GENETIC RESOURCES AND CONSERVATION (BT401)

INTRODUCTION

Genetic resources (GRs) refer to genetic material of actual or potential value. Genetic material is any material of plant, animal, microbial or other origin containing functional units of heredity. Examples include material of plant, animal, or microbial origin, such as medicinal plants, agricultural crops and animal breeds.

Animals, plants, micro-organisms and invertebrates which are used for Food, Agriculture and Forestry are called **Genetic Resources**. Together with the components which fulfill agri-ecological functions they are grouped under the concept **Agrobiodiversity**.

Genetic resources for Food, Agriculture and Forestry include both **wildspecies** and **domesticated forms**. Reflecting the main areas of use–cropproduction, animal husbandry, forestry, fisheries and micro-organisms – they are grouped in

1. Plant genetic resources

2. Animal genetic resources

3. Forest genetic resources

4. Aquatic genetic resources and

5. Genetic resources of micro-organisms and invertebrates

Types of Genetic Resources

Plant genetic resources:

Genetic resources of field crops comprise crop species and their wild relatives, varieties, landraces, and genetic variation within the species. The genetic heritage of crops is stored in the different plant parts; seed and tissue. Plant genetic resources are used by farmers and scientists as the raw material for breeding new plant varieties and in biotechnology and are a reservoir of genetic diversity which acts as a buffer against environmental and economic change.

Plant genetic resources constitute the foundation upon which agriculture and world food security is based. But many plant genetic resources which may be vital to future agricultural development and food security have been lost to us this century, and more are threatened. Country Reports written by 155 governments for the Leipzig Conference indicate that recent losses of diversity have been large, and that the process of "erosion “continues. Of major concern is the irreversible loss of genes, the basic functional unit of inheritance and the primary source of the variation in the appearance, characteristics and behavior among plants.

"The diversity of life on earth is essential to the survival of humanity. The conservation and utilization of plant genetic resources is key to improving agricultural productivity and sustainability. It contributes to food security and poverty alleviation

Animal genetic resources:

The term *animal genetic resources* (AnGR) is used to include all animal species, breeds and strains that are of economic, scientific and cultural interest to humankind in terms of food and agricultural production for the present or the future. Another equivalent term increasingly used is *farm animal genetic resources*. There are more than 40 species of animals that have been domesticated (or semi-domesticated) during the past 10 to 12 thousand years which contribute directly (through animal products used for food and fibre) and indirectly (through functions and products such as draft power, manure, transport, store of wealth etc.) Common species include cattle, sheep, goats, pigs, chickens, horses, buffalo, but many other domesticated animals such as camels, donkeys, elephants, reindeer, rabbits etc. are important to different cultures and regions

of the world

Forest genetic resources:

Forest genetic resources (FGR) are the heritable materials maintained within and among tree and other woody plant species that are of actual or potential economic, environmental, scientific or societal value. They are crucial to the adaptation and protection of our ecosystems, landscapes and production systems, yet are subject to increasing pressures and unsustainable use. Conservation and sustainable management of FGR is therefore a must to ensure that present and future generations continue to benefit from forests and trees.Genetic diversity is needed in order to ensure that forest trees can survive, adapt and evolve under changing environmental conditions. It also maintains the vitality of forests and provides resilience to stresses such as pests and diseases

Aquatic genetic resource:

Aquatic genetic resources include all genetic resources living in water. By that we understand fish, cyclostomes, mussels, decapods, marine mammals, aquatic plants and all other water dwelling organisms that populate marine, coastal or inland waters, or are kept in aquaculture.Sea-water and freshwater fish, but also crustaceans, mussels and other seafood belong to the most important sources of protein for human consumption worldwide. As the basis of the fishing industry, they play, at the same time, a major role in socioeconomic terms. Particularly in developing countries local fishing and the related branches of production guarantee the income of a large part of coastal communities.

Invertibrate and micro organism genetic resources:

The term of "microorganism" as it is understood here encompasses fungi (example gratia mycorrhizae, edible mushrooms), yeast, microalgae, protozoa, bacteria, archaebacteria, mycoplasmas and viruses. Microbes play a critically important role in the cycling of nutrients in terrestrial and aquatic ecosystems globally. Marine microbes are responsible for approximately

half of the global primary production and play a huge role in the cycling of carbon, nitrogen, phosphorus and other nutrients

An “invertebrate” is any animal without a backbone. Earthworms, nematodes and insects are referred as invertebrates. Invertebrates include a great number of species that perform valuable functions in agro ecosystems.
Small, out-of-sight and uncharismatic these animals may be, but their significance is enormous. Some larger soil-dwelling invertebrates, such as earthworms, ants and termites, have been described as “ecosystem engineers”. They create the physical structures needed to maintain healthy soil communities and for basic soil process such as water infiltration and storage, and sequestration and cycling of carbon. They help maintain the chemical fertility needed for plant growth.

SIGNIFICANCE

The diversity of genetic resources for food and agriculture (i.e. plants/crops, animals, aquatic resources, forests, micro-organisms and invertebrates) plays a crucial role in meeting basic human food and nutritional needs. It is essential for maintaining and enhancing the efficiency and the resilience of production systems, as well as contributing to sustainable diets and to the delivery of ecosystem services, such as pest and disease regulation.

Strategic role of plant genetic resources in achieving global food security and sustainable agriculture

Over recent decades, agriculture has undergone enormous changes as a result of both technological advances and changing human needs and desires. On the one hand, yields per unit area have increased dramatically through a combination of improved crop varieties and a greater use of external inputs.1 On the other hand, there has been increasing pressure on land for uses other than the production of food, growing concerns about the sustainability and safety of some modern practices. In spite of advances in food production, food insecurity and malnutrition are still widespread. The latest FAO figures indicate that in 2009 there were around 1 billion

chronically hungry people in the world, an increase of about 200 million since the World Food Summit in 1996. It is estimated that the number of hungry people increased by over 100 million due to the food price crisis of 2007-2008 alone. Most of the worst affected people (about 75 percent) live in rural areas of developing countries and depend directly or indirectly on agriculture for a large part of their livelihoods. A 70 percent increase in world agricultural production over today's levels will be required to meet the food demands of the estimated 9.2 billion people in 2050. A major share of this productivity increase will have to come from the use of PGRFA to produce higher yielding, more nutritious, more stable and more eco-efficient crop varieties.

PLANT GENETIC RESOURCES

It represents the sum total of diversity accumulated through years of evolution under domestication and natural selection. Principally the genetic resources or germplasm of plants come from

(a) Wildlife or primitive form
(b) Plants migrations in secondary forms
(c) Material bred through meticulous plant breeding programs

Categories of germplasm:

There are 5 categories of germplasm

1) Land Races:

"Primitive cultivars which were selected and cultivated by farmers for many generations. Land races even respond- to –selection for high yield, but to certain extent. Since land races posses' valuable alleles, their conservation is essential. The main drawbacks of land races are that they are less uniform and low yielders. Land races have been collected in maize, sorghum, pearl millet and many other crops

2) Obsolete Cultivars:

Improved varieties of recent past are known as obsolete cultivars. These are the varieties which were popular earlier and now have been replaced by new varieties. These varieties have several desirable characters and constitute an important part of gene pool.

3. Modern Cultivars:

The currently cultivated yielding varieties are referred to as modern cultivars. Modern cultivars are also known as improved cultivars or advanced cultivars. These varieties have high yield potential and uniformly as compared to obsolete

Varieties and land races. Modern cultivars constitute a major part of working collections and are extensively used as parents in the breeding programmes for further genetic improvement in various characters.

4. Breeding Lines:

Pre-released plants which have been developed by plant breeders for use in modern scientific plant breeding are known as advanced lines, cultures and **stocks.** They include advanced cultures which are not yet ready for release to farmers. Sometimes advanced breeding lines and stock are not very much productive, but constitute valuable part of gene pool for various economic characters.

5. Wild Forms of Cultivated Species:

Wild Relatives are naturally occurring plant species which have common ancestry with crops and can cross with crop species are referred as wild relatives or wild species. Wild relatives are important sources of resistance to biotic (disease and insects) and abiotic (drought, cold, frost, salinity, etc.) stresses,

Wild forms of cultivated species are available in many crop plants. Such plants have generally high degree of resistance to biotic and abiotic stresses and are utilized in breeding programmes for genetic improvement of resistance to biotic and abiotic stresses

Mutation breeding is used as when the derived character is not found in the genetic stocks of cultivated species and their wild relatives. Mutations do occur in natures as well as can be induced through the use of physical and chemical mutagens. The extra variability which is created through induced mutations constitutes important component of gene pool.

Conservation of germplasm:

A species or a population sample of a particular part of its genetic variation can be maintained through in conservation.

The sum total of all the genes present in a crop and its related species constitutes its germplasm. It is ordinarily represented by a collection of various strains and species**.** Germplasm provides the raw .materials (= genes). The breeder uses these to develop commercial crop varieties.

Therefore, germplasm is the basic indispensable ingredient of all breeding programmes. Thus a great emphasis is placed on collection, evaluation and conservation of germplasm. Conventionally, germplasm is conserved as seeds stored at ambient temperature, low temperature or ultralow temperature.

Applications or significance of germplasm conservation

1. The conservation of germplasm involves the preservation of the genetic diversity of a particular plant or genetic stock. It can be used at any time in future.
2. It is important to conserve the endangered plants or else some of the valuable genetic traits present in the existing and primitive plants will be lost.
3. Main crops produce recalcitrant or short lived seeds.
4. Similarly, in case of clonal crops seeds are not the best material to conserve due to their genetic heterogeneity and unknown worth. Their genes need to be conserved.
5. The roots and tubers loose viability rapidly. Their storage requires large space, low temperature and is expensive. In addition, materials modified by genetic engineering may some, times be unstable. Such materials are needed to be conserved intact for future use

Methods of germplasm conservation

The very objective of germplasm conservation (or storage) is to preserve the genetic diversity of a particular plant or genetic stock for its use at any time in future. In recent years, many new plant species with desired and improved characteristics have started replacing the primitive and conventionally used agricultural plants. It is important to conserve the endangered plants or else some of the valuable genetic traits present in the primitive plants may be lost.

A global body namely International Board of Plant Genetic Resources (IBPGR) has been established for germplasm conservation. Its main objective is to provide necessary support for collection, conservation and utilization of plant genetic resources throughout the world.

There are two approaches for germplasm conservation of plant genetic materials:

1. In-situ conservation
2. Ex-situ conservation

1. In-Situ Conservation:

The conservation of germplasm in their natural environment by establishing biosphere reserves (or national parks/gene sanctuaries) is regarded as in-situ conservation. This approach is particularly useful for preservation of land plants in a near natural habitat along with several wild relatives with genetic diversity. The in-situ conservation is considered as a high priority germplasm preservation programme.

The major limitations of in-situ conservation are listed below:

i. The risk of losing germplasm due to environmental hazards

ii. The cost of maintenance of a large number of genotypes is very high.

2. Ex-Situ Conservation:

Ex-situ conservation is the chief method for the preservation of germplasm obtained from cultivated and wild plant materials. The genetic materials in the form of seeds or from in vitro cultures (plant cells, tissues or organs) can be preserved as gene banks for long term storage under suitable conditions. For successful establishment of gene banks, adequate knowledge of genetic structure of plant populations, and the techniques involved in sampling, regeneration, maintenance of gene pools etc. are essential.

Germplasm conservation in the form of seeds:

Usually, seeds are the most common and convenient materials to conserve plant germplasm. This is because many plants are propagated through seeds, and seeds occupy relatively small space. Further, seeds can be easily transported to various places.

There are however, certain limitations in the conservation of seeds:

i. Viability of seeds is reduced or lost with passage of time.

ii. Seeds are susceptible to insect or pathogen attack, often leading to their destruction.

iii. This approach is exclusively confined to seed propagating plants, and therefore it is of no use for vegetative propagated plants e.g. potato, Ipomoea, Dioscorea.

iv. It is difficult to maintain clones through seed conservation.

Certain seeds are heterogeneous and therefore, are not suitable for true genotype maintenance.

Advantages and Limitations of Germplasm Storage

The potential advantages of these techniques are as follows:

- Requirement of relatively very small space,

- Storage of germplasm free from diseases, insects and other pathogens, and weeds,
- Storage over long periods,
- Reduce risk of errors in labeling, etc. In addition, such materials are ‘clean’ sources of ‘nucleus seed’,
- They are ideal for germplasm exchange.

However, these approaches suffer from the following disadvantages:

(i) Sophisticated facilities are required (particularly for freeze preservation and DNA cloning),

(ii) They demand a greater skill in handling and maintenance than the conventional techniques,

(iii) Even shoot tip derived plants may show genetic instability.

The Global Strategy for Plant Conservation

A Plan to Save the World's Plant Species - grew out of the Convention on Biological Diversity and is being fed into government policy around the world.

The GSPC highlights the importance of plants and the ecosystem services they provide for all life on earth, and aims to ensure their conservation

The vision of the GSPC is:

"Without plants, there is no life. The functioning of the planet, and our survival, depends on plants. The Strategy seeks to halt the continuing loss of plant diversity."

The mission of the GSPC is:

"The Global Strategy for Plant Conservation is a catalyst for working together at al levels - local, national, regional and global - to understand, conserve and use sustainably the world's immense wealth of plant diversity whilst promoting awareness and building the necessary capacities for its implementation."

The GSPC has 5 main objectives:

- Plant diversity is well understood, documented and recognized
- Plant diversity is urgently and effectively conserved
- Plant diversity is used in a sustainable and equitable manner
- Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on Earth is promoted
- The capacities and public engagement necessary to implement the strategy have been developed.

International treaty on Plant Genetic Resources for food and Agriculture

The **International Treaty on Plant Genetic Resources for Food and Agriculture** (**IT PGRFA)** popularly known as the **International Seed Treaty**, is a comprehensive international agreement in harmony with the Convention on Biological Diversity,

Aims of International treaty:

It aims at guaranteeing food security through the conservation, exchange and sustainable use of the world's plant genetic resources for food and agriculture (PGRFA), as well as the fair and equitable benefit sharing arising from its use.

It also recognizes Farmers' Rights, subject to national laws to:

a) The protection of traditional knowledge relevant to plant genetic resources for food and agriculture;

b) The right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture; and

c) The right to participate in making decisions, at the national level, on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture.

National Conservation strategies

Plant genetic resources for food and agriculture (PGRFA) are defined as any genetic material of plant origin of actual or potential value for food and agriculture. Serving as a reservoir of heritable traits, these resources are indispensable ‘raw materials’ for generating superior crop varieties. The variety of choices that they provide permit the much desired diversification of crops, foods and farming systems, all of which are indices of the resilience of agricultural systems. PGRFA also provide invaluable ecosystem services that contribute to sustainable agricultural production systems. To prevent losses and maximize the availability of a wide range of PGRFA for current and future requirements, there is an urgent need to ensure more systematic conservation and sustainable use efforts at national levels.

National strategies for PGRFA should identify a national vision, goals and objectives, and the

corresponding plan of action, including responsibilities, resources, and timeframes for activities relevant to the conservation and sustainable use of PGRFA. A National Strategy for PGRFA should:

- Enhance the efficiencies of countries' interventions to domesticate the Second GPA, and hence implement the Treaty, and also meet other international obligations;
- Provide a single overarching framework for the management of PGRFA in order to attain clearly defined goals within a country's overall agricultural, environmental, and economic policies and development agenda;
- Facilitate the monitoring of progress as priority activities and their timeframes are clearly identified;
- Improve the national-level coordination of all PGRFA activities across the constituent sectors thereby enabling concerted actions, the pooling of resources and the avoidance of wasteful duplications and rivalry;
- Foster partnerships and linkages that are underpinned by mutually beneficial collaborative endeavors; and
- Facilitate the ease of developing country reports to regional and global initiatives, frameworks, agreements, etc.

