Virtual University

MUHAMMAD IMRAN

BT-401 Genetic Resources and Conservation

MSC ZOOLOGY

MUHAMMAD IMRAN
MSC ZOOLOGY 4TH SEMESTER

Lecture 1

Genetic Resources and Conservation

Introduction:

Genetic resources are the heritable characteristics of a plant or animal of real or potential benefit to people. 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 agriecological functions they are grouped under the concept **Agrobiodiversity**. Genetic resources for Food, Agriculture and Forestry include both **wild species** and **domesticated forms**. Reflecting the main areas of use – crop production, animal husbandry, forestry, fisheries and microorganisms.

There are two important themes with regard to genetic resources.

- First one is sharing of benefits
- The second relates to food security.

Access and Benefit Sharing Agreement (ABSA)

An Access and Benefit Sharing Agreement (ABSA) is an agreement that defines the fair and equitable sharing of benefits arising from the use of genetic resources.

Nagoya Protocol

The *Nagoya Protocol* focuses on the equitable sharing of genetic material (plant, animal, microbial, other) including the traditional knowledge associated with the genetic resources, and the benefits that arise from their use.

Component

1. Access to Genetic resources
2. Sharing of benefits

Lecture -2 Types of Genetic Resources

1. Plant genetic resources

Plant Genetic Resources for Food and Agriculture (PGRFA) are the raw material that farmers and plant breeders use to improve the quality and productivity of crops. They can be defined as any genetic material of plant origin of actual or potential value for food and agriculture, e.g. seeds, tubers, mature plants etc.

2. Animal genetic resources

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.

3. 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.

4. Aquatic genetic resources

Aquatic genetic resources also comprise all water-dwelling genetic resources.

5. Genetic resources of micro-organisms

Genetic resources of micro-organisms means genetic material of actual or potential value from microorganisms.

6. Invertebrates Genetic Resources

Invertebrates include a great number of species that perform valuable functions in agro-ecosystems

Lecture -3 Significance of Genetic Resources

Genetic resources are sometimes called the "first resource" of the natural resources on this planet - the others being land, air, and water.

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.

Genes are the link from generation to generation of all living matter. Therefore, attention to genetic resources means attention to the vast diversity among and between species of animals, plants, and microorganisms.

Genetic resources must be maintained as an investment for the future. Genetic resources are of tremendous practical and historical significance for human life from daily survival to generating the wealth of nations, yet their crucial role in supporting human society is frequently overlooked and undervalued.

Genetic conservation is an integral part of a much broader activity concerned with protecting the many plants, animals, microorganisms, and communities of organisms that help to mold and stabilize the environment and maintain the quality of air, water, and soil.

Conservation ensures that future generations will benefit from earth's biological resources.

Conserving genetic resources is a means of safeguarding the living materials exploited by agriculture, industry, forestry, and aquaculture to provide food, feed, medicines, fiber for clothing and furnishing, fuel for cooking and heating, and the food and industrial products of microbial activity.

Lecture -4-5: Plant Genetic Resources

Plant genetic resources are the building blocks and fundamental not only in crop improvement program, but also for the very survival of the species in time and space. Plant genetic resources include all our agricultural crops and even some of their wild relatives because they too often have valuable traits. Plant genetic resources are components of biodiversity which sustain the humankind.

Germplasm:

Germplasm of a crop may be define as the sum total of all hereditary material. i.e. all the alleles of various genes, present in a crop specie and its wild and weedy relatives . It is also termed as Genetic Resources.

Kinds of Plant Genetic Resources

PGR can be broadly divided into two types depending upon the state of their domestication

- Cultivated Plant Genetic resources
- Wild plant Genetic Resources

Alternatively, They may be termed as indigenous or exotic on their base on their place of origin.

Plant Genetic resources or Germplasm of a crop consist of 5 types of material:-

- Land races
- Obsolete varieties
- Varieties in cultivation
- Breeding lines
- Wild form and wild relatives

1. Landrace:

A landrace is a local variety of a domesticated plant species which has developed largely adaptation to the natural and cultural environment in which it lives. It differs from a cultivar which has been selectively bred to conform to a particular standard of characteristics. Landrace populations are often variable in appearance, but they can be identified by their appearance and have a certain genetic.

2. Obsolete varieties

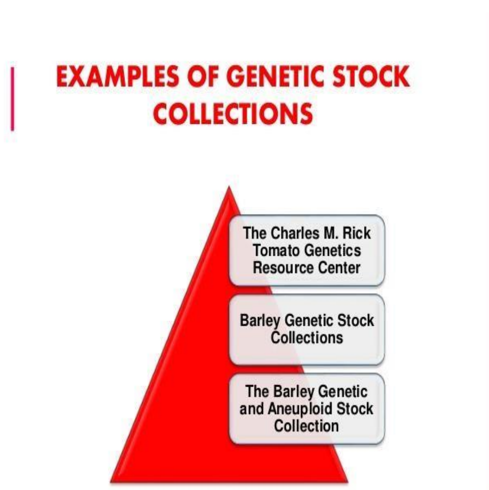
Obsolete varieties are varieties developed since the advent of scientific agriculture in the late nineteenth century and that are no longer cultivated. Although no longer grown commercially, such varieties are usually maintained in collections for use in current and future breeding programs. These varieties were developed by systematic breeding effort, were once commercially cultivated but are no more grown. For example Wheat varieties K65, K68, Pb591

3. Varieties in cultivation

Varieties in cultivation are the easiest to use in the breeding program. And they form a major part of working collections. They are good source of gene for yield, quality etc. they can be introduced in a new area and directly released for cultivation.

4. Breeding Lines

These are lines/ populations developed in breeding programs have narrow genetic base and often contain valuable gene combination. This group nearly contain homozygous line or mutant lines and lines derived from biology programs, including transgenic lines. They are ordinarily maintained as working collection by breeders



5. Wild Form and Wild Relatives

Wild forms are wild species from which crop species are directly derived. They are easy to cross with the concerned crop species. The wild relatives include all other species. Which are related to the crop species by descent during their evolution.

Genetic stocks

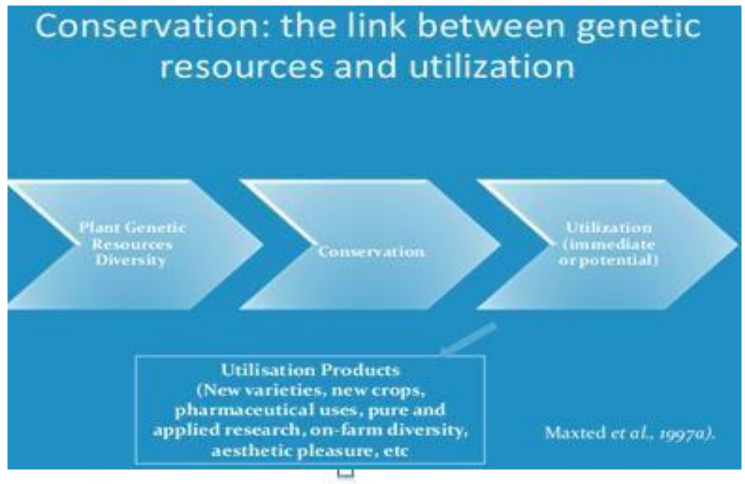
Genetic stocks, broadly defined as plants or populations generated and/or selected for genetic studies, represent a unique and growing class of extremely valuable germplasm which, depending on crop, type of genetic stock and user community may represent genetic resources of either transient or long-lasting value.

Genetic stocks can be divided into three general groups:-

1. cytological stocks
2. mutants stock
3. Germplasm set

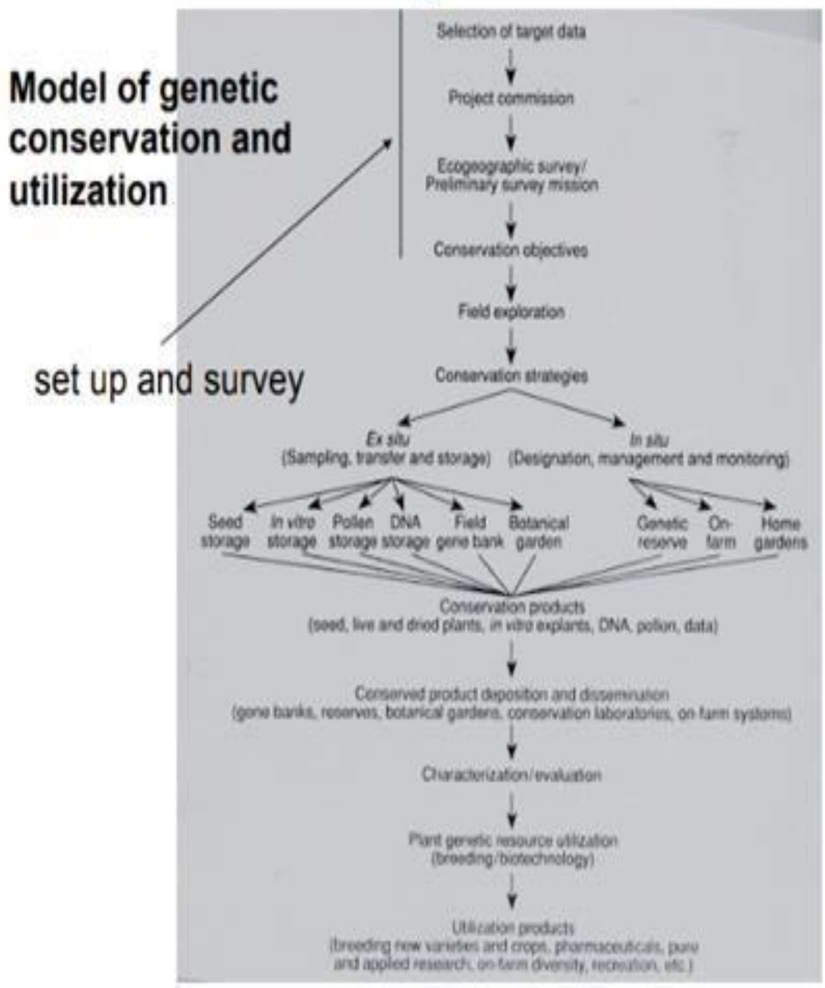
Lecture -6 CONSERVATION OF PLANT GENETIC RESOURCES

Germplasm or plant genetic resource has to be maintained in such a state that minimize the risk of loss and allows either is direct planting in the field or its preparation of planting with relative case this is called plant genetic resources conservation or germplasm conservation



Why do we need to conserve plant genetic resources?

- conservation of plant genetic resources is necessary for food security and agro-biodiversity
- Biodiversity provides a valuable source of compounds to the medical, food and crop protection industries.
- Maintenance of ecosystem
- Genetic resources need to be conserved so that they may be used in crop research and be used as sources of genes for crop improvement.

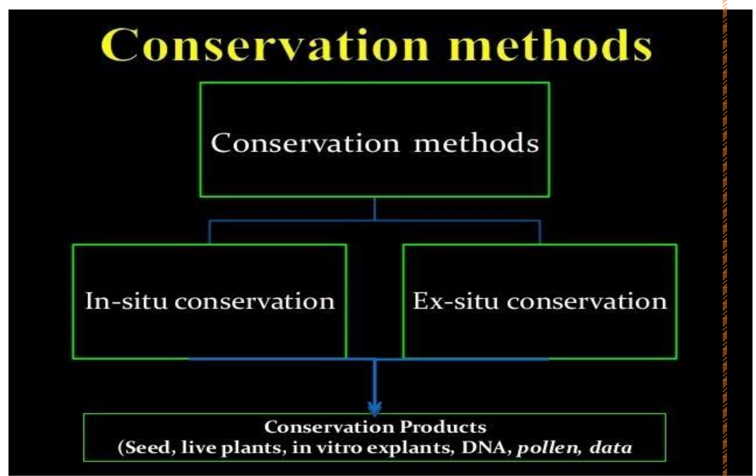


Gene pool ---Conservation ----Utilization

<u>Conservation of plant genetic resources</u>

- Selection of target texa
- Project commission
- Eco geographic survey/preliminary survey mission
- Conservation objectives
- Filed exploration
- Conservation strategies
- Conserved product deposition and dissemination
- Characterization/ Evaluation
- PGR utilization
- Utilization products

Lecture -7 Conservation of Plant Genetic Resources



1. In Situ Conservation

This method involves protection of endangered species in their natural habitats. It helps in recovering populations in the surroundings where they have developed their distinct features.

Example: National Parks, Biosphere reserves, Gene sanctuaries etc.

Types of in situ conservation

1. National park
2. Biosphere reserve
3. Gene sanctuary

1. National park

National park may be define as a area declared by state for the purpose of protecting, propagating wildlife there in or its natural environment for their scientific educational and recreational value

2. Biosphere reserve

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located.

3. Gene sanctuary

The genetic diversity is sometimes conserved under natural habitat. In other words, areas of great genetic diversity are protected from human interference. These protected areas in natural habitat are referred to as gene sanctuaries.

2. Ex Situ Conservation

It involves placing of threatened animals and plants in special care unit for their protection. It helps in recovering populations or preventing their extinction under stimulated conditions that closely resemble their natural habitats.

Example: Seed Gene bank, Botanical gardens, zoological parks

- Ex-situ techniques are implemented in well-defined situations·
- To safeguard populations or individuals that are in danger of physical destruction when protection in situ is not possible
- To safeguard populations which are in danger of genetic deterioration;
- To ensure a readily available, continuous supply of reproductive material, either creating a production source or through storage
- To allow commercial improvement of a species through breeding activities and supply of genetically improved reproductive material.

Types of Ex Situ conservation

- Gene bank
- Botanical garden

1. Gene Bank

Gene bank refers to a place or organization where germplasm can be conserved in living state. Gene banks are also known as germplasm banks.

Types of Seed Bank

Seed Gene Bank

A place where germplasm is conserved in the form of seeds is called seed gene bank. Seeds are very convenient for storage because they occupy smaller space than whole plants.

Field Gene Bank

Field gene banks also called plant gene banks are areas of land in which germplasm collections of growing plants are assembled.

2. Botanical Garden

A botanical garden or botanic garden is a garden dedicated to the collection, cultivation and display of a wide range of plants labeled with their botanical names

Lecture -8 Merits and Demerits of in situ and Ex situ Conservation In situ Conservation

Merits:-

- Plants and animals conserved in their natural environment
- Biodiversity permanently protected
- Natural and cultural heritage protected permanently
- Ecological integrity is maintained and managed
- Opportunities may arise for ecologically sustainable land uses (which come with associated economic benefits)
- Facilitates scientific research of the site

Demerits:-

- Genetic diversity may have already been dramatically decreased
- Conditions that threatened the organisms in the area may still be present, e.g. disease or interspecific competition
- Poachers and Eco tourists may see the thriving area as an opportunity and may cause damage

Ex situ Conservation

Merits:-

- It can be used to protect individual animals in a controlled environment. This means that issues such as predation and hunting can be monitored and managed more easily.
- It can be used to reintroduce species that have left an area.

Demerits:-

- Usually only a small number of individuals can be cared for.
- It can be difficult and expensive to create and sustain the right environment.
- The animals that are habituated (used to) human contact may be less likely to exhibit natural behaviors and may be more likely to catch a disease from humans.
- This type of conservation is usually less successful as many species can't breed successfully in captivity or don't adapt to their new environment when moved to a new location.

Lecture - 9: The Global Strategy for Plant Conservation

The **Global Strategy for Plant Conservation** (**GSPC**) is a program of the UN's Convention on Biological Diversity founded in 1999. It is 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.

Vision of GSPC :-

"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"

Objectives:

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 GSPC has 5 main objectives:

1. Plant diversity is well understood, documented and recognized
2. Plant diversity is urgently and effectively conserved
3. Plant diversity is used in a sustainable and equitable manner
4. Plant diversity is used in a sustainable and equitable manner
5. The capacities and public engagement necessary to implement the strategy have been developed.

Lecture 10: The International Treaty on Plant Genetic Resources for Food and Agriculture

What is special about agricultural genetic resources?

- To feed the world, we all need these resources.
- Agricultural resources have been shared and exchanged over thousands of years. Mostly it is impossible to identify a single country of origin.
- Countries and regions are "interdependent": they all depend for their food and agriculture on crops that originated elsewhere.

Objective:-

Conservation and sustainable use, fair and equitable benefit-sharing, for sustainable agriculture and food security.

Article 5: Conservation, Exploration, Collection, Characterization, Evaluation and Documentation.

Article 6: Sustainable Use of Plant Genetic Resources:

The Contracting parties shall develop and maintain appropriate policy and legal measures that promote the sustainable use of plant genetic resources for food and agriculture.

Article 9: Farmers' Rights:

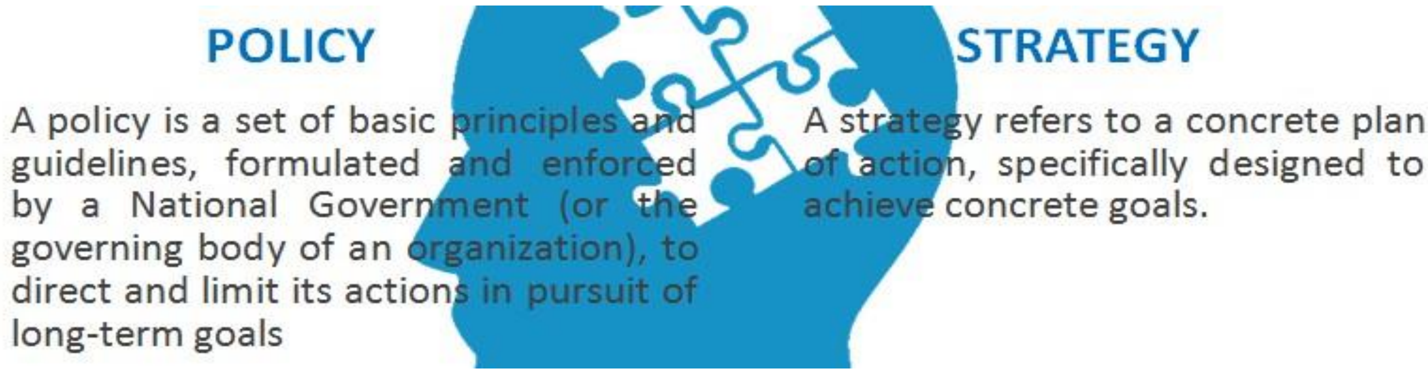
Recognition of the enormous contribution that farmers and their communities have made and continue to make to the conservation and development of plant genetic resources. Farmers' Rights include the protection of traditional knowledge and the right to participate equitably in benefit-sharing and in national decision-making about plant genetic resources. National Governments are responsible for realizing these rights.

Lecture -11: National Strategy for PGRFA

What is a National Strategy for PGRFA?

A National Strategy for PGRFA is the blueprint for the management of a country's PGRFA as a continuum of interventions in order to achieve clearly defined time bound goals.

Difference between policy and strategy:



National Strategy for PGRFA:-

- A well-designed National Strategy needs to be tailored to the particular circumstances and needs of the country,
- should be amenable to review and updating as country situations change.
- The National Strategy for PGRFA should also be complementary to other national, regional and global conservation strategies or initiatives.

Why is a National Strategy for PGRFA needed?

In practical terms, a National Strategy for PGRFA may help a county in setting priorities, assigning budgetary and other resources, building capacity, and designing the seamless dovetailing of all aspects of national PGRFA management in service of its own goals. As a result, a country will be in a position to safeguard its PGRFA assets; facilitate to access to needed genetic materials and govern the sharing of the accruing benefits; add value to them through crop improvement; and sustainably intensify crop production as may be needed.

Lecture 12: Wild Plant Genetic Resources

"Wild plant resources refers 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 biogeographical regions and habitat types.

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

- Prickly Acacia/Keekar
- Coral Tree
- Deodar Cedar
- Dalbergia Sissoo /Sheesham Tree
- *Calotropis procera*/Giant milkweed
- Alovera
- Marijuana

1. 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.

2. 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.

3. 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.

4. Dalbergia Sissoo /Sheesham Tree

Dalbergia Sissoo, 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.

Lecture 13-14: Domesticated Plant Genetic Resources

Some domesticated plant resources in Pakistan are as follow;

- Fruit Trees
- Citrus Fruits
- Nut Trees
- Legumes
- Cereals
- Vegetables
- Herbs and Shurbs etc

1. Legumes

Legumes, commonly known as beans and pulses, are plants of the family fabaceae, also known as leguminosae. Legumes are second to cereals in providing food for the world. Legume seeds are rich in protein, providing a highly nutritional food resource. The major staple foods such as beans, mong, mash, soya, lentils, peas and chickpeas are all legumes. Legumes improve soil quality by adding organic matter to the soil with nitrogen and more carbon. Total area under major pulse crops in pakistan is about 1.5m hectares

2. Mungbean

Mungbean is the important kharif pulses of Pakistan. It is grown during spring season mainly in southern Punjab and Sindh province. Punjab is the major mungbean growing province that alone accounted for 88% area and 85% of the total mungbean production id from Punjab. Cultivation is concentrated in the districts of Layyah, Bhakkar, Mainwali and Rawalpindi.

3. Vegetable

Pakistan covering 75% of the total area under vegetables, accounting for 74% of the total production. The major share in the production is of Punjab (63%) followed by Sindh (14%), Baluchistan (12%) and KPK (11%). Maximum area is grown under **potatoes** and about 88 % occurs in Punjab. About 46% of onion is cultivated in Sindh and 25% in Punjab. Chili is at the third position of which 84% is cultivated in Sindh.

