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Role of Seed Banks in the Conservation of Plant Diversity and Ecological Restoration

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ABSTRACT
An appropriate method for conservation of a particular plant gene pool needs extensive approach, collaborate the different ex situ and in situ methods. Gene banks are a type of bio repository that preserves genetic material. According to Dekker, 1997, [12] a seed bank stores seeds to preserve genetic diversity; hence it is a type of gene bank. There are currently more than 1,000 seed banks exist around the world, varying in type, size and focus. The world's largest secure seed storage is Svalbard Global Seed Vault. Whereas in India, Indian Seed Vault is the largest secure seed bank lies in a high-altitude mountain pass on the Chang La seed vault in Ladakh. Seed banks are maintained with the objectives of improving the effectiveness of sustainable management and conservation of biodiversity through adequate conservation and preserving the genes that plant breeders need to disease resistance, nutritional quality, drought tolerance, taste, increase yield etc. of crops. There are two most important studies regarding seed bank, i.e., soil seed bank and canopy seed bank. In agroecosystem, soil seed bank is more closely related to weed seed bank study [8]. According to Karim et al., 2018 [15], Parthenium weed (Parthenium hysterophorus L., Family: Asteraceae) is an invasive alien species threatening the biodiversity and the environment in Malaysia. A canopy seed bank or aerial seed bank is the aggregate of viable seed stored by a plant in its canopy. Canopy seed banks occur in plants that delays seed dispersal for some reason. Seed dispersal in serotinous species is normally triggered by fire and seeds are short-lived after release, germinating during the first favourable period [9]. Therefore, Seed banks have a vital role to play in supporting integrated strategies for conservation and sustainable use of plants. The cost effectiveness of seed banking technology clearly depends on the seed biology of the target species, and the role that the collection will play in long-term conservation and ecological restoration strategies. Seed bank recognises the opportunity to provide ecological restoration materials to users. Seed banks respond to the increasing demand for seed and provide information to support habitat restoration and also reintroduction of threatened species.

Keywords: *conservation, diversity, seed bank*

INTRODUCTION

A particular plant gene pool requires a holistic approach, combining the different ex situ and in situ methods is an appropriate procedure for conservation. The conservation of components of biological diversity outside their natural habitat is called ex-situ conservation. The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species, and in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties is called in-situ conservation. Conservation of agricultural genetic resources, whether in situ (in farmers' fields) or ex situ (in a germplasm repository), provides variation for breeding and selection efforts [6]. The conservation and utilization of germplasm is in continuous evolution.

Gene bank is one of the types of bio repository. Because it is a biological materials repository that gathers, processes, preserves, and issues bio specimens to carry future scientific investigation. For plant, this is done by stocking the seeds, freezing cuttings from the plant, or in vitro storage. In a gene bank, genetic material is preserved in a several ways, cryopreservation (freezing at -196° Celsius in liquid nitrogen), being placed in artificial ecosystems, and put in controlled nutrient mediums. Gene banks are utilized to preserve and store the plant genetic resources of major crop plants and their crop wild relatives for maintaining agricultural biodiversity.

According to Dekker, 1997 [12], a seed bank stores seeds to preserve genetic diversity; hence it is a type of gene bank. There are so many plants that are used less frequently now but these were used decades ago by humans; seed banks recommend a way to preserve that historical, social and cultural value. Collected seeds are stored at constant low moisture and low temperatures are guarded against loss of genetic resources that are otherwise maintained in field collections or in-situ. Seed banks are just like seed libraries which hold valuable information can be used to originate genetically modified versions of existing seeds, and about evolved strategies to conflict plant stress.

There are currently more than 1,000 seed banks exist around the world, varying in type, size and focus. The world's largest secure seed storage is Svalbard Global Seed Vault. It is situated in north, in the permafrost, 1300 kilometres beyond the Arctic Circle, opened by the Norwegian Government on February, 2008.

Indian Seed Vault is that the largest secure seed bank lies during a high-altitude pass on the Chang La seed vault in Ladakh, India. It is the second largest seed bank within the world. The National Bureau of Plant Genetic Resources and the Defence Institute of High Altitude Research jointly set up this in the year 2010.