In practical terms, a National Strategy for PGRFA may help a country in setting priorities, assign budgetary and other resources, build capacity, and design the seamless dovetailing of all aspects of national PGRFA management in service of reaching its own national goals.

Genetic diversity for sustainable agriculture

PGR are a strategic resource and lie at the heart of sustainable agriculture. The link between genetic diversity and sustainability has two main dimensions: firstly the deployment of different crops and varieties and the use of genetically heterogeneous varieties and populations can be adopted as a mechanism to reduce risk and increase overall production stability; and secondly, genetic diversity is the basis for breeding new crop varieties to meet a variety of challenges. A large number of the country reports expressed concern about the increasing use of genetically uniform varieties and the trend for them to be grown on ever

larger areas, resulting in increased genetic vulnerability.

Many called for a greater use of genetic diversity to counter this. The deployment of diversity at the farm and field level helps provide a buffer against the spread of new
Pests and diseases and the vagaries of weather. In the case of pests and diseases, for example, while some individual component might be susceptible, there is a strong possibility that other components will be partially or totally resistant or tolerant. In such situations, the resistant or tolerant component can produce some yield, thus avoiding total crop failure, and in many circumstances such genetic diversity can also significantly slow the overall rate of spread of a disease or pest.

The development and production of appropriate crop varieties provides one of the best mechanisms for addressing many of the most important agricultural challenges related to sustainability. Varieties that are pest and disease resistant require fewer fungicide and insecticide applications; varieties that compete better with weeds require less herbicide; varieties that use water more efficiently can produce higher yields with less water; and varieties that use nitrogen more efficiently require less nitrogenous fertilizer, with a concomitant saving in fossil fuel. While varieties having many of these characteristics already exist, the situation is far from static. Agricultural environments change as do farming systems; new pests and diseases arise and the demand for specific products is constantly shifting. The result is that there is a continual need for new varieties. A variety that performs well in one location may not do so in another and a variety that produces a good yield this year may be knocked out by a new pest next year. In order to be able to continually adapt agriculture to ever changing conditions, plant breeders need to develop and maintain a pipeline of new varieties. Genetic diversity underpins the whole process of producing new varieties; it is the reservoir that enables breeders to maintain a full pipeline.

Ecosystem services and PGRFA

Agriculture contributes to development not only as an economic activity and as a source of livelihoods, but is also an important provider of environmental services.
Four broad categories of services provided by ecosystems are:

1. provisioning services: the supply of products from ecosystems, such as food and genetic

resources

2. regulating services: the benefits, such as water purification obtained from the regulation of ecosystem processes
3. cultural services: non-material benefits obtained from ecosystems such as recreation, education and ecotourism
4. Supporting services: the services needed for the production of all other ecosystem services. These include such things as nutrient recycling and soil formation.

PGRFA plays an important role in all of the four categories. In addition to being a direct 'provisioning service', genetic resources provide the raw material for improving the production of more and better food, either directly or through providing better feed for livestock. They are also important as the basis for improving fiber, fuel or any other crop product. In the area of 'regulating services,'

PGRFA are the basis for improving such services as carbon sequestration by crops, for example, deeper-rooted rangeland species and the control of water run-off and soil erosion. The diversity of traditional crops and foods can provide an important cultural service, e.g. through its importance in agro tourism or ecotourism; and as a 'supporting service' PGRFA can underpin the development of new varieties, for

Example food and forage legumes, having an enhanced ability to recycle nutrients such as nitrogen within an agro-ecosystem.

PGRFA and food security

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security are: availability, stability of supply, access and utilization.7 The PGRFA sector has multiple roles to play in helping ensure food security, for example: producing more and better food for rural and urban consumers; providing healthy and more nutritious food; and enhancing income generation and rural development. There is, however, need for a greater recognition of the multiple roles and contributions that PGRFA can play and for a strengthening of the linkages among all relevant institutions dealing with food security at the global, regional, national and local levels.

Domesticated plant genetic resources of Pakistan

“Plant domestication is the process whereby wild plants have been evolved into crop plants through artificial selection.”

This involves an early hybridization event followed by selective breeding. Domestication is the result of an immensely slow process, hundreds or thousands of years. This is called co-evolution because during domestication both plants and human behaviors evolved to suit one another.

Pakistan with a land area of 79.61 million ha. Is located at the western end of South Asian subcontinent and is characterized to contain the major archaeological sites of Indus civilization. Pakistan is situated in proximity to three of the major centers of diversity described by Vavilov (China, Indian subcontinent and Central Asia) and holds many plant species. The diversity of genetic resources provides the sustainable basis for food supply and security. A variety of crops like wheat, rice, maize, barley, sorghum, millet, cotton, brassicas, sunhemp, tobacco, sugarcane, chickpea, mung, mash, lentil, groundnuts, sesame, chilies, onion, garlic, coriander, turmeric and various other vegetables and fruits are cultivated in Pakistan. Besides the crops mentioned above, a number of other minor crops like buckwheat, foxtail millet, faba bean, common bean and various medicinal plants are being grown particularly in northern mountains or tribal areas for a very long period and rich genetic diversity is found in these crops. The main popular fruits of the country are citrus, mango, banana, grapes, apple, peach, plum, apricot, pomegranate, dates and some nuts. The various native crops of the region and introduction during the period of time are given

Some of the domestic resources in Pakistan is as follows

- **Cereals**

  Wheat is the major food crop of Pakistan grown over an area of 8 million ha. Scattered over a wide range of ecological regions. Presently most of the area is occupied by improved varieties but local land races still exist in Baluchistan and Northern Mountains due to local preferences or non-availability of improved varieties suitable for these areas. The local land races of wheat and barley are of great importance for quality and their tolerance to drought and salinity

- **Food legumes**

The area under pulses is 1.48 million ha. And it is an important group of food crops providing proteins. Among food legumes, the chickpea, lathyrus, lentil mung bean, mash bean, pigeon pea, cowpea, moth bean, broad bean, and common bean constitute important gene pools of various legumes

- **Oil Seed crops**

The main oil seed crops of Pakistan are rape and mustard, sesame, linseed and castor. The sunflower, soybean and groundnut are introductions. Most of the oil seed crops are grown on marginal areas. Although the extent of genetic diversity in introduced oil seed crops is low but the indigenous crops express a wide diversity in morphological traits and response to various stresses.

- **Horticultural crops**

A wide range of fruit species like mango, guava, citrus, banana, jujubar (ber), Eugenia (Jaman), apple, peach, plum, apricot, grapes, and nuts like almond and walnut are grown. These possess wide genetic variability in fruit size, shape, colour, maturity time and quality etc. These fruit species have been diversified through human selection over hundreds of years

- **Pome fruit diversity**

The minor pome fruit species growing in the region are Pyruspashia, Malusdomestica, Cydoniaoblonga, Sorbuslanata, Pyrusphasia (wild pear) occurs at elevations between 750 and 2 500 m.The domestic apple (Malusdomestica) is planted widely and produces small to medium-sized early maturing fruits.. People use the fruit cooked, boiled and preserved in sugar, and for medicinal purposes

- **Tree nuts**

Walnuts and almonds are cultivated tree nuts of economic importance to local communities. . Because these species have small trees and are found in areas where there is extreme drought, they may be valuable as root stock for cultivated almonds. Hazelnuts are found in the moist forests of the Kalam Valley, but trees are rare.

Wild Plant genetic resources of Pakistan:

“Wild plant resources refer to those that grow spontaneously in self-maintaining populations in

natural or semi-natural ecosystems and can exist independently."

Wild species used by humans occur in all bio geographical regions and habitat types

Some of the common wild plant genetic resources are as follow;

- Prickly Acacia/Keekar
- Coral Tree
- Deodar Cedar
- DalbergiaSissoo/Sheesham Tree
- *Calotropisprocera*/Giant milkweed
- Alovera
- Marijuana

Prickly Acacia/Keekar

Acacia nilotica is widespread in Asia eastwards to Pakistan and India.

Acacia nilotica is a pioneer species, easily regenerated from seed

It can become a weed when introduced out of its native range, particularly in more humid zones Acacia nilotica has a wealth of medicinal uses. Gum has been used as an emulsifying agent and emollient. It is edible and is used to relieve throat and chest complaints. The pods are desirable as fodder for cattle, and the leaves, young shoots and young pods are thought to aid milk production.

Coral Tree

The bright red distinctive flowers of the coral tree make it a pleasure to look at and a favorite among exotic gardens. In the fall, the large multicolored leaves drop. In the warmest areas it keeps its leaves all year. Because of the claw like spines that grow along the trunk and branches of the tree, another name for it is **Tiger's Claw**. A large plant, these trees reach up to 80 feet tall. They have bean shaped seedpods, which are highly poisonous to humans if eaten.

Deodar Cedar

Also called the Himalayan Cedar, Deodar Cedars are the national tree of Pakistan.

Gardens in Pakistan have some trees that are over 200 years old. These trees live in mountainous areas and can grow in altitudes as high as 10,000 feet. The cones have thin scales and round out in shape as they mature. Another plant used widely in decorative gardening, the silvery green needles and low drooping branches make it an attractive choice.

***DalbergiaSissoo* / Sheesham Tree**

DalbergiaSissoo, also known as Indian Rosewood, is the source of Sheesham wood.

The tree is native to India and Pakistan and grows all over the Sub-Himalayan Regions Its leaves are compound, and produces pink-white flowers that resemble a pea flower. It gives a dry fruit that is a thin and papery pale brown pod. The tree mainly offers timber

***Calotropisprocera*/Giant milkweed**

This species was cultivated as a garden plant (i.e. ornamental) in the past. It is now out of favor because it is poisonous and generally regarded as a weed. A large shrub with waxy stems and leaves that contain a milky sap. It thrives on poor soils, particularly where overgrazing has removed competition from native grasses

The milky sap of this plant is toxic to humans and sometimes also to livestock.

DOMESTIC ANIMALS RESOURCES

Human beings started domesticating animals as soon as intelligence dawned upon him. Man has an instinctive love for domestic animals and his home seems to be incomplete without them the cow, the dog, the goat, the horse, the sheep became his domestic friends. He also domesticated various other animals for serving his own interests.

Many kinds of domestic animals belonging to the tropical and sub-tropical regions are found in Pakistan

Some important domestic animals

The cow is the most useful of all the domestic animals. The milk of the cow is both a food and a drink. Bulls are very useful to the village people. They draw the plough, pull the cart, and carry loads.

The horse, another domestic friend, is a noble and lovely animal. It has been serving man in ways more than one from the hoary past. Before the invention of the modern means of transport, it was the chief means of carrying letters and people from one place to another. It is noted for its intelligence and swiftness.

The Dog: Of all the domestic animals, the dog is perhaps the most well-known for its qualities of obedience, intelligence and watchfulness and its quick power of smell. Friends may discard a man in distress but his dog shall never do so; it follows him in adversity and prosperity. Nowadays trained dogs have created a sensation by finding out absconding criminals. They serve many useful purposes of man in different walks of human life

Uses of Domestic Animals

Domestic animals are reared for several purposes. The most important of them are kept for agricultural purposes, milk and its by-products, transportation and other purposes.

1. **Fertilizing the fields:** Domestic animals also yield dung and farmyard manure, which are so necessary for fertilizing the fields.
2. **Agricultural purposes:** We use cattle for many agricultural purposes such as the drawing of ploughs and carts, lifting of water from the wells, carrying of loads, crushing of cane and seed, threshing of grain, and to the performance of such other forms of productive activities. For agricultural purposes, bullock and buffalo are the most important.
3. **Milching**: Cow, goat, sheep, and buffalo are kept mainly for milching.
4. **Wool:** Goat and sheep also yield wool.
5. **Transportation:** Horses, ponies, asses, mules, camels, sometimes also elephants, were old means of transport.

WILD LIFE ANIMALS IN PAKISTAN.

A number of different species of wild animals exist in Pakistan. Owing to the difference of geography and climate among the different regions of Pakistan, the diversity in the wildlife of Pakistan is huge. You will find poisonous snakes in deserts and wild bears in the mountains. The rivers, forests, mountains, deserts and plains of Pakistan are abundant with wild animals of different species. Some of the animals are found in large numbers while some are endangered species and steps should be taken for their protection and for increasing their population.

Fishing Cat

This medium sized wild cat is found in very limited numbers in Pakistan. Fishing cat resides close to rivers, lakes, and streams. The last sighting of this amazing cat was in 2012 in Sindh.

Aisatic Black Bear

Asiatic black bear is found in some parts of Pakistan. According to estimates the population of this wild bear is somewhere around 1,000 animals in Pakistan.

Grey Wolf

Grey wolf is found in the deserts of Tharparkar, Cholistan and in the lower hills of Baluchistan. The grey wolf population is largely dependent on livestock, primarily sheep and goats. They also eat small rodents like rats.

Sind Krait

This is a highly venomous snake found in Pakistan. The snake is often confused with the common krait. Pakistan has a huge population Sind Krait. It is found in different areas of Sindh as well as in some northern areas of Pakistan

Indus River Dolphin

This fresh water dolphin is found in the Indus River in Pakistan. There are five different areas in the Indus river where this dolphin is found. These areas are separated by the irrigation barrages.

Himalayan Brown Bear

As the name of the animal suggests, it is found in and around the Himalaya Mountain Range. It is the largest animal found in the Himalayas. The color of the bear is reddish or sandy brown. The population of this beautiful animal is only 150 to 200 in Pakistan.

Mugger Crocodile

Mugger crocodile is also known as Indus crocodile and Indian crocodile. This crocodile has a medium size and it can reach lengths up to 16 feet. It is found in fresh water ponds, lakes, sluggish rivers, marshes and swamps. It is the only species of crocodile found in Pakistan. The estimated population of Mugger crocodile in Pakistan is between 400 and 450. It is found in the rivers in Sindh and Baluchistan.

Asiatic Cobra

Asiatic Cobra is the most venomous species of cobra in the world. This dangerous snake is found in the northern half of Pakistan. In case you ever come across this dangerous snake, stay away from it. Once a woman was bitten by this snake in the northwestern Pakistan. She suffered from severe neurotoxicity. She was rushed to the nearest hospital; however she died on her way to the hospital. Immediate, appropriate medical treatment should be given in case of a bite by Asiatic cobra.

Alpine Markhors

This beautiful wild goat is found in the northern mountain ranges of Pakistan. Markhor is also the national animal of Pakistan. The total global population of Markhors in estimated to be 2,500 and out of this about 1,500 Markhors are found in Pakistan.

Snow Leopard

This is an extremely rare animal that is found in the mountain ranges of South and Central Asia. In Pakistan this beautiful wild animal is found in the northern mountains of Pakistan. According to reports there are only 200 Snow Leopards left in Pakistan. These are found in the Hindu Kush, Karakoram, Pamir, and Himalayan Mountains in KPK, Azad Kashmir and GilgitBaltistan.