Some important types of vegetables in Pakistan are as follow;

- Potato
- Chilli
- Onion
- Cauliflower
- Carrot
- Tomato
- Cucumber

Cereals:-

Cereal crops are interchangeably called grain crops. Cereal grains contain 60% to 70% starch and are excellent energy rich food for humans. A healthy human diet must include 20 to 30 g/day of dietary fiber, which can easily achieved by eating whole grain cereal products

Major cereal crops in Pakistan are as follow;

- Wheat
- Rice
- Maze
- Rye
- Barley
- Oats

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

Fruit Trees:-

Some fruit trees in Pakistan are as follow;

Orange, Mango, Apple, Apricot, Banana, Cherry, Guava, Peach, Lemon, Litchi, Papaya, Olive and Dates.

1. Orange

Pakistan is the sixth largest producer of Kinow (mandarin) and oranges in the world, with 2.1 million tons The soil and climatic conditions in Pakistan have given the Kinnow a unique flavor which distinguishes it from other varieties throughout world. An ideal condition for growing kinow includes abundance of water, rich nitrogen content in the soil and relatively cool weather. Winter in the plains of Punjab province provides an excellent atmosphere for this fruit and the resulting fruit is sweet and has a very distinct taste.

2. Mango

Pakistan produces over 150 varieties of mango. Pakistan is an important mango growing country in the world. The soil and climatic conditions of Pakistan are highly suitable for mango cultivation. According to FAO production year book of 2001, Pakistan stands fifht among mango growing countries of the World.

3. Nut Trees

Nut Trees in Pakistan are as follow;

- Almonds
- Walnut
- Tree Nuts

1. Almonds

Almonds fall in the family of peaches, plums and nectarines. Seeds of these plants are edible as Almond. Almond plants blossom into beautiful pink flowers in spring in addition to yielding fruits in summer.

Lecture 15: Animal genetic resources (angr)

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.

Animal genetic resources for food and agriculture:

The term "animal genetic resources for food and agriculture" is often shortened to "farm animal genetic resources" or simply "animal genetic resources" and sometimes referred to as "livestock biodiversity" or simply "livestock diversity".

Values of animal genetic resources:

- Direct use value
- Indirect use value
- Option value
- Bequest value
- Existence value

List of animal species for food and agriculture:

Widespread species	
Species	*No. of breeds*
Pig	350
Goat	320
Sheep	850
Cattle	815
Buffalo	70
Horse	350
Donkey/Ass	70
Dromedary	50
Bactrian Camel	6

Widespread species	
Species	*No. of breeds*
Llama	2
Alpaka	2
Chicken	>300
Turkey	>30
Duck	>65
Muscovy Duck	None
Domestic goose	>60
Guinea Fowl	10 varieties
Japanese Quail	>6
Pigeon	150
Ostrich	4 races

Threats to AnGR:-

- Despite the importance of animal genetic resources and their diversity, their diversity has been continually decreasing over time.
- One of the greatest threats to livestock diversity is pressure from large-scale commercial production systems to maintain only high-output breeds.
- Changes in climate will have an impact on livestock and food production in many ways.
- Some major disease threats that livestock currently face include, rinderpest, foot and mouth disease, and Peste des petits ruminants (PPR), also known as sheep and goat plague.

Lecture 16-17: Domesticated Animal Resources

"Animals that are not wild and is kept as a pet or to produce food"

For example; Dog, Buffalo, Goat, Sheep, Cattle, Cat

Domesticated animal resources are important as follow;

- Animals provide milk
- Hair from goat and sheep is used for making woolen clothing, shawls and blankets
- Some drugs are especially obtained from animals. Ex. Heparin an anti-coagulant is used to control clots in blood, is obtained from ox lungs and pig intestines
- Animal's meat is the part our of diet
- Animals are a great source of leather which is used for making foot wear, belts, wallets bags, furniture

1. Dog

Dogs were probably the first tame animals. They have accompanied humans for some 10,000 years. Some scientists assert that all dogs, domestic and wild, share a common ancestor in the small South Asian wolf. Dogs are kept as pets, hunting, herding, guarding, pest control, transportation, draft, working, show, racing, sport, rescuing, guiding, servicing, fighting, meat, research, patrol, fibre. Humans have bred hundreds of different domestic dog breeds some of which could never survive in the wild

2. Buffalo

Water buffalo, including "**river buffalo**" (*Bubalus bubalis bubalis*) and "**swamp buffalo**" (*Bubalus bubalis carabenesis*). There are 74 breeds of domestic water buffalo numbering some 165 million animals, Longevity of the domesticated water buffalo can be 40 years. The breed was selected mainly for its milk, which contains 8 percent butterfat. Wild water buffalo live in Southeast Asian swamps and forests, where they feed on grass and sedges. **Examples: Nilli Ravi, Murrah, Jaffrabadi, Mehsana, Bhadawari.**

3. Horse

Horse (*equus ferus*) was probably domesticated some 6,000 years ago. Early domestic horses were milked and eaten as well as used for transportation. Progenitor of the horse as we know it no longer exists in the wild, though it likely resembled the related przewalski's horse.

Example:

“Animals that are not wild and is kept as a pet or to produce food”

For example; Goat**,** Sheep, Cat**,** Chicken

1. Goat

A goat is a hoofed mammal in the genus ‘Capra’. Goats are tough and versatile.

Goats can survive and thrive just about anywhere. Most goats are referred to as ‘domestic goats which are sub-species of the ‘wild goat’. Altogether there are nine species of goat in the world, the domestic goat is the most common. Domesticating goats are used to have easy access to goat hair, meat and milk Goat skin is also still used today to make gloves and other items of clothing.

2. Sheep

Sheep originated from wild sheep. Sheep were domesticated by humans around 10,000 BC. Selection for economically important traits like wool type resulted in more than 200 distinct breeds of sheep. Sheep are social animals, important reason they like to flock together is for protection. Sheep are timid, nervous and easily frightened animals and for the most part defenseless against predators. Sheep have an excellent sense of hearing, sensitive to high frequency noise and get scared by loud noises.

3. Cat

Domestic cat, (*Felis catus*), also called **house cat**. Fossil evidence found in China dating to approximately 5,300 years ago revealed that cats similar in size to modern domestic cats. Cats are among the most highly specialized of the flesh-eating mammals. Their brains are large and well-developed. Cats are digitigrades; that is, they walk on their toes. The cat’s body has great elasticity they are often valued by humans for companionship and for their ability Hunt vermin.

4. Chicken

Domestic chickens have small heads, short beaks and wings and a round body perched on featherless legs Subspecies of red junglefowl, a species native to southern Asia. Chickens are able to remember and recognise over 100 individuals; they can also recognize humans. Chickens have very sophisticated social behaviour with a dominance hierarchy where higher individuals dominate subordinate individuals. The meat and eggs of chickens are widely eaten by people across the world.

Lecture 18: Wild Animal Genetic Resources in Pakistan

Some most important wild animal resources in Pakistan are as follow;

- Snow Leopard
- Alpine Markhors
- Asiatic Cobra
- Mugger Crocodile
- Himalayan Brown Bear
- Indus River Dolphin
- Asian Black Bear
- Fishing Cat

1. Snow Leopard

This is an extremely rare animal found in the mountain ranges of South and Central Asia. In Pakistan this 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 Gilgit Baltistan.

2. Alpine Markhors

This wild goat is found in the northern mountain ranges of Pakistan. Markhor is the national animal of Pakistan. The total global population of Markhors in estimated to be 2,500. About 1,500 Markhors are found in Pakistan. This specie is in high risk of extinction now a days.

3. 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. Person bitten by this snake suffers from severe neurotoxicity. Immediate, appropriate medical treatment should be given in case of a bite by Asiatic cobra.

4. Mugger Crocodile

Mugger crocodile also known as Indus crocodile and Indian crocodile. This crocodile has a medium size, 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.

5. Himalayan Brown Bear

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.

Lecture 19: Aquatic Genetic Resources

Aquatic genetic resources include all genetic resources living in water

It include; Fish, Cyclostomes, Mussels, Decapods, Marine mammals , Aquatic plants , All other water dwelling organisms

Diversity in Aquatic Genetic Resources:

There is a huge diversity of aquatic species in the world's water bodies

According to FAO, there are approximately;

- 31 000 species of finfish
- 85 000 species of mollusks
- 47 000 species of crustaceans
- 13 000 species of seaweeds

Importance of Aquatic Genetic Resources:

According to WWF/IUCN; “If human fail to preserve aquatic genetic resources, it will cost in diminished quality of life”

Crustaceans, mussels and other seafood belong to the most important sources of protein for human consumption worldwide. Fishing industry plays a major role in socioeconomic terms. Developing countries local fishing and the related branches of production guarantee the income of a large part of coastal communities

Danger to Aquatic Genetic Resources:

Aquatic pollution:

- Pollution caused by industrial effluents and wastewater of private households has severely damaged the habitats of many fish species
- Nutrient input through farming has resulted in algal blooms
- Oil tanker disasters causing oil spills destroyed entire coastal areas
- Above issues can cause a loss of general fitness of the animals, remain stunted in growth and become less fertile
- Famous example of effect of aquatic pollution is “MINAMATA Disease.” This disease was spread due to consuming mercury poisoned fishes by people

Global warming:

- Global warming is a problem that will increasingly affect the oceanic fish communities in the future.

- The changes in temperature render habitats less attractive to some species and more attractive for others.
- It is not confirm that which consequences this will have for the composition of future biological communities and whether this will entail a loss of genetic diversity.

Overfishing:

- Fisheries can jeopardize the intra-specific genetic diversity through overexploitation.
- The large numbers of many marine fish species and the wide ranging habitats seems virtually impossible that one fish species could be eradicated through overfishing.
- Fisheries can drastically lower the numerical abundance of individual stocks or even entire fish species by overfishing
- **For example**, various cod and herring stocks in the North Atlantic

Lecture 20-21: Terminologies

Endangered Species:

"A species of plant or animal that is in immediate danger of becoming extinct and needs protection to survive." e.g. Gray Wolves

Threatened Species:

"A species is likely to become endangered if it is not protected" e.g. Giant Panda

Extinct species:

"A species of plant or animal that is no longer living." e.g. Passenger Pigeon, white Rhino

Mutation:

A **Mutation** occurs when a DNA gene is damaged or changed in such a way as to alter the genetic message carried by that gene

Mutagen:

Mutagen is an agent of substance that can bring about a permanent alteration to the physical composition of a DNA gene such that the genetic message is changed

Natural Selection:

"A natural process that results in the survival and reproductive success of individuals or groups "

Gene Pool:

"The combination of all the genes present in a given population is called the gene pool of that population."

Genetic Diversity:

"The variation in the amount of genetic information within and among individuals of a population, a species, an assemblage, or a community."

Genetic Drift:

"Random changes in gene frequency especially in small populations when leading to preservation or extinction of particular genes"

Bottleneck Effect:

"The bottleneck effect is a sharp lowering of a population's gene pool because of an environmental, or human-caused, change."

Founder Effect:

“The effect on the resulting gene pool that occurs when a new isolated population is founded by a small number of individuals possessing limited genetic variation relative to the larger population from which they have migrated”

Genetic Resources:

“Genetic resources are the heritable characteristics of a plant or animal of real or potential benefit to people.”

Plant Genetic Resources:

“Plant Genetic Resources for Food and Agriculture (PGRFA) are the raw material that farmers and plant breeders use to improve the quality and productivity of crops.”

Animal genetic resources:

“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.”

Breeding:

“The activity of keeping animals or plants in order to produce animals or plants that have particular qualities”

Inbreeding:

“Inbreeding, the mating of individuals or organisms that are closely related through common ancestry.”

Outbreeding:

“The intentional breeding of distantly related or unrelated individuals for the purpose of producing offspri ng of superior quality.”

National Strategy for PGRFA:

“A National Strategy for PGRFA is the blueprint for the management of a country’s PGRFA as a continuum of interventions in order to achieve clearly defined time bound goals.”

Migration:

“Migration is the relatively long-distance movement of individuals, usually on a seasonal basis.”

e.g. Some crustaceans migrate for breeding

Aquatic Genetic Resources:

“Aquatic genetic resources include all genetic resources living in water” **e.g.** Fish, cyclostomes,mussels, decapods, marine mammals

Domesticated Animal Resources:

“Animals that are not wild and is kept as a pet or to produce food”**e.g.** Dog, Buffalo, Goat, Sheep, Cattle

Antibiotic:

“Antibiotic is chemical substance produced by microorganisms that can kill or inhibit the growth of other microorganisms”

Gene Flow:

“The introduction of genetic material (by interbreeding) from one population of a species to another”

Vertical Gene transfer: “The transfer of genes from parents to offspring.”

Horizontal gene transfer:

"Horizontal gene transfer is known to occur between different species, such as between prokaryotes and eukaryotes, between the three DNA-containing organelles of eukaryotes, the nucleus, the mitochondrion and the chloroplast."

Lecture 22: Genetic Resources of Microorganisms

The complexity and diversity of microbial populations is highest among all living organisms. The diversity of microbial communities and their ecologic roles are being explored in;

- Soil
- Water
- Plants
- In animals
- In extreme environments such as the arctic deep-sea vents or high saline lakes.

Microorganisms include;

- Algae, Bacteria (including cyanobacteria), Fungi (including yeasts), Protistan groups, Viruses.

Number & Richness Genetic Resources of Microorganism:

- Numbers of species described and currently accepted in most groups of microorganisms worldwide are respectively 143,000 & 18,500
- 120 new species of bacteria and 1,500 new species of fungi are added to science each year
- This clearly demonstrating that knowledge of these groups is grossly inadequate

Microbial Genetic Resources Program:

To establish a long term microbial preservation facility as "National Culture Collection of Pakistan (NCCP)" for collection and preservation of microbial genetic resources from Pakistani ecology for basic and applied microbiology and biotechnology research following the Best Practice Guidelines of OECD (2001). To distribute the economically important strains to scientific community, institutions and industry on commercial basis for research or utilization in industrial processes as a regular activity of the NCCP by following national and international laws and regulations.

Lecture -23: Significance of Genetic Resources of Microorganisms

Importance of Genetic resources of Microorganism:

In ecosystems, microorganisms are important as;

- **Symbionts** (endophytes, mycorrhizae, and in insect guts),
- In **nitrogen fixation** (rhizobia, cyanobacteria, cyanobacteria-containing lichens),
- In the **biodegradation** of dead animal and plant material,
- In **controlling** the size of populations of plants and insects through natural bio-control
- **Antibiotic** is chemical substance produced by microorganisms that can kill or inhibit the growth of other microorganisms. Antibiotics kill or inhibit other organisms by interfering the metabolic process in the bacterium that is not found in the host.

Importance of microorganism in agriculture:

- Plant growth promotion through soil microorganisms,
- In the understanding and surveillance of microbial plant pathogens
- Biological control,
- beneficial symbiosis in the guts of ruminant livestock,
- Production of chemicals of direct benefit to agriculture
- Workhorses in agro-industrial processes.

Role of Microorganism in food production system:

Fermentation, Probiotics, Production of chemicals of benefit to food production, Understanding and surveillance of health hazardous microorganisms such as food toxins and food borne pathogens.

Lecture 24: Genetic Diversity

What is genetic diversity?

Variation of all living forms at the genetic level: genes, allels or neucleotides.

Source of genetic diversity:

- Mutations
- Speciation
- Errors in Meiosis

Examples of genetic diversity:

The domestication of wolves into various breeds of dogs via selective breeding has greatly increased the genetic diversity of the canine genome as compared to its lupine origins. In general, woody plants like trees have a higher genetic diversity than vascular plants like grasses.

Significance of genetic diversity:

The huge variety of different gene sets define an individual or a whole population's ability to tolerate stress from any given environmental factor. Some individuals might be able to tolerate an increased load of pollutants in their environment. Others carrying different genes might suffer from infertility or even die under the exact same environmental conditions.

Anthropogenic activities effecting Genetic Diversity:

Any change in the environment, natural or human induced causes a selection of events that only the fittest survive. Anthropogenic impact is apparent in the coastal zone . Man made activities increases the number of changes occurring to individual and populations. Such pressure is exerted by:

- Artificial selection (harvesting, aquaculture)
- Degradation of habitats
- The release of farmed fish into the wild.

Anthropogenic activities reduce the sum of genes available. It leaves behind a population that is less capable of tolerating any further natural or anthropogenic ally caused changes in environment.

Why to prevent the loss of Genetic Diversity?

- The loss of genetic diversity is difficult to see or measure. In contrast, the reduction and extinction of populations is far easier to see.
- Extinction is not only the loss of whole species, but is also preceded by a loss of genetic diversity within the species.
- This loss reduces the species ability to perform its inherent role in the whole ecosystem.
- The loss of genetic diversity within a species result in the loss of useful and desirable traits (e.g. resistance to parasites).
- Reduced diversity eliminate options to use untapped resources for food production, industry, medicine.

Lecture 25-27: Endangered Species in Pakistan

> "A species of plant or animal that is in immediate danger of becoming extinct and needs protection to survive."

Endangered species are like fire alarms. They tell us about problems in our home we call Earth. Endangered species must be protected for better health of earth and ecosystem balancing.

Endangered Species in Pakistan:

Pakistan is host to a number of **endemic species** and sub species. Some **birds** have their principal surviving population located in Pakistan. The **Northern Areas** of Pakistan provide a habitat for a number of globally significant wildlife species. The survival of these species is threatened by loss of habitat stemming from human activities, excessive hunting by locals and outsiders, and weak enforcement of wildlife protection laws

Why Species Become Endangered:

1. Overhunting or overharvesting
2. Habitat loss
3. Highly specialized species
4. Pollution
5. New species introduction and competition
6. Human-wildlife conflict
7. Disease
8. Low birth rate
9. High genetic vulnerability

Some most endangered species in Pakistan are as follow;

- The Indus River dolphin
- Markhor
- Asian Black Bear
- Snow Leopard
- Marco Polo sheep
- Marbled Teal
- White-Headed Duck
- Musk Deer

1. The Indus River Dolphin

The Indus River dolphin is one of the world's rarest mammals. It is second most endangered freshwater river dolphin. Approximately 1,100 specimens of this species exist today in a small fraction of their former range. Population of this species has gradually declined due to various factors e.g. water pollution, poaching, fragmentation of habitat due to barrages and dolphin stranding in the irrigation canals

2. Markhor

The national animal of Pakistan is on the brink of extinction. Wild goat is classified as "near threatened" by the International Union for the Conservation of Nature. Now it is found only in the Hazarganji-Chiltan National Park, Balochistan. There is some good news, though. It was discovered in early 2015 that their population has increased by 20%.

3. Asian Black Bear

This big black monster seems to be an interesting hunting trophy for many people. Expansion of human settlement into wildlife territory has affected their growth. This is putting a threat on their species

4. Snow Leopard

A unique creature in the mountainous areas of Pakistan. Estimated that the total remaining population is 7,000 to 10,000 worldwide. Approximately, 300 are found in Pakistan. Due to hunting and rapid human expansion, there is a very limited amount of these beasts left.

5. Marco Polo sheep

Marco Polo sheep (Ovis ammon) have a scattered distribution in the Karakorum Mountain Range and Hindu Kush. In Pakistan, they are mostly found in the Khunjerab National Park and adjoining areas. The sheep have an endangered status and their numbers have been rapidly decreasing in the last two decades.

6. White-Headed Duck

Wintering populations of the globally significant white-headed duck (Oxyura leucocephala) have decreased during the last few years. It is estimated that only 50 birds are remaining. Wintering sites in Pakistan are limited to three adjoining wetlands. These are known as the Ucchali Complex in Punjab.

7. Musk Deer

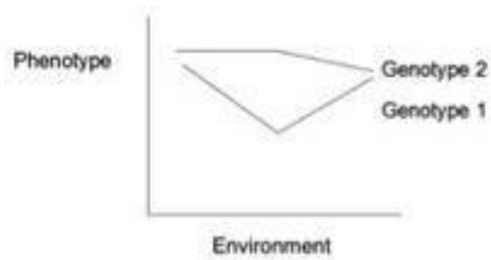
Adult musk deer males have prominent downward curving canine teeth, an unusual feature for a member of the deer family. This specie is present in the **Machiara** and **Neelum** valleys in **Azad Kashmir**, in the **Gilgit** area and the **Palas Valley**. Musk deer have become extremely rare. People trap and kill them to obtain a valuable pod containing musk which is sold for use in perfumes

8. Long Billed Vultures

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.

Lecture 28-30: 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.



There are two different conceptions of gene–environment interaction.

- Tabery has labeled them *biometric* and *developmental* interaction
- Sesardic uses the terms *statistical* and *commonsense* interaction.

1. Biometric gene–environment 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 and behavioral genetics. Any interaction results in the breakdown of the additivity of the main effects of 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.

2. Developmental gene–environment interaction

- Developmental gene–environment interaction is a concept more commonly used by developmental geneticists and developmental psycho-biologists.
- 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.

This norm of reaction shows lines that are not parallel indicating a gene by environment interaction. Each genotype is responding to environmental variation in a different way.

Gene-environment interaction:

Methods of analysis

How to identify Gene Environment interaction?

There are two main methods to analyze gene environment interaction

1. **Traditional Genetic Designs**
2. **Molecular Analyses**

1. Traditional Genetic Designs

Adoption studies

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.

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.

2. Molecular Analyses

Does the effect of specific genes differ in two environments?

1. Interaction with single genes
2. Interaction with multiple genes
3. Genome-wide association studies and genome wide interaction studies

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.

Interaction with multiple genes

Since the same environmental factor could interact with multiple genes, a polygenic approach can be taken to analyze GxE interactions.

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.

Gene-environment interaction:

`Examples

In Drosophila:

Mean bristle number on Drosophila could vary with changing temperatures.

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.

Phenylketonuria (PKU)

It is a human genetic condition caused by mutations to a gene coding for a particular liver enzyme. In the absence of this enzyme, 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. Change in environment (lowering Phenylalanine consumption) can affect the phenotype of a particular trait, demonstrating a gene-environment interaction.