Seed banks provide conditions necessary for the longevity of seeds. Seeds are stored under low temperatures that keep seeds dormant until they are used for replanting. It’s easy for plants to be stored in their seed form since they are small in size and therefore, they occupy minimum space. The storage a huge variety of seeds makes possible through this system.

OBJECTIVES

- Improving the effectiveness of sustainable management and conservation of biodiversity through adequate conservation, use and handling of genetic resources.
- Preservation of genes that are needed by plant breeders to increase yield, disease resistance, drought tolerance, nutritional quality, taste, etc. of crops.
- For food security and agro-biodiversity conservation of plant genetic resources is very much necessary.

CONSERVATION

Conservation means the protection of genetic diversity of crop plants from genetic erosion. Germplasm conservation or preservation is done through two important methods i.e. in-situ Conservation and ex-situ Conservation.

In-situ Conservation:

Preservation or conservation of germplasm under natural habitat is called as in-situ conservation. Generally, conservation requires establishment of natural or biosphere reserves, national parks or protection of endangered areas or species.

Advantages

- Biodiversity permanently protected.
- Plants and animals conserved in their natural environment.
- Ecological integrity is maintained and managed.
- Provide facilities for scientific research of the site.
- Opportunities may occur for ecologically sustainable land uses (which come with associated economic benefits).
- Representative examples of ecosystems also permanently protected.
- Natural and cultural heritage protected permanently.
- It may be possible to improve the ecological integrity of the area and restore it if it has been damaged by poaching etc.

Disadvantages

- Genetic diversity may have already been dramatically decreased.
- Endangered habitats may be fragmented so the area may not be large enough to ensure the survival of these species.
- Poachers and ecotourists may see the thriving area as an opportunity and may cause damage.
- Conditions may still be present which threatened the organisms in the area, e.g. disease or inter specific competition.

Ex-situ Conservation

Preservation of germplasm in gene banks is called Ex-situ conservation. It is the foremost practical method of germplasm conservation.

1. Germplasm handling is easy.
2. Entire genetic diversity of a crop species can preserve at one place.
3. It is a cheapest method of germplasm conservation.

Advantages

- Medical assistance and health of individuals can be perfect stated as required.
- Conserved materials are completely protected from poaching and predation.
- For further conservation efforts as well as for education purposes, the conservation sites can be used as attractions to raise funds.
- Selective breeding programmes can be put into place.
- Populations can be more effectively managed and divided if disaster strikes.
- Genetic diversity of the population can be measured.
- The chances of reproductive success can be increased through use of modern reproductive technology.
- Research into reproductive physiology, lifestyle and ecology of an endangered species is made easier.

Disadvantages

- Correct survival environmental conditions may be difficult to achieve.
- Captive populations have limited genetic diversity.
- The organisms are living outside their natural habitat.
- Animals can be exposed to a wide range of different diseases.
- Nutritional issues may arise.
- Animals may not behave as normal making reproduction difficult.
- There can be difficulties with acceptance by the existing wild members of the species.
- Animals may not survive reintroduction into the wild.
- Expensive to maintain.

Methods of Germplasm Conservation

Seed banks [Figure 1]

The seeds of various genotypes or germplasm can be stored through this system. For seed conservation, this system requires minimum space and it is quite easy, relatively safe.

Plant bank [Figure 2]

Here plants are conserved through growing an orchard or a field in which accessions of fruit trees or vegetatively propagated crops. The large areas are required for this system. It is costly to establish and maintain, susceptible to damage from disease, insect attacks, natural disasters, human handling errors.

Shoot tip banks [Figure 3]
Slow growth cultures of shoot tips and node segments can be conserved through this system. Meristem culture is used for conservation of genetic stocks. Germplasms can be maintained as virus free and other pathogens free through this conservation. This conservation is helpful for vegetatively or asexually propagated crops like cassava, potato, sweet potato etc. because seed production of these crops is poor.

Cell and organ banks [Figure 4]
Cell and organ bank means cell and organ is collected and conserved based on cryopreservation (at $-196^{0}C$ in liquid nitrogen) of embryogenic cell cultures, somatic/zygotic embryos.