Sand Cat

This wild cat is native to Pakistan. It is the smallest of the wild cats and can be found in the desserts of Pakistan

White head duck

This can be found all over the Pakistan. The male has a blue bill and the female looks like an ordinary duck

Humaliyan Black Bears

These can be found in the mountains of Kashmir,Sawat,Khaghan and chitral

This bear has medium size with a white V shape patch on its chest they weigh fro anywhere between 110 to 200 kg.

Aquatic genetic resources:

Aquatic genetic resources include all genetic resources living in water. By that we understand fish, cyclostomes, mussels, decapods, marine mammals, aquatic plants and all other water dwelling organisms that populate marine, coastal or inland waters, or are kept in aquaculture.

Sea-water and freshwater fish, but also crustaceans, mussels and other seafood belong to the most important sources of protein for human consumption worldwide. As the basis of the fishing industry, they play, at the same time, a major role in socioeconomic terms. Particularly in developing countries local fishing and the related branches of production guarantee the income of a large part of coastal communities.

Freshwater fisheries use both wild stocks of lakes, reservoirs and rivers, and stocks in aquaculture that are, more or less, affected by breeding. While professional lake and river fishing has sharply decreased in Germany during the last century, recreational fishing, with currently

more than 1.6 million anglers, is becoming increasingly more important.

The use and exchange of aquatic genetic resources have been crucial elements in helping aquaculture become the fastest growing food producing sector over the past three to four decades although it has been estimated that less than 9% of the current aquatic species being farmed have been the subject of formal genetic improvement programs. Today, aquaculture accounts for nearly half of all fish consumed and the proportionate contribution is expected to increase to meet future needs. Improvements in aquaculture technology, aquatic animal health/aquatic biosecurity, animal husbandry, nutrition, larval rearing, genetics and breeding have led to a great diversity of farmed aquatic animals. More aquatic species are being farmed today than ever before: in 1950, countries reported farming 72 species from 34 families; by 2013 production was reported and estimated for nearly 575 species items associated with over 115 families.

Aquatic genetic resources include all genetic resources living in water

It includes

- Fish
- Cyclostomes
- Mussels
- Decapods
- Marine mammals
- Aquatic plants
- All other water dwelling organisms

Importance of Aquatic genetic Recourses

The contribution of aquaculture to world food fish production increased from 3.9% in 1970 to more than 50% in 2014 with growth expected to continue. Aquatic genetic resources are of key importance for the further genetic improvement of fish strains to achieve sustainable development of aquaculture.

MICROORGANISM GENETIC RESOURCES

A microscopic organism (including viruses, bacteria, archaea, fungi, protists, microscopic plants (called green algae), and animals such as plankton) **M**icroorganisms generally receive scant or no attention in overall reviews of biological diversity and global genetic resources, perhaps because they are often studied by different methodologies and scientists based in laboratories rather than herbaria, museums, botanic gardens, or germplasm banks

The use and exchange of agricultural microorganisms

Presents a wealth of opportunities for improvement of food and agricultural production systems, and for contributing to energy production and waste management in agriculture.

The following areas where **use of microorganisms** currently plays an important role in agricultural have been identified in the study:

(1) Plant growth promotion through soil microorganisms,

(2) In the understanding and surveillance of microbial plant pathogens

(3) Biological control,

(4) Beneficial symbiosis in the guts of ruminant livestock,

(5) Production of chemicals of direct benefit to agriculture,

(6) Workhorses in agro-industrial processes.

Benefits of microorganism

Microorganisms also provide beneficial services in food production systems. Important areas of use that were identified are

(1) Fermentation,

(2) Probiotics,

(3) Production of chemicals of benefit to food production, and

(4) Understanding and surveillance of health hazardous microorganisms such as food toxins and food borne pathogens

Future trendsand issues

Microbes permeate the entire food and agricultural process. While the most visible role of agricultural uses of microorganisms is probably that of producing and delivering food,

microbiology is critical to other agricultural sectors as well, for example for production of energy based on plant or other organic materials and for bioremediation of agricultural wastes. Microbial influences on food and agriculture produce both advancements and disasters, as some microorganisms present a threat to plant and animal health and contaminate food production processes.

ENDANGERED SPECIES OF PAKISTAN

Animals are an important part in Pakistan's ever so beautiful landscapes. Sadly, due to increase in pollution, destruction of habitats and hunting enthusiasts, these animals are at risk of extinction.

These are some of the many endangered animals in Pakistan:

1. Markhor

Yep, the national animal! It is on the brink of extinction, too. This wild goat is classified as "near threatened" by the International Union for the Conservation of Nature. There is some good news, though. It was discovered in early 2015 that their population has increased by 20%

Mountain Weasel

These are creatures that live in the higher altitudes, mainly Kashmir. The habitat change is pushing their number to dangerously low. Human development is causing this change, such as the construction of roads and bridges. Their food supply is also reduced, having to share it with domesticated cattle and horses.

Asian Black Bear

This big black monster seems to be an interesting hunting trophy for many people. That and expansion of human settlement into wildlife territory has affected their growth putting a threat on their species. It's a shame people are destroying such things for personal pleasure.

Baluchistan Forest Dormouse

This tiny rodent is apparently an ingredient in medicine, putting it in high demand, especially for the Chinese. An interesting fact, this creature has a crescent shape on its chest. They might look ugly and small, but they are an important part to the habitat and its cycle.

Black Finless Porpoise

For a sea creature to be fin-less and unique should be all for special treatment and

preservation. Unfortunately, this and many other marine creatures are suffering due to human stupidity and pollution.

European Otter

This endangered animal is one of the most rapidly dying creatures in Pakistan. Considering it's a water animal, and the amount of pollution in our water, it is not so surprising why.

Vole

Due to habitat changes these little rats are facing threats of extinction, this also one of the endangered animals the WWF has especially highlighted for protection.

Indus River Dolphin

This is a dolphin at high risk thanks to the development of the dams and other water storage and collection resources. This is one of the most recognized sea creatures we have, it would be helpful if we learn to take care of it, before it dies out forever.

Branded Eagle Ray

This fish is a part of the eagle ray family of fish who live in naturally low sea areas and shallow waters. Unfortunately, water pollution – people throwing away shopping bags and waste, factories spilling their waste chemical matter and sewage – is harming this beautiful sea creature

Bigeye Tuna

This is an important fish for food. Unfortunately, rapidly increasing, uncontrolled pollution and recreational fishing has caused massive drop in the number of this fish. This endangered animal is killed brutally for human pleasure.

Marco Polo Sheet

This sheep, found in the northern areas, is a target for many hunters. Their spiraling horns and imposing stature is a thing of beauty, don't let them die forever.

Snow Leopard

A unique creature in the mountainous areas of Pakistan that is also sadly under threat. According to the International Union for the Conservation of Nature, as of 2003, the size of the global population of this beauty was estimated at 4,080–6,590 adults, of which fewer than 2,500 individuals may reproduce in the wild. Due to hunting and rapid human expansion, there is a very limited amount of these beasts left

Siberian Cranes

Siberian Cranes nest in scattered breeding territories, preferring wide expanses of fresh water with good visibility. Sadly, water pollution due to human negligence and selfishness is the prime cause for their decrease in population. At one time, they were a common sight in Pakistan. Maybe one day if humans keep on with their selfish encroachment, you will say the same about horses or cows.

Green Sea Turtle

It's shocking to know that one of the most fascinating creatures isn't developing because of our man-made horrid climate. It is illegal, around the world to collect, kill or harm them but law never stopped Pakistanis, did it? These animals are captured for their shells and skins to be sold at high prices in the black market.

Long Billed Vultures

These creatures may seem sinister because they are flesh eaters, but they play an important role in Pakistan's ecological landscape. They feed off of dead animal carcases and are an important part of the Parsi community's ritual disposition of their dead. The deadly drug Diclofenac Sodium, which is used in the feed for cattle is a chemical compound that kills these vultures at a rapid rate. Pakistani skies were populated by throngs of vultures until 2001 and now areas like Changa Manga forest, which boasted a population of over 1500 vultures, has none today

GENE–ENVIRONMENT INTERACTION

Gene–environment interaction (or **genotype–environment interaction** or **G×E**) is when two different genotypes respond to environmental variation in different ways. A norm of reaction is a graph that shows the relationship between genes and environmental factors when phenotypic differences are continuous.

There are two different conceptions of gene–environment interaction. Tabery has labeled them *biometric* and *developmental* interaction, while Sesardic uses the terms *statistical* and *commonsense* interaction

The biometric (or statistical) conception has its origins in research programs that seek to

measure the relative proportions of genetic and environmental contributions to phenotypic variation within populations. Biometric gene–environment interaction has particular currency in population genetics andbehavioral genetics. Any interaction results in the breakdown of the additively of the main effectsof heredity and environment, but whether such interaction is present in particular settings is an empirical question. Biometric interaction is relevant in the context of research on individual differences rather than in the context of the development of a particular organism.

Developmental gene–environment interaction is a concept more commonly used by developmental geneticists and developmental psychobiologists. Developmental interaction is not seen merely as a statistical phenomenon. Whether statistical interaction is present or not, developmental interaction is in any case manifested in the causal interaction of genes and environments in producing an individual's phenotype.

Methods to analyze Gene environment interaction

Traditional Genetic Designs

Adoption studies have been used to investigate how similar individuals that have been adopted are to their biological parents with whom they did not share the same environment with. Additionally, adopted individuals are compared to their adoptive family due to the difference in genes but shared environment. For example, an adoption study showed that Swedish men with disadvantaged adoptive environments and a genetic predisposition were more likely to abuse alcohol.

Twin studies

Using monozygotic twins, the effects of different environments on identical genotypes could be observed. Later studies leverage biometrical modeling techniques to include the comparisons of dizygotic twins to ultimately determine the different levels of gene expression in different environments

Family studies

Family-based research focuses on the comparison of low-risk controls to high risk children to determine the environmental effect on subjects with different levels of genetic risk. For example,

a Danish study on high-risk children with schizophrenic mothers depicted that children without a stable caregiver were associated with an increased risk of schizophrenia

Molecular Analyses

Interaction with single genes

The often used method to detect gene-environment interactions is by studying the effect a single gene variation (candidate gene) has with respect to a particular environment. Single nucleotide polymorphisms (SNP's) are compared with single binary exposure factors to determine any effects.

Candidate studies such as these require strong biological hypotheses which are currently difficult to select given the little understanding of biological mechanisms that lead to higher risk.

These studies are also often difficult to replicate commonly due to small sample sizes which typically results in disputed results.

The polygenic nature of complex phenotypes suggests single candidate studies could be ineffective in determining the various smaller scale effects from the large number of influencing gene variants.

Interaction with multiple genes

Since the same environmental factor could interact with multiple genes, a polygenic approach can be taken to analyze GxE interactions. A polygenic score is generated using the alleles associated with a trait and their respective weights based on effect and examined in combination with environmental exposure. Though this method of research is still early, it is consistent with psychiatric disorders. As a result of the overlap of endophenotypes amongst disorders this suggests that the outcomes of gene-environment interactions are applicable across various diagnoses.

Genome-wide association studies and genome wide interaction studies

A genome wide interaction scan (GEWIS) approach examines the interaction between the environment and a large number of independent SNP's. A effective approach to this all-encompassing study occurs in two-steps where the genome is first filtered using gene-level tests

and pathway based gene set analyses. The second step uses the SNP's with G-E association and tests for interaction.

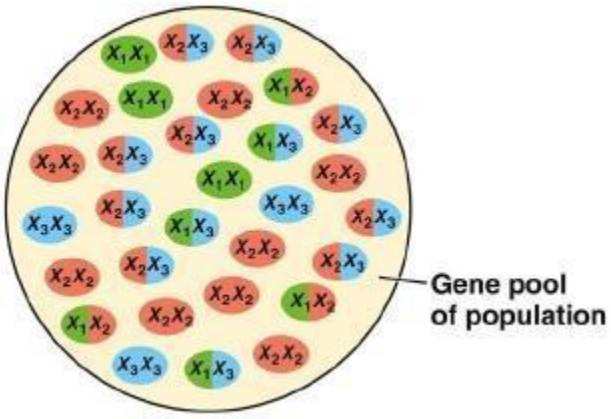
Examples

1. In plants: Seven genetically distinct yarrow plants were collected and three cuttings taken from each plant. One cutting of each genotype was planted at low, medium, and high elevations, respectively. When the plants matured, no one genotype grew best at all altitudes, and at each altitude the seven genotypes fared differently. For example, one genotype grew the tallest at the medium elevation but attained only middling height at the other two elevations. The best growers at low and high elevation grew poorly at medium elevation. The medium altitude produced the worst overall results, but still yielded one tall and two medium-tall samples. Altitude had an effect on each genotype, but not to the same degree nor in the same way.
2. Phenylketonuria (PKU) is a human genetic condition caused by mutations to a gene coding for a particular liver enzyme. In the absence of this enzyme,
3. An amino acid known as phenylalanine does not get converted into the next amino acid in a biochemical pathway, and therefore too much phenylalanine passes into the blood and other tissues. This disturbs brain development leading to mental retardation and other problems. PKU affects approximately 1 out of every 15,000 infants in the U.S. However, most affected infants do not grow up impaired because of a standard screening program used in the U.S. and other industrialized societies. Newborns found to have high levels of phenylalanine in their blood can be put on a special, phenylalanine-free diet. If they are put on this diet right away and stay on it, these children avoid the severe effects of PKU. This example shows that a change in environment (lowering Phenylalanine consumption) can affect the phenotype of a particular trait,.

GENE POOL

The **gene pool** is the set of all genes, or genetic information, in any population, usually of a particular species. A **gene pool** is a collection of all the genes in a population. This can be any population - frogs in a pond, trees in a forest, or people in a town. A gene pool isn't a real place; it's an abstract idea or an imaginary collection.

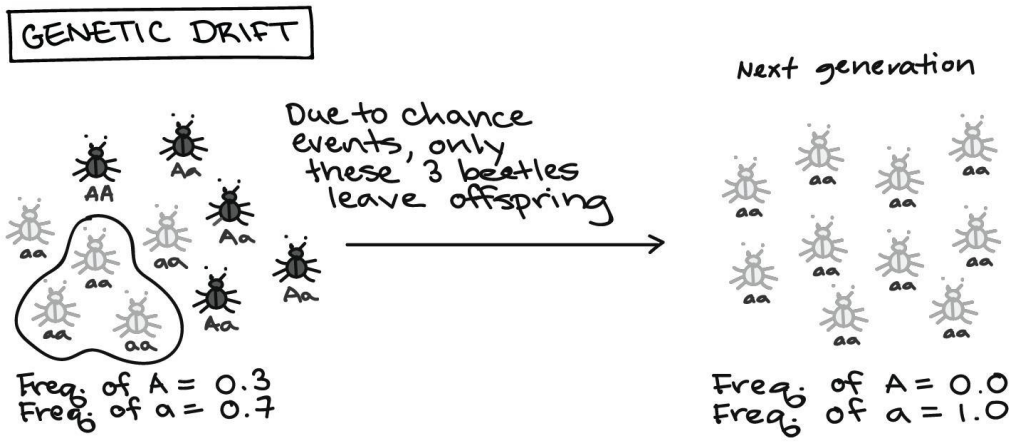
The gene pool is all the different alleles that are present in a population. For example; you have a population of goats or cows of different colors. The colors are caused by different variations of the same gene. All the different variations of the gene make up the gene pool. The gene pool does not bother with frequencies; a variant is either present or not.