Lecture -31-32: Gene pool

The combination of all the genes present in a given population is called the gene pool of that population." All the genes and alleles in a population are called a gene pool

Characteristics of gene pool:

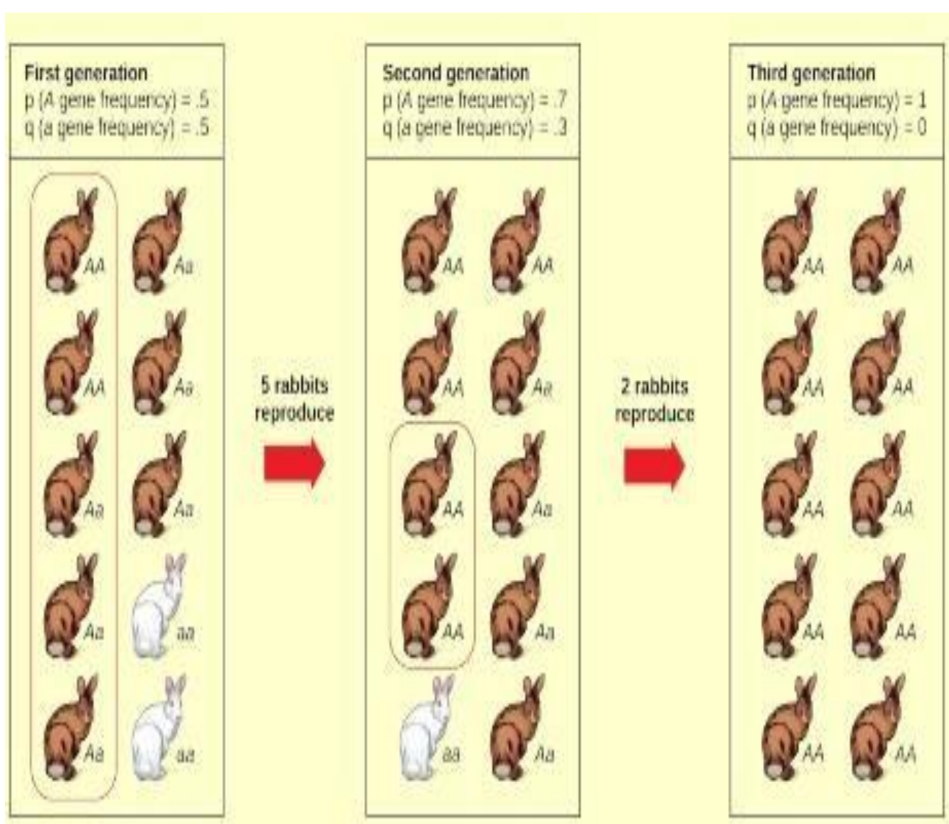
- It includes all the variants or alleles of every gene.
- It includes all the genes present in the population.
- In most cases, the population includes individuals of the same species.
- A gene pool includes even those genes whose effects are not visible in an individual.

Importance of gene pool:

Populations with larger gene pools tend to have more genes, hence, more genetic diversity. Each gene has a specific purpose for survival, such as giving the plant/animal a particular characteristic, resistance to a disease, tolerance to harsh climate, and so on. A population with a larger genetic diversity will be better prepared to deal with disease outbreaks or extreme environmental changes. Those populations will have genes that protect them from adverse changes. Populations with a lesser number of genes in their gene pool will be susceptible to problems. This may cause them to become endangered or even perish altogether, i.e., become extinct. Populations with a large gene pool will have more chances of survival; those with small gene pools are in danger of acquiring genetic diseases, deformities, and infertility.

Examples:

A number of animal species, such as mountain lions in the Americas, and leopards in South Africa, are threatened by human activities. Their habitat has been divided into fragments, surrounded by towns and farmlands. This results in interbreeding among smaller populations, The small gene pool makes them susceptible to diseases.



The Gene Pool System of Classification:

1. Primary Gene Pool (GP1):
2. Secondary Gene Pool (GP2):
3. Tertiary Gene Pool (GP3):

Causes of changes in Gene pool:

The allele frequency in a population's gene pool can be affected by evolutionary mechanisms, such as;

- Mutation
- Gene flow
- Inbreeding
- Natural selection,
- Founder effect

- Random genetic drift.

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Topic-Genetic Drift

<u>**PPT-33-38**</u>

LECTURE 33: Genetic Drift

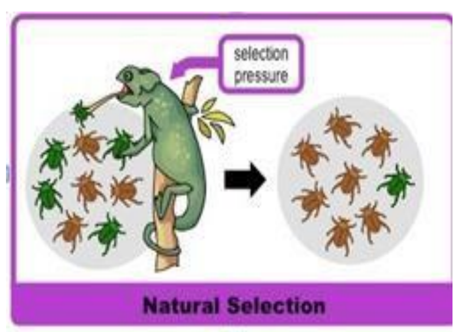
Genetic drift is the phenomenon of change in the frequency of alleles (variants of a gene) in a population of organisms due to chance or random events

Occurs in all populations of non-infinite size, but its effects are strongest in small populations. May result in the loss of some alleles (including beneficial ones) and the **fixation**, or rise to 100% frequency, of other alleles.

LECTURE 34: Genetic drift Vs. Natural Selection:

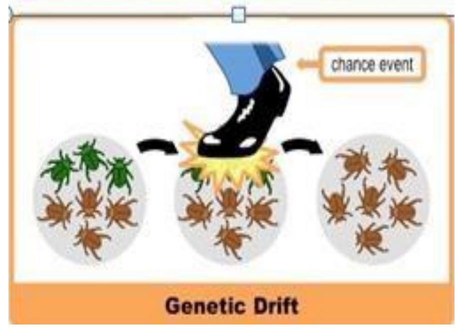
Genetic drift is the converse of natural selection.

- **Natural selection** shows the positive changes in the genome that may give its possessor an adaptive advantage**;**
- **genetic drift** shows changes in the genome that may be advantageous, deleterious or may have no effect.
- **Natural selection** is response to an organism's environmental challenges.
- **Genetic drift** is completely random and is solely based on luck.
- **Natural selection** will always result in the selection of allele that gives an advantage to its possessor, while genetic drift causes advantageous genes to be removed in the following generations.
- **Genetic drift** is largely influenced by the population size, whereas natural selection is not.
- **Genetic drift** leads to the reduction of genetic variations, or may sometimes be responsible for introducing genetic variation in a population**.**
- **Natural selection** will always result in introducing more genetic variations in a population.



Difference Between Genetic Drift and Gene Flow:

- **Gene flow** occurs via mixing of genes with other populations while **genetic drift** takes place when the allele frequency is changed between two generations of a population.
- **Genetic drift** takes place between two generations whereas **gene flow** takes place between two populations
- **Genetic drift** occurs in only one species while **gene flow** could take place between either two populations or two species.
- Physical barriers matter for the gene flow but not for the genetic drift.



LECTURE 35-38: Types of Genetic Drift

- **Bottleneck effect**
- **Founder effect**

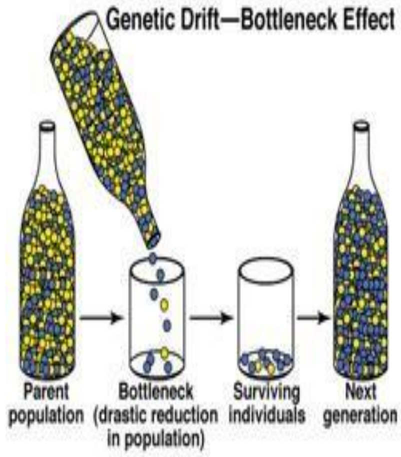
1. Bottleneck effect

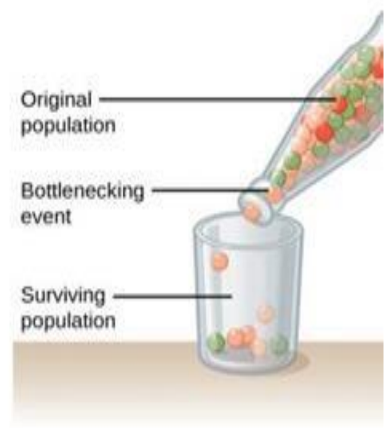
The **bottleneck effect** is a sharp lowering of a population's gene pool because of an environmental, or human-caused, change.

It is an extreme example of genetic drift that happens when the size of a population is severely reduced. Events like natural disasters (earthquakes, floods, fires) can decimate a population, killing most individuals and leaving behind a small, random assortment of survivors.

Bottleneck effect and Allele Frequencies:

Allele frequencies in a group may be very different from those of the population prior to the event,. even some alleles may be missing entirely. The smaller population will also be more susceptible to the effects of genetic drift for generations (until its numbers return to normal). Effect potentially causing even more alleles to be lost.





Examples

In human evolution

It is theorized, based on genetic evidence, that a few tens of thousands of years ago the population of Homo sapiens was reduced for a period to a few thousand or tens of thousands of people. Such a bottleneck would explain the extremely low level of genetic diversity found within our species, when contrasted with others, such as Chimps.

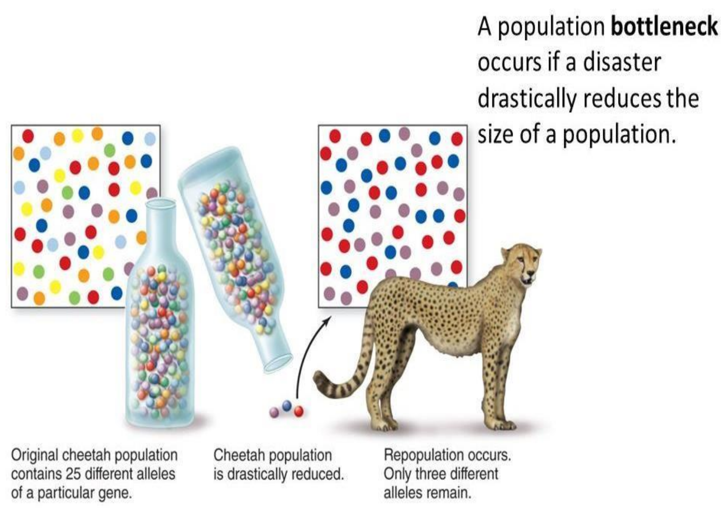
Cheetah

All Cheetah shared a small number of alleles.

- Less then 1% diversity
- As if all cheetahs are identical twins

Bottleneck effect

- 10,000 years ago
- Ice age
- Last 100 years
- Poaching and loss of habitat



Northern Elephant seal:

Example:

Northern elephant seals have reduced genetic variation most likely due to being hunted. Population bottleneck in 1890s due to overhunting. Hunting reduced their population size to as few as 20 individuals at the end if the 19th century. Now over 30, 000, very little variation left in this population.

2. The Founder Effect

In population genetics, the founder effect is the loss of genetic variation that occurs when a new population is established by a very small number of individuals from a larger population.

A founder effect occurs when a new colony is started by a few members of the original population. This small population size means that the colony may have:

- Reduced genetic variation from the original population.
- A non-random sample of the genes in the original population.

Examples

The Amish People

Around 200 German immigrants settled in Pennsylvania within community marriages. Developed syndrome named Ellis-van Creveld syndrome.

Common symptoms are;

- Haemophilia
- Dwarfism (1/14 carry the gene)

- Still births/infant deaths
- Physical deformities

Sickle Cell Disease

For most of humanity's existence, sickle cell disease usually meant an early death, most likely as a young child. (It still does in underdeveloped nations.) In fact, the average life span for a sufferer in the US in 1973 was only 14 years. Now it's 40–60 years in the US. The cause of this disorder: genetic changes meant to protect against malaria. As a result, those who suffer from sickle cell disease overwhelmingly come from tropical areas or places where malaria is common.

Meleda Disease

A relatively unassuming island among the Adriatic islands of Croatia, Mljet is home to one of the rarest diseases in the world. (Although no one knows the exact prevalence, it has been estimated at 1 in 100,000.) Formally known as Meleda, the island was used by the Republic of Ragusa from 1358 to 1808 as a quarantine for those suffering from ailments such as leprosy or plague. Sometime in the intervening centuries, inbreeding and a lack of genetic diversity ended up spreading mal de Meleda throughout the population.

Huntington's Disease

Huntington's disease (aka Huntington's chorea) is a genetic disorder which results in slowly progressing brain cell death. There are two distinct populations in which the disorder occurs much more often.

1. The first group is the Afrikaner population of South Africa.
2. The second group is the residents of the Lake Maracaibo region of Venezuela.

Retinitis Pigmentosa

A group of genetic disorders which affect the cells in the retina, retinitis pigmentosa often results in difficulty seeing at night as well as other forms of partial blindness. Eventually, most sufferers lose nearly all their sight, often presenting as a severe form of tunnel vision. Retinitis pigmentosa affects as many as 1 in 4,000 people. However, one small subset of people has a much higher rate of occurrence: Ashkenazi Jews.

Twin Births

Somebody call Alex Jones: There's a Nazi conspiracy afoot. For years, a remote Brazilian town was held up as an example of research conducted by the notorious Dr. Josef Mengele. The reasoning: Candido Godoi has a twin rate nearly 1,000 percent higher than the rest of the world. However, more recent research has led people to point to a genetic founder effect as the real reason. The small town of around 6,000 was formed by a small number of families, specifically German immigrants.

Ellis-van Creveld Syndrome

Though this particular syndrome isn't exclusive to the Old Order Amish of Pennsylvania, it is unusually prevalent among them. For the general population, it only occurs in 1 in 60,000 to 200,000 births. For the Amish, it is many times more common than that. The reason: Around 200 German immigrants formed the initial settlement in the 18th century. Also, they tended to marry within their own community, failing to see the pitfalls concerning genetic diversity.

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Topic- Breeding Systems

LECTURE 39: 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.

1. **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 operations.

2. **Out-Breeding**

   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. Within pure-breeding, there are several types of mating systems. Outbreeding is the recommended breeding practice for most purebred sheep breeders.

3. **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.

4. **Linebreeding**

   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 matings, etc. Line breeding is a mild form of inbreeding.

5. **Crossbreeding**

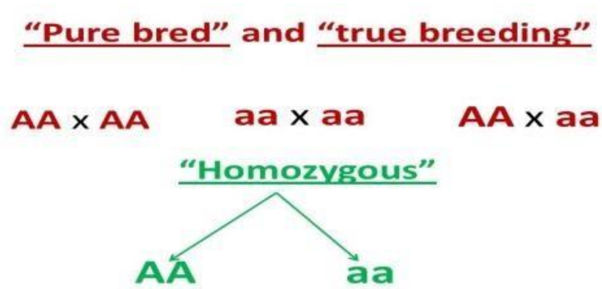
   Crossbreeding is the mating of rams and ewes of different breed compositions or types. However, it does not denote indiscriminate mixing of breeds, but rather is a systematic utilization of different breed resources to produce crossbred progeny of a specific type. Crossbreeding is used extensively in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

Crossbreeding offers two distinct advantages:

1) heterosis; and

2) breed complementarity

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



LECTURE 40- Inbreeding

Inbreeding is the mating of individuals or organisms that are closely related through common ancestry. It is opposed to outbreeding, which is the mating of unrelated organisms. Inbreeding is useful in the retention of desirable characteristics or the elimination of undesirable ones, but it often results in decreased vigour, size, and fertility of the offspring because of the combined effect of harmful genes that were recessive in both parents.

There are 3 types of Inbreeding;

- Close inbreeding
- Mild inbreeding
- Line inbreeding

1. **Close Inbreeding**

Animals are very closely related and can be traced back to more than one common ancestor. Closest form of inbreeding in domestic animals involves mating between full brothers and sisters (full siblings). Second closest form of inbreeding involves mating between grand-parents and grand-offspring, half brothers and sisters (half siblings)

2. **Mild Inbreeding**

Mating of relatives beyond 2nd generation and upto 6th generation.

Line Breeding

Mating animals that are more distantly related which can be traced back to one common ancestor.

e.g. Cousins Grandparents to grand offspring, Half-brother to half-sister. Line breeding increases genetic purity amongst the animals of progeny generations.

Advantages of Inbreeding

1. Inbreeding is essential to the development of pre-potent animals — animals that uniformly "stamp" their characteristics on their progeny.
2. Inbreeding uncover genes that produce abnormalities or
3. In general, inbreeding results in an overall lowering in performance: vigor, disease resistance, reproductive efficiency, and survivability.
4. 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.
5. Inbreeding suggests only highly qualified operators who are making an effort to stabilize important traits in a given set of animals.

Disadvantages of Inbreeding

- An increase in the prevalence of inherited disorders
- A decrease in viability
- A decrease in reproductive ability, and
- The loss of genetic diversity (i.e. decrease in genetic variation).
- Developmental disruption, higher infant mortality and a shorter life span
- Reduction of immune system function.

Inbreeding depression

Inbreeding depression is the reduced biological fitness in a given population as a result of **inbreeding**, or breeding of related individuals. In a small population, matings between relatives are common. This inbreeding may lower the population's ability to survive and reproduce, a phenomenon called inbreeding depression.

LECTURE 41: Out breeding

"The intentional breeding of distantly related or unrelated individuals for the purpose of producing offspring of superior quality."

Types of Out breeding:

3 types;

- Cross breeding
- Grading up
- Species cross

1. **Crossbreeding**

Crossbreeding is the mating of two animals of different breeds . Superior traits that results in the crossbred progeny from crossbreeding are called **hybrid vigor** or **heterosis**

2. **Grading up**

Breeding of animals of two different breeds where the animals of an indigenous breed/genetic group is mated by an improved pure breed for several generations towards attaining the superior traits of the improved breed. Grading up is continuous use of purebred sires of the same breed in a grade herd. By fifth generation, the graded animals may reach almost purebred levels.

3. **Species Crossing**

The crossing of animals of different species **e.g.**

- Zebra + Any other Equine = Zebroid
- Lion + Tiger = Liger
- Domestic Cattle + Americon Bison = Beefalo

Advantages of Out breeding:

- Out breeding often produces offspring of superior quality because it increases homozygosity (the occurrence of two alleles for the same trait at corresponding positions on homologous chromosomes)
- Sharply reduce the risk of deleterious recessive genes being expressed
- One of the benefits of out breeding is less chance of genetic abnormalities
- The ability to make a breed stronger

Disadvantages of Out breeding:

- Introduction of new genes into population
- Animal discomfort: accidently produce traits that are damaging to the health of the animal

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Topic- Migration

LECTURE 42 -Animal migration

Animal migration is the relatively long-distance movement of individuals, usually on a seasonal basis. It is found in all major animal groups, including birds, mammals, fish, reptiles, amphibians, insects, and crustaceans. Migration is a behavioral adaptation that helps animal's survival.

Trigger for the migration

The trigger for the migration may be:

1. local climate
2. local availability of food
3. the season of the year
4. for mating reasons

Some animals travel relatively short distances to find food or more favorable living or breeding conditions. Most animals that migrate do so to find food or more livable conditions. Some animals migrate to breed.

Finding way:

Scientists aren't really sure exactly how some animals figure out how to get to where they are going. They think that:

- Some animals use landmarks like rivers and streams to find their way.
- Some animals may navigate by the position of the sun and stars.
- Some animals use smell to figure out where they are going.
- Some species that may use the Earth's magnetic field to navigate.

EXAMPLES:

- The Atlantic Salmon begins its life in a river and migrates downstream to the ocean. After several years, it heads back upstream to lay eggs and begin the cycle all over again.
- Some crustaceans also migrate for breeding. In many species of crabs, the females will move into shallow coastal waters to mate and lay her eggs and then they return to deeper ocean waters.
- Frogs and toads often move very short distances to breeding ponds and lakes to lay their eggs.
- Some sea turtles, like the loggerhead, return year-after-year to the same sandy beach on which they hatched to lay their eggs.
- Sometimes animals migrate to find a place to hibernate.
- Little brown bats live in trees in warm months, then in cold weather they migrate to caves where it is warmer.

LECTURE 43: Types of Migration

1. Daily migration

Many birds make daily movements from their nest in response to environmental forces such as light, darkness temperature, humidity etc. Daily migration from their resting site to feeding area. **Eg:** crows, sparrows, starling

2. 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

3. Seasonal migration

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

4. Moult migration

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

5. Cyclic migration

Migration of birds is seasonal, but do not occur at regular intervals. **Eg:** snowy owl in search of lemming in US in winter is occurs in 3 – 5 years.

6. Partial migration

All the birds of migratory bird do not leave the native land and hence are always represented by certain individuals **Eg:** finch, titmouse

7. Irregular migration

Sometimes some birds disperse for a short 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. black stork (Ciconia nigra), Glossy ibis (Plegadis falcinellus).

8. Altitudinal or vertical migration

The birds living at high altitude descends at lower altitude in winter to save themselves from intense cold of high altitude. They return again to high altitude with advent of summer. **Eg:** blue grouse

9. Latitudinal or equatorial migration

The birds migrate from east to west and vice- versa. Resident of east Europe and west Asia migrate towards the Atlantic coast. The most familiar migration are those from north to south and vice versa **Eg:** California gull, golden plover

10. 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.

LECTURE 44: Causes & Effects of migration

Causes of Migration

- Shortage of food supply on the breeding ground
- Environmental factors
- Internal factors
- Photoperiodism

- Fat deposition

Effects of Migration

- To secure a better climate for living by avoiding unfavorable climatic conditions. e.g. intense cold, hot, stormy conditions and food storage.
- By alternatively exploiting two different habitat for food due to migration more birds can be able to exist.
- Change in climate provide greater variety in birds diet.
- long working hours by moving towards summer season areas provide more chance to gather food for young ones
- Predation pressure is less because it arrives in large number in breeding ground, which helps in their survival.
- Migration provides evolutionary benefits e.g. gene flow
- Migration provides geographic dispersal of birds (isolating mechanism)

Some migratory animals are carrier to infectious diseases, as a result spread infection in other area too.