DNA banks [Figure 5]
DNA segments from the genomes of germplasm accessions are maintained and conserved is called DNA bank.

Fig.1:-*Seed bank*


Fig.2:-*Plant bank*


Fig.3:-*Shoot tip bank*

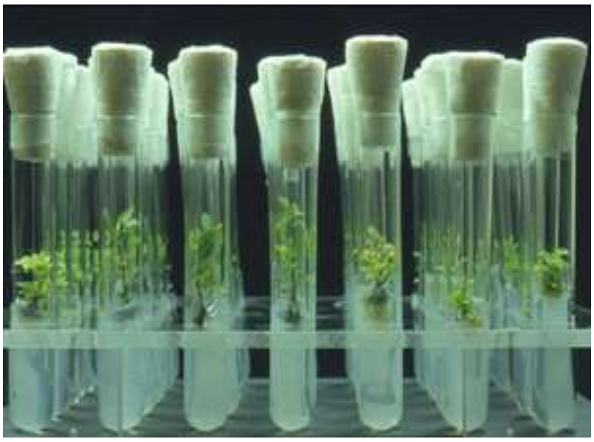
Fig.4:-*Cell and organ bank*

Fig.5:- *DNA Bank*

Distribution of germplasm

This is the supply of seeds of the different accessions in response to requests from plant breeders and research workers. Seeds are distributed only from active collections and not from base collections.

Step 1: Decide whether the accession should be distributed or not

↓

Are there enough seeds in stock? — No → Programme regeneration and inform recipient

↓

Step 2: Determine the location in the seed store

↓

Step 3: Prepare the sample for distribution

↓

Step 4: Prepare the information lists to accompany the seed

↓

Step 5: Dispatch the seeds

↓

Step 6: Enter the data into the data files

The seeds have to send out in such a way that they arrive in good condition and are capable of germination. Dispensation will take time and environmental conditions during transport can be detrimental to seed quality. Therefore, it is approved that seeds should be issued in water and vapour containers i.e. sealed laminated aluminium foil packets. The types of germplasm distributed by CGIAR gene banks, 2017–

2019 is shown in Figure 6.