The composition of a population's gene pool can change over time Through evolution. This can occur by a variety of mechanisms, Including mutations, natural selection, and genetic drift. The result is a gene pool that is altered to be attuned to the needs of the population's specific environment For example, the migration of human populations from equatorial regions toward northern climates, where they were exposed to relatively low amounts of sunlight, resulted in changes over time in skin pigmentation, with skin becoming lighter in color to augment vitamin D absorption (vitamin D is critical for proper bone development). The genetic modifications underlying the change in pigmentation ultimately became a part of many of those populations' gene pools.

Genetic drift

Genetic drift is change in allele frequencies in a population from generation to generation that occurs due to chance events In each generation, some individuals may, just by chance, leave behind a few more descendants (and genes, of course!) than other individuals. The genes of the next generation will be the genes of the "lucky" individuals, not necessarily the healthier or "better" individuals. That, in a nutshell, is genetic drift.



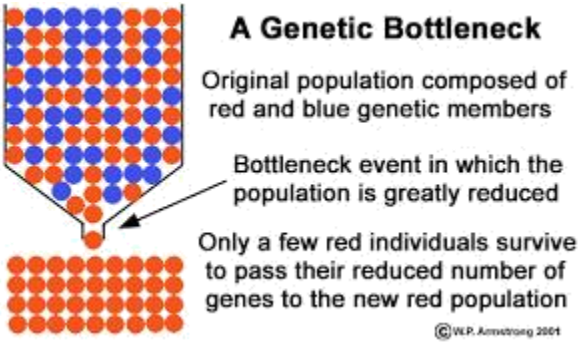
There are two major types of genetic drift: population bottlenecks and the founder effect.

1. **The bottleneck effect**

2. **The founder effect**

A population bottleneck is when a population's size becomes very small very quickly. This is usually due to a catastrophic environmental event, hunting a species to near extinction, or habitat destruction. When the size of the population is reduced so quickly, many alleles are lost and the genetic variation of the • **An example of a bottleneck effect:** Northern elephant seals have reduced genetic variation most likely due to being hunted. Hunting reduced their population size to as few as 20 individuals at the end if the 19th century. Since then their population has rebounded to over 30,000 but the genes still carry the marks of their bottleneck. They have much less variation than a population of Southern Elephant seals that have not been hunted.

population decreases.



The **founder effect** is when a few individuals in a population colonize a new location that's separate from the old population. This also greatly reduces the population size, as well as reduces the genetic variability of the population.

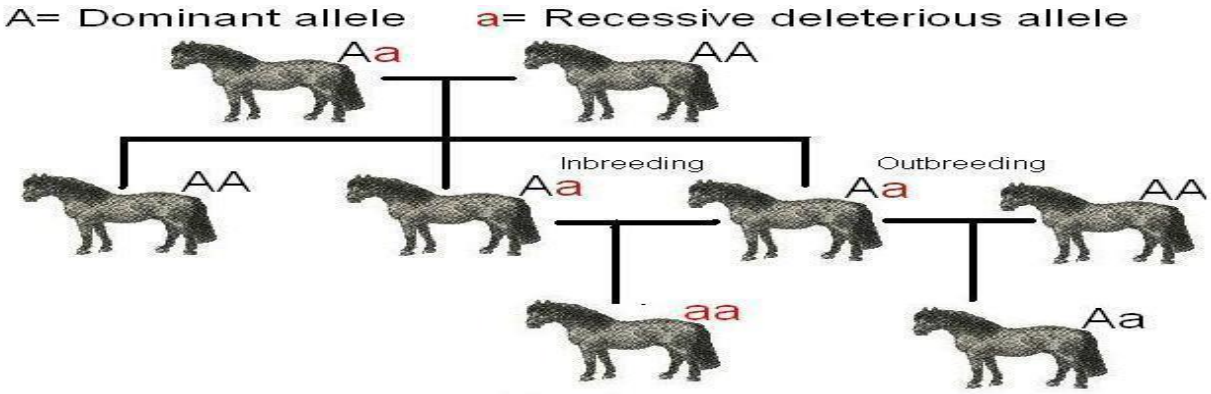
Huntington's disease also occurs in unusually high frequency near Lake Maraciabo, Venezuela. After much research, scientists were not only able to discover the mutation that causes the devastating disease, but also trace it back to the founder herself. 200 years ago, a women had 10 children all of whom stayed in the area to raise their own children. Unfortunately, Huntington's is a dominant allele meaning that if one parent carries it, there is a 50:50 chance it will be passed to the offspring. The disease has been able to persist for so long because natural selection no longer acts after reproduction, which is when Huntington's begins to take its effects.

BREEDING SYSTEMS

Animal breeding is a branch of animal science that addresses the evaluation of the genetic value of domestic livestock. A breed is a group of domestic animals with a homogeneous appearance, behavior, and other characteristics that distinguish it from other animals.

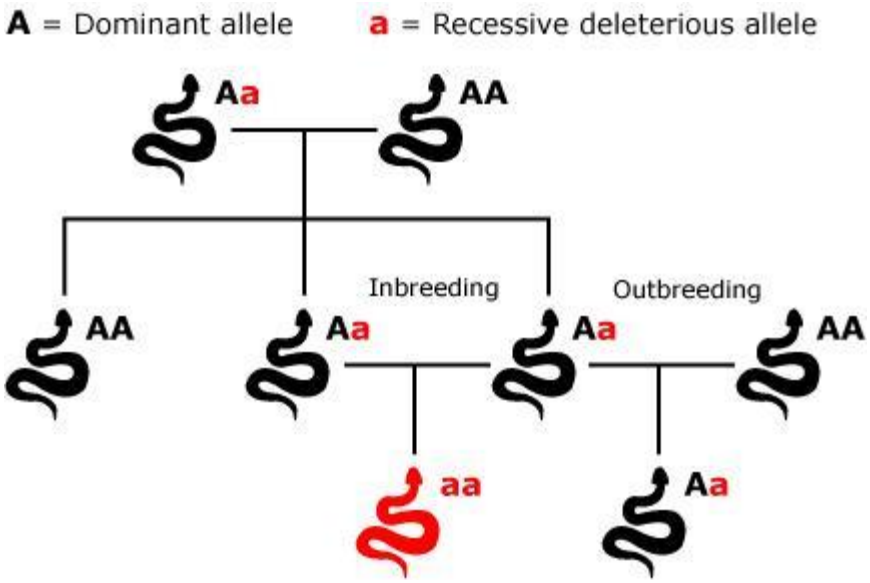
Pure-breeding

Pure-breeding is the mating of rams and ewes of the same breed or type. A purebred flock can be managed as a single flock because all ewes and rams are of the same breed. The goal of purebred sheep production is to provide superior genetics (seedstock) to the commercial sheep industry. Seedstock are marketed as rams and replacement ewes to other seedstock producers or to commercial sheep operation



Out-breeding

Within pure-breeding, there are several types of mating systems. Out-breeding is the mating of animals of the same breed but which have no closer relationship than at least 4 to 6 generations. Outbreeding is the recommended breeding practice for most purebred sheep breeders.



Inbreeding

Inbreeding is a system of breeding in which closely related animals are mated. This includes sire to daughter, son to dam, and brother to sister. Technically, inbreeding
is defined as the mating of animals more closely related than the average relationship within the breed or population concerned. The primary genetic consequence of inbreeding is to increase the frequency of pairing of similar genes.

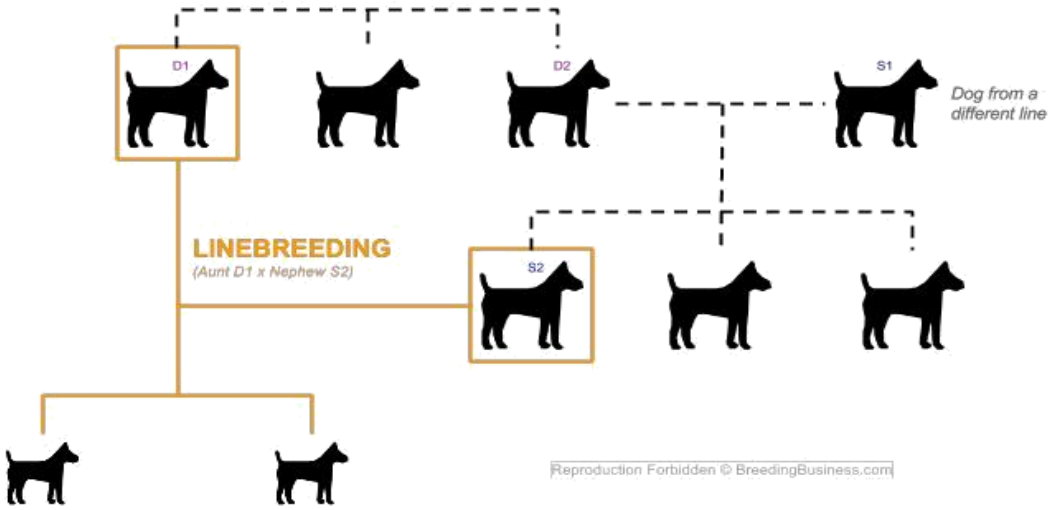
Inbreeding is essential to the development of prepotent animals — animals that uniformly "stamp" their characteristics on their progeny. Inbreeding may also be used to uncover genes that produce abnormalities or death — genes that, in outbred herds, are generally present in low frequencies. Inbreeding is suggested for only highly qualified operators who are making an effort to stabilize important traits in a given set of animals.

In general, inbreeding results in an overall lowering in performance: vigor, disease resistance, reproductive efficiency, and survivability. It also increases the frequency of abnormalities. For example, the spread of spider lamb disease in black-faced sheep is believed to be the

consequence of inbreeding.

Line breeding

Linebreeding is a system of breeding in which the degree of relationship is less intense than in inbreeding and is usually directed towards keeping the offspring related to some highly prized ancestor. The degree of relationship is not closer than half-brother half-sister matings or cousin mating, etc. Line breeding is a mild form of inbreeding



Crossbreeding

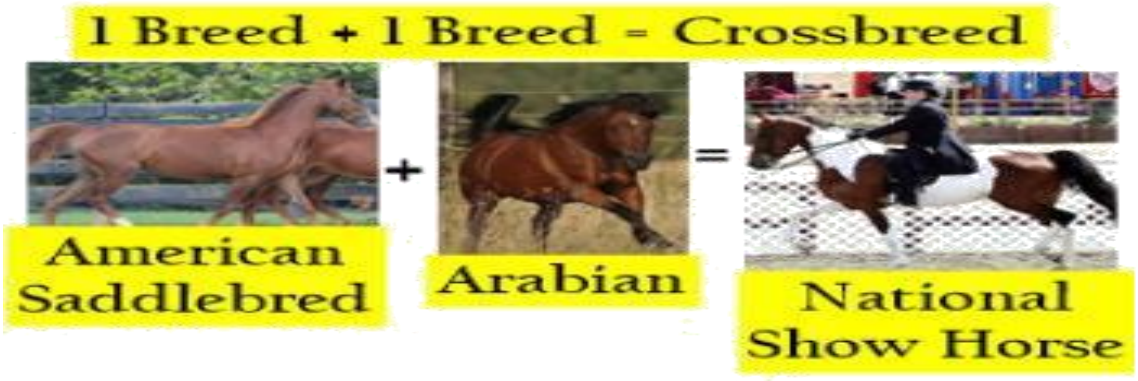
Crossbreeding is the mating of rams and ewes of different breed compositions or types. However, it does not denote indiscriminate mixing of breeds, but rather is a systematic utilization of different breed resources to produce crossbred progeny of a specific type. Crossbreeding is used extensively in the commercial sheep industry and the majority of slaughter lambs are crossbred.

Crossbreeding offers two distinct advantages:

1) heterosis;

2) breed complementarity.

Heterosis or hybrid vigor is the superiority of the crossbred offspring. Mathematically, heterosis is the difference in performance between the crossbredand the average performance of its purebred parents.



MIGRATION

Migration is the act of moving from one place to another, and is often associated with seasonal movements of animals between their breeding territory and a wintering range. This activity is most readily observed in **birds** but has been documented in many other animals as well, including **insects**, **fish** whales, and other **mammals** Migration is a complex **behavior** that involves timing, navigation and other survival skills.

Types of Migration

Daily migration

Many birds make daily movements from their nest in response to environmental forces

E.g. light, darkness temperature, humidity etc. Daily migration is from their resting site to feeding area, e.g. crows, sparrows, starling

Local migration

Local migration occurs because of heavy rain, flood, excessive cold &hot .Return to that area when crisis is over Flowering of certain plants and ripening of fruits also cause local migration

Seasonal migration

Response to change in the season. This type of migration is for food or breeding Tropical & sub-tropical countries area, this occurs in the beginning or end of the warm season. They migrate from the south to the north during summer known as "summer visitors" e.g. Snow bunting, red wing, shore lark

Molt migration

Most ducks, males and juveniles birds migrate short distances northward for molting Leaving behind the females and young birds in breeding ground

Irregular migration

Some birds disperse for a short Sometimes or long distance for the sake of food and safety. The birds can also swept away by powerful wind and hurricanes to very long distance e.g. blackstork (Ciconianigra), Glossyibis(Plegadisfalcinellus)

Altitude or vertical migrations:

Birds living at high altitude descend at lower altitude in winter to save themselves from intense cold of high altitude. They return again to high altitude with advent of summer. Birds migrate either in flocks or in pairs e.g. blue grouse

Latitudinal or equatorial migrations:

The birds migrate from east to west and vice- versa. Resident of east Europe and west Asia migrate towards the Atlantic coast e.g. California gull, golden plover

Longitudinal migration:

Movement from north to south, and vice versa Birds living in northern temperate and subarctic zones during summer (getting facilities for nesting and feeding) move towards south during winter. Some tropical birds migrate during rainy season to the outer tropics to breed and return to

the central tropics in dry season. E.g. gross beaks, starling

Advantages of Migration

Despite the dangers of long-distance travel, many different animals have developed migration strategies, presumably as a defense against the greater dangers of environmental uncertainty and competition.

The breeding range of migratory animals is likely to cover a region whose environment becomes increasingly inhospitable after the breeding season is over (i.e. there is less food available in the winter), so it is advantageous to travel elsewhere.

The wintering ranges will have food available year-round, but also many more animals competing for that food, as well as increased competition for shelter in which to raise their young. Hence the advantage of returning to the breeding grounds, where competition is less severe.

Causes of migration:

Migration is driven by a simple fact:

Resources on Earth fluctuate. Warm summer months may be followed by inhospitable cold. Plants – or other meals – may be abundant, but only for a short time. The best place to give birth or hatch young may not be a good place to find food.While migrations can be complex and varied, the motivations behind them are simple. Food, breeding and climate are recurring themes. For Example for the humpback whales, the best place to feed isn't the best place to breed. During the warm months, these whales feed in nutrient-rich waters of the high latitudes. However, they mate and calve in warmer waters that contain little food, so after these whales have journeyed as much as 5,000 miles (8,047 km) to their breeding grounds, they will fast throughout the winter.

For the Pacific salmon, migration defines its lifespan. After spending their adult lives in the ocean, these fish journey against the current of the freshwater rivers where they hatched. Once home, they spawn and die. It's a difficult and dangerous task: Only one out of a thousand salmon may live to return to the stream where it was hatched

Effects of migration

Migratory animals can impact ecological communities and ecosystem function,

The effects of migrants on communities and ecosystems can be broadly divided into two categories; ‘trophic’ effects and ‘transport’ or vector effect

Trophic effects are the result of the direct effects of migrants as providers of a pulse of

consumers, competitors, and/or prey.