Migration involve following types of hazards;

1. Natural Hazards

- Climate change
- Drought
- Food supply
- Predators
- Physical demand of migrants
- Damage to host environment

2. Anthropogenic hazards to migrants

- Barriers (fences, dams & skyscrapers)
- Water, air craft and fishes practices
- Telegraphic wires, towers and light houses
- Illegal hunting

LECTURE 45: Example of Migration

1. The Great Migration

The **Great Migration** isn't called great by chance. Every year in the Great Rift Valley of Tanzania and Kenya, which are located in Africa, more than 1.5 million wildebeest migrate northwest across the grassy plains of the Serengeti. Zebras and other grazing animals also take part in this migration. These animals are constantly on the search for food, following the grasses that flourish during the rainy season.

2. The Sardine Run

One of the largest and most ecologically important migrations occurs along the eastern coast of South Africa, the **Sardine Run**. In July, after spawning in the cold waters of the Cape of South Africa millions of sardines migrate north to warmer waters in the KwaZulu-Natal coast.

3. Migration in Salmon

Salmon live out most of their lives at sea, however after sexually maturing, they migrate back upriver to spawn at the very same place where they were born. This migration can cover hundreds of miles in distance and is very difficult and dangerous for the fish as most of them are killed on the way or die soon after spawning.

4. Migration in Crab

During the rainy season October/November millions of red crabs living in Christmas Island migrate from inland to the coast in order to spawn. The sheer number of crabs seems to cover the ground in a carpet of red, each year tourists flock to the island to witness the crabs migrate and although they still have to avoid predators the residents of Christmas island have done much to help the crabs.

5. Migration in Artic Tern bird

The longest migration of all is undertaken by the Artic Tern bird which flies between it's Artic and Antartic breeding grounds each year, a distance of at least 12000 miles/19000 kilometers. Over the course of its lifetime an Artic Tern can migrate up to 2.4 million kilometers which is equivalent to around three journeys to the moon and back.

6. **Migration in Monarch butterflies**

Monarch butterflies are not able to survive the cold winters of most of the United States so they migrate south and west each autumn to escape the cold weather. The monarch migration usually starts in about October of each year, but can start earlier if the weather turns cold sooner than that.

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Topic- Gene flow:

LECTURE 46: Gene flow

The introduction of genetic material (by interbreeding) from one population of a species to another" **OR**

"In case of pollens(plant sperm) moved across the river from population to other"

The introduction of new alleles through gene flow increases variability within the population and makes possible new combinations of traits. In human beings gene flow usually comes about through the actual migration of human populations, either voluntary or forced.

Gene flow is the exchange of **genes** between two separate populations. This is most often accomplished when animals or spores from plants migrate to a new area. Any time a **gene** is introduced into a population where that **gene** once did not exist, **gene flow** has occurred.

Examples of Gene flow:

- A population of flowers on one side of a river transports pollen to the flowers on the other side of the river, producing offspring.
- Blue-eyed people from Sweden move to a small town in Mexico where people all have brown eyes. When they mate, some of their children now have blue eyes.
- Some birds with shorter beaks enter into a population of birds with much longer beaks, resulting in the hatching of birds with in-between sized beaks.
- A bunch of women from West Africa, where malarial is present, mate with a group of Europeans. Their children are less susceptible to contracting malaria due to the presence of antibodies from their West African mothers.

Gene Flow between species:

Gene flow between species take place in two forms;

- Horizontal Gene Transfer
- Vertical Gene Transfer

Vertical gene transfer

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

Horizontal Gene Transfer

Horizontal gene transfer is known to occur between different species, such as between prokaryotes and eukaryotes, between the three DNA-containing organelles of eukaryotes, the nucleus, the mitochondrion and the chloroplast."

Horizontal gene transfer is basically the transfer of genes between organisms via methods other than asexual or sexual reproduction. Genes and the characteristics code for are passed down from parent to progeny.

There are three ways for bacteria to transfer their DNA horizontally

- **Conjugation**

The transfer of DNA directly from one cell to another through cell-cell contact often involving **plasmids**

- **Transformation**

Bacteria are capable of taking up DNA directly from their environment and incorporating it into their genomes known as **natural transformation**

- **Transduction**

Transduction is the transfer of DNA from one cell to another by a virus

LECTURE 47-48: Barriers to Gene flow

1. Allopatric Speciation

"Gene flow blocked by physical barriers results in Allopatric speciation"

- It is geographical isolation that doesn't allow population of the same species to exchange genetic material
- Physical barriers to gene flow both "natural" and "artificial"
- Natural physical barriers include mountain ranges, oceans or vast deserts
- Artificial physical barriers are man-made barriers such as "The Great Chine Wall", barrages or dams etc

Steps of Allopatric Speciation

1. A geographic change separates members of a population into more than one group.
2. Different gene mutations occur and build up in the different populations over time.
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: Darwin finches (adaptive radiation).

2. 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. This is often result of Reproductive isolation

Reproductive isolation:

The mechanisms of reproductive isolation are a collection of evolutionary mechanisms, behaviors and physiological processes critical for speciation. They prevent members of different species from producing offspring, or ensure that any offspring are sterile. These barriers maintain the integrity of a species by reducing gene flow between related species

Types Reproductive isolation

- **Pre-zygotic isolation**
- **Post-zygotic isolation**

Examples of Sympatric Speciation: In Apple Maggot Flies

How do allopatric and sympatric speciation differ

Allopatric speciation is speciation that results when a population is separated by a physical barrier. It is also referred to as geographic speciation. Sympatric speciation is speciation that occurs without physical separation of members of the population.

LECTURE 49: Gene Flow- Examples

1. Examples of Gene flow in human:

- In recent years, gene flow has been observed between the Caucasian population and the African American population. African-Americans are descendants of the natives of West Africa, whereas the Caucasians are descendants of the natives of Europe. The African-American population is inherently resistant to malaria whereas, the European population isn't. The offspring produced by the mating of the individuals of these populations were seen to be resistant to the disease.
- Another example of gene flow was during the Vietnam War, when the American soldiers mated successfully with Vietnamese women, in the 1960s and 1970s, and altered the allele frequency of the Vietnamese population.

2. Gene flow in Pollen grain

A pollen grain of a wind pollinated plant manages to fertilize some other plant to produce seed that give rise to viable offspring, then a change in the allele frequency may be brought about.

3. Gene flow in Moths

A population of moths that are white in color migrate to a population of brown-colored moths and successfully mate to give rise to viable offspring. Here, we can say that there is a change in the allele frequency. Over time, the number of these white moths will increase.

4. Gene flow in Gray wolf

When the gray wolf mates with a coyote, this may give rise to viable red wolves, and therefore, a change in the number of individuals carrying a particular allele has been observed.

5. Gene flow in Atlantic Cod

In the Atlantic cod populations, high gene flow has been observed over a large geographical area. Thus, the genetic variations between these cod populations was low.

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Topic: Extinction

PPT: 50-56

LECTURE 50: Extinction

"A species becomes extinct when the last existing member of that species dies."

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)
- Evolutionary changes in their members (genetic inbreeding, poor reproduction, decline in population numbers).

Extinction becomes a certainty when there are no surviving individuals that are able to reproduce and create a new generation. A species may become functionally extinct when only a handful of individuals survive, which are unable to reproduce due to;

- Poor health,
- Age,
- Sparse distribution over a large range,
- A lack of individuals of both sexes (in sexually reproducing species)

Extinction Rate according to IUCN

Mammals (20%), Birds (10-15%), Reptiles (5%), Fishes , insects, molluscus, plants(0-5%), Amphibians (2530%).

Mass Extinction:

Extinction event (also known as a **mass extinction** or **biotic crisis**) is a widespread and rapid decrease in the biodiversity on Earth."

Biologists suspect we're living through the sixth major mass extinction. Earth has witnessed five, when more than 75% of species disappeared. Paleontologists spot them when species go missing from the global fossil record.

"We don't always know what caused them extinct but most had something to do with rapid climate change"

Example of Extinction:

White Rhino

White rhinos are the second largest land mammal. Southern white rhinos were thought to be extinct in the late 19th century, In 1895 a small population of less than 100 individuals was discovered in KwazuluNatal, South Africa.

Sudan

Sudan, the "gentle giant" who lived in the Ol Pejeta conservancy in **Kenya**, was put down on **Monday 19 march 2018** after the pain from a degenerative illness became too great. **Sudan,** last male of this specie, There are only two female Rhinos left behind on this planet.

Passenger Pigeon

The passenger pigeon may have once constituted 25 to 40 percent of the bird population. The 19th century brought widespread hunting and trapping of the birds, which severely diminished their populations. The last passenger pigeon, named "**Martha"** died at age 29 at the Cincinnati Zoo in 1914.

LECTURE 51: CAUSES OF EXTINCTION

The causes of extinction are as follows

1. Climate change
2. Habitat destruction
3. lack of genetic diversity
4. Better-adaptive condition
5. Pollution
6. Human over-population
7. Poaching and hunting

1. Climate Change

Almost half of plant and animal species have experienced local extinctions due to climate change. Global warming could trigger not just local but global extinctions of animals and plants. Species already threatened by habitat destruction, pollution, alien invasion and overhunting are more vulnerable to climate change. Diversity of species in any one ecosystem could be affected by rises in average temperatures or a shift of climate regime

2. Habitat destruction

Deforestation has killed off more species than we can count. Rainforest can disappear in the next 100 years if deforestation is not stopped. 13 million hectares of forest have been converted or destroyed Coral reefs are also threatened Reefs are home to 25% of marine animal. To date, 27% of coral reefs have been destroyed.

3. Lack of genetic diversity

When species starts dwindling in numbers, there's a smaller pool of available mates. Dwindling population of African cheetah's suffers from unusually low genetic diversity. Thus may lack the resiliency to survive another major environmental disruption.

4. Better-Adaptive conditions

Better-adapted" populations always win out over those that lag behind. Often don't know exactly what the favorable adaptation, until after the event. Determining which is the "better adapted" species takes thousands or even millions of years. Fact is that the vast majority of animals have gone extinct in this comparatively unexciting way.

5. Pollution

Marine animals are exquisitely sensitive to traces of toxic chemicals in lakes, oceans and rivers. Drastic changes in oxygen levels, caused by industrial pollution, can suffocate entire populations. Large bodied animal and rare species are more prone to the changes caused by humans to the planet. Constant exposure to pollution can render plants and animals more susceptible to dangers including starvation, loss of habitat and disease

6. Poaching & Hunting

Human hunters are responsible for wiping out the population of large animals. Researchers found that most of the animals that time died because of increased hunting. Horn of Rhino ivory of elephants, the fur and organs of tigers, the deliciousness of tuna and the supposedly medicinal effect of shark's fin etc are some reasons for over-hunting.

LECTURE 52: Effects of Extinction

Some major effects of extinction are as follow;

- Destruction of Ecosystems
- Upsetting the balance of nature
- Medical study
- Bees and pollination

1. Destruction of Ecosystems

Species of animals cannot live away from each other. They work together to form an ecosystem. Extinction of one species can effect other by effecting food chain .They depend upon each other and their environment to survive. So in this way it can destroy whole ecosystem

2. Upsetting the balance of nature

A keystone species is an important to an ecosystem. The grizzly bear is a keystone species. It catch and eat salmon. As the bears move from rivers and streams back to the land, they bring nutrients from the fish to the land in their waste. These nutrients keep the forest healthy so the many animals and plants can live. Without grizzly bears, the forest ecosystem could collapse. But the grizzly bear is now listed as a threatened species. Its extinction can upset the whole balance of the nature.

3. Medical study

Many different species have unique bodily processes that can cure human diseases. e.g. the toxins produced by **dart-poison frogs** in the rain forest have yielded information about how alkaloid compounds behave in living organisms. Scientists also study bears for clues about how they recycle blood toxins during hibernation to find potential solutions to kidney disorders. Plants from forests are useful for medicinal purposes.

4. Bees and pollination

Bees are responsible for pollinating more than 250,000 species of plants. "Colony collapse disorder" is wiping out entire populations of the insect. Scientists have yet to discover its true cause. Continued losses could threaten the supply of crops like almonds, apples and cucumbers. From all species, humans rely upon for food 87 rely on pollinators mainly honeybees. Only 28 different crops could survive without such assistance.

LECTURE 53-54: Animals That Are Now Extinct

More than **99** percent of all species, amounting to over **five billion species**, that ever lived on Earth are estimated to be extinct. Estimates on the number of Earth's current species range from 10 million to 14 million, of which about 1.2 million have been documented and over 86 percent have not yet been described. Major extinction events are nothing new for the planet, but species are now dying out at an alarming rate. According to the **Center for Biological Diversity**, Nearly 20,000 species of plants and animals are at a high risk of extinction and if trends continue, Earth could see another mass extinction event within a few centuries.

Extinct animals

1. West African Black Rhinoceros

The West African black rhinoceros (*Diceros bicornis longipes*) was a subspecies of the black rhino that was declared extinct in 2011.

2. Pyrenean Ibex

The Pyrenean ibex (Capra pyrenaica pyrenaica) was a subspecies of the Iberian wild goat that went extinct in 2000.

3. Passenger Pigeon

The passenger pigeon may have once constituted 25 to 40 percent of the bird population. The 19th century brought widespread hunting and trapping of the birds, which severely diminished their populations.   The last passenger pigeon, named "**Martha,"**died at age 29 at the Cincinnati Zoo in 1914.

4. Quagga

The Quagga was a subspecies of the common plains zebra and a native of South Africa. Known for its unique stripes, the Quagga was hunted for its hide and killed by ranchers who believed the animals competed with livestock for grazing area. The last known Quagga died at the Amsterdam Zoo in 1883.

5. Caribbean Monk Seal

Last seen in the early 1950s

6. Sea mink

The sea mink (Neovison macrodon) once lived along the coasts of Maine and New Brunswick, but was prized for its fur and was hunted to extinction in the second half of the 19th century.

7. Tasmanian Tiger

Know as Tasmanian tigers due to their stripes, thylacines (Thylacinus cynocephalus) were the largest modern carnivorous marsupial according to the Smithsonian Institution.

8. Tecopa Pupfish

The Tecopa pupfish was native to the Mojave desert in California and could survive in waters as warm as 108 degrees Fahrenheit.

9. Great Auk

10. Javan Tiger

The Javan tiger was a tiger subspecies that likely became extinct in the mid-1970s, according to the International Union for Conservation of Nature

11. Bubal Hartebeest

The animals were hunted to extinction and the last known Bubal hartebeest was killed in Algeria sometime between 1945 and 1954, according to the International Union for Conservation of Nature.

12. **Steller' s sea cow**

The largest mammals, other than whales, to have existed in the holocene epoch, the Steller's sea cow reached up to nine metres in length but was hunted to extinction in 1768, within 27 years of its discovery by Europeans.

13. **Dodo**

Perhaps the most famous extinct species, the dodo - endemic to Mauritius - was wiped out in just a few decades. The first recorded mention of the flightless bird was by Dutch sailors in 1598; the last sighting of one in 1662. It owes much of its fame to its appearance in Alice's Adventures in Wonderland.

LECTURE 55-56: Extinct Plants

1. Acalypha rubrinervis

calypha rubrinervis (**string tree** or **stringwood**) is an extinct plant in the spurge family (Euphorbiaceae), from the island of Saint Helena in the South Atlantic Ocean. It was called string tree on account of the thin pendulous inflorescences which resembled red strings.

2. Adiantum lianxianense

Adiantum lianxianense was a fern species in the subfamily Vittarioideae of the Pteridaceae. It was endemic to Guangdong. Its natural habitat was subtropical or tropical moist lowland forest. It became extinct due to habitat loss

3. Sterculia khasiana

Sterculia khasiana was a species of plant in the Sterculiaceae family. It was an endemic tree of the Khasi Hills in Meghalaya in India. It became extinct due to habitat loss.

4. Madhuca insignis

Madhuca insignis is a species of plant in the Sapotaceae family. It is endemic to India. It had been declared extinct due to habitat loss. However, a *Madhuca insignis* population has been rediscovered along the banks of the river Kumaradhara, in Dakshina Kannada region of Karnataka state, India.

5. Myrcia skeldingii

Myrcia skeldingii was a species of plant in the Myrtaceae family. It was endemic to Jamaica. It became extinct due to habitat loss.

6. kokia cookei

It was presumed extinct in the 1950s when the last seedling died, until 1970 when a single specimen was found. This specimen died eight years later in a fire, though not before a branch was taken and grafted onto another related, and also endangered, tree.

7. sephora toromiro

Easter Island, where Sephora toromiro once grew, is a case study in what will happen to humanity if we don't care for our forests and our natural environment. By the 1800s, nearly all of the island's forests had been eliminated by humans, and the subsequent social collapse was stunning. Humans obviously weren't the only ones who suffered. Sephora toromiro was once commonplace and widespread. It is currently extinct in the wild. But maybe not for much longer.

8. sigillaria

The Sigillaria tree is one you would probably find strange today. It's a tree that doesn't reproduce via seeds, like today's deciduous and coniferous trees do. It was a spore-bearing, tree-like plant that flourished in the late Carboniferous period.

9. Araucarioxylon arizonicum

The tree lived during the Triassic period when Arizona was a dense, tropical area, unlike the desert that it is today. They became extinct between 200 and 250 million years ago. They could grow as tall as 60 meters.

10. saint helena olive

The tree became increasingly rare in the 19th century when only 12-15 specimens were recorded on the island. The final wild specimen died in 1994, while the last in cultivation died in 2003.

11. Wood's Cycad

Wood's Cycad is endemic to the oNgoye Forest of KwaZulu-Natal, South Africa. Only a cluster of four specimens was ever found (1895), and that number fell to a single three meter high tree in 1916. It was that year the the tree was removed and sent to the Government Botanist in Pretoria, where it later did in 1964.

12. Franklinia

Franklinia also became extinct during the era of man, though much less recently. The last known sighting of *Franklinia* in its native range was in 1803.

13. Cyanea superba

Cyanea superba is a rare plant that, much like the cycad above, is extinct in the wild but is still cultivated in captivity. The date of its extinction is complicated, as different subspecies of the plant became extinct at varying dates between 1932 and 2002.
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LECTURE 57-58: Threatened species

Threatened species are any species (including animals, plants, fungi, etc.) which are vulnerable to endangerment in the near future. Species that are threatened are sometimes characterized by the population dynamics measure of critical dispensation, a mathematical measure of biomass related to population growth rate.

1. American hart's - tongue fern:

Appearance

Hart's Tongue Fern is a rare treat for the eyes; it is so green, glossy, and large that it defies reality.

Habitat

This fern is found in close association with outcrops of dolomitic limestone, in coulees, gorges and in cool limestone sinkholes in mature hardwood forests.

Why It's Threatened?

Quarrying, recreation and residential development have all destroyed these plants and their habitat. Canadian populations are threatened by lumbering and the development of land for ski resorts and country estates, among other activities.

2. Dwarf lake iris

Appearance

Dwarf lake iris is a miniature iris with showy, deep blue flowers.

Habitat

Occurring close to Great Lakes shorelines in cool, moist lakeshore air, dwarf lake iris is found on sand or in thin soil over limestone-rich gravel or bedrock.

Why is the Dwarf Lake Iris Threatened?

- Habitat Loss or Degradation
- Collection

Recovery Plan: In process

3. Eastern prairie fringed orchid

Appearance - This plant is 8 to 40 inches tall and has an upright leafy stem with a flower cluster called an inflorescence. The 3 to 8 inch lance-shaped leaves sheath the stem.
Habitat Requirements - The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetlands such as sedge meadows, marsh edges, even bogs. It requires full sun for optimum growth and flowering and a grassy habitat with little or no woody encroachment

Why is the eastern prairie fringed orchid threatened?

- Historic Decline
- Current Decline

Recovery Plan - In September 1999 a recovery plan was completed by the U.S.

4. Fassett's locoweed

Appearance - Fassett's locoweed is a 4- to 12-inch tall perennial herb of the pea family. It appears silvery-grey in color because of white, silky hairs that cover most of the plant.

Habitat - Fassett's locoweed grows on gentle, sand-gravel shoreline slopes around shallow lakes fed by groundwater seepage. These lakes are subject to frequent, large fluctuations in water levels.

Why is the Fassett's locoweed threatened?

Habitat Loss or Degradation -

Recovery Plan - The U.S. Fish and Wildlife Service prepared a recovery plan that describes actions needed to help this plant survive

5. Houghton's goldenrod

Appearance- Houghton's goldenrod is a showy goldenrod found only on the northern Great Lakes shoreline of Lakes Huron and Michigan. It is threatened by loss of habitat due to increased human activity in shoreline areas.

Habitat

Houghton's goldenrod typically grows on moist sandy beaches and shallow depressions between low sand ridges along the shoreline. This habitat is called interdunal wetland.

Why is the Houghton's goldenrod Threatened?

- Habitat destruction
- Road maintenance activities,

6. Lakeside daisy

Appearance: A small herbaceous, perennial plant in the Aster family , the Lakeside daisy produces daisy-like flowers consisting of bright yellow ray florets and golden yellow disk florets.
Lakeside daisy habitat: The Lakeside daisy is typically found in dry, rocky, prairie grassland over limestone in areas characterized by a thin soil layer, although it is also known to occur on limestone or dolomite cliffs near the Lake Huron shore.

Why is the Lakeside daisy Threatened?

- Habitat destruction
- Collection

  Recovery Plan: Recovery strategies have been developed for the conservation of the Lakeside daisy in the United States.