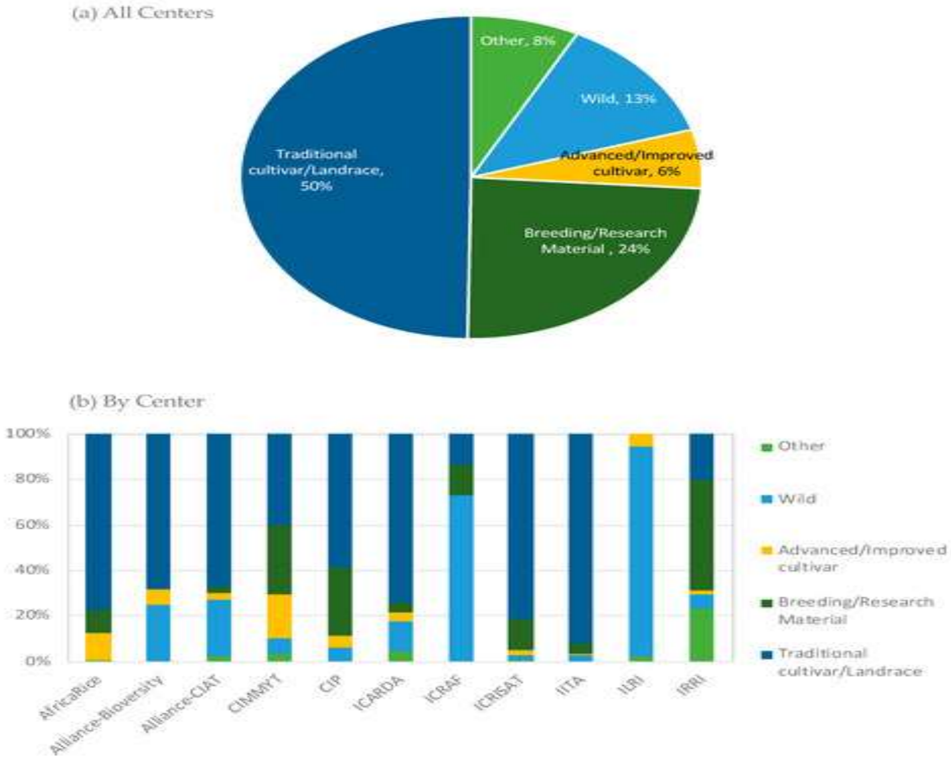

Fig.6:-*Types of germplasm distributed by CGIAR genebanks, 2017–2019.[14].*

Gene Bank

Gene bank refers to a place or organization where germplasms can be conserved in living state. Gene banks are also known as germplasm banks. The germplasm is preserved in the form of seeds, pollen or in vitro cultures. In the case of a field gene bank, it is stored as plants grown under the field condition.

Types of Gene Bank

Gene banks are mainly of two types, viz.:
(1) Seed gene banks, and
(2) Field gene banks.

Seed Gene Bank

Seed gene bank means a place or organization, where germplasm is conserved in the form of seeds. This is very convenient for storage of seed as it occupy smaller space, than whole plants. All crops seed cannot be stored at low temperature in the seed banks. In seed banks, only orthodox seeds can be conserved as germplasms.

Fig.7:-*Svalbard global seed vault International rice gene bank*

In the seed banks, there are three types of conservation, viz.:

(i) Short term: Working collection is stored for short term (3-5 years) at 5-10°C.

(ii) Medium term: Active collections are stored for medium term (10-15 years) at zero degree Celsius.

(iii) Long-term: Base collections are conserved for long term (50 years or more) at -18 or -20°C.

The Svalbard global seed vault International rice gene bank is shown in Figure 7. The *Oryza* species and other genera in the collection of the International Rice Gene bank at IRRI are shown in Table 1.

Diversity in some Mexican maize landraces conserved in the CIMMYT Gene Bank is shown in Figure 8.

Table 1:-*Oryza species and other genera in the collection of the International Rice Genebank at IRRI [17].*

Species complex	Species	Genome[1]	Accession (*n*)
O. sativa complex	*O. glaberrima*	AA	1 255
	O. barthii	AA	224
	O. longistaminata	AA	134
	O. sativa	AA	76 614
	O. nivara	AA	468
	O. rufipogon	AA	712
	O. meridionalis	AA	43
	O. glumaepatula	AA	37
*O. ridleyi*complex	*O. longiglumis*	4*x*	6
	O. ridleyi	4*x*	17
*O. meyeriana*complex	*O. granulate*	2*x*	22
	O. meyeriana	2*x*	8
*O. officinalis*complex	*O. officinalis*	CC	247
	O. minuta	BBCC	65
	O. eichingeri[2]	CC	23
	O. rhizomatis	CC	19
	O. punctate	BB, BBCC	54
	O. latifolia	CCDD	37
	O. alta	CCDD	10
	O. grandiglumis	CCDD	10
	O. australiensis	EE	25
*Oryza*species not assigned to any complex			
O. schlechteri		4*x*	1
O. brachyantha		FF	17
Hybrids			587
Other genera in the Oryzeae			
Chikusichloaaquatica			1
Hygroryzaaristata			4
Leersiahexandra			1

L. perrieri	1
L. tisseranti	3
Porteresiacoarctata	1
Rhynchoryzasubulata	1
Total number of registered accessions	80 647

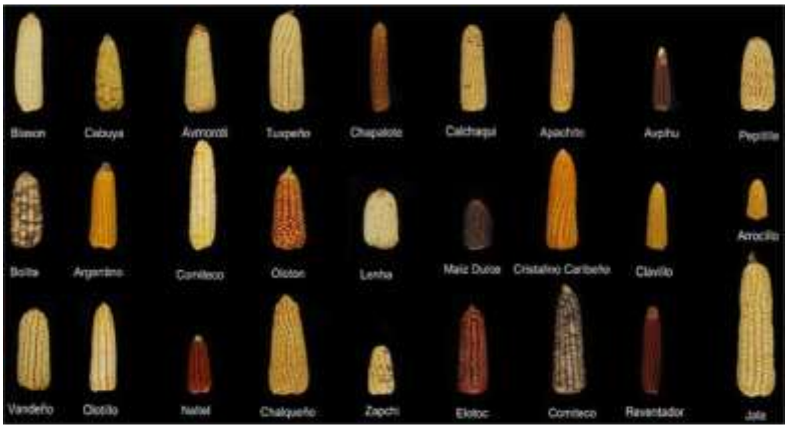

Fig.8:-*Diversity in some Mexican maize landraces conserved in the CIMMYT Gene Bank (Courtesy: Genetics Resources Program, CIMMYT) [18].*