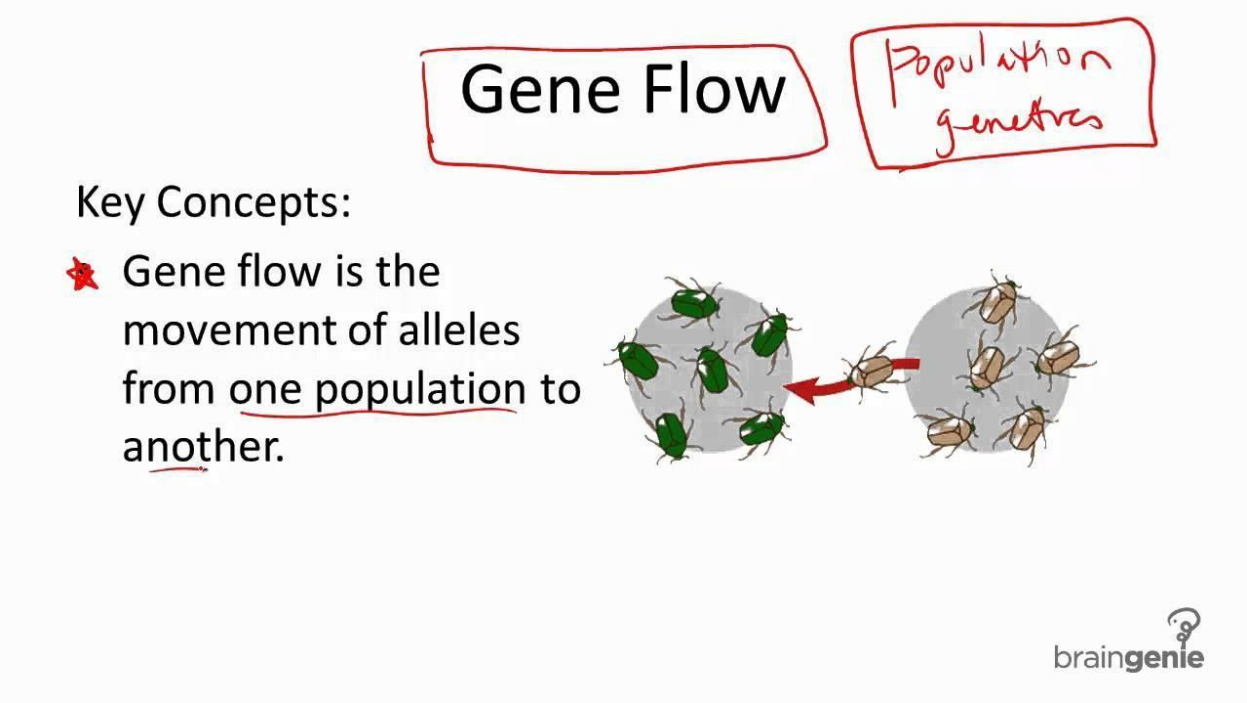
Transport effects are indirect, and are the result of migratory animals acting as vectors for disease, nutrients and energy, and other materials such as seeds across habitat or ecosystem boundaries

Both of these have potential consequences for both local community and ecosystem dynamics

Migration can impact communities in multi-faceted ways. Even without considering species interactions, many local communities are enriched by migratory species, which persist by utilizing transient pulses of resources, or simply visit en route between their breeding and non-breeding habitats

GENE FLOW

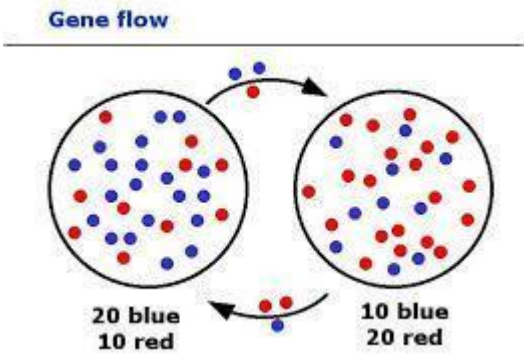
In population genetics, gene flow (also known as gene migration) is the transfer of alleles or genes from one population to another.



Migration into or out of a population may be responsible for a marked change in allele frequencies (the proportion of members carrying a particular variant of a

gene). Immigration may also result in the addition of new genetic variants to the established gene pool of a particular species or population.

There are a number of factors that affect the rate of gene flow between different populations. One of the most significant factors is mobility, as greater mobility of an individual tends to give it greater migratory potential. Animals tend to be more mobile than plants, although pollen and seeds may be carried great distances by animals or wind.



Maintained gene flow between two populations can also lead to a combination of the two gene pools, reducing the genetic variation between the two groups. It is for this reason that gene flow strongly acts against speciation, by recombining the gene pools of the groups, and thus, repairing the developing differences in genetic variation that would have led to full speciation and creation of daughter species.

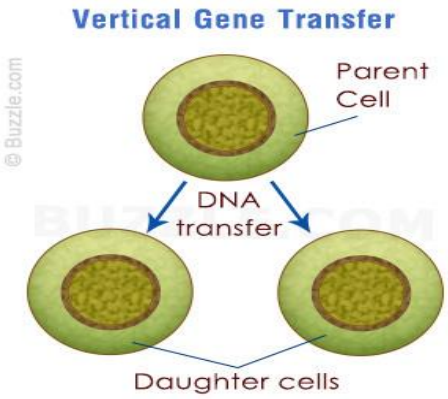
For example, if a species of grass grows on both sides of a highway, pollen is likely to be transported from one side to the other and vice versa. If this pollen is able to fertilize the plant where it ends up and produce viable offspring, then the alleles in the pollen have effectively been able to move from the population on one side of the highway to the other

Gene Flow between species

Gene flow between species takes place in two forms

1. Vertical gene transfer

In vertical gene transfer, the transfer of genetic material is from parents to offspring. It may be through sexual or asexual reproduction.



2. Horizontal gene transfer

Horizontal gene transfer, also known as lateral gene transfer, the transmission of DNA (deoxyribonucleic acid) between different genomes. Horizontal gene transfer is known to occur between different species, such as between prokaryotes (organisms whose cells lack a defined nucleus) and eukaryotes (organisms whose cells contain a defined nucleus), and between the three DNA-containing organelles of eukaryotes—the nucleus, the mitochondrion, and the chloroplast.

Acquisition of DNA through horizontal gene transfer is distinguished from the transmission of genetic material from parents to offspring during reproduction, which is known as vertical gene transfer.

Barriers to Gene flow

Allopatric Speciation

Allopatric speciation is speciation that happens when two populations of the same species become isolated from each other due to geographic changes. Speciation is a gradual process by which populations evolve into different species. A species is itself defined as a population that can interbreed, so during speciation, members of a population form two or more distinct populations that can no longer breed with each other.

Steps of Allopatric Speciation

1. A geographic change separates members of a population into more than one group. Such changes could include the formation of a new mountain range or new waterway, or the development of new canyons, for example. Also, human activities such as civil engineering, agriculture, and pollution can have an effect on habitable environments and cause some members of a population to migrate.
2. Different gene mutations occur and build up in the different populations over time. The different variations of genes may lead to different characteristics between the two populations.
3. The populations become so different that members of the different populations can no longer breed with each other anymore if were they to be in the same habitat in the same time. If this is the case, allopatric speciation has occurred.

Example

Grand Canyon Squirrels

When the Grand Canyon was formed, it created a natural barrier between the squirrels living in the area. About 10,000 years ago, the squirrel population was separated from each other by this geographic change and could no longer live in the same area. Over thousands of years, the

divided squirrel populations became two different species. Kaibab squirrels live on the north rim of the canyon and have a small range, while Abert squirrels live on the south rim and live in a much larger range. Members of these two species have a similar size, shape, and diet, and slight color differences, but they are no longer in contact with each other and have become so different during their separation that they are now separate species.

Sympatric speciation

Sympatric speciation is speciation that occurs when two groups of the same species live in the same geographic location, but they evolve differently until they can no longer interbreed and are considered different species. It is different from other types of speciation, which involve the formation of a new species when a population is split into groups via a geographic barrier or migration. Sympatric speciation can be seen in many different types of organisms including bacteria, cichlid fish, and the apple maggot fly, but it can be difficult to tell when sympatric speciation is occurring or has occurred in nature.

Sympatric speciation is unique because it takes place while two subpopulations of the same species are occupying the same range or in a range that highly overlaps. Even though the territory that the organisms live in is the same, they are able to split into two different groups that eventually become so genetically different from one another that they can no longer breed with each other. When one group can no longer breed with another, it is a separate species.

Example

In Cichlids

Another example of sympatric speciation is found in two species of Midas cichlid fish (*Amphilophus* species), which live in Lake Apoyo, a volcanic crater lake in Nicaragua. Researchers analyzed the DNA, appearance, and ecology of these two closely related species. The two species, though overall very similar, do have slight differences in appearance, and they cannot interbreed. All available evidence suggests that one species evolved from the other, which

is the species of Midas cichlids that originally colonized the lake. The newer species evolved relatively recently, but in evolutionary terms, this means that it is thought to have evolved less than 10,000 years ago.

EXTINCTION

Extinction, in biology, the dying out or termination of a species. Extinction occurs when species are diminished because of environmental forces (habitat fragmentation, global change, overexploitation of species for human use) or because of evolutionary changes in their members (genetic inbreeding, poor reproduction, decline in population numbers).

Many species have become extinct because of hunting and overharvesting, the conversion of wetlands and forests to croplands and urban areas, pollution, the introduction of invasive species, and other forms of human-caused destruction of their natural environments. Indeed, current rates of human-induced extinctions are estimated to be about 1,000 times greater than past natural (background) rates of extinction, leading some scientists to call modern times the sixth mass extinction. This high extinction rate is largely due to the exponential growth in human numbers: from about 1 billion in 1850, the world's population reached 2 billion in 1930 and more than 6 billion in 2000, and it is expected to reach about 10 billion by 2050. As a result of increasing human populations, habitat loss is the greatest factor in current levels of extinction. For example, less than one-sixth of the land area of Europe has remained unmodified by human activity, and more than half of all wildlife habitat has been eliminated in more than four-fifths of countries in the paleotropics (the Old World tropics that span Africa, Asia, and Indonesia).

In addition, increased levels of greenhouse gases have begun to alter the world's climate, with slowly increasing surface temperatures expected by the middle of the

21st century to force many species to migrate toward the poles and

up mountain slopes in order to remain in habitats with the same climate conditions. Most ecologists, conservation biologists, and climate scientists worry that global warming will contribute greatly to species extinctions. For example, one study released in 2015 that examined 130 extinction models from previous studies predicted that 5.2 percent of species would be lost as a result of global warming alone with a rise in average temperatures of 2 °C (3.6 °F) above temperature benchmarkstaken before the start of the Industrial Revolution. The study also predicted that about 16 percent of Earth's species would be lost if surface warming increased to

about 4.3 °C (7.7 °F).

Overexploitation from hunting and harvesting also has adversely affected many species. For example, about 20 million tropical fish and 12 million corals are harvested annually for the aquarium trade, depleting natural populations in some parts of the world.

All these factors have increased the numbers of threatened species. Almost one in four mammal species, including four of the six remaining species of great apes, and one in eight bird species were considered at significant risk of extinction at the start of the 21st century. In addition, the World Wildlife Fund noted in a 2016 report that vertebrate populations overall declined by 58 percent between 1970 and 2010.

International co-operation and assistance is needed in capacity building to remodel available livestock farms/research stations to conserve and develop genetic resources. This will enhance the sustainable use of indigenous resources. This will also help develop new stations / live animals gene banks to conserve the breeds' in-situ.

Expertise is required in animal breeding and computations for developing recording, evaluation and reporting systems such as BREEDPLAN for Nili-Ravi and Kundhi buffaloes and Sahiwal and Red Sindhi cattle. Animal Information System is required to monitor breed statistics. International support is required in molecular genetics training at M.Sc / Ph.D level for genetic characterization of breeds and identification of qualitative and quantitative markers of economic traits.

Short courses for planners, researchers and for people in development and execution of breeding strategies and conservation programs are also needed. Collaborative efforts are needed to define the available non-descript populations to definite breeds and their economic valuation in almost all species.

A wide range of genetic and agronomic strategies should be employed to minimize crop uniformity and consequent susceptibility. Programs of genetic enhancement should be developed

to make diverse germplasm resources useful to crop breeders. Research is needed to elucidate the components for establishing viable and genetically diverse populations of wild species. Biotechnology research efforts should focus on developing enhanced methods for characterizing, managing, and using genetic resource. All nations and international agencies need to pool their limited resources and collaborate on the myriad facets of genetic conservation. Worldwide concern demands that periodic assessment and monitoring of collaborative activities be required in the future to ensure maintenance and use of genetic resources, our common biological heritage.

PROTECTED AREAS

The IUCN definition of a protected area is "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values". (for more information and background see the definition of Protected area).

The term protected area refers to a very wide range of land and water management types that have some value for biodiversity and landscape conservation. Designating areas for protection is a cornerstone strategy of biodiversity conservation [1] and the practice and concept of protected areas has evolved over time. Countries around the world have extensive systems of protected areas which vary considerably, depending on national needs and priorities, and on differences in legislative, institutional and financial resources.

Protected areas can be found across different environments from the mountains to sea, across deserts, forests, freshwater lakes and even national boundaries (territories). They are known by a multitude of names in different countries ranging from national park, nature reserve, wilderness area, wildlife management area, tourism management areas and ecological stations to sacred groves. Many of these nationally designated protected areas also form part of international protected area systems created under global conventions (e.g. World Heritage sites) and regional agreements (e.g. Natura 2000 sites in Europe). The mechanism and degree of protection varies

considerably across types of protected area. For detailed information on each type of protected area, please browse the pages in the ‘Protected Areas’ category of the Areas theme.

History

The earliest types of protected areas for the conservation of resources can be traced back to around 200 BC when land owned by royalty was designated as private hunting reserves.[3] Gradually, protected areas were opened or created for public recreational use. One of the earliest modern protected areas is considered to be Yellowstone National Park, designated in 1872 as a ‘public park or pleasuring ground for the benefit and enjoyment of the people’.

Concern for the loss of biodiversity increased in the early 1900s, and the international recognition of protected areas as a tool for conservation gained prominence in the 1950s. In 1962, the First Conference on National Parks was held and the first UN List of National Parks and Equivalent Reserves that amalgamated all of the world’s protected areas was produced. During the 1970s, several global multilateral environmental agreements were adopted such as the World Heritage Convention, the Convention on Wetlands of International Importanceand the Birds Directive in the European Union. These agreements are still highly regarded today and form the basis of the legal structures that protect some of the most important areas of biodiversity.

During the 1980s, several regional frameworks for the protection of biodiversity were adopted such as the Barcelona Convention for the protection of Mediterranean areas. The adoption of the Convention of Biological Diversity in 1992 set internationally agreed targets for increasing the global area covered by protected areas. These targets have been important catalysts in the upwards trend of protected area designations, such as the marked increase in marine protected areas that has been observed since the early 2000s.