7. Northern wild monkshood

Appearance - Northern monkshood is noted for its very distinctive, blue hood-shaped flowers.

Habitat - Northern monkshood is typically found on shaded to partially shaded cliffs, on cool, streamside sites. These areas have cool soil conditions, co

Why Is The Northern Monkshood Threatened?

- Habitat Loss or Degradation
- Collection

Recovery Plan - The U.S. Fish and Wildlife Service has developed a recovery plan that describes actions needed to help the plant survive.

8. Pitcher's thistle

Appearance - The Pitcher’s thistle grows for five to eight years before it flowers. Its nonflowering form is a rosette or cluster of silvery leaves and its flowering form typically has one stem with many branches.

Habitat - Pitcher’s thistle grows on the open sand dunes and low open beach ridges of the Great Lakes’ shores.

Why is the Pitcher's thistle threatened?

- Shoreline Development -
- Road Maintenance and Construction
- Shoreline Recreation Activities

Project Planning - In areas where the Pitcher’s thistle is found it is considered during project planning for federally funded or authorized projects such as marina development and road construction.

9. Prairie bush-clover

Appearance: The showy pink flowers of prairie bush clover are less often seen than the silvery-green pods because of the plant's short blooming season and its ability to produce pods directly from flowers that never open.

Habitat: Dry to mesic prairies with gravelly soils

How is prairie bush clover threatened?

Conversion of pasture to cropland, overgrazing, agricultural expansion, herbicide application, urban expansion, rock quarrying, and transportation right-of-way maintenance and rerouting

Topic: Cryopreservation

PPT-59-64

LECTURE 59: Cryopreservation

Why preservation is important?

Until two decades ago the genetic resources were getting depleted owing to the continuous depredation by man. It was imperative therefore that many of the elite, economically important and endangered species are preserved to make them available when needed. Many methodologies have been devised for long term preservation of material.

Methodologies

There are various methods of storage :

1. **Cryopreservation** - generally involves storage in liquid nitrogen.

2. **Cold storage** - it involves storage in low and non freezing temperature.

3. **Low pressure** – it involves partially reducing the atmospheric pressure of surrounding.

4. **Low oxygen storage** - it involves reducing the oxygen level but maintaining the pressure.

Cryo-preservation

Cryo is Greek word. (krayos – frost). It literally means preservation in "frozen state."

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).

Objective:

The objective of cryopreservation is to minimize damage to biological materials, including tissues, mammalian cells, bacteria, fungi, plant cells, and viruses, during low temperature freezing and storage.

Cryopreservation can be done at

- Over solid carbon dioxide (at -79 degree)
- Low temperature deep freezer (at -80 degree)
- In vapor phase nitrogen (at -150 degree)
- In liquid nitrogen (at -196 degree)

Freezable tissues

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.

LECTURE 60: Cryopreservation Technique:

A **cryoprotectant** is a substance used to protect biological tissue from freezing damage. Due to ice crystal formation cell membrane and cell integrity can ruptured. **cryoprotectants** are usually antifreeze compound.

Types of Cryoprotectants:

1. **Membrane permitting** which can freely diffuse the membrane such as **glycerol** (G), **ethylene glycol** (**EG**) and **dimethyl sulfoxide** (**DMSO**)
2. **Non Membrane permitting** which cannot **permeate** the cell membrane such as **sugars**

Cryopreservation technique:

- Slow freezing and thawing
- Rapid freezing and thawing
- Vitrification
- Ultrarapid freezing

1. Slow Freezing- Slow thawing

With this method organs are labeled into vials after equilibration with a cryoprotectant solution and then cooled at rate of 0.5-2 ^oC per minute down to -1 ^oC. Seeding is then induced and a holding period of 5 to 15 minutes allows equilibration of the temperature. Thereafter embryos are cooled to -60 ^oC or lower at a rate of 0.3 to 0.5 ^oC per minute before being transfer to liquid nitrogen. Frozen embryos must be slowly thawed at a rate of less then 25 ^oC per minute to prevent osmotic shock

2. Rapid cooling and rapid thawing

In this technique , however cooling is terminated at -30 to -40 ^oC and embryos are then plunged into liquid nitrogen for rapid cooling to -196 ^oC. Thawing is therefore performed rapidly (200 to 500 ^oC per minute) to prevent recrystallization

3. Vitrification

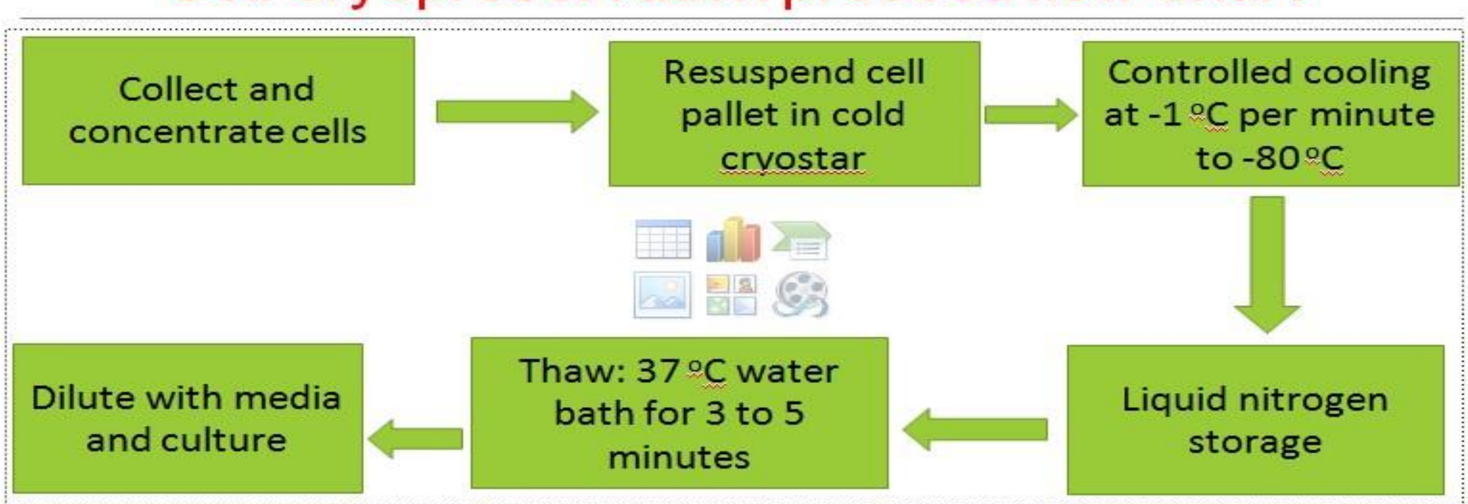
Vitrification is the process of cooling where the water in the tissue becomes glass rather than crystals. Glass is a liquid that is too cold (too viscous) to flow. In other words vitrification is solidification due to increased viscosity rather than crystallization.

4. Ultrarapid Freezing

In this technique serial equilibration of embryos in high concentration of DMSO (3-5 M) supplemented with sucrose (0.3 to 0.5 M). The embryos are then plunged into liquid Nitrogen. Thawing is then done with warm water bath (approximately 500 ^oC per minute).

	Slow freezing	Vitrification
Damage due to ice formation	yes	no
Speed of freezing	0.3°C/min.	23,000°C/min.
Amount of cryoprotectant	low	high
Cell survival	low	high
Procedure	simple	complex

Cell cryopreservation process flow chart



LECTURE 61: Mechanism of cryopreservation in plants

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

- Selection of material.
- Addition of cryoprotectant.
- Freezing.
- Storage in liquid nitrogen.
- Thawing.

- Washing and re-culturing.
- Measurement of viability.
- Regeneration of plants.

1.Selection of plant material

Selection of proper plant material is important. Two important factors depend on it such as (a) nature and (b) density. Any tissue can be selected for this purpose. e.g. meristem, embryo, ovules, seeds etc.. The density should be high.

2. Addition of cryoprotectant

They are chemical which prevent cryo-destruction. These are sucrose, alcohols, glycols, some amino acid (proline), DMSO (dimethyl sulfoxide). Generally two Cryo protective agents should be used together instead of single one as they are more effective. 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

3. Freezing

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.

The sensitivity of cells to low temperature depends on the plant species. There are four different types of methods :

1. **Slow freezing method** - the tissue or plant material is slowly frozen at slow cooling rate. The advantage is the plant cells are partially dehydrated and survive better.
2. **Rapid freezing method** - it involves plunging the vials in liquid nitrogen. The temperature decreases from -300 to -1000 degree rapidly.
3. **Combined freezing method** - this is combination of both slow and rapid freezing method. The process is carried out in step wise like manner.
4. **Dry freezing method** - in this method dehydrated cells and seeds are stored.

4. Storage

The maintenance of the frozen cells or material at specific temperature is very important. In general the temperature is kept -70 to -196 degree. Prolong storage is done at temperature of -196 degree in liquid nitrogen. To prevent damage, continuous supply of nitrogen is done.

5. Thawing

Usually carried out by plunging the vials into warm water bath with vigorous swirling. As thawing occurs the vials are transferred to another bath at 0 degree.

6. Washing and re-culturing

The preserved material is washed few times to remove the cryoprotectant. This material is then recultured in a fresh medium

7. Measurement of viability

- There is possibility of death of cells due to storage stress.
- Thus viability can be found at any stage.
- It is calculated by formula :

$$\left(\frac{No\ of\ cells\ growing}{No\ of\ cells\ thawed}\right) \times 100$$

8.Plant regeneration

The viable seeds are cultured on non specific growth medium. Suitable environmental conditions are maintained.

Cory-conservation of animal genetic resources

Cory-conservation of animal genetic resources is a strategy wherein samples of animal genetic materials are preserved cryogenically.

- Animal genetic resources, as defined by the Food and Agriculture Organization of the United Nations, are "those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them
- Genetic materials that are typically cryogenically preserved include sperm, oocytes, embryos and somatic cells.
- Cryogenic facilities are called gene banks and can vary greatly in size usually according to the economic resources available.
- They must be able to facilitate germplasm collection, processing, freezing, and long term storage, all in a hygienic and organized manner.
- Cryo-conservation is the process of freezing cells and tissues using liquid nitrogen to achieve extreme low temperatures with the intent of using the preserved sample to prevent the loss of genetic diversity.
- Semen, embryos, oocytes, somatic cells, nuclear DNA, and other types of biomaterial such as blood and serum can be stored using cryopreservation, in order to preserve genetic materials.

Methodology:

1. **Collection:** Here are several ways to collect the genetic materials based on which type of germplasm. **Examples:** Embryo**,** Somatic cells

2. **Freezing:** There are two cryopreservation freezing methods

- Slow freezing
- Vitrification

LECTURE 63: Advantages and disadvantages of Cryopreservation

Advantages:

- Cryopreservation helps in the preservation of biological materials.
- Cryopreservation is used to maintain the biosynthetic properties of plants
- Sperm, gametes, embryos, tissues, bone marrow, organ can be preserved.
- Helps to study the adapting nature of plants and animals under the low temperature.
- Used to preserve the genetic materials of the plants which are on the verge of extinction
- Prevent in breeding
- Reduced risk of microbial contamination
- Reduced risk of cross contamination with other cell lines
- Reduced risk of genetic drift and morphological changes
- Embryo cryopreservation is used most often to store good quality excess embryos resulting from an IVF treatment cycle.
- Embryos can be stored for a patient who elects to have her eggs fertilized with donor sperms. Pregnancies have been reported from embryos stored for 16 years.
- Human sperm cryopreservation is widely used to store donor and partner spermatozoa to preserve sperms
- It also ensure the recovery of a small number of spermatozoa in several male factor infertility17 .
- It is commonly called sperm-banking is a procedure to preserve sperm cells.

Disadvantages:

There are few disadvantages to storing eggs.

- During the cycle where the eggs are harvested, patients undergo a traditional IVF protocol.
- There are known side effects with fertility medication including the risk of ovarian hyper stimulation syndrome or OHSS.

- The lengthy process of slow-rate freezing and the subsequent long-term storage of these valuable cells can often be costly, consuming large amounts of energy to accurately maintain such low temperatures.

Ovarian hyper stimulation syndrome (OHSS)

Ovarian hyper stimulation syndrome (OHSS) affects women taking injectable hormone medications to stimulate the development of eggs in the ovaries. This may occur in women undergoing in vitro fertilization (IVF), ovulation induction or intrauterine insemination. Too much hormone medication in system can lead to OHSS, in which ovaries become swollen and painful. A small number of women may develop severe OHSS, which can cause rapid weight gain, abdominal pain, vomiting and shortness of breath. Less often, OHSS happens during fertility treatments using medications you take by mouth, such as clomiphene (Clomid, Serophene).

Treatment:-

- Anti-nausea medication, prescription painkillers or both
- Frequent physical exams and ultrasounds
- Daily weigh-ins and waist measurements to check for drastic changes
- Measurements of how much urine you produce each day
- Blood tests to monitor for dehydration, electrolyte imbalance and other problems
- Adequate fluid intake
- Drainage of excess abdominal fluid using a needle inserted in your abdominal cavity • Support stockings, to help prevent blood clots

<u>Obstacles</u>

Upto 60% human body is composed of water. What's the issue then?

- Actually the freezing point of water is 0 degree centigrade while the cryoscopy temperature can be as low as -90 degree centigrade. • Very expensive Technique
- Ice formation can result in the needle shaped crystals resulting in the damage to cell membrane.
- Unequal distribution or over distribution of cryoprotectants.
- Moreover, thermal gradients can induce mechanical stress due to uneven expansion or contraction in the biomaterial.
- The cooling rate required for optimal survival varies by several orders of magnitude between different cell types. • Mass transfer limitations

LECTURE 64: Applications of Cryopreservation

In Animal Husbandry

The introduction of cryopreservation technology leads a major breakthrough in animal husbandry .Since the 1st successful cryopreservation of bull semen has been used to propagate the rare and endangered species using assisted reproduction techniques.

In fishery science

The 1st report on fish sperm cryopreservation was published by Blaxter (1953). To date milt (semen) of over 200 species of fresh water and marine fish have been cryopreserved and have been adequated for the purpose of cryobanking(10,11,12) . In fish aquaculture the successful cryopreservation of gametes and embryos could offer new commercial possibilities, allowing the unlimited production of fry and potentially healthier and better conditioned fish as required

In medical science

Low temperature have been used in medicine and to prevent food spoilage since ancient time. Now- a-days it is used in fertility treatment the transport of human organs and the long- term storage of biological specimens, either for future or simply as a record of biodiversity.

Cryopreservation of oocyte

Human oocyte cryopreservation is a new technology in which a woman's eggs are extracted, frozen or stored. Egg freezing benefits two groups of women. One those who are diagnosed with a medical condition whereby the necessary treatments for cure may render them sterile or unable to produce viable eggs. The second who are delaying their childbearing for personal reasons. Eggs frozen at the age of 35 are more usable than fresh oocytes produced at age 43 years of age

Cryopreservation of testicular tissue

Cryopreservation of immature testicular tissue is a developing method to avail reproduction to young boys who need to have gonado toxic therapy

Embryo cryopreservation

Embryo cryopreservation is used most often to store goodquality excess embryos resulting from an IVF treatment cycle. Embryos can be stored for a patient who elects to have her eggs fertilized with donar sperms. Pregnancies have been reported from embryos stored for 16 years

Cryopreservation of ovarian tissue

Ovarian tissue cryopreservation is considered to be an experimental technique for fertility preservation. This procedure is an option for patients who require immediate gonadotoxic treatment of aggressive malignancies when there is insufficient time to allow the woman to undergo ovulation induction, oocyte retrieval and crypreservation oocytes and/or embryos.

Cryopreservation of sperm:

Today human sperm cryopreservation is widely used to store donor and partner spermatozoa before assisted reproduction treatments to preserve spermatozoa before therapy for malignant diseases, vasectomy or surgical in fertility treatments and to ensure the recovery of a small number of spermatozoa in several male factor infertility

Cryopreservation of stem cell:

An important application of cryopreservation is in the freezing and storage of hematopoietic stem cell, which are found in the bone marrow rescue, hematopoietic stem cells are collected from a patient's bone marrow prior to treatment with high-dose chemotherapy. Following treatment, the patient's cryopreserved cells are thawed and infuse back into the body. This procedure is necessary, since high dose chemotherapy is extremely toxic to the bone marrow

Preservation of micro-biology cultures:

Bacteria and fungi can be kept short term refrigerated however, cell division and metabolism is not completely arrested and thus is not an optimal option for long term storage or to preserve cultures genetically or phenotypically as cell divisions can led to mutations

To conserve plant biodiversity

conservation of plant biodiversity is an important issue concerning the human population worldwide. Conservation of plant biodiversity can be performed in situ and ex situ. These two methods are complementary and are not exclusive. They offer different alternatives for conservation, but selection of the appropriate strategy should be based on a number of criteria, including the biological nature of the species and the feasibility of applying the chosen methods 22 . At present biotechnological methods have been used to conserve endangered, rare crop ornamental, medicinal and forest species for short- ,medium-, and long- term

Future of cryopreservation

Vitrification method of cryopreservation may bring new opportunities to research protocols. It is still an experimental procedure. There are two major concern about vitrification - toxicity of high concentration of cryoprotectants used and microbial contamination of liquid nitrogen. Several IVF programs have adopted the vitrification method as the sole procedure for day-3 human embryos and for human blastocysts, with excellent survival and pregnancy rates. The challenge now is to find a protocol to successfully vitrify human oocytes for which the slow freezing method has yet to produce acceptable.

LECTURE -65: Protected areas

What are Protected areas?

"A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values"

History of protected areas

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. 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'

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 Importance and 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.

Coverage:

According to the World Database on Protected Areas (WDPA) there are over 210,000 protected areas around the world.

Criteria:

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.

LECTURE - 66: Categories of Protected areas

Category Ia: Strict Nature Reserve

Primary objective

To conserve Regionally, Nationally, Globally outstanding ecosystems, Species (occurrences or aggregations), Geo diversity features

Other Objectives

To preserve ecosystems, To secure examples of the natural environment for scientific studies, To minimize disturbance through careful planning, To conserve cultural and spiritual values associated with nature.

Distinguishing features

The area should generally:

- Have a largely complete set of expected native species.
- Be capable of being managed to ensure minimal disturbance.
- Be free of significant direct intervention by modern humans.
- Have a full set of expected native ecosystems, largely intact with intact ecological processes, or processes capable of being restored with minimal management intervention.
- Be managed for relatively low visitation by humans

Definition:

Protected areas that are strictly set aside to protect biodiversity where human visitation, use and impacts are strictly controlled to ensure protection of the conservation values.

Role in the landscape/seascape

- Protecting some of the earth's richness that will not survive outside.
- Protecting additional ecosystem services.
- Providing areas where ecosystems can be studied in as pristine an environment as possible.
- Protecting natural sites that are also of religious and cultural significance.

Issues for consideration

- There are few areas not under some kind of legal or at least traditional ownership, so that finding places that exclude human activity is often problematic.
- Most apparent problem is with climate and air pollution
- New and emerging diseases.
- In an increasingly modified ecology, it may become increasingly difficult to maintain pristine areas through non-intervention.

LECTURE 67: IUCN Categories of Protected Areas

Category II: Category II: National Park

Definition:

Large natural or near natural areas set aside to protect large-scale ecological processes, which also provide a foundation for environmentally scientific, educational, recreational and visitor opportunities.

Primary objective

To protect natural biodiversity along with its underlying ecological structure.

Other objectives

- To manage the area in order to perpetuate, in as natural a state as possible.
- To maintain viable and ecologically functional populations.
- To contribute to local economies through tourism.
- To manage visitor use for inspirational, educational recreational purposes.

Distinguishing features

- The area should contain representative examples of major natural regions, and biological and environmental features or scenery.
- It should be of sufficient size to maintain ecological processes.
- The composition, structure and function of biodiversity should be to a great degree in a “natural” state.

Role in the landscape/seascape

- Protecting larger-scale ecological processes.
- Protecting compatible ecosystem services.
- Protecting particular species and communities that require relatively large areas of undisturbed habitat.
- To inform and excite visitors about the need for and potential of conservation programmes.
- To support compatible economic development, mostly through recreation and tourism, that can contribute to local and national economies and in particular to local communities.

Issues for consideration

Commercialization of land and water in category II is creating challenges in many parts of the world.

LECTURE 68-69: Category III: National Monument-Feature

Definition: Protected areas set aside to protect a specific natural monument.

They are generally quite small protected areas and often have high visitor value

Primary objective

To protect specific outstanding natural features. Their associated biodiversity and habitats

Other objectives

- To provide biodiversity protection in landscapes or seascapes that have otherwise undergone major changes
- To conserve traditional spiritual and cultural values of the site.

Distinguishing features

Category III protected areas are usually relatively small sites that focus on one or more prominent natural features and the associated ecology, rather than on a broader ecosystem.

Criteria

Natural geological and geomorphological features: Waterfalls, cliffs, craters, caves etc.

Culturally-influenced natural features: Cave dwellings

Natural-cultural sites: Forms of sacred natural sites (sacred groves, springs, waterfalls, mountains, sea coves etc.) of importance to one or more faith groups
Cultural sites with associated ecology: Where protection of a cultural site also protects significant and important biodiversity, such as archaeological or historical sites that are inseparably linked to a natural area

Role in the landscape/seascape

Important natural monuments can sometimes provide an incentive for protection and an opportunity for environmental/cultural education even in areas where other forms of protection are resisted due to population or development pressure, such as important sacred or cultural sites and in these cases category III can preserve samples of natural habitat in otherwise cultural or fragmented landscapes.

Supported by:

Developed by the International Union for Conservation of Nature (IUCN) with support of the World Commission on Protected Areas (WCPA) and other international institutions such as the Convention on Biological Diversity (CBD), and assigned by national governments.