Fig.9:-*Rice*

Fig.10:-*Wheat*

Fig.11:-*Pulses*

Fig.12:-*Oil seeds*

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Fig.13:-*Spices*

Genetic diversity of different crops.
Scope of the Seed Bank:

- ***Common varieties:*** Members states will collaborate with each other in the development of a list of common variety.
- ***Maintaining seed quality:*** Members states will develop a common minimum seed quality standard and seed testing procedure.
- ***Seed reserve****:* The seed reserve to be maintained shall consist of quality seeds of rice, wheat, pulses and oilseeds. [Fig 9-13].

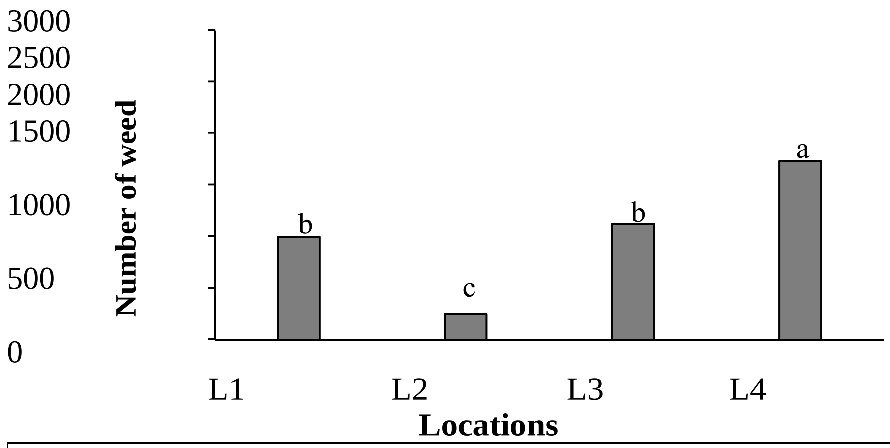
There are two most important studies regarding seed banks, which are as follows

Soil Seed Bank

The natural storage of seeds, often dormant, within the soils of most ecosystems is named soil seed bank. Charles Darwin [11] observed the emergence of seedlings from soil sample taken from the bottom of a lake in 1859. Brenchley [7] was first published about Soil Seed Bank on Web of Science, where it was called as “buried seeds”.

In agroeco system, soil seed bank is closely related to weed seed study and other fields interested in soil seed banks include forest regeneration and restoration ecology [8].

An indication of future weed infestation potential of the species and is important for creating strategic planning for its sustainable management is named weed seed bank. Karim *et al.*, 2018,[15]reported that parthenium weed (*Parthenium hysterophorus* L., Family: Asteraceae) is an invasive alien species threatening the biodiversity and thus the environment in Malaysia.



Number of parthenium weed seed in four different locations at Kuala, Muda, Kedah. (Note: L1=Kg. Sungai Pasir, L2= Kg. Zainal Abidin, L3=Kg. Sg. Tok Rawang, L4=Kg. Kongsi 6. Dissimilar small letters on the bars indicate significant difference reported by [15]

Seed Longevity
Seed longevity depends on so many factors and also variable; some species seed viability remains more than 100 years. Thompson *et al*. [21]1997 reported that in typical soils the seed longevity may vary from nearly zero to several hundred years. Bewley, [2] reported that lotus (*Nelumbo nucifera*) were found buried under the soil of a pond remain still-viable seeds; carbon dating technique was used and these seeds were estimated to be around 1,200 years old.