Coverage

According to the World Database on Protected Areas (WDPA) there are over 210,000 protected areas around the world. The proportion of areas protected globally (percentage of terrestrial area

and territorial waters up to 12 nautical miles) amount to 11.9%. The proportion of terrestrial areas protected amounts to 12.9% and marine areas to 6.3%, as recorded in WDPA for 2009

Critaria

The criteria used to define protected areas vary widely, depending on the objective and on the mechanisms behind the establishment of the protected area. They are usually locations of significant environmental, cultural or natural value that in most cases have some form of management authority in place for their protection. For the criteria associated with different types of protected area, please see the relevant section in the areas under the 'Protected Areas' category.

Management

Governance types

Protected areas can be under the control and responsibility of a range of actors. Governance types describe the different means of management authority and responsibility that can exist for protected areas but they do not necessarily relate to ownership. These 'governance' types have been categorized by IUCN as the following:

1. Governance by government. This includes federal, national or sub-national ministry or agencies in charge as well as government delegated management (e.g. to an NGO).
2. Shared governance (often termed co-management). This includes transboundary management between more than one government as well as collaborative and joint management that can take place between government and non-governmental actors.
3. Private governance. This includes areas declared and run by individual land-owners, non-profit organisations and for-profit organisations.
4. Governance by indigenous peoples and local communities. This includes indigenous peoples protected areas and territories and community conserved areas

As protected areas are created for a range of purposes, there are a wide variety of management approaches applied. These vary from those which are highly protected sites

where few if any people are allowed to enter, to much less restrictive approaches where conservation is integrated with traditional and sustainable human activities and practices. Some protected areas ban activities like food collecting, hunting or extraction of natural resources while for others it is an accepted and even a necessary part of management. For detailed management practices associated with different types of protected area, please see the relevant section in the areas under the 'Protected Areas' category.

Legal and compliance

The classification of a protected area which meets the IUCN definition requires that such areas are managed for conservation by legal or other effective means, and therefore legal recognition and protection at the national or sub-national level is likely to be present in these sites, although not compulsory if other means of conservation are in place (e.g. through recognition of land tenure). The level of legal protection and enforcement will vary between countries, and will depend on the governance type of the area that receives differing levels of recognition by government in different countries. Nonetheless, a number of national laws are likely to apply to these sites which control economic activities in order to maintain the conservation values.

Protected areas are typically designated by national governments. The basis for their designation may be:

1. National – designated under national law, as part of the protected areas system established within the country to meet national goals and priorities. The majority of protected areas are created in this way.
2. Regional – designated in order to fulfil a national commitment to a regional convention or agreement which the government of the country has signed. Existing protected areas may be put forward, or new protected areas created to meet such obligations.. Examples include, but are not limited to:

- Specially Protected Areas of Mediterranean Importance (established under the Barcelona Convention for Mediterranean countries)
- Natura 2000 (established under legislation applying to all member states of the European Union)

3. International – designated in order to fulfil a national commitment to an international convention or agreement which the government of the country has signed. In common with Regional-level sites, existing protected areas may be put forward, or new protected areas created to meet such obligations. The three international conventions or programmes under which protected areas are designated are:

- Convention on Wetlands of International Importance, Especially as Waterfowl Habitats (Ramsar Convention)
- The Convention Concerning the Protection of the World Cultural and Natural Heritage (UNESCO World Heritage Convention)
- UNESCO Man and the Biosphere Programme.

In areas designated at a national level, legal protection is granted by the national legal instruments in place. Areas designated under regional or international agreements are protected if the state ratifies the relevant Convention, which means that the state consents to being bound to the treaty. The criteria of the convention may state that the site must be legally protected in order for it to be regarded as designed under the convention. For example, for a site to be inscribed on the UNESCO World Heritage List a site must have been given legal protection at the national level [7]. However not all conventions require legal protection as one of their designating criteria. It is not a criteria within the Ramsar Convention for sites to be legally protected, although many governments do extend legal protection to these areas in recognition of their value [8].

As designated protected areas, these sites receive international attention and have been incorporated into a number of environmental safeguard standards. These include those of multilateral financial institutions including the World Bank, the International Finance Corporation, the European Investment Bank, the Asian Development Bank, the European Bank for Reconstruction and Development and the Inter-American Development Bank. Such standards often require that no project activities are accepted within or around these areas unless they do not adversely impact the area and are compatible with the conservation aims of the protected area. In cases where projects are eligible for funding, additional requirements often apply, including consultation with and informed consent by stakeholders and managers, as well as the implementation of additional programs to enhance the conservation aims of the protected

area. These standards often refer to those that have been designated as well as areas officially proposed for protection.

In addition, a number of sector specific safeguard standards refer to protected areas, many of which are related to certification programs, such as the Roundtable on Sustainable Biomaterials (RSB), the Alliance for Responsible Mining (ARM) and the Responsible Jewellery Council (RJC), which require members to identify and respect legally protected areas. Protected areas form one of the values of the High Conservation Value (HCV) approach and are therefore included in a number of certification programmes and standards that adopt this approach requiring that such values are maintained or enhanced. These include the Roundtable on Sustainable Palm Oil (RSPO), the Forest Stewardship Council (FSC) , and the Round Table on Responsible Soy Association (RTRS) and the Climate, Community and Biodiversity Alliance (CCBA).

Biodiversity importance – The actual biodiversity criteria used to identify and designate protected areas will vary between countries and between areas, however all protected areas meeting the IUCN definition must be designated "to achieve the long-term conservation of nature". The specific biodiversity values to be protected and conserved will vary significantly between areas, and further surveys and detailed information will be required to support site-scale assessment and decision making.

Socio-cultural values – The social, economic and cultural values also vary significantly and site level information is required to determine the socio-cultural values of each protected area, which could be considerable.

Protected Area Categories

IUCN protected area management categories classify protected areas according to their management objectives. The categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

IUCN Protected Area Categories System

Ia Strict Nature Reserve: Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring

Ib Wilderness Area: Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park: Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

III Natural Monument or Feature: Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area: Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape: A protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources: Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural

resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

NATIONAL PARKS

A **national park** is a park in use for conservation purposes. Often it is a reserve of natural, semi-natural, or developed land that a sovereign state declares or owns. Although individual nations designate their own national parks differently, there is a common idea: the conservation of 'wild nature' for posterity and as a symbol of national pride.[1] An international organization, the International Union for Conservation of Nature (IUCN), and its World Commission on Protected Areas, has defined "National Park" as its *Category II* type of protected areas.

In Pakistan a National Park is an area of outstanding scenic merit and natural beauty where the landscape, flora and fauna are protected and preserved in a natural state. Public access for recreation, education and research is provided for. Access roads and other facilities should be planned so they do not conflict with the main objectives of national parks. Hunting wild animals is prohibited, as is firing gun or otherwise interfering with animals and plants. Clearing land for cultivation, mining or allowing polluted water to flow in National Parks is also prohibited. Under the regulations, these acts may be allowed for scientific purposes or to improve the park

Following are the major National Parks of Pakistan

- Hingol National Park
- Hazarganji Chiltan National Park
- Kirthar National Park
- Lal Suhanra National Park
- Margalla Hills National Park
- Ayubia National Park
- Deosai National Park
- Chitral Gol National Park
- Khunjerab National Park

- Machiara National Park

Hingol National Park :

Hingol National Park spread over an area of about 1,650 square km along the Makran Coast, Balochistan is the largest of National Parks of Pakistan, and is located approximately 190 kilometres from Karachi. The area was for the first time declared reserved in 1988. The park area covers parts of the three districts of Lasbela, Gawader and Awaran of Balochistan province containing a variety of topographical features and vegetation, varying from arid sub tropical forest in the north to arid montane in the west. Large tracts of the NP are covered with drift sand and can be classified as coastal semi desert. The National Park includes the estuary of the Hingol river which supports a significant diversity of bird and fish species.

Hingol is known to support threatened invertebrates in addition to a variety of bird species. The River Hingol has been nurturing crocodiles for centuries. The Marsh Crocodile, Olive Ridley and Green Marine Turtles, endemic and threatened species of fish, such as the Mahasheer occur and schools of Plumbeous Dolphins (Sousa plumbea) are known from close in-shore areas. The park is an excellent habitat to wild animals including over 3000 ibexes, and 1500 Urials and more than 1200 Chinkara, besides number of resident and migratory birds. The Houbara Bustard (Chlamydotis undulata), Dalmatian and Spot-billed Pelican (Pelecanus philippensis) are regular visitors to the area.

Mammals in the park include Sindh Leopard, Indian Fox, Jungle Cat, Jackals, Sind Wild Goat, Blandford's Urial, Chinkara Gazelle, Honey Badger, Indian Pangolin, Hedgehog, Porcupine, Indian Grey Mongoose, Cairo Spiny mouse and the Rock Mouse. As for the birds, Houbara Bustard, Dalmatian and Spot-billed Pelican, Lagger Falcon, Red-headed merlin, Kestrel, Grey Partridge, See See Partridge, , Eagle owl , Sind pied woodpecker, Hume's chat, Brown rock pipit, Striped Buning, Finche Larks, Hoopoe, Shrikes and Wheatears. Beside Bonnelli's, Imperial Tawny and Golden Eagle are also found here. There are three varieties of vultures, namely Eurasian Griffon Vulture, Egyptian Vulture and the Cinereous Vulture. As for sand grouse, there are many varieties like Stone Curlew, Indian, Coroneted, Painted and Close-Barred Sand Grouse.

Hazarganji Chiltan National Park

Spread over 38,429 acres, Hazarganji Chiltan National Park, is another beautiful national park of Pakistan. "Hazarganji" literally means "Of a thousand treasures".This park was primarily established to provide refuge to the endangered Chiltan wild goat or Markhor. In the 1950s it was said to exceed 1,200, but in November 1970 the population was estimated to number about 200, based on a total count of 107 individuals. At present the total population of the Chiltan wild goat is estimated to be about 800. The Suleiman markhor is also present in the northern part of the Chiltan Range and a few urial still survive on the western slopes between 1,500m and 2,100m. Carnivores include Stripped hyena and Red fox.

Other mammals in the park include Indian wolf, Leopard, Caracal, Jackal, Red fox, Porcupine and Desert hare. Houbara bustard, Griffon vulture, Egyptian vulture, Honey buzzard, Laggar falcon, Peregrine falcon, Kestrel, Indian sparrow hawk, Scops owl, Common cuckoo, European bee-eater, Rock partridge, European nightjar, Long-billed pipit, Orphean warbler, Variable wheatear, Blue rock thrush, Stonechat, and Lichtenstein's desert finch are some of the bird species found in the park.Reptiles in the park include Monitor lizard, Russell's viper, Saw scaled viper and Spiny tailed lizard**.**

Kirthar National Park

Kirthar National Park is the the second largest national park of Pakistan spread over an area of 3000 square kilometres. Kirthar was designated a national park by the Sindh Wildlife Department in 1974, the first of Pakistan's parks to be included in the UN's listing of National Parks of 1975. The rolling valleys and rugged lines of the Kirthar hills form a natural haven for Urial sheep, Ibex and Chinkara gazelle. Jungle cats, desert cats and even the occasional leopard or desert wolf also prowl the park. Pangolin (scaly anteaters), porcupines and monitor lizards abound the park area. The best season to visit the park is from October to February, since in summers it is scorching hot. However, it is the greenest in August during the monsoons.

Lal Suhanra National

Park was declared a national park on 26 October 1972, following recommendations made by the Wildlife Enquiry Committee in 1971. Blackbuck became virtually extinct in the Cholistan Desert but the species has been re-introduced in Lal Suhanra within large enclosures, together with Chinkara gazelle, Nilgai antelope, Hog deer and Indian rhinoceros. There is big lake in the center of the park called Patisar Lake, which is ideal for bird watching. Patisar Lake regularly holds between 10,000 and 30,000 ducks and common coot in mid-winter. Over 13,00 waterfowl were present in January 1987. The park also supports a large population of birds of prey.Beside Black Buck, Nilgai antelope is also being bred in the Park. Recently a pair of rhinos has been added. The best attraction is the lion safari to see the lions in their natural habitat from close quarters. One lion with four lionesses roam freely and one can go as close as the photograph above. But one is not advisable to get out of the vehicle since these lions are wild and can devour on anything live and close.

Mammals in the park include Long-eared Hedgehog, , Black buck, Chinkara gazelle, Hog deer, Red fox, Bengal Fox, Golden Jackal, Porcupine, Caracal cat, Mongoose, Jungle cat, Indian Wolf, Wild boar, Honey Badger, Little Civet, Indian (Black-naped) Hare, Smooth-coated Otter and Indian rhino.

As for birds more than 160 species are found in the jungle, some of the notable birds are Houbara bustard, Griffon vulture, Honey buzzard, Marsh harrier, Hen harrier, Laggar falcon, Peregrine falcon, Kestrel, Indian sparrow hawk, Egyptian vulture, Larks, Shrikes, Wheatears and Barn Owl. Reptiles in the park are Monitor lizard, Russell's viper, Indian cobra, Saw scaled viper, Wolf snake, John's sand boa and Spiny tailed lizard.

Margalla Hills National Park

Margalla Hills National Park, is located in the foothills of the Himalayan range. The topography is rugged, with numerous valleys and many steep and even precipitous slopes. The park was setup to provide refugee to the Gray Goral, Barking deer and the Leopard. Protection to these animals have benefited other unusual and interesting smaller animal as well. Margalla Hills Park

provides an excellent opportunity for bird watching. A Cheer Pheasant hatchery has been established at Chak Jabri and Dhok Jewan to raise captive Cheer pheasants that have become extinct in the hills. These are then released in the wild.

Asiatic leopard, Wild boar, Golden Jackal, Rhesus Macaque, Leopard cat, Gray Goral sheep, Barking deer, Chinkara gazelle, Red fox, Pangolin, Porcupine, Yellow throated marten and Fruit bats are some of the mammals found in the park. Birds in the park include Himalayan Griffon vulture, Laggar falcon, Peregrine falcon, Kestrel, Indian sparrow hawk, Egyptian vulture, White cheeked bulbul, yellow vented bulbul, Paradise flycatcher, Black partridge, Cheer pheasant, Khalij pheasant, Golden oriole, Spotted dove, Collared dove, Larks, Shrikes, Wheatears and buntings.

Besides, a number of species of reptiles like the Russell's viper, Indian cobra, Himalayan pit viper and Saw scaled viper are also found in Margalla Hills Park.

Wildlife sanctuary

A wildlife sanctuary, is a naturally occurring sanctuary, such as an island, that provides protection for species from hunting, predation, competition or poaching; it is a protected area, a geographic territory within which wildlife is protected. Refuges can preserve animals that are endangered.

The main difference between a wildlife sanctuary and a national park is that human activities are not at all allowed in a national park. On the other hand, rights of some limited human activities are provided within the boundary of a sanctuary.