Management

These areas are managed to maintain certain natural features, and this can be carried out by a range of actions depending on the governance type of the area.

Legal and compliance

The classification of a Category III protected area requires that such areas are managed for conservation by legal or other effective means, and therefore legal recognition and protection at the national or subnational level is likely to be present in these sites. The level of legal protection will however vary between countries, and will depend on the governance type of the area, as they receive differing levels of recognition by government in different countries. Nonetheless a number of national laws are likely to apply to these sites that deter large-scale economic activities in order to maintain the conservation values of these areas.

Biodiversity importance

The main emphasis of protection in category III areas is on the natural features found in these sites. Their role in the conservation of species and habitats, hence, varies. In some cases their contribution to biodiversity conservation may be indirect result of protection of natural features. In other cases (e.g. natural cave system) they may play a key role in the wider conservation strategy of an area

Socio-cultural values

Category III areas are likely to hold socio-cultural values as they may have features such as sacred groves, springs, waterfalls, mountains, sea coves etc. of importance to one or more faith groups. These areas are often of significant tourism value and can be managed with the objective of promoting sustainable tourism.

Issues for consideration

- It will sometimes be difficult to ascertain the conservation attributes of category III sites, particularly in cases where there may be pressure to accept sites within a protected area system to help protect cultural or spiritual values.
- Not all natural monuments are permanent
- It is sometimes difficult to draw the boundaries between a natural monument and cultural site, particularly where archaeological remains are included within category III.
- Some apparent “monuments” may require protection of a larger ecosystem to survive.

ategory III differs from the other categories in the following ways:	
Category Ia	Category III is not confined to natural and pristine landscapes but could be established in areas that are otherwise cultural or fragmented landscapes. Visitation and recreation is often encouraged and research and monitoring limited to the understanding and maintenance of a particular natural feature.
Category II	The emphasis of category III management is not on protection of the whole ecosystem, but of particular natural features; otherwise category III is similar to category II and managed in much the same way but at a rather smaller scale in both size and complexity of management.
Category IV	The emphasis of category III management is not on protection of the key species or habitats, but of particular natural features.
Category V	Category III is not confined to cultural landscapes and management practices will probably focus more on stricter protection of the particular feature than in the case of category V.
Category VI	Category III is not aimed at sustainable resource use.

LECTURE 70-71: Category IV: Habitat-Species Management Area

Habitat-Species Management Area

Definition: IUCN Management Category IV (Habitat/Species Management Area) refers to areas that are managed to protect particular species or habitats. They are defined by IUCN as *“protected areas aiming to protect particular species or habitats and management reflect this priority.*

Primary objective: To maintain, conserve and restore species and habitats.

Other objectives

- To protect vegetation patterns.
- To protect fragments of habitats as components of landscape or seascape-scale conservation strategies.
- To develop public education and appreciation of the species or habitat
- Developed by the International Union for Conservation of Nature (IUCN) with support of the World Commission on Protected Areas (WCPA) and other international institutions such as the Convention on Biological Diversity (CBD), and assigned by national governments.

Distinguishing features

- Protection of particular species
- Protection of habitats
- Active management to maintain target species
- Active management of culturally-defined ecosystems

Role in the landscape/seascape

- Protect critically endangered populations of species.
- Protect rare or threatened habitats.
- Provide flexible management strategies and options in buffer zones around, or connectivity conservation corridors between, more strictly protected areas that are more acceptable to local communities and other stakeholders;
- Maintain species that have become dependent on cultural landscapes where their original habitats have disappeared or been altered.

Management

These areas are managed to maintain or restore certain species and/or habitats, and this can be carried out by a range of actors depending on the governance type of the area (see IUCN Protected Area Management Categories for information on governance types). These are often areas that have already undergone substantial modification, where a high degree of human pressure often exists, and significant management intervention is necessary. Category IV areas will generally be publically accessible.

Legal and compliance

The classification of a category IV protected area requires that such areas are managed for conservation by legal or other effective means, and therefore legal recognition and protection at the national or subnational level is likely to be present in these sites. The level of legal protection will however vary between countries, and will depend on the governance type of the area, as they receive differing levels of recognition by government in different countries. Nonetheless a number of national laws are likely to apply to these sites that deter large-scale economic activities in order to maintain the conservation values of these areas.

Biodiversity importance

Category IV areas are important for their role in ‘plugging the gaps’ in conservation strategies by protecting key species or habitats in ecosystems. It provides a management approach for areas that have already undergone substantial modification, necessitating protection of remaining fragments for identified target species with or without intervention.

Socio-cultural values

- While Category IV areas are not necessarily associated with human presence and intervention, many exist in crowded landscapes and seascapes where human pressure is comparatively greater, both in terms of potential illegal use and visitor pressure
- Many category IV protected areas exist in crowded landscapes and seascapes.
- The category IV protected areas that rely on regular management intervention need appropriate resources from the management authority.
- Because they usually protect part of an ecosystem, successful long-term management of category IV protected areas necessitates careful monitoring and an even greater-than-usual emphasis on overall ecosystem approaches and compatible management in other parts of the landscape or seascap.

Category IV differs from the other categories in the following ways:

Category Ia	Category IV protected areas are not strictly protected from human use; scientific research may take place but generally as a secondary objective.
Category II	Category IV protected areas aim their conservation at particular species or habitats and may in consequence have to pay less attention to other elements of the ecosystem in consequence, whereas category II protected areas aim to conserve fully functional ecosystems.
Category III	The objective of category IV areas is of a more biological nature whereas category III is site-specific and more morphologically or culturally oriented.
Category V	Category IV protected areas aim to protect identified target species and habitats whereas category V aims to protect overall landscapes/seascapes with value for nature conservation
Category VI	Management interventions in category IV protected areas are primarily aimed at maintaining species or habitats while in category VI protected areas they are aimed at linking nature conservation with the sustainable use of resources

LECTURE 72-73: Category V: Protected Landscape-Seascape

Definition: 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.

Supported by

Developed by the International Union for Conservation of Nature (IUCN) with support of the World Commission on Protected Areas (WCPA) and other international institutions such as the Convention on Biological Diversity (CBD), and assigned by national governments. Where safeguarding the integrity of this interaction is vital to protect and sustain the area and its associated nature conservation and other values.

Primary objective: To protect and sustain important landscapes/seascaps and the associated nature conservation.

Other objectives

- To maintain a balanced interaction of nature and culture.
- To contribute to broad-scale conservation by maintaining species associated with cultural landscapes and/or by providing conservation opportunities in heavily used landscapes;
- To provide opportunities for enjoyment, well-being and socio-economic activity through recreation and tourism;
- To provide natural products and environmental services;
- To provide a framework to underpin active involvement by the community in the management of valued landscapes or seascapes and the natural and cultural heritage that they contain;
- To encourage the conservation of agrobiodiversity and aquatic biodiversity;
- To act as models of sustainability so that lessons can be learnt for wider application.

Distinguishing features

- Landscape and/or coastal and island seascape of high and/or distinct scenic quality and with significant associated habitats, flora and fauna and associated cultural features
- A balanced interaction between people and nature
- Unique or traditional land-use patterns

Desirable characteristics:

- Opportunities for recreation and tourism consistent with life style and economic activities;
- Unique or traditional social organizations, as evidenced in local customs, livelihoods and beliefs;

- Recognition by artists of all kinds and in cultural traditions (now and in the past);
- Potential for ecological and/or landscape restoration

Role in the landscape/seascape

- Some category V protected areas act as a buffer around a core of one or more strictly protected areas
- Category V protected areas may also act as linking habitat between several other protected areas.
- Category V offers unique contributions to conservation of biological diversity. In particular:
- Species or habitats that have evolved in association with cultural management systems and can only survive if those management systems are maintained
- To provide a framework when conservation objectives need to be met over a large.

Management

Management of these areas can be carried out by a range of actors depending on the governance type of the area .A high degree of human intervention is to be expected within these areas, including agriculture and forestry, although these practices should be traditional and sustainable systems of land-use.

Legal and compliance

The classification of a category V protected area requires that such areas are managed for conservation by legal or other effective means, and therefore legal recognition and protection at the national or subnational level is likely to be present in these sites. The level of legal protection will however vary between countries, and will depend on the governance type of the area, as they receive differing levels of recognition by government in different countries. As designated protected areas, these sites receive international attention and have been incorporated into a number of environmental safeguard standards.

Biodeversity impotance

The biodiversity importance of category V areas is due to the important role they play in conservation at the landscape/seascape scale, particularly as part of a mosaic of management patterns, protected area designations and other conservation mechanisms.

Socio culture values

- Evidence of traditional land use patterns is a key criterion for category V areas, and therefore these areas will hold certain socio-cultural values, largely that of resource use by local people such as sustainable forestry and agriculture. Human settlements are very likely to be present as a key characteristic of these areas is a long-history of interaction between people and their environment.
- Being a relatively flexible model, category V may sometimes offer conservation options where more strictly protected areas are not feasible.
- Category V protected areas can seek to maintain current practices, restore historical management systems or, perhaps most commonly, maintain key landscape values whilst accommodating contemporary development and change: decisions about this need to be made in management plans.
- The emphasis on interactions of people and nature over time raises the conceptual question for any individual category V protected area: at what point on the temporal continuum should management focus?
- Since social, economic and conservation considerations are all integral to the category V concept, defining measures of performance for all of these values is important in measuring success.

Category V differs from the other categories in the following ways:

Category Ia	Human intervention is expected. Category V does not prioritize research, though it can offer opportunities to study interactions between people and nature.
Category Ib	Category V protected areas are not "wilderness" as defined by IUCN. Many will be subject to management intervention inimical to the concept of category Ib.
Category II	Category II seeks to minimize human activity in order to allow for "as natural a state as possible". Category V includes an option of continuous human interaction.
Category III	Category III focuses on specific features and single values and emphasises the monumentality, uniqueness and/or rarity of individual features, whereas these are not required for category V protected areas, which encompasses broader landscapes and multiple values.
Category IV	Category V aims to protect overall landscapes and seascapes that have value to biodiversity, whereas category IV aims often quite specifically to protect identified target species and habitats. Category V protected areas will often be larger than category IV.
Category VI	Category VI emphasises the need to link nature conservation in natural areas whilst supporting sustainable livelihoods: conversely category V emphasises values from long-term interactions of people and nature in modified conditions. In category VI the emphasis is on sustainable use of environmental products and services (typically hunting, grazing, management of natural resources), whereas in category V the emphasis is on more intensive uses (typically agriculture, forestry, tourism). Category VI will usually be more "natural" than category V.

LECTURE 74-75: Protected Area with Sustainable Use of Natural Resources

Protected Area with Sustainable Use of Natural Resources

Definition: Protected areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems.

Generally large, with most of the area in a natural condition. Where a proportion is under sustainable natural resource management.

Supported by

Developed by the International Union for Conservation of Nature (IUCN) with support of the World Commission on Protected Areas (WCPA) and other international institutions such as the Convention on Biological Diversity (CBD), and assigned by national governments.

Primary objective

- To protect natural ecosystems.
- Use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.

Other objectives

- To promote sustainable use of natural resources, considering ecological, economic and social dimensions;
- To promote social and economic benefits to local communities where relevant;
- To facilitate inter-generational security for local communities' livelihoods – therefore ensuring that such livelihoods are sustainable;
- To integrate other cultural approaches, belief systems and world-views within a range of social and economic approaches to nature conservation;
- To contribute to developing and/or maintaining a more balanced relationship between humans and the rest of nature;

Criteria

- These areas aim to conserve ecosystems and habitats, together with associated cultural values and natural resource management systems

- They are unique in that they have the sustainable use of natural resources as a means to achieve nature conservation, together and in synergy with other actions more common to the other categories, such as protection.
- The category is not designed to accommodate large-scale industrial harvest.
- In general, IUCN recommends that a proportion of the area is retained in a natural condition, which in some cases might imply its definition as a no-take management zone.

Role in the landscape/seascape

Category VI

- Protected areas are particularly adapted to the application of landscape approaches.
- This is an appropriate category for large natural areas.
- It is particularly appropriate to the conservation of natural ecosystems when there are few or no areas without use or occupation.

Management

Management of these areas can be carried out by a range of actions depending on the governance type of the area. Human occupation and intervention is to be expected in these areas, although most practices will be traditional and low-impact as sustainable use is actively promoted.

Legal and compliance

The classification of a category VI protected area requires that such areas are managed for conservation by legal or other effective means, and therefore legal recognition and protection at the national or subnational level is likely to be present for these sites. The level of legal protection will however vary between countries, and will depend on the governance type of the area, as they receive differing levels of recognition by government in different countries. Nonetheless a number of national laws are likely to apply to these sites that restrict large-scale economic activities in order to maintain the conservation values of these areas.

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 such as but not limited to the World Bank [2] and the International Finance Corporation.

Biodiversity importance

Category VI areas are unique among the IUCN Categories as they seek to achieve biodiversity conservation through a synergy between the sustainable uses of natural resources together with protection. These areas tend to be relatively large and are particularly relevant for the application of landscape approaches to conservation. As intervention within these areas is aimed at maintaining or restoring natural ecosystems, they can be anticipated to have high biodiversity values, and may include no-take areas as an integral part of maintaining these values.

Socio-cultural values

These areas can be expected to hold significant socio-cultural value. While industrial use is not expected, sustainable use by local and traditional communities is a key criterion, and the maintenance of these sustainable practices is as important as the maintenance of the natural resources on which people rely.

Issues for consideration

- Protection of natural ecosystems and promotion of sustainable use must be integrated and mutually beneficial.
- New skills and tools need to be developed by management authorities to address the new challenges that emerge from planning, monitoring and managing sustainable use areas.
- There is also need for development of appropriate forms of governance suitable for category VI protected areas and the multiple stakeholders that are often involved.

Category VI differs from the other categories in the following ways:

Category Ia	Category VI protected areas do conserve biodiversity, particularly at ecosystem and landscape scale, but the aim would not be to protect them strictly from human interference. Although scientific research may be important, it would be considered a priority only when applied to sustainable uses of natural resources, either in order to improve them, or to understand how to minimize the risks to ecological sustainability.
Category II	Category VI protected areas aim to conserve ecosystems, as complete and functional as possible, and their species and genetic diversity and associated environmental services, but differ from category II in the role they play in the promotion of sustainable use of natural resources. Tourism can be developed in category VI protected areas, but only as a very secondary activity or when they are part of the local communities' socio-economic strategies (e.g., in relation to ecotourism development).
Category III	Category VI protected areas might include the protection of specific natural or cultural features, including species and genetic diversity, among their objectives, whenever the sustainable use of natural resources is also part of the objectives, but they are more oriented to the protection of ecosystems, ecological processes, and maintenance of environmental services through nature protection and promotion of management approaches that lead to the sustainable use of natural resources.
Category IV	Category VI protected areas are more oriented to the protection of ecosystems, ecological processes, and maintenance of environmental services through nature protection and promotion of the sustainable use of natural resources. While category IV protected areas tend to prioritize active management, category VI promotes the sustainable use of natural resources.
Category V	Category V applies to areas where landscapes have been transformed as a result of long-term interactions with humans; category VI areas remain as predominantly natural ecosystems. The emphasis in category VI is therefore more on the protection of natural ecosystems and ecological processes, through nature protection and promotion of the sustainable use of natural resources.

LECTURE 76-77: National Parks of Pakistan

Important National Parks of Pakistan

"National park is an area which is strictly reserved for the betterment of the wildlife & biodiversity, and where activities like developmental, forestry, poaching, hunting and grazing on cultivation are not permitted"

- In these parks private ownership rights are not allowed.
- Their boundaries are well marked and circumscribed.
- They are usually small reserves spreading in an area of 100 sq. km. to 500 sq. km.
- In national parks, the emphasis is on the preservation of a single floral or faunal species.

Major National parks in Pakistan are as follow;

- 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
- It is the largest of National Parks of Pakistan
- The area was for the first time declared reserved in 1988.
- Hingol is known to support threatened invertebrates in addition to a variety of bird species

- The park is an excellent habitat to wild animals including over 3000 ibexes, and 1500 Urials and more than 1200 Chinkara
- A number of resident and migratory birds are supported by this park.

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,
- This is the first of Pakistan's parks to be included in the UN's listing of National Parks of 1975
- This is natural haven for Urial sheep, Ibex, Chinkara gazelle,
- Jungle cats, desert cats, occasional leopard, desert wolf also prowl the park.

Lal Suhanra National Park

- Blackbuck became virtually extinct in the Cholistan Desert but the species has been reintroduced in Lal Suhanra
- 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 midwinter.
- The park supports a large population of birds of prey.
- Nilgai antelope is also being bred in the Park.

Margalla Hills National Park

- Margalla hills national park, is located in the foothills of the himalayan range.
- Area is drained by the river kurang and its tributaries, which flow into the river soan
- Park is the most accessible park in pakistan due to its close proximity to the national capital, islamabad.
- Asiatic leopard, wild boar, golden jackal, rhesus macaque, leopard cat, are some of the mammals found in the park.
- Birds in the park include Himalayan Griffon vulture, Laggar falcon.

LECTURE 78-79: Zoological Parks in Pakistan

"A zoological park is a location where animals are kept in captivity for study and viewing."

The zoo originally evolved from the menageries of the ancient world, in which royalty would exhibit their collection of exotic pets. Unfortunately not all zoos are scientific in nature, and extreme controversy has arisen regarding how the animals are treated. Suffice to say, regulation is necessary to ensure proper care. Conservation (not exploitation) should always be the central goal behind any legitimate zoo. 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 Zoological Parks in Pakistan

Some of famous zoological parks in Pakistan are listed bellow;

- Bahawalpur Zoo
- Changa Manga Wildlife Park
- Clifton Fish Aquarium
- Hyderabad Zoo
- Islamabad Zoo

- Jallo Wildlife Park
- Jungle World
- Karachi Municipal Aquarium
- Karachi Safari Park
- Karachi Zoo
- Lahore Walkthrough Aviary
- Lahore Zoo
- Lahore Zoo Safari
- Landhi Korangi Aquarium
- Landhi Korangi Zoo

Bahawalpur Zoo

Nawab of former state Bahawalpur, Sir Sadiq Muhammad Khan Abbasi, established Bahawalpur Zoo in 1942 . It covers an area of 25 acres. The Bahawalpur Zoo came under administration of Wildlife Department in 1982. The lion, black tiger, fish, watch, crocodile and many other animals which were mummified during 1942 and 1974 are kept in museum. Domestic cats, jackals, an Indian civet cat, Crocodiles, lions, tigers and hyenas etc are present in zoo.

Lahore Safari Zoo

A Safari Zoo is established since 1996-2001 for public recreation within the suitable environmental location, It is just 13 KM away from motorway link Thokar Niazbaig, Multan Road, Lahore. The Safari Zoo is offering stunning display of the animals and birds unique in this region. In 2004, the largest walkthrough aviary of Pakistan was constructed in the facility and was opened for visitors. Amazing fact is that In July 2016, a record 34,340 tourists visited Lahore's Safari Zoo and an income of Rs0.93 million was generated by wildlife and parks department

LECTURE 80-81: Botanical Garden

What is a botanical gardens?

It is a garden dedicated to the collection, cultivation and display of a wide range of plants labeled with their botanical names. It may contain specialist plant collections such as tropical plants, or other species of plants.

Types of plants in botanical gardens

1. cacti and succulent plants.
2. herb gardens.
3. greenhouses, shade houses.
4. tropical plants.
5. Medicinal Plants.
6. aromatic or textile plants
7. other exotic plants.

Who is responsible for a botanical gardens?

Botanical gardens are often run by universities or other scientific research organizations, and often have associated herbaria and research programmers in plant taxonomy or some other aspect of botanical science.

Importance of Botanical garden

1- Enjoyment
2- Economic
3- Scientific research

Botanic gardens contain collections of plants for education, scientific purposes and display; they can be: taxonomically-based - collections of a particular family, genus or group of cultivars; or collections of native plants; or useful species such as medicinal, aromatic or textile plants.

4- Conservation

Conservation of rare and threatened plants. The conservation of plant diversity is critical for sustainable development and botanic gardens are playing a key role as centers of conservation action. Botanical gardens can promote diversity. Because they include many species of plant.

5- Climate Change

Plants can alter the temperature of the Earth's atmosphere. Through the process of photosynthesis, plants use energy from the sun to draw down carbon dioxide from the atmosphere and then use it to create the carbohydrates they need to grow. Since carbon dioxide is one of the most abundant greenhouse gases, the removal of the gas from the atmosphere may temper the warming of our planet as a whole. *transpiration in plants can increase water vapor in the atmosphere, causing more precipitation and cloud cover in an area. The additional cloud cover often reinforces the cooling by blocking sunlight. *Contribute to soil fertility and prevent soil erosion.

Research botanical gardens

- Abdul Wali Khan University Botanical Garden, Mardan
- Botanical Garden, Governor's House, Lahore
- Botanical Garden, Govt Zamindar College, Gujrat
- Danishmandan Botanic Garden, Lahore
- Botanical Garden, University of the Punjab, Quaid-e-Azam Campus, Lahore
- Faisalabad Botanical Gardens (part of Gatwala Wildlife Park), Faisalabad
- Forman Christian College Botanic Garden, Lahore
- Government College University Botanic Garden of GCU, Lahore
- Karachi University Botanic Garden of Karachi University, Karachi
- Lahore Botanical Gardens, Lahore
- National Herbarium, Islamabad
- Pakistan Forest Institute Botanical Garden of Pakistan Forest Institute, Peshawar
- Quaid-i-Azam University Botanical Garden, Islamabad
- Shah Abdul Latif Herbarium and Botanical Garden of Shah Abdul Latif University, Khairpur
- University of Peshawar Botanical Garden of University of Peshawar, Peshawar
- living plants museum of medicinal plants, Pakistan Forest Institute, Peshawar
- Bagh-e-Jinnah, Lahore
- Rani Bagh Arboretum, Hyderabad
- Sukh Chayn Gardens, Lahore

LECTURE 82-84: Ramsar Convention

History: Ramsar is one of the global inter-governmental environmental agreements. The treaty was negotiated in1960s by countries and NGOs. To avoid the increasing loss and degradation of wetland habitat for migratory water birds. In an 18 nations meeting it was adopted in the Iranian city of Ramsar On 2nd February 1971. Came into force in 21st December 1975

Mission

The Convention's mission is

"The conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.