James Beal started one of the longest-running soil seed viability trials in Michigan in 1879. In this experiment, 20 bottles holding 50 seeds from 21 species were burried. After every five years, a bottle from every species was retrieved and germinated on a tray of sterilized soil which was kept in a growth chamber. Later, after responsibility for managing the experiment was envoyed to caretakers, the period between retrievals became longer. In 1980, more than 100 years after the trial was started, seeds of only three species were observed to be germinated: moth mullein (*Verbas cumblattaria*), common mullein (*Verbas cumthapsus*) and common mallow (*Malva neglecta*) [20].

Population Density and Diversity
One of the key factors for the persistence and density fluctuations of plant population is the mortality of seeds in the soil, especially for annual plants. Studies on the genetic structure of *Androsacese ptentrionalis* populations in the seed bank compared to those of established plants exhibited that diversity within populations is higher below ground than above ground.

Species of *Striga* (witchweed) are known to leave maximum seed densities in the soil compared to other plant genera; this is a major factor that aids their invasive potential [19]. Each plant has the capacity to produce between 90,000 and 450,000 seeds, although a majority of these seeds are non-viable [1]. It has been observed that only two witchweeds would produce enough seeds required to refill a seed bank after seasonal losses [10]

Associated Ecosystem
In non-flowering plants such as ferns and bryophytes, the term soil diaspore bank may be used.

Perennial plants have vegetative propagules from where new plants were form and migration into new field, or reestablishment after being top-killed. Dekker,[12] told that these propagules are actually the soil bud bank, and include dormant and adventitious buds on stolons, rhizomes, and bulbs.

Canopy seed bank or Aerial seed bank:
A canopy seed bank or aerial seed bank is the sum total of viable seed stored by a plant in its canopy. Canopy seed banks appear in plants that delays seed dispersal for some reason.

It is often associated with serotiny. Serotiny means retention of seeds in closed fruits or cones within the crown for more than one year and it is common in species from a number of important families in fire-prone areas of Australia (Proteaceae, Myrtaceae, Cupressaceae, Casuarinaceae), South Africa (Proteaceae, Bruniaceae) and North America (Pinaceae) [16].Cowling [9]reported that in serotinous species, seed dispersal is normally triggered by fire and seeds are short-lived after release, germinating during the first favourable period. There is a tendency of some plants to keep seed in a cone (e.g. in the genus *Pinus*) or woody fruits (e.g. in the genus *Banksia*), until seed release is stimulated by the passage of a wildfire.

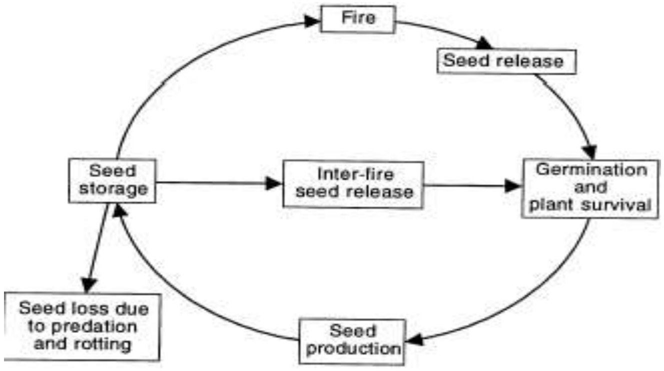


***Fig.14:**-Flow diagram for a serotinous perennial plant. [13].*

It also develops in plants that colonise areas of shifting sands viz. sand dunes. Here, the seed is detained in the canopy even if the canopy becomes buried. So, the seed is secured in place until good germination conditions occur.

Importance of Seed Banks

Preservation of Crop Diversity

One of the most important reasons for the storage of seeds is preservation of crop diversity. Just as human beings and animals are adapted to different conditions for survival, so are crops. Different kinds of the same species exist due to this adaptive nature. Therefore, it is of critical need that such diversity is preserved.

Protection from Climate Change

The global environment is witnessing radical climatic change that has been accelerated by increased industrial pollution for a couple of decades. Crop extinction is assured with such extreme climate changes. The danger of total elimination of certain species of crops is eliminated if seeds are stored in seed banks.

Protection from Natural Disasters

Natural disasters are unpredictable events that could lead to complete extinction of crops from the face of the earth. The foresight of preserving seeds in a seed bank could save such a situation. For example, during the 2004 tsunami Malaysian rice paddies were wiped out and international seed banks provided farmers with seeds that helped them to start over.