Importance of Wildlife Sanctuaries

- Sanctuary is created for the purpose of protecting endangered species with a limited territorial range
- Endangered species in wildlife sanctuaries are typically closely monitored
- Wildlife sanctuaries offer wildlife rehabilitation

- Wildlife sanctuaries help to preserve and bring back endangered species by giving them a natural environment to live in while they are in no danger of predetors or humans.
- Wildlife sanctuaries also educate people about the creatures sothat they can maybe help in preserving them

Wildlife Sanctuaries of Pakistan are;

- Baltistan Wildlife Sanctuary
- Chasma and Taunsa Barrage Dolphin Sanctuary
- Cholistan Wildlife Sanctuary
- Hab Dam Wildlife Sanctuary
- Kargah Wildlife Sanctuary
- Mahal Kohistan Wildlife Sanctuary
- Naltar Wildlife Sanctuary
- Nara Desert wildlife Sanctuary
- Rann of Kutch Wildlife Sanctuary

Runn of Kutch Wildlife Sanctuary,

Runn of Kutch Wildlife Sanctuary, spread over 566,375 ha is part of the great Thar desert and comprises stabilized sand dunes, some more than 170m in height, with broad inter-dunal valleys of alluvial soil, integral with the large Rann of Kutch across the frontier with India, which includes permanent saline marshes, coastal brackish lagoons, tidal mudflats, and estuarine habitats. The site supports many locally and globally threatened species, including the Great Indian bustard, Houbara bustard, Sarus crane, and hyena and supports more than 1% of the biogeographical population of flamingos. Some 500,000 agro-pastoralists live in 330 villages/hamlets in the site area, and rich archaeological remains include three giant temples dating from 1375-1449. Scarcity of water remains the potential threat to the ecosystem. WWF-Pakistan and Sindh authorities have carried out work with GEF funding and a management plan is in preparation. The other wildlife in the sanctuary include Peafowl, Storks, Chinkara Gazelle, Blue bull (Nilgai), Pangolin, Desert Wolf and Desert Cat. This area used to have the only population of the Indian Wild Ass or Onager in Pakistan. Unfortunately they are thought to have

been exterminated. spread over 566,375 ha is part of the great Thar desert and comprises stabilized sand dunes, some more than 170m in height, with broad inter-dunal valleys of alluvial soil, integral with the large Rann of Kutch across the frontier with India, which includes permanent saline marshes, coastal brackish lagoons, tidal mudflats, and estuarine habitats. The site supports many locally and globally threatened species, including the Great Indian bustard, Houbara bustard, Sarus crane, and hyena and supports more than 1% of the biogeographical population of flamingos. Some 500,000 agro-pastoralists live in 330 villages/hamlets in the site area, and rich archaeological remains include three giant temples dating from 1375-1449. Scarcity of water remains the potential threat to the ecosystem. WWF-Pakistan and Sindh authorities have carried out work with GEF funding and a management plan is in preparation. The other wildlife in the sanctuary include Peafowl, Storks, Chinkara Gazelle, Blue bull (Nilgai), Pangolin, Desert Wolf and Desert Cat. This area used to have the only population of the Indian Wild Ass or Onager in Pakistan. Unfortunately they are thought to have been exterminated.

Chasma and Taunsa Barrage Dolphin Sanctuary

Chashma and Taunsa Barrage are declared Wildlife Sanctuaries by the Punjab government. A very important breeding, staging and wintering area for a wide variety of waterfowl, including at least one threatened species (Marmaronetta angustirostris). Mid-winter waterfowl counts in recent years have regularly exceeded 20,000 birds. The endangered Indus Dolphin (Platanista indi) occurs in the river both upstream and downstream of the barrage. Since the 1970s, the population of the Indus Dolphin has significantly increased here.

Cholistan Wildlife Sanctuary

Cholistan Wildlife Sanctuary is part of the Cholistan desert in the south eastern portion of the province of Punjab and contains some of the most rare and interesting wildlife in Pakistan. Some of the rare animals of this region are Desert wolf (rare), Indian fox, Red fox, Jackal, Small Indian civet, Small Indian mongoose, Indian grey mongoose, Indian desert cat, Jungle cat, Caracal cat, Chinkara grazelle, Blackbuck, Nilgai antelope, Houbara bustard, Peregrine falcon, Saker falcon, Black backed vulture, Indian cobra, Monitor lizard, Saw scaled viper and Russells viper.

Zoological Parks in Pakistan

A zoo (short for zoological garden or zoological park and also called an animal park or menagerie) is a facility in which animals are housed within enclosures, displayed to the public, and in which they may also breed.

Importance of Zoological Parks in Pakistan

- Zoos provide the opportunity for people to see a glimpse of this side of nature.
- Zoo plays important role in conservation of many threatened/endangered species
- Wild animals in captivity help us manage and conserve them in the wild.
- Zoos raise money for conservation efforts.
- Zoo provides area for recreational purposes

List of some famous zoo in Pakistan

- Bahawalpur Zoo
- Changa Manga Wildlife Park
- Clifton Fish Aquarium
- Hyderabad Zoo
- Islamabad Zoo
- Jallo Wildlife Park
- Karachi Safari Park
- Karachi Zoo
- Lahore Walkthrough Aviary
- Lahore Zoo
- Lahore Zoo Safari

Bahawalpur zoo

established in 1942, is a 25-acre (10 ha) zoological garden in Bahawalpur, Punjab, Pakistan.[1] It is managed by the Government of Pakistan. The zoo has occasionally bred and supplied wild cats, such as Asiatic lions and Bengal tigers, to other zoos in the country. It also has an aquarium and zoological museum with stuffed birds, reptiles and mammals. The exhibits are a mix between old style cages and newer moated enclosures. One older exhibit houses a pair of domestic cats, jackals, and an Indian civet cat. Crocodiles are kept in a large outdoor enclosure. lions, tigers, and hyenas are housed in more modern moated enclosures. A large pond in the zoo is home to pelicans, cranes, and geese. Several peafowl are also on exhibit. Blackbuck, hog deer, nilgai, European red deer, chinkara, and European mouflon are all housed in large paddocks.

The zoo also includes a museum with stuffed animals, including what is claimed to be the last lion shot in the Punjab

Lahore Safari Zoo

The Woodland Wildlife Park was established in 1981 over 242 acres (98 ha) as a government funded public facility. In 1998, it was handed over to the Punjab Wildlife and Parks Department (PWPD) by the Forest Department. In 2006, Government of Pakistan sanctioned 87 million Pakistani rupees to reconstruct the 2 kilometres (1.2 mi) road leading to the wildlife park. This development increased the accessibility to the facility.

The species housed here include Indian peafowl, Bengal tiger, common pheasant, emu, lion, mute swan, nilgai, ostrich and silver pheasantamong a few others. Largest walkthrough aviary of Pakistan is located in the Lahore Zoo Safari. Boating and fishing facilities have been developed near a lake. The lake is the biggest in the city, complete with four islands. There are also safari tracks in the lion and Bengal tiger areas, covering an area of 80 acres (32 ha). It has been recently renamed as Lahore Safari Zoo.

Conservation of genetic resources through mapping of existing biological diversity

Biological diversity (biodiversity) is the variability among living organisms: within and between species and ecosystems. Biodiversity is considered as the foundation of agriculture being the source of all crops and livestock species that have been domesticated and bred since the beginning of agriculture approximately 10,000 years ago. Crops like corn and wheat were inedible wild crops but through years of domestication, edible varieties have been made available as important commodities. At present, loss of specific species, groups of species (extinction) or decrease in number of particular organisms (endangerment) are taking place in different parts of the world at a rapid pace. These losses are often manifestations of degradation or destruction in the ecosystem or habitat. According to the Food and Agriculture Organization of the United Nations (FAO), it is estimated that about three-quarter of the genetic diversity in agricultural crops have been lost over the last century due to various reasons such as combination of different agricultural production systems and globalization.

DNA Banks

More plant conservationists are turning to DNA technologies to have effective conservation strategies. The DNA bank is an efficient, simple and long-term method used in conserving genetic resource for biodiversity. Compared to traditional seed or field gene banks, DNA banks lessen the risk of exposing genetic information in natural surroundings. It only requires small sample size for storage and keeps the stable nature of DNA in cold storage. Since whole plants cannot be obtained from DNA, the stored genetic material must be introduced through genetic techniques. In vitro techniques are also valuable for conserving plant biodiversity. Such techniques involve three basic steps: culture initiation, culture maintenance and multiplication, and storage. For medium-term storage (few months to few years), slow growth strategies are applied. For undefined time of storage, cryopreservation is applied. In cryopreservation, plant tissues are processed to become artificial seeds and stored at very low temperatures to impede growth. Cryopreservation allows 20 percent increase in regeneration process compared to other conservation methods.

Molecular Markers

Molecular markers are used to map out the genetic base of crops and select favorable traits to

come up with a better germplasm for growers. Molecular markers are short strings or sequence of nucleic acid which composes a DNA segment that are closely linked to specific genes in a chromosome. Thus, if the markers are present, then the specific gene of interest is also present. Marker-assisted selection (MAS) such as single nucleotide polymorphisms (SNPs), is widely used in different agricultural research centers to design genotyping arrays with thousands of markers spread over the entire genome of the crops. After observing the desired traits in selected plants, these are then incorporated through modern or conventional breeding methods in existing crop varieties. Generated plants with the desired trait may be tested in the field for agronomic assessment and resistance screening against pests and diseases. Selected plants plants will be multiplied through tissue culture and other techniques. Recent advances in genomic, proteomic and metabolomic research offer unique opportunities for the search, identification, and commercial utilization of biological products and molecules in the pharmaceutical, nutraceutical, agricultural, and environmental sectors.

DNA and Protein Profiling

To come up with effective conservation management programs for endangered crop varieties, it is important to evaluate their genetic relatedness and distances from other relatives. Such information could be derived through DNA profiling commonly conducted through electrophoresis. Through this method, an individual organism is identified using unique characteristics of its DNA. DNA profiling depends on sections of the DNA that do not code for a protein. These areas contain repetitive sections of a sequence called short tandem repeats (STRs). Organisms inherit different numbers of repeated sequences from each parents and the variation in the number of repeats within an STR lead to DNA of different lengths. The targeted STR regions on the DNA are multiplied through polymerase chain reaction (PCR) and then separated by electrophoresis in a genetic analyzer. The analyzer is composed of a gel-filled capillary tube where DNA travels. When electric current is passed through the tube, the DNA fragments move through the gel tube by size (smallest travels first). The digital output of the analyzer is read and interpreted through a genotyping software. Proteins are involved in different important processes within the cell. The entire set of proteins in a cell is referred to as proteome, and the study concerned with how proteins work and assembled is called proteomics. Proteomics is based on the endproducts of gene activity: the protein patterns formed from unique genetic activities. Through two-dimensional acrylamide gel electrophoresis (2DE), complex mix of proteins is

sorted in based on each protein's specific combination of charge and molecular weight. These patterns are standard for protein discovery because the same proteins would migrate at the same points on the gel. The protein bands are developed in digital images and then analyzed in mass spectrometers.

CRYOPRESERVATION

Cryo-preservation or cryo-conservation is a process where organelles, cells, tissues, extracellular matrix, organs or any other biological constructs susceptible to damage caused by unregulated chemical kinetics are preserved by cooling to very low temperatures(typically −80 °C using solid carbon dioxide or −196 °C using liquid nitrogen). Cryopreservation is based on the ability of certain small molecules to enter cells and prevent dehydration and formation of intracellular ice crystals, which can cause cell death and destruction of cell organelles during the freezing process. Two common cryoprotective agents are dimethyl sulfoxide (DMSO) and glycerol. Glycerol is used primarily for cryoprotection of red blood cells, and DMSO is used for protection of most other cells and tissues. A sugar called trehalose, which occurs in organisms capable of surviving extreme dehydration, is used for freeze-drying methods of cryopreservation. Trehalose stabilizes cell membranes, and it is particularly useful for the preservation of sperm, stem cells, and blood cells.

Mechanism of cryopreservation

The cryopreservation technique followed by the regeneration of plants involves following steps :

Freezable tissues

Generally, cryopreservation is easier for thin samples and small clumps of individual cells, because these can be cooled more quickly and so require lesser doses of toxic cryoprotectants. Therefore, cryopreservation of human livers and hearts for storage and transplant is still impractical.

Nevertheless, suitable combinations of cryoprotectants and regimes of cooling and rinsing during warming often allow the successful cryopreservation of biological materials, particularly cell suspensions or thin tissue samples. Examples include:

- Semen in semen cryopreservation
- Blood
    - Special cells for transfusion

    - Stem cells. It is optimal in high concentration of synthetic serum, stepwise equilibration and slow cooling.
    - Umbilical cord blood
- Tissue samples like tumors and histological cross sections
- Eggs (oocytes) in oocyte cryopreservation
- Embryos at cleavage stage (that are 2, 4 or 8 cells) or at blastocyst stage, in embryo cryopreservation
- Ovarian tissue in ovarian tissue cryopreservation
- Plant seeds or shoots may be cryopreserved for conservation purposes.

Risk

Phenomena which can cause damage to cells during cryopreservation mainly occur during the freezing stage, and include: solution effects, extracellular ice formation, dehydration and intracellular ice formation. Many of these effects can be reduced by cryoprotectants. Once the preserved material has become frozen, it is relatively safe from further damage. However, estimates based on the accumulation of radiation-induced DNA damage during cryonic storage have suggested a maximum storage period of 1000 years.

Solution effects

As ice crystals grow in freezing water, solutes are excluded, causing them to become concentrated in the remaining liquid water. High concentrations of some solutes can be very damaging.

Extracellular ice formation

When tissues are cooled slowly, water migrates out of cells and ice forms in the extracellular space. Too much extracellular ice can cause mechanical damage to the cell membrane due to crushing.

Dehydration

Migration of water, causing extracellular ice formation, can also cause cellular dehydration. The associated stresses on the cell can cause damage directly.

Intracellular ice formation

While some organisms and tissues can tolerate some extracellular ice, any appreciable intracellular ice is almost always fatal to cells.

RULES & REGULATIONS:

International Treaties

Pakistan is signatory to a large number of international treaties and conventions. These are listed below.

1. Convention on biological diversity, 1992
2. Cartagena protocol on Bio Safety, 2001
3. CITES, 1973
4. Ramsar Convention, 1971
5. Convention on the conservation of migratory species, 1981
6. UNFCC, 1997

Statutes

1. Pakistan Environmental Protection Act, 1997:

It provides for the protection, conservation, rehabilitation and improvement of the environment; for prevention and control of pollution and for the protection of sustainable development.

3. Pakistan Penal Code, 1860:

The polluter of the environment can be punished under this code for certain types of pollution. These pollutions are of following types;

- Punishment for water pollution
- Punishment for atmospheric pollution
- Punishments for general pollution

It will be proper to discuss the concept of general pollution under the heads

- Public nuisance
- Spread of Infection
- Adulteration of Food, Drink and Drugs
- Negligent Handling of Poisons
- Combustibles and Explosives
- Act Endangering Human Life

- Personal Safety of Others
- Mischief

All these have different punishments under the Pakistan Penal Code.

4. Forest Act, 1927;

This law empowers provincial governments to manage forests under their area. The government can reserve the state-owned forest land, assume control of privately owned forest land and declare any government owned land in a protected area. It prohibits the clearing of forest for cultivation, grazing, hunting, removing forest produce, quarrying and felling, lopping and topping of tree, branches in reserved or protected areas.

5. Pakistan Terrestrial Water & Maritime Zones Act, 1976;

It includes provisions for preservation, development and protection of marine environment and control of marine pollution and exploration, development, conservation and management of living resources in Pakistan's Exclusive Economic Zone (EEZ) .A ship carrying nuclear and hazardous substances will have to inform the Government of Pakistan.

6. The Agricultural Pesticide Ordinance, 1971;

It allows for the registration and control of pesticides use but there is no specific legislation for the use of fertilizers. It regulates the importation, manufacture, distribution, sale and use of pesticides for agriculture including plant growth regulations and there use in forestry. These rules were amended in 1984.These rules establish the Agricultural Technical Advisory Committee (APTA) for carrying out the registration of pesticides. APTA obtains information about the product including name, composition, active ingredients, efficacy, labeling and direction of use as well as methods for analysis of disposal of surplus pesticides and packaging.