The Convention uses a broad definition of wetlands which includes

All lakes and rivers, Underground Aquifers, Swamps and Marshes, Wet Grasslands, Peatlands, Oases, Estuaries, Deltas, Tidal flats, Mangroves etc.

Concept

- Wetlands are among the most diverse and productive ecosystems.
- They provide essential services and supply all our fresh water.
- Wetlands continue to be degraded and converted to other uses.

The "three pillars" of the convention

The Contracting Parties (160)commit to:

- Work towards the wise use of all their wetlands.
- Designate suitable wetlands for the list of Wetlands of International Importance.
- Cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

Significant Ramsar sites of Pakistan

In 2013, 19 (nineteen) Ramsar sites has been declared in Pakistan.

Area: Covering an area of 1,343,627 hectares (3,320,170 acres)

Religion wise significant ramsar sites of Pakistan

Baluchistan

- Astola Island
- Hub Dam
- Jiwani Costal Wetland
- Miani Hor
- Ormara Turtle beach

Sindh

- Keenjhar (Kalri) Lake
- Haleji Lake
- Drigh Lake
- Indus Dolphin reserve
- Jubho lagoon
- Nurri Lagoon
- Deh Akro-II
- Indus Delta
- Runn of Kutc

Punjab

- Uchhali Complex
- Taunsa Barrage
- Chashma Barrage

Khyber Pakhtunkhwa

- Tanda Dam
- Thanedar Wala

Threats to Wetlands

Half of the world's wetland have disappeared since long.

- Continued development in all aspects is the need of hour with proper management
- Unmanaged activities pose major threats to wetlands, despite their value and importance.

Industrial Development:

The rapid industrial development at the beginning of 19th century led to present-day situation of wetland being affected by human activities.

Invasive species

Alien invasive species have had severe impacts on local aquatic flora and fauna, and can upset the natural balance of an ecosytem. For example, the introduction of Nile perch to Lake Victoria has pushed many of the lake's native cichlid species to extinction.

Pollution

Pollution in wetlands is a growing concern, affecting drinking water sources and biological diversity. Drainage and run-off from fertilized crops and pesticides used in industry introduce nitrogen and phosphorous nutrients and other toxins like mercury to water sources. These chemicals can affect the health and reproduction of species, posing a serious threat to biological diversity.

Climate change

Worldwide there are now over 40,000 dams which alter the natural flow of water and impact on existing ecosystems

LECTURE 85-86: Wildlife Sanctuaries in Pakistan

"Sanctuary is an area which is of adequate ecological, faunal, floral, Geo-morphological, natural or zoological significance."

The Sanctuary is declared for the purpose of protecting, propagating or developing wildlife or its environment

- A sanctuary is a protected area which is reserved for the conservation of only animal and human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with well-being of animals
- Boundaries of sanctuaries are not well defined and controlled biotic interference is permitted
- 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;

- Astor Wildlife Sanctuary
- 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

1. **Runn of Kutch Wildlife Sanctuary**

It spread over 566,375 ha is part of the great Thar desert and comprises. 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, Threatened species include the Great Indian bustard, Houbara bustard, Sarus crane this area used to have the only population of the Indian Wild Ass or Onager in Pakistan.

1. **Chashma and Taunsa Barrage**

They 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.

2. **Cholistan Wildlife Sanctuary**

It is part of the Cholistan desert in the south eastern portion of the province of Punjab. It 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, Saker falcon, Black backed vulture, Indian cobra, Monitor lizard, Saw scaled viper and Russells viper.

LECTURE -87: Concept of Game Reserve

Definition: “A game reserve is an area wherein controlled hunting and shooting is permitted on permit basis”

- A game reserve (wildlife preserve) is a large area of land where wild animals live safely or are hunted in a controlled way for sport.
- In the game reserves the major focus is specifically the animals.
- If hunting is prohibited, a game reserve may be considered a ”Nature Reserve”
- Wherein all aspects of naturally-occurring life in the area are considered.
- Most of the areas in game reserves have created to provide habitat protection for animal species commonly referred to as game (huntable species for sport or meat)

Game Count:

- Game count to be conducted as it provides an estimation of the game population
- It is to ascertain the number of female animals, as this indicates the production potential.
- It is an estimate that walking 6km to water isn’t unnatural for an animal.
- Some of the Reserve’s water points will be done away or moved to more suitable locations.

LECTURE -88: Critically Endangered Animals

1- **Bulmer’s Fruit Bat**

The Buler’s Fruit bat is elisted as Critically Endangered (CR) Facing an extremely high risk of extinction in the wild, on the IUCN red list of threatened species.

Major threats:

This is the large bat that has been hunted for meat at the known sites.

2- **Great Indian Bustard**

The 2011 Red List of birds, released by the International Union for Conservation of Nature (IUCN), has enlisted the bird in the critically Endangered category, the highest level of threat. The population of the species is estimated to be just 250. Hunting, habitat loss and fragmentation have reduced the number of this species, which was found in large numbers in the grasslands of India and Pakistan. But their population is now restricted to small and isolated fragments of remaining habitats, says the Birdlife International, which prepared the list.

3- **Madagascar Pochard**

The Madagascan Pochard is endemic to the island. It is very rare and was known only from a single location in the northern central plateau, at Lake Alaotra basin. In spite of several breeding attempts between 2006 and 2012, only 21 adults were counted in 2012. The young die by starvation due to absence of adequate food items and too deep water. Hunting and trapping, and increase of human population involving degradation of the habitat are important threats. Introduction of exotic plants, mammals (Rats) and fish have destroyed the food supplies. Nest predation by rats and raptors also occurs regularly.

4- **Pygmy Three-Toed Sloth**

Classified as critically endangered and believed to have a rapidly declining population and habitat area, pygmy three-toed cloths (Bradypus pygmaeus) are entirely native to the island of Escudo De Veragua, off the Caribbean coast of Panama. The most recent data on these sloths is dishearting, indicating there may be only 48 left, a significant decrease from the last estimate of 79 in 2013.

Threats:

1. Illegal logging of mangrove forests for firewood and
2. Hunting

LECTURE 89: In Vitro Germplasm Conservation

In 1972, conservation of habitats rich in genetic diversity was recommended in the UN conference. Then an International Board for Plant Genetic Resource (IBPGR) was established. This board has objectives to provide necessary support for collection, conservation and utilization of plant genetic resources from anywhere in the world.

(a) In situ Conservation:

Since 1980, in situ conservation has received high priority in the world conservation strategy. The method of conservation is to preserve land races with wild relatives in which genetic diversity exists.

(b) Ex situ Conservation

It is the chief mode of conservation of genetic resources including both cultivated and wild ones. Under suitable conditions genetic resources are conserved for a long term as gene bank. Such gene bank is of two types:

o In vivo Gene Bank o In vitro
Gene Bank

(i) In vivo Gene Bank:

Generally plant seeds, vegetative propagules are used for storage for long time. The whole plants are preserved. This type of conservation strategy is called in vivo gene bank. In this approach, conservation method of storage is used for preservation of plant genetic resources

(ii) In vitro Gene Bank:

3. This approach includes the conservation of genetic resources by non-conventional methods. In this approach explants are grown on medium.

Methods of Preservation

Free Preservation or Cryopreservation:

Cryopreservation (Latin Kuos means frost) means storage of materials at very low temperature. Plant cells and tissue cultures are brought to zero state of metabolism by subjecting them to ultra-low temperature i.e. -I96°C. It is done by using liquid nitrogen which provides approximately -496°C. Cryoprotectants (e.g. glycerol, proline, mannitol, dimethylsulfoxide, sorbitol) are also used to protect the viable cells from the damage during freezing and thawing (to become unfrozen or warm). Germplasm of some plants (in the form of shoot tips, nodal or meristem explant culture) are stored at low and nonfreezing temperature (1-9°C). At low temperature, growth of plant material is slow down but not completely stopped as in cryo-preservation. In cold storage there is no risk of cold injuries.

Low-pressure and Low-oxygen Storage:

For conservation of cultured plant materials low-pressure storage (LPS) and low-oxygen storage (LOS) have been developed. These are alternative methods of cryopreservation and cold storage

LECTURE - 91: Tissue Culture Conservation

- Using this method, millions of genetically identical plants can be obtained from a single bud. This method has, therefore, become an alternative to vegetative propagation. Shoot tip propagation is exploited intensively in horticulture and the nurseries for rapid clonal propagation of many dicots, monocots and gymnosperms.

- Conservation in tissue culture in in vitro genebanks is often combined with cryopreservation. Cultures in the active genebank are maintained by successive subculturing allowing culture renewal and distribution. For medium term storage, sub-culture intervals are extended, reducing processing costs by arresting growth using cold treatments, adapted light conditions, culture medium modifications (osmotic active compounds, growth retardants). This increases efficient use of resources and staff time and offsets selection risks and contamination

Advantages of tissue culture conservation

- Source of disease-free material.
- It is most appropriate for rapid multiplication purposes, dissemination and active collections.

Tissue Culture Conservation

- labour intensive
- risk of losing valuable germplasm
- genetic instability

Practical considerations

Security

- Purity: freedom from contaminating organisms.
- Authenticity: correct identity.
- Stability: fit-for-purpose and trueness-to-type.

Culture facilities

- Use culture growth rooms with temperature control, lighting and shelving.
- Aim for a room where the humidity is 40–50%. High humidity increases fungal growth, while low humidity dries cultures and creates dust problems.
- Use an isolated growth room for in vitro explants of materials taken directly from the field to allow time to detect insect infestations and prevent their spread to other cultures.
- Ensure a light intensity in the range from 10 to 1000 μmol S-1 m-2. Most plant cultures require 50–200 μmol S-1 m-2.
- Use ventilation systems or air-conditioning units to regulate temperature. Air should not flow directly onto the cultures. Common growth room temperatures range from 22ºC to 28ºC, depending on species requirements.
- Back-up generators are advisable for areas with frequent power cuts to control temperature and light.

Genetic stability during storage

Great care should be taken to select culture practices to reduce this variation and ensure genetic integrity.

Preferred practices are:

- Avoid using germplasm propagated via dedifferentiated and adventitious routes for conservation.
- Select germplasm from young cultures because somaclonal variation increases and totipotency decreases during prolonged culture.

Medium term storage using slow growth

1. **Physical growth limitation**
    - Low temperature
    - Low light/restricted photoperiod
    - Minimal containment
    - Minimal O_2
    - Osmotic (water) stress
2. **Chemical growth limitation**
    - Growth regulator retardation
    - Growth inhibitors
3. **Minimal nutrition**
    - Low macro nutrient levels
    - Low micro nutrients levels

LECTURE -92: DNA Banks

DNA banks can now be considered as a means of complimentary conservation. DNA storage is particularly useful for those species that cannot be conserved in traditional seed or field genebanks and nor conserved in situ due to high risk in that area.

Advantages

DNA banking is an efficient, simple and long-term method to conserve the genetic information.

Disadvantages

There are problems with subsequent gene isolation, cloning and transfer of DNA back to a plant and it currently does not allow the regeneration of the same genotype as the original sample.

Storage strategy

Determining what to store and for how long is an important consideration, used to determine sample size, capacity of the DNA bank, preparation of samples and documentation. Long-term needs and expected volume and number of samples to be stored will determine organization and repository design.

Processing of samples

DNA preserved in DNA banks will be stored either within cells and extracted upon retrieval from storage or extracted from cells and purified before storage. The quality of the DNA is expressed through yield, purity, molecular weight, amplification efficiency and authenticity of sequences. The quality of DNA extracted from plant specimens is dependent on the condition of the specimen before storage, the storage environment and the duration of storage. Rapid drying of plant samples with silica gel or lyophilisation helps to preserve the DNA.

Storage

Once extracted DNA is a stable biomolecule, although it can easily be degraded during extraction and storage. Quality declines within days in hydrated samples held at room temperature or in refrigerators. Drying the sample or storing it in freezers or liquid nitrogen achieves better preservation of DNA molecular size. For this reason, DNA is better conserved in a form that is close to the original state and most DNA banks store cells or tissues and extract DNA upon request.

There is little information on the long-term stability of extracted DNA during frozen storage, but most repositories consider several years to decades as realistic. Information on the stability of purified DNA dissolved in buffer suggests that the overall fragment size decreases with storage time, and that the usefulness of the specimen for PCR-based assays may be 1–2 years when stored at 4 ºC, 4–7 years when stored at -18 Cº and greater than 4 years when stored at -80 Cº (Madisen et al. 1987; Visvikis et al. 1998). The choice of temperature usually depends on the moisture level within the sample.

It is proposed that replicated DNA samples can be maintained at -20ºC for short- and mid-term storage (up to 2 years), and at -70ºC or in liquid nitrogen for longer periods. For rice, DNA clones, such as ESTs, full-length cDNAs, BACs, PACs and YACs, are maintained in labelled 96-well microplates or 384-well microplates stored in -80°C ultra low temperature freezers. These clones are preserved in duplicate or triplicate to reduce risk of loss from equipment failures. For cDNA clones, plasmid DNA is extracted from the host Escherichia coli, and stored at -30°C in labelled 1.5 ml Eppendorf tubes.

LECTURE -93-95: Gene Sanctuaries

A type of Insitu conservation. The genetic diversity is sometimes conserved under natural habitat. In other words, areas of great genetic diversity are protected from human interference. These protected areas in natural habitat are referred to as gene sanctuaries. Gene sanctuary is generally established in the centres of diversity or microcenter

Gene sanctuary is Also Known As Natural Park or biosphere reserve. Efforts are being made to setup gene sanctuaries for banana, sugarcane, rice and Mango. In Ethiopia gene sanctuaries for conservation of wild relatives of coffee was setup in 1984.

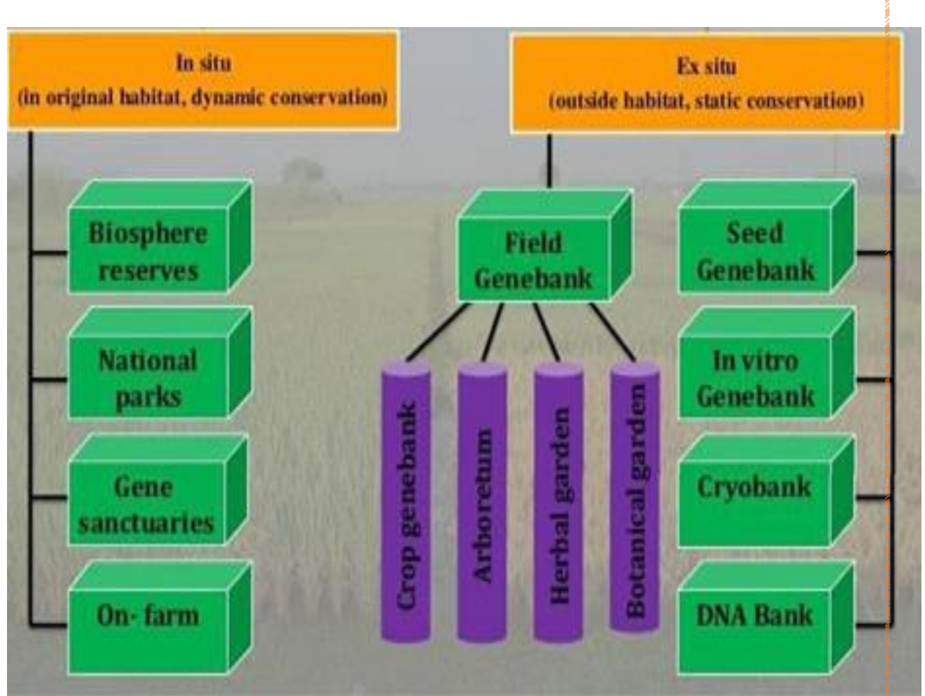
Types of gene sanctuaries

1. **In-situ (In original habitat, dynamic conservation)**

- Biosphere reserves
- National Parks
- On farm

2. Ex-situ (outside habitat, static conservation)

- Field gene (Crop gene bank, Arboretum, herbal garden, botanical garden)
- Seed gene bank
- In-vitro gene bank
- Cryo bank
- DNA bank



Importance of Gene Sanctuaries

1. Gene sanctuaries not only preserve the existing genetic diversity present in a population, it also allows evolution to continue. As a result new allele and gene combination would appear with time.
2. A gene sanctuary is best located in the center of origin of crop species concerned, preferably covering the microcenter within the center of origin
3. Gene sanctuary is a very good method of insitu conservation it protects the loss of genetic diversity caused by human intervention. It allows natural selection and evolution to operate.
4. It is a very good method of in Situ Conservation.

Drawbacks of Gene Sanctuaries

There are two main drawbacks of gene sanctuary.

1. Firstly, entire variability of a crop species cannot conserved.
2. Secondly, its maintenance and establishment is a difficult task.

LECTURE -96: Application of storage technologies for germplasm conservation and limitations

Storage of seed is indispensable to most of plantation forestry, and the practice should not be dismissed too readily as a basic tool in maintaining genetic diversity. Conventional seed storage offers several advantages:

1. Seeds of many valuable species can survive long-term storage ('longterm' is defined as spanning a period of time longer than one rotation
2. Good storage facilities are now available in most of the world, and they are used extensively for tree seed storage for various regeneration purposes;
3. Seed storage is a relatively cheap method for conserving a broad range of germplasm
4. Large land areas are not tied up in conservation
5. International exchange of genetic material is facilitated by seed storage.

Limitations

1. seeds of many important tree species cannot adequately survive long-term storage;
2. seeds of many tropical hardwoods cannot survive even a year of conventional seed storage;
3. some genetic damage or change in gene frequencies may occur during seed storage. Cryogenic storage at its current level of technology offers great promise for long-term storage of true orthodox and sub-orthodox seeds. It has potential for application to recalcitrant species, but much more research and development will be required. Some advantages of cryogenic storage are:

- it can apparently extend storage life of true-orthodox species far beyond that possible in conventional storage;
- genetic damage may be much less than what occurs in conventional storage. Disadvantages include
- special equipment is required, which is not readily found in forestry facilities; (2) it is costly for large seeds
- recalcitrant seeds (both classes) cannot be stored cryogenically with current technology.

LECTURE -97: Invertebrates Genetic Resources

Genetic resources of Invertebrates means genetic material of actual or potential value from Invertebrates.
Invertebrates include a great number of species that perform valuable functions in agro-ecosystems. Micro-organisms and invertebrates together are the most numerous group of species on Earth. Invertebrates are animals without a backbone. They account for more than 95% of all animals and comprise many subgroups of diverse species ranging from tiny insects to giant squid. Although the problems caused by invertebrate pests are well known – and considerable effort and resources are devoted to managing them – the vital contributions that invertebrates make to agriculture and food security are often overlooked.

- Perhaps the most neglected group of all – in research, in farming practices, and in policies and strategies for agriculture and biodiversity – are the soil-dwelling invertebrates
- 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 processes such as water infiltration and storage, and sequestration and cycling of carbon.
- They help maintain the chemical fertility needed for plant growth. Also vitally important are the invertebrates that process the leaf litter that falls onto the surface of the soil

A second major group of invertebrate providers of ecosystem services are the pollinators. It has been estimated that at least 35 percent of world food production comes from crops that are dependent on insect pollination. Pollinating insects include wild species spilling over from natural or semi-natural habitats close to crop fields, and managed pollinators (usually honey bees) that can be brought in by farmers specifically to provide pollination. Both wild and managed pollinators are in decline – probably as a result of multiple interacting causes, including land-use change (e.g. the loss of flower-rich meadows), increased use of pesticides, socio-economic factors that make beekeeping less attractive, and the spread of the parasitic mite Varroa destructor and other pathogens of bees. The situation has caused such concern that it has been described as a "pollination crisis"

LECTURE -98: Effects of climate change on invertebrate Genetic resources and their management

Climate change is expected to affect all three of the main groups of invertebrate ecosystem-service providers as well as invertebrate pests. Invertebrates have limited ability to control their body temperatures. Therefore, although some groups such as soil-dwelling organisms are to some degree buffered against the effects of temperature fluctuations in the wider environment, it is likely that rising temperatures will directly influence the distribution of invertebrate species. Many of the challenges associated with the management of invertebrate genetic resources in agriculture in the context of climate change will relate to climate-driven or human-assisted movement of invertebrate species.

- Most invertebrates are expected to change their geographical distribution in response to climate change so as to remain in areas to which they are well adapted. This view is strongly supported by sub-fossil evidence of insect distri- bution during the glaciations and interglacial periods of the Quaternary Period.

- The current world is very different from that of the early Quaternary Period. Human activities have created barriers to the migration of invertebrate species. These barriers are likely to affect species in natural ecosystems rather more severely than those associated with agro-ecosystems. The movement of the latter is likely to be facilitated rather than hindered by human-induced landscape changes. In situ adaptation of invertebrate species is expected to be most marked where movement is not an option (e.g. on low, isolatedislands).

- It is very difficult to predict how the combined effects of changing temperatures, changing rainfall patterns and elevated carbon dioxide levels will affect invertebrates and their capacities to provide ecosystem services or to act as pests. As yet, few studies have attempted to investigate interactions of this kind. Further complexity is added by the prospect that the other components of
the ecosystem with which invertebrates interact – food plants, micro-organisms, etc. will also be affected by climate change.