Disease Resistance

Plant diseases are highly infectious and very destructive to plants. A serious erupt could completely remove the plants. Farmers can store the seeds in seed banks, intervene and supply them with seeds that will enable them start on a clean slate where diseases have destroyed crops and left no traces.

Provide seed material for research

Stored seed in seed banks might be easily available to scientists and researchers who wish to study these seeds especially if such research could lead to betterment of crop production.

Preservation from Man-made Disasters

Man-made disasters such as war and oil spills could lead to the extinction of crops. Counties which are engaged in war make it difficult for farmers to continue farming and it’s easy for crops to disappear. Once peace is restored, seeds can be recovered from seed banks and replanted.

Field Gene Banks *[Figure 15 & 16]*

1. For the conservation of gene, planting the crop is essential [6].
2. It provides an easy and ready access to the plant genetic resources for

characterization, evaluation or utilization.
3. More adequate soil, weather, etc are needed.
4. Creation of artificial ecosystem for this purpose.
5. Through this method one can compare the differences among the plats of different plant species and can study it in details.
6. While same material conserved in the form of seed, in vitro or cryopreserved must be germinated and grown before it can be used.

Fig.15:*-Field Gene Bank*

Fig.16:*-Field Gene Bank*

Principles
1. Field gene banks also called plant gene banks are areas of land in which germplasm collections of growing plants are assembled.
2. This is also called ex-situ conservation of germplasm.
3. In field gene banks, germplasm is maintained in the form of plants as a permanent living collection.
4. These are often established to maintain working collections of living plants for experimental purposes.
5. Conserved in field gene banks of those plant species that do not produce seeds readily or have recalcitrant seeds.
6. It is the source of germplasm for some species such as cassava, coconut, mango, rubber, yam and cocoa.

Advantages of Field Gene Bank
1. There are so many advantages in field gene bank like crop diversity conservation, sources of propagating material, resources for research and study, production and income generation, making healthy environment, providing diversity options and selection opportunity.
2. It can be directly utilized in the breeding programmes.
3. Large number of germplasm samples or entire variability can be conserved in a very small space.
4. In seed banks, handling of germplasm is easy.
5. It provides opportunities for continuous evaluation for various economic characters.
6. It can be directly utilized in the breeding programme.
7. Field gene bank may be different types e.g., crop specific park, crop specific field gene bank, community field gene bank, village level field gene bank [4].
8. It provides opportunities for various economic characters [5].
9. More than 500000 accessions of crops are being globally maintained in the field gene bank of 103 countries.

Disadvantages of Gene Bank

There are some important demerits as given below:

1. Field gene banks can not cover the entire genetic diversity of a species. It can cover only a fraction of the full range of diversity of a species.
2. The germplasm in field gene banks is exposed to pathogens and insects and sometimes is damaged by natural disasters such as bushfires, cyclones, floods, etc.
3. Maintenance of germplasm in the field gene banks is costly affair.
4. Seeds of recalcitrant species cannot be stored in seed banks.
5. There is a chance of viability loss and thereby loss of germplasm due to failure of power supply.
6. Periodical evaluation of seed viability is essential. Multiplication is require to get new or fresh seeds for storage at specific interval.
7. The germplasm in the field gene banks is sensitive to pathogen, insects and sometimes it is destroyed by natural disasters such as bushfires, floods etc.

Field gene banks have been established in many countries for different crops.

FIELD GENE BANK IN SOME COUNTRIES

Name of country	Crop species for which field gene bank is established
India	Global collection of coconut has been conserved in Andaman and Nicobar
Indonesia	Coconut and other perennial crops
Malaysia	Oil palm
Philippines	South East Asian germplasm of banana

On the basis of status of Research Institutes, gene banks are again classified into two types, viz.:
(i) National gene banks, and
(ii) International or global gene banks.
National gene banks are maintained by each country and International or global gene banks are located in International Crop Research Institutes/Centres. In India, gene banks are govorned by concerned Crop Research Institutes of ICAR. National Bureau of Plant Genetic Resources, New Delhi is also maintaining germplasm of various field crops.Forest Research Institute, Dehradun deals with germplasm of forest species and Botanical Survey of India, Kolkata deals with germplasm of remaining plant species.