7. **The Canal & Drainage Act, 1873;**

It seeks to regulate and control the development of irrigation and distribution of supplies.

8. Explosives Act, 1884

This act is to regulate the manufacture, possession, use, transport, sale and importation of explosives. Explosives mean gunpowder, nitroglycerine, dynamite, gun-cotton; blasting powders, fulminate of mercury or of other metals, colored fires and every other substance etc. Explosives include fog-signal, fireworks, fuses, rockets, detonators, ammunitions and percussion caps etc.

11. West Pakistan Fisheries Ordinance, 1961;

It is an ordinance to amend and consolidate the law relating to fisheries in the West Pakistan. It says that no person will be allowed to use dynamite, pesticides or other explosives for catching the fish. Government can declare any water area as sanctuary. Then there will be no permit for fishing except some license. An Inspector of Fisheries may without a warrant arrest any person committing in his view any offence under section 6, 7, 8, 9 or 11.

12. The Cutting of Trees (Prohibition) Act, 1992;

An act to provide for the prohibition of cutting of trees near the external frontiers of Pakistan If a person violates the law he will be punished by a fine up to 5000 rupees.

13. The Wild Birds and Animals Protection Act, 1912

An act to make better provisions for the protection and preservation of certain wild birds and animals. It deals with the hunting, sale and import of the wild birds and animals.

Rules & Regulations

1. **National Environmental Quality Standards(self-monitoring and reporting by industry) Rules,2001**

These rules have been made to specify limits to the industrial pollution. EIP (Environmental Improvement Plans) are established. Ever industry will have to provide their levels of pollution regularly to EIP. Then these will be examined.

2. **Environmental Samples Rules , 2001**

These rules are for the proper sampling of different tests. In this regulation many methods are present for the sample collection, handling, transportation and analysis. An authorized person will take the samples in clean bottles. These shall be closes and handled in a certain way. Samples will be labeled. Sample mixing will be prevented. If a person does not follow these rules he will be punished under these rules.

3. Hazardous Substances Rules,2003

These rules are established for the safe handling, sale, transportation and use of hazardous substances. For the transportation and handling of the hazardous substances, the license will be issued. The containers of the hazardous substances will be safe and leakage free. The labeling will be done .Warning signs will be printed like (DANGER).A picture of the skull and cross bones will be printed on the containers.

International Treaties

1. Convention on Biological Diversity;

It is about the conservation and wise use of different biological resources (plants and animals).It was adopted in 1992 at Rio De Janeiro, Brazil and entered force on January, 1993, which was 90 days after the 30th ratification. Pakistan signed it in June 1992 at United Nations Conference on Environment and Development held at Rio De Janeiro, Brazil and ratified it on 26th July 1994.

2. Cartagena Protocol on Biosafety;

The Bio safety (Protocol to CBD) deals with the safe handling, storage and Trans-boundary movement of the Genetically Modified Organisms (GMO). Cartagena protocol was adopted on June 2001 in Cartagena, Spain and entered into force on September 11th; 2003.Pakistan signed the Cartagena protocol in June 2001 and has ratified it in May 2009.

3. Convention on International trade in Endangered Species of Wild Fauna and Flora (CITES)

It deals with cooperation among countries for the protection of certain endangered species of the wild animals and prevent their over exploitation through international trade. The convention was adopted on 3rd march 1973 and entered into force on first July 1975.pakistan signed the convention in 1973 and ratified it in April 1976.

4. Convention on wetlands of international importance especially as waterfowl habitat (Ramsar convention)

The Ramsar convention deals with the protection of water bodies of international importance and attached biodiversity, along with promoting wise use of allied resources. The convention was adopted in 1971 at Ramsar, Iran and entered into force in 1975.Pakistan signed the Ramsar convention in 1971,and ratified it in July 1976.there are 19 Ramsar sites in Pakistan

5. Convention on the conservation of migratory species

It deals with the conservation and protection of the migratory species. Pakistan signed this convention in 1981 and ratified it in decemberv1987.

QUARNITINE REGULATIONS

Quarantine is a strategy of control to prevent the spread of pests and diseases. It covers all regulatory actions taken to exclude animal or plant pests or pathogens from a site, area, country, or group of countries. For example, when animal or plant genetic resources are imported from another country or region, there is a risk that they may contain or carry pests or pathogens that could be damaging to agriculture. For this reason, countries use quarantine practices to protect their agriculture and living natural resources from potential damage or destruction. Quarantine is usually a government responsibility, and the manner in which quarantine is executed differs among nations. National agencies responsible for plant quarantine may have other responsibilities, such as domestic pest control; research; pesticide registration, safety, and residue monitoring; or seed quality and labeling.

REDUCING THE RISKS FROM PESTS AND PATHOGENS

Quarantine practices in most countries have at least three common functions. The first is exclusion or regulatory actions to prevent or reduce the risk of entry of exotic pathogens, pests, or parasites along artificial pathways. Second is the containment, suppression, or eradication of pests or pathogens that have been recently introduced. Third is the assisting of exporters to meet the quarantine requirements of importing countries. The general concepts and objectives of plant and animal quarantine are similar; but differences in biology, agricultural production, marketing, exporting, and importing necessitate a variety of quarantine procedures. Animal and plant quarantine procedures. Animal and plant quarantine programs are intended to protect agriculture

from the threat of entry of exotic hazardous organisms. In some countries this objective may be extended to the protection of natural domestic flora and fauna. Both types of programs regulate the importation of living individuals.

THE PRINCIPLES OF SUCCESSFUL QUARANTINE

Few reports have examined the challenges and opportunities of developing an effective and efficient quarantine program that addresses the needs and constraints posed by the increasing international movement of germplasm. One recent study (Plucknett and Smith, 1988) describes six principles of successful quarantine. They are summarized as follows:

1. Sound scientific and technical principles should form the foundation of a quarantine program. This should include expertise from a diverse array of scientific disciplines, including, for example, virology, mycology, microbiology, nematology, malacology, entomology, taxonomy, pathology, weed science, and genetic resources.

2. Pests and pathogens should be ranked by quarantine services according to the potential danger they pose to crops and the potential for success in excluding them. For example, germplasm from centers of diversity should receive a high priority because of the potential for such accessions to harbor coevolved pests or pathogens.

3. When germplasm must be planted and grown for the purposes of quarantine testing, it should be done in an area geographically and ecologically separated from the major growing areas for that crop, to prevent the establishment of crop-specific pests or pathogens.

4. When germplasm is endangered or the need for particular accessions is particularly urgent, some discretion should be possible on the part of quarantine officials in allowing exceptions for controlled entry, despite existing regulations to the contrary.

5. Decentralized quarantine services are generally more efficient because they enfold a wider range of expertise in germplasm assessment. However, decentralization places a greater burden on the national system to ensure high standards and to promote accurate and efficient information exchange.

6. Because delays in transit can be detrimental for any germplasm accessions, access to good communication and transportation services is essential for quarantine.

Management of Genetic Resources

Pakistan is located in Central Asian Region, which is one of the centers of biodiversity. The climate and topography of this country is ideal for a variety of plant and animal species that need to be preserved. Pakistan is well known as one of the most important country for research of genetic resources. The Plant Genetic Resources Program (PGRP) is the main National Program that is functioning for overall management of PGRs including exploration, collection, exchange, safe storage on long, medium and short term basis, evaluation, documentation and distribution to other research institutes for sustainable utilization of plant genetic resources of crops and wild relatives within the country and abroad.

• Other research and educational institutes both at Federal and Provincial level are also handling conservation and use of plant genetic resources of selected crop commodities or groups of plant species. Some of the private herbal medicinal companies such as Qarshi and Hamdard have established herbal gardens at their premises and regularly seek assistance from PGRP and other organizations for strengthening their germplasm collection for biodiversity conservation.

• Attock oil refinery in Rawalpindi has also developed a biodiversity park as an environment improvement strategy for compensating the pressure on biodiversity due to industrial processing in the nearby vicinity

• PGRP is a component of the Institute of Agricultural Biotechnology and Genetic Resources (IABGR) which is itself one of the nine institutes that are involved in research and development activities of several crop commodities, livestock sector and social sciences.

• PGRP is regularly funded by the government of Pakistan and additional financial support is received from other projects sponsored by Agricultural Linkages Program (ALP), Generation Challenge Program, Pakistan Science Foundation (PSF) and National Biotechnology Commission (NBC) and several other organizations.

• Plant Genetic Resources Institute hosts the sole National Genebank of Pakistan for conservation of plant genetic resources and six labs including

1. germplasm exploration lab

2. Seed preservation lab

3. in vitro conservation lab

4. Germplasm evaluation lab

5. Plant introduction and seed health lab

6. Data management lab.

National Genebank of Pakistan at Plant Genetic Resources Institute has two types of conservation facilities for the seed of orthodox crop species at low temperature and relative humidity. These facilities include active collection and base collection. These two types of collections complement each other. The seeds are stored at 10°C and 40 percent relative humidity in active collection and at 5°C and 40 percent relative humidity for base collection.

Plant exploration is the avenue to germplasm for crop improvement, which cannot be obtained by exchange. The Plant Exploration Laboratory has organized more than hundred expeditions in different agro-ecological regions of Pakistan to collect the targeted plant species. The main emphasis is to collect the major crops and their wild relatives as these species are under threat.

Seed stock in the Genebank is periodically subjected to germination tests in Seed Preservation Laboratory for monitoring their viability and vigor. Studies are also conducted to find out most appropriate storage conditions for conservation of germplasm. Physiological and biochemical studies are being undertaken to investigate the process of seed deterioration during storage.

The in vitro conservation activities in PGRI are related to conservation of vegetatively propagated crops which cannot be conserved as seed either due to their heterogeneity or recalcitrant behavior. The major emphasis is being given on research to develop appropriate methods of conservation for sugarcane, sweet potato, apricot, grapes and banana. In vitro laboratory of PGRI has employed a variety of techniques for conservation of the germplasm of vegetatively propagated species namely grapes, peach, pear, sweet potato, banana and sugarcane that are economically high potential crops for sustainable development in agriculture.

Without evaluation, utilization of germplasm in crop improvement is not possible. When Plant Genetic Resources Institute was established in 1993, considering the importance of germplasm evaluation, a modern state of the art Germplasm Evaluation Laboratory was also present in the institute. Since 1994, germplasm evaluation is a regular activity at the institute using agro-

morphological, biochemical and molecular markers. The lab has evaluated more than half of the germplasm of cereals, minor cereals, legumes, vegetables, oilseed and medicinal plants, which are being utilized by national and international researchers.

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The Data Management Laboratory maintains the genetic resources information and disseminates this information to the national and international stakeholders.

Clonal repository is field Gene bank where genetic resources of clonally propagated crops like fruits are preserved as living plants. Plant Genetic Resources Institute maintains the clonal repository of more than three hundred accessions of fruit plants including grapes, guava, pomegranate, plum, peach, almond, pear, apple, apricot, fig, persimmon, citrus, pecan nut and walnut.

In Pakistan, Creative utilization of indigenous animal genetic resources is the only way of their conservation. Various institutions are involved in the capacity building to develop AnGR, in the country. These institutions have their own set-ups at federal and provincial level. These institutions include Ministry of Food, Agriculture and Livestock at federal level and livestock departments at provincial level. Then there are research organizations both at federal as well as provincial level. Universities impart education and conduct research both in veterinary and animal sciences.

At federal level, livestock sector is under the control of Ministry of Food, Agriculture and Livestock. Within the Ministry, there is Livestock Division, responsible for policy formulation, planning and inter-provincial coordination of livestock development activities. In Punjab, Livestock and Dairy Development Department is responsible for the uplift of livestock in the province.

There are various universities, in the country, that are offering undergraduate studies in veterinary and animal production disciplines. The basic degrees in animal production and veterinary sciences are B.Sc. (Hons) Animal Husbandry and DVM (Doctor of Veterinary Medicine), respectively. Masters and doctorate degrees are also offered in various disciplines of livestock production and veterinary sciences.

The Universities involved in imparting animal husbandry or veterinary education at under or postgraduate level are: University of Agriculture, Faisalabad; University of Veterinary and Animal Sciences, Lahore; NWFP Agriculture University Peshawar; Sindh Agriculture University Tandojam; Gomal University, Dera Ismail Khan and Baqai Veterinary and Medical University (private), Karachi. The Quaid-e-Azam University, Islamabad; University of Arid Agriculture, Rawalpindi, Virtual University of Pakistan and AllamaIqbal Open University, Islamabad also offer postgraduate courses in few disciplines.

The main institutes devoted to research for the development of livestock are: Animal Sciences Institute (ASI) at National Agricultural Research Centre, Islamabad; Livestock Production Research Institute (LPRI), Bahadurnagar, Okara; Barani Livestock Production Research Institute (BLPRI), Kherimurat, District Attock; Research Institute for physiology of Animal Reproduction (RIPAR), Bhunikey, Pattoki, Kasur; Poultry Research Institute (PRI), Rawalpindi; Animal Nutrition Research Centre, RakhDeraChahl, Lahore and Poultry Research Institute, Karachi. The main objectives of these institutes are conduction of applied research on breeding, feeding, management, reproduction, health and marketing of livestock and poultry. None of these institutions is, however, working on researching for issues of animal conservation as such.

FUTURE PERSPECTIVE

akistan has rich Genetic Resources wealth But there is lack of associations or community based social organizations that can voice for conservation of indigenous resources.

Much work is being done for the conservation of plant genetic resources but animal genetic resources (AnGR) still need attention.

Following strategies should be followed for effective conservation and utilization of AnGR:

1. Formulating the National Livestock and wild-life Breeding Policies.

2. Encouraging the Formation of Breed Associations.

3. Developing Professional Human Resources.

4. Strengthening Research and Development Institutions.

5. Developing Infrastructure for marketing International co-operation and assistance is needed in capacity building to remodel available livestock farms/research stations to conserve and develop genetic resources. This will enhance the sustainable use of indigenous resources. This will also help develop new stations / live animals gene banks to conserve the breeds' insitu.

Expertise is required in animal breeding and computations for developing recording, evaluation and reporting systems such as BREEDPLAN for Nili-Ravi and Kundhi buffaloes and Sahiwal and Red Sindhi cattle. Animal Information System is required to monitor breed statistics. International support is required in molecular genetics training at M.Sc / Ph.D level for genetic characterization of breeds and identification of qualitative and quantitative markers of economic traits.

Short courses for planners, researchers and for people in development and execution of breeding strategies and conservation programs are also needed. Collaborative efforts are needed to define the available non-descript populations to definite breeds and their economic valuation in almost all species.

A wide range of genetic and agronomic strategies should be employed to minimize crop uniformity and consequent susceptibility. Programs of genetic enhancement should be developed to make diverse germplasm resources useful to crop breeders. Research is needed to elucidate the components for establishing viable and genetically diverse populations of wild species. Biotechnology research efforts should focus on developing enhanced methods for characterizing, managing, and using genetic resources.

All nations and international agencies need to pool their limited resources and collaborate on the myriad facets of genetic conservation. Worldwide concern demands that periodic assessment and monitoring of collaborative activities be required in the future to ensure maintenance and use of genetic resources, our common biological heritage.