance, using horticultural techniques, of individual plants. It is used mainly for species with recalcitrant seeds, or for possibly clonally propagated species of agricultural importance (playing a major role in global and local food concerns). This method of *ex-situ* conservation removes the species from its natural ecological contexts, preserving it under semi-isolated conditions whereby natural evolution and adaptation processes are either temporarily halted or altered by introducing the specimen to an unnatural habitat with suppressed selection pressures so that it can survive and be conserved.

In Field Gene Banks, germplasm is maintained in the form of plants as a permanent living collection. Field gene banks are often established to maintain working collections of living plants for experimental purposes. The conservation of germplasm as field gene bank involves the collecting of materials and planting in the orchard or field in another location. The Field Gene Bank is useful for characterization and evaluation of plants and makes utilization of the germplasms easy.

The conservation of germplasm in field Gene Bank involves the collecting of materials and planting in the orchard or field in another location. Field Gene Bank has traditionally been used for perennial plants, including:

• species producing recalcitrant seeds;

• species producing little or no seeds;

• species that are preferably stored as clonal material;

• Species that have a long life cycle to generate breeding and/or planting material.

Field Gene Banks are commonly used for such species as cocoa, rubber, coconut, coffee, sugarcane, banana, tuber crops, tropical and temperate fruits, Field Gene Bank has traditionally been used for perennial plants [15]. Conservation in field genebank is necessary because some species have short-lived seeds (recalcitrant), for example cocoa, coconut, oil palm, rubber and many tropical fruits like mango, mangosteen, jackfruit, durian and rambutan. Seeds of some recalcitrant species can only be stored without desiccation for a few days, weeks or months. Even if technology for conserving recalcitrant seed is developed there will still be a problem with the long regeneration cycle of perennial species. Field Gene Bank is commonly used vegetatively propagated crops (e.g. wild onion and garlic) and forage grasses (e.g. sterile hybrids or shy seed producers).

Formal living collections have a long history of making significant contributions in diverse areas of science. The CBD marks a transition from an exploitative and inequitable relationship between the providers and users of biological diversity to a new global relationship based on the principles of equity and ethics [16]. Field genebanks provide an easy and ready access to the plant genetic resources, for characterization, evaluation or utilization, while the same material conserved in the form of seeds, *in vitro* or cryo must be germinated or regenerated and grown before it can be used. They are also useful for conserving vegetatively propagated genotypes that commonly produce variants (genetic variation) since these can be more easily identified and rouged out in the field than *in vitro*.

Examples of Field Gene Banks worldwide

Ethiopia is considered to be one of the richest centers of genetic resources in the world. Biodiversity also plays a crucial role in the different sectors like energy, agriculture, forestry, fisheries, wildlife, industry, health, tourism, commerce, irrigation, and power. For plant species with recalcitrant and intermediate storage behavior, there are 10 (ten) field gene banks under Institute of Biodiversity Conservation (IBC) control and small sized fields in the various research stations of the Ethiopian Institute of Agricultural Research (EIAR) and at universities [17]. The plan for the immediate future is to increase the number of field gene banks in different agro-ecological zones. Community gardens, backyards, and holy places are being considered for inclusion in the future plan.

In India the germplasm of major commercial fruits (eg. Mango, litchi) and ornamental trees in India are mainly being maintained in Field Gene Banks by the horticultural and related research institutes. National Bureau of Plant Genetic Resources (NBPGR) has a broad germplasm collection of various horticultural species and accessions drawn from different parts of the world, ranging from sweet orange, mandarins, tangelo, grape fruit, lemon, lime, tangor, sour orange etc.

Conclusion:

There is increasing global awareness of the need for conserving genetic resources of crop plants for their current use and for posterity. A field Gene Bank can complement with *in situ* conservation method effectively. A field Gene Bank is readily accessible and useable for characterization, evaluation and crop improvement. It is one of the options of a complementary strategy for the conservation of germplasm of many plant species. The main limitation is that Field Gene Banks is that it takes a great deal of space and are sometimes difficult to maintain and protect from natural disasters. They are often susceptible to the spread of diseases and may suffer from neglect. So the site for a Field Gene Bank should have a suitable climate and soil for the species and should have an adequate water supply. The site should be chosen in a location with little or no threat of pests, diseases, bush fire and vandalism. Field genebank, although having many disadvantages, excels other methods of conservation in being able to provide a continuous opportunity for evaluation of the germplasm.

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