NATIONAL GENE BANKS

Crop species	Location of Gene Bank	Name of Research Institute/Centre
Rice	Cuttack	Central Rice Research Institute (CRRI)
Wheat	Karnal	Directorate of Wheat Research (DWR)
Maize	New Delhi	Indian Agricultural Research Institute (IARI)
Sorghum	Hyderabad	National Research Centre for Sorghum
Pulses	Kanpur	Indian Institute for Pulse Research (IIPR)
Oilseed crops	Hyderabad	Directorate of Oilseed Research (DOR)
Groundnut	Junagarh	National Research Centre for Groundnut
Soybean	Indore	National Research Centre for Soybean
Sugarcane	Coimbatore	Sugarcane Breeding Institute (SBI)
Cotton	Nagpur	Central Institute for Cotton Research (CICR)
Tobacco	Rajamundry	Central Tobacco Research Institute (CTRI)
Potato	Shimla	Central Potato Research Institute (CPRI)
Tuber crops	Trivandrum	Central Tuber Crop Research Institute (CRRI)
Forage crops (IGFRI)	Jhansi	Indian Grassland and Fodder Research Institute
Horticultural crops	Bangalore	Indian Institute for Horticultural Research (IIHR)
Citrus	Nagpur	National Research Centre for Citrus
Grapes	Pune	National Research Centre for Grapes

INTERNATIONAL OR GLOBAL GENE BANKS

Crop species	Location of Gene Bank	Name of Research Institute/Centre
Rice	Philippines	International Rice Research Institute (IRRI)
Maize and Wheat (Triticale, Barley, Sorghum)	Mexico	International Wheat and Maize Improvement Centre (CIMMYT)
Cassava, Beans, Rice and Maize	Columbia	International Centre for Tropical Agriculture (CIAT)
Cowpea, Soybean, Limabean, Cassava, Sweet Potato	Nigeria	International Institute for Tropical Agriculture (IITA)
Potato	Peru	International Potato Centre
Sorghum, Pearl millet, Pigeon pea, Groundnut	India	International Crop Research Institute for Semi Arid Tropics (ICRISAT)
Durum Wheat, Barley, Beans	Syria	International Centre for Agriculture Research in Dry land Areas (ICARDA)
Vegetables, Soybean, Mung Bean, Sweet Potato	Taiwan	Asian Vegetable Research and Development Centre (AVRDC)

CRYOPRESERVATION *[Figure 17]*

1. The storage of seeds, pollen tissue or embryos in liquid nitrogen.
2. Cryopreservation is also used for the conservation of the liver stock genetics through conservation of animal genetic.
3. This method can be used for virtual storage of material without deterioration over a much greater time period relative to all other methods of ex-situ conservation.

Fig.17:- *Cryopreservation*

Advantages

1. Large number of germplasm samples or entire variability can be conserved in very small space.
2. In seed bank handling of gerplasm is easy.

Disadvantages

1. Recalcitrant seeds cannot be stored in the seed bank.
2. Failure of power supply may lead to loss of viability and thereby loss of germplasm occurs.

CONCLUSION

Seed banks have a vital role to play in supporting integrated strategies for conservation and sustainable use of plants. The cost effectiveness of seed banking technology clearly depends on the seed biology of the target species, and the role that the collection will play in long-term conservation and ecological restoration strategies. In view of rapid loss of biodiversity, the collection and preservation of germplasm has become important and demanded urgency.

Seed bank recognises the opportunity to provide ecological restoration materials to users. They will need to pay attention to testing and documenting the viability and germination of the species on media comparable with the eventual field soil situation.

The challenge is to develop the science and technology, which supports other sectors to ensure that seed collections benefit from an active and relevant programme of research, in order to solve seed problems and to respond to the needs of users. Germplasm preservation is not only hope for plant under threat of extinction, but also saves medicinal and other valuable plants on which lives are dependent. Seed banks respond to the increasing demand for seed and provide information to support habitat restoration and also reintroduction of threatened species.

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