- It has been suggested that, in the future, parts of the world will have novel climates that have no current equivalent anywhere on the planet. This will inevitably lead to novel associations among invertebrate species and novel effects on agriculture. The consequences of such changes are difficult to predict.

- Extreme weather events such as heat waves, droughts and floods − which are predicted to increase in frequency due to climate change − are often followed by pest outbreaks. Among other contributing factors, these outbreaks can occur because the extreme event eliminates or weakens a pest's natural enemies.

- Warmer, shorter winters will mean that many invertebrates become active and start reproducing earlier in the year. Some species may be able to produce additional generations of offspring in a single year, which in the case of herbivores can have a major impact on host plants. Similarly, warmer winters may mean that pests are able to establish themselves in areas where they have not previously caused problems. The capacity of locally occurring natural enemies to respond and keep these pest populations under control may be in doubt.

- Climate change is expected to have a profound effect on soil invertebrates and the services they provide. Temperature is a key factor regulating many of the biogeochemical processes in which invertebrates participate or by which they are affected, including soil respiration, litter decomposition, nitrogen mineralization and denitrification.

- Studies have shown that both elevated temperatures and elevated carbon dioxide levels affect the abundance of invertebrate species and the composition of soil communities. Some species are better able to adapt than others. For some invertebrates, the ability to migrate down the soil profile to cooler and moister levels will offer an important survival strategy.

LECTURE -99: Roles of invertebrate genetic resources in coping with Climate change

Because of the many ecosystem services that they provide, invertebrates have a key role to play in adapting agriculture to the effects of climate change. The extent to which the individual services provided by invertebrates will be enhanced or impeded by climate change is difficult to predict. However, if invertebrate biodiversity is lost, the capacity of ecosystems to adapt is likely to diminish.

- Healthy soils – and healthy, diverse soil invertebrate communities – will be vital to climate change adaptation. For example, earthworms help to maintain soil structure and the availability of water throughout the soil profile. Studies have shown that the presence of these animals can help to alleviate the effects of drought on crop Production. Studies have also revealed the remarkable ability of diverse soil invertebrate communities to restore the structure of degraded soil. He potential for managing soil invertebrates to enhance their beneficial roles has been little explored. Few if any deliberate attempts have been made to introduce soil invertebrates into new countries or ecosystems. Given the potential for such species to become invasive, it is inadvisable to attempt any such introductions until soil ecology is much better understood than it is today. However, every effort should be made to avoid agricultural practices that disrupt resident soil invertebrate communities and the services they provide.

- In the case of classical biological control agents, the genetic diversity of introduced populations may be relatively low because the introduction was based on a small founder population. This lack of diversity may inhibit the ability of the population to respond to climate change.

- It is likely that some pests, as they move into new areas in response to climate change, will at least temporarily escape from their natural enemies. This is likely to increase demand for classical biological control agents, especially in places where the newly established pest population is separated from its original home by a physical barrier such as the sea or a mountain range. For this reason, access to new classical biological control agents is likely to be particularly important for island countries.

LECTURE -100: Conservation of invertebrates genetic resources

The IUCN's Red List of Threatened Species includes 44,838 species with assessed conservation statuses in its 2008 update . This number has been increasing each year and undoubtedly reflects the work of many, yet it still only represents 2.73% of all described species to date. Moreover, a quick analysis allows for a view of really how biased these assessments are towards some taxonomic groups. Considering the better studied ones, mammals and birds, 100% of the currently described species have been evaluated for their conservation statuses and, out of these, 21% out of 5,488 mammal species and 12% out of 9,990 bird species are considered to be endangered.

Turning our attention to one of the lesser studied groups, we see that only 0.13% out of all the described insect species have an evaluated status, 50% of which are endangered. This means that half of the few insect species whose conservation statuses have been assessed were classified as threatened, yet extremely few out of the 950,000 calculated species known to science have been graced with conservational study. Let me highlight that this last number does not include an estimate of the insect species that are yet to be described (surely many more than birds or mammals), which means that considering insects alone, the actual number of threatened species could easily surpass that of the sum of all existing vertebrates. A similar scenario is shared by the rest of invertebrates, plants, algae, lichens and mushrooms: very few known species have been evaluated for their threatened statuses, with few exceptions. Therefore, it appears necessary to enrich the Red List of Threatened Species with many invertebrate species endemic and/or living in specific habitats easily endangered (caves, small lakes, small rivers).

Generally all invertebrate populations would benefit from:

a) A reduction in all forms of environmental pollution.
b) An immediate cutback in greenhouse-effect gas emissions, in order to prevent short-term climatic changes.
c) A decrease in the current rate of habitat destruction resulting from human activities. An example of how habitat conversion for human usage could be compensated would be achieved by a more frequent adoption of what is known as "Green roofs". This architectural practice is common, for instance, in some northern European regions and consists of creating gardens or other green areas in roof tops, thus 'giving back' a certain percentage of the soil surface that was 'robbed' by the construction.

Maintaining insect species that can provide pollination services for a wide range of crops is also vital to the future of agriculture in the face of climate change. Pollinator populations not only need to be able to cope with changing climatic conditions, they must also be able to provide the pollination services needed to meet increasing demands for food and retain the capacity to adapt to potential changes in the types of crops grown.

The natural habitats of wild pollinator species need to be identified and preserved. As land use changes, it may be necessary to protect or develop corridors of suitable habitat that ensure food and nesting resources are available for pollinators. The presence of areas of natural and semi-natural habitat next to crop fields has been shown to increase the diversity of pollinator populations and enhance the services they provide. Deliberate planting of climate-resilient plants that favour pollinators can serve as a means of maintaining the habitats and floral resources needed by wild pollinators and managed bees. An advantage of having a range of (non-crop) food resources available in the landscape is that the diverse vegetation is likely to support a diverse assemblage of pollinators. This is important, as crops with generalized flowers (i.e. flowers that can be pollinated by a range of species) may produce more reliably when a variety of different pollinator species are present. The insurance provided by a diverse assemblage of pollinators may also facilitate adaptation, because different species will have different capacities to respond to climate change. The world's most important managed specie is honey bee. This reflects with the species adaptability. It can flourish under many different conditions – from arctic to tropical and from rainforest to desert.

Climate change may mean that, in any given area, new honey bee races or hybrids that suit local conditions will need to be introduced (e.g. those that are drought resistance or do not abscond).

LECTURE 101-: Forest Genetic Resources

Introduction:

Forest genetic resources or tree genetic resources are genetic material of shrub and tree species of actual or future value. Forest denotes a stand, population or landscape of trees, and typically other associated woody plants.

Definition:

Forest genetic resources are essential for forest-depending communities who rely for a substantial part of their livelihoods on timber and non-timber forest products (for example fruits, gums and resins) for food security, domestic use and income generation.

- These resources are also the basis for large-scale wood production in planted forests to satisfy the worldwide need for timber and paper.

Genetic refers to variation of genetic DNA origin, and variation of genes at different levels:

1. variation between species,
2. variation between populations within species
3. variation between individual trees within populations. The largest variation is between species, and loss of whole species is therefore also the most dramatic loss of future options.

- Resources refers to the use of genetic variation—in the broad sense stated above—considered to be of potential value for humans at present or in the future.

The State of the World's Forest Genetic Resources

In 2014, the Food and Agriculture Organization of the United Nations published the first State of the World's Forest Genetic Resources .The publication addressed the conservation, management and sustainable use of forest tree and other woody plant genetic resources of actual and potential value for human well-being in the broad range of management systems.

Forest genetic resources and climate change

Diversity of forest genetic resources enables the potential for a species (or a population) to adapt to climatic changes and related future challenges such as temperature changes, drought, pests, diseases and forest fires. Though forest trees are known for showing great plasticity in their response to climate changes, not all species are naturally capable to adapt at the pace necessary.

LECTURE 102-Significance of Forest Genetic Resources

- Forests provide us with many benefits, from the tangible economic returns of high value timber to more nebulous but no less important ecosystem services, such as regulating water flows.
- Forests provide human beings with drinkable water, food, medicines, an environment to enjoy and fuelwood for energy, among other goods.
- They bind soil on steep hillsides, preventing flooding and erosion further down river valleys. They help to regulate the local climate too.
- Globally, forests remove carbon dioxide from the atmosphere and produce oxygen.
- While it is impossible to assign a precise economic value to forests, it is clear that their contribution is huge. In Europe, one estimate put the value of “marketed non wood goods” from forests at €2.3 billion and the value of “marketed services _at €619 million”. The environmental values of forests through ecological services they provide, essentially for free – is probably even greater than the value captured by markets.

Why do forest genetic resources matter?

The high levels of genetic variation that are present within many tree species can be beneficially developed and used by foresters and tree growers. Whereas agricultural crop breeders and farmers often substantially modify the growing environment to suit a specific crop species or variety, tree growers commonly identify species and provenances which can provide some improved levels of the goods and services required even without intensive selection and improvement, or intense management requirements, or major modification of the external environment.

Threats

- Forests are under threat, chiefly as a result of human activities, including climate change.
- On a continent-wide scale, changes in rainfall patterns and temperature mean that some tree species will be unable to survive in their current locations. Others may be able to colonize new areas.
- Changes in climate also make it possible for pests and diseases to invade new areas, destroying the forests there.
- Overall, we can be sure that the composition and distribution of forests will change. It is because humans – and indeed the whole planet – derive so many benefits from forests and trees that we need to be concerned about how they will adapt to climate change.

LECTURE -103: The impacts of climate change on FGR

Climate change may also result in high variability in temperature and precipitation, with an increase in incidence of extreme events, such as flooding, late frosts and intensive summer droughts, amongst other events. In some areas, such as the Mediterranean and the Neo-tropics, an increase in seasonality is also expected. Under such conditions, natural selection may not result in efficient adaptation because selection pressures are multi-directional, involving traits that may be inversely correlated at the gene level. The standing genetic variation in populations may then not be large enough to create the rare new genotypic combinations that are required. Ecosystems affected by abrupt change may sustain rapid and widespread transformation as ecological tipping points are exceeded. Given the pivotal role of trees in ecosystem function, abrupt climate change impacts on them may thus have profound consequences for forests as a whole. Irreversible loss of ecosystem integrity and function may follow, with replacement by new nonendemic ecosystems.

Direct impacts of climate change

These include high tree mortality through extreme climatic events, particularly drought in combination with widespread regeneration failure, for example, examined the evidence for anthropogenic climate change leading to future large-scale "dieback" in Amazonian rain forest. Analysis suggested that dryseason water stress is likely to increase in eastern Amazonia over the 21st century, with the region tending toward a climate more appropriate to seasonal forests.

Effects of changing climate on organisms associated with trees

In particular, changes in the biology of insect pests and diseases may make ecosystems more susceptible to tree mortality. Because of improved environmental conditions for the pest and reduced tree resistance due to increased stress, pests may react to climate change with range expansions and/or increases in attack severity.

Changes in abiotic disturbance regimes

These include changes in fire regimes, flooding, landslides and/or hurricanes. Fire and climate are closely linked and are also associated with changes in land use. Coupled climate and fire-risk models suggest not only an increase in the frequency of fires but also in fire size and length of the fire-risk season, with some areas subject to risk that were not before. **Malhi et al. (2009)** considered how tipping points may be reached in Amazonian rainforest by a combination of increased dryness and an increased incidence of fire events

Invasion by organisms foreign to local ecosystems

This includes the increased risk of establishment by invasive species which accidentally arrive into ports of entry, through globalized commerce. By making new niches available, climate change will facilitate the survival of mammals, insects, diseases and/or weeds foreign to endemic ecosystems.

LECTURE -104: Responses of tree populations to environmental change

Tree populations rely on three interplaying mechanisms to respond to environmental change:

1. adaptation

2. Migration
3. phenotypic plasticity

1. Adaptation and standing genetic variation

Genetic adaptations that make a population more suited for survival are achieved through gene frequency changes across generation. Many tree species have high genetic variability in adaptive traits and can therefore grow under a wide range of conditions. Indeed, phenotypic traits of adaptive importance, such as drought tolerance, cold-hardiness, resistance to pests and diseases, and flowering and fruiting period, have been shown to vary across ecological and geographic gradients to an extent that may be as important as the differences observed amongst species.

2. Migration via pollen and seed movement

Pollen is known on occasions to travel very long distances, particularly in wind dispersed broadleaves and conifers, but also sometimes for animal-pollinated species. Pale ecological reconstructions of the decolonization of temperate zones during the Holocene have also suggested that seeds are capable of travelling long distances rapidly, in the range of several hundreds of meters per year. Landscape genetic approaches, macrofossil evidence and theoretical studies, however, indicate that cryptic refugia may have been overlooked, considerably reducing migration estimates. In addition, modern estimates of contemporary seed dispersal, although pointing to the existence of long distance dispersal events, generally indicate that median migration rates are in the range of a few tens of meters per year.

3. The role of phenotypic plasticity

Phenotypic plasticity is defined as the capacity of a particular genotype to express different phenotypes under different environmental conditions. The concept is often edžtended to populations and species, with plastic trees those with flexible morphology and physiology that grow at least reasonably well under a range of different environmental stresses without genetic change. A degree of phenotypic plasticity is found in most trees, but varies substantially amongst and within species. Even in species with very little genetic diversity, such as Pinus pineaL, strong phenotypic plasticity is expressed for growth related traits, which may have helped the species colonise new environments. At least in the short term, high plasticity is likely to favour tree survival under changing environmental conditions, although trade-offs between traits can be expected. Since phenotypic plasticity has a heritable basis and may be selected for under changing environments, complex interactions between traits are possible, depending on the magnitude and structure of change.

LECTURE -105: Responses of tree populations to catastrophic biotic and abiotic disturbances

Tree populations have developed mechanisms to respond to naturally occurring disturbances within their range. North American conifers, for example, have adapted to outbreaks of the defoliating insect spruce budworm (Choristoneura fumiferana Clem.) that have recurred at periodic intervals (~every 35 years) at least since the middle of the Holocene, 6000 years ago. Climate change may however cause range expansions in herbivorous insects and in diseases, causing increased mortality in non-adapted populations. This is illustrated by whitebark pine, where a warming climate has increased the access of stands to native bark beetles that are now able to reach higher elevations, resulting in high mortality due to low defenses in trees that have had little previous contact with this beetle.

Tree populations respond to abrupt, non-linear environmental changes through the mechanisms already outlined: natural selection favours genotypes with increased tolerance or resistance to disturbances, and phenotypic plasticity plays a role. It is well known, for example, that populations of Pinus contortaDougl. ex Loud. and P. banksiana Lamb. from parts of North America more prone to natural fires have a higher proportion of serotinous cones than those from elsewhere. Serotinous cones remain tightly closed until a hot fire has destroyed standing trees, then releasing seed to initiate rapid post-fire regeneration.

Co-evolution and biotic disturbances

Co evolution describes a situation where two Ior more) species reciprocally affect each other's evolution.

- Such as the classic case of host-pathogen interaction, where changes in R-gene resistance in the host lead to corresponding changes in v-gene virulence in the pathogen, triggering further rounds of change in one and then the other.
- In trees, such gene-for-gene relationships have, for example, been found in a number of North American white pines in their interaction with blister rust.
- Further important examples of co-evolution in trees include interactions with herbivores and pollinators.
- In the former case, a number of constitutive and induced defence systems, both mechanical defences (e.g., resin canals, sclereid cells and thorns) as well as chemical defences (e.g., the production of toxic phenols and terpenoids), have evolved in response to herbivory. Insects and pathogens have developed mechanisms to de-activate these defences and even utilize them for their own benefit; for example, some insects use tree terpenes as precursors for their communication pheromones or incorporate them into their own defense systems.

Responses to alien invasive species

Under climate change, FGR are likely to be increasingly threatened by alien invasive species i.e., more competitive trees, fungal and other diseases and herbivores that do not occur naturally in their local ecosystems, and to which they lack adequate defenses. The consequences of exotic pest invasions may be a catastrophic elimination of FGR, such as the cases of chestnut blight and white pine blister rust. At a provenance level, exotic introductions may result in hybridisation and outbreeding depression in local tree populations already stressed by climate change, but, more positively, hybridisation may also introduce the new genetic variation required by trees to adapt to novel environments.

LECTURE -106: FGR-based strategies to respond to climate change

Isbell et al. (2011) stated that ͞ŵaŶy species are Ŷeeded to ŵaiŶtaiŶ ŵultiple functions at multiple times and places in a changing world. As climate change progresses, poorly-performing trees will be naturally replaced by alternatives that are better suited to new conditions, altering the relative abundance of different species and genotypes in landscapes. As resilience rests on the maintenance of genetic, species and ecosystem diversity, management strategies should support diversification at all three levels.

To date, few countries have however taken practical steps to reduce the risk of FGR loss due to climate change. Relevant steps are usually only indirectly incorporated into action plans for forest management under climate change. In France, for example, FGR are not explicitly mentioned in the national adaptation strategy. They are, however, part of the action plan for forests, one of the sectors included in the national strategy for biodiversity, where recommendations for their conservation and sustainable use are explicitly mentioned.

Assisted migration

Assisted migration involves human movement of tree seed and seedlings from current locations to sites modelled to experience analogous environmental conditions in the future. Assisted migration may be undertaken over long distances, or just beyond the current range limit of particular genotypes and populations, or within the existing range. A gradual form of assisted migration could consist of reforestation of harvested sites with seed from adjacent locations likely to be better adapted to the planting site under future climate (e.g., in the Northern hemisphere, using seed from sources to the south; in mountainous regions using seed from lower elevations).

Selection and breeding

Climate change-related traits including plasticity and adaptation to increased drought need to be incorporated more actively into breeding programs (IUFRO, 2006). Many existing provenance trials were established before the need to respond to large scale anthropogenic environmental change was considered an important research issue and the traits measured have therefore often not been the most important ones from this perspective. Nevertheless, information from old trials can be reinterpreted in the context of climate threats. New trials established to assess explicit responses to climate change are being established in a number of countries. Traits needed to respond to different climatic conditions not often considered previously in breeding include: Pest and disease resistance climate-change-mediated increases in pest and disease attack are a crucial issue in commercial forestry. To date, one of the most extensive programmers to develop trees with resistance to insect pests in temperate regions is in British Columbia.

1. **Drought resistance**

Drought stress induces a range of physiological and biochemical responses in plants and an assortment of genes with diverse functions are induced or repressed in organ-specific changes , which may make breeding more difficult, for example, using microarray analysis, detected that up to 113 genes were significantly induced by drought in two Mediterranean pine species. Species-dependent features shape the transcriptome response; for example, almost none of the 27 genes reliably responsive to water stress in Arabidopsis thaliana(L.) Heynh., differentially regulated under drought in poplar and pine. Candidate genes for drought tolerance include those involved in the synthesis of abscisic acid, transcriptional regulators of drought-inducible pathways, and late embryogenesis abundant proteins; shifts at such loci have been linked to global warmingsistance**.**

2. **Fire resistance/tolerance**

Since fire incidence and severity will increase in many regions under climate change, breeding for features such as serotiny, thicker bark and higher water use efficiency may all be required**.**

3. **Cyclone resistance/salt tolerance**

Rising sea levels and an increase in the frequency of storms have the potential to wreak heavy damage on coastal forests, with low elevation islands at particular risk. Differential abilities to withstand storms and salinity are found more commonly amongst, rather than within, species, but the possibility of intraspecific selection should be further explored.

4. **Phenotypic plasticity**

Important but generally poorly understood, the plasticity of particular tree species and populations is vital for responding to climate change, and can be studied in common garden tests. Plasticity across environments can be quantified and response functions for particular populations generated, which describe the change in a trait as a function of the transfer distance or the change in an environmental factor. Populations vary in their response functions: in Pinus contorta, for example, some populations have a high growth rate over a much wider range of climatic conditions than others do.

LECTURE -107: Conservation of FGR

Safeguarding the genetic variety of forest trees is an important part of biodiversity conservation. Genetic diversity ensures the success of species in environments that are highly variable and subject to change.

For most forest tree species, management plans for the conservation units allow silvicultural interventions directed towards the support of and quantity of regenerating material. Applying given critical values for the number and density of seed trees, shortening of the regeneration time, regulating competition by other tree species and controlling invasive species should also be taken into consideration. A good level of genetic diversity and reduced consanguinity in the regenerated seedlings should be a management objective. Natural regeneration should be the preferred means but if this fails to occur, assisted regeneration can be carried out using local seed lots to maintain local phenotypic identitynatural regeneration both in terms of quality.

Three different strategies have recently been proposed to enhance resilience of forest stands to climate change in central Europe.

This includes

1. Conservation of forest structures by sivicultural intervention for older stands located in areas predicted to have low impacts from climate change;
2. Active adaptation by thinning, re-spacing and choice of alternative species are proposed for stands where the impacts are anticipated to be severe and
3. Passive adaptation for stands of low value (ecological and economics) that will rely on natural evolution facing the future climate shift.

Ex situ conservation

Conservation of FGR is likely to become more complicated with rapidly changing climate. Therefore, actions for ex situ conservation will become increasingly important as a complement to, or substitute for, in situ conservation. Generally defined as planted forests established outside the original habitat of the genetic resources, ex situ conservation stands may be genetic resources of unknown genetic variability or characterized genetically by phenotypic traits or molecular markers. They tend to be expensive to establish and to maintain. Dynamic conservation can take place in ex situ stands when natural selection occurs at a site and when artificially planted trees (species, provenances, families) can be regenerated from seeds without much intervention. If the original population is sufficiently sampled and the stand is large enough (minimum viable population size) (FAO, 1992), these stands could provide sources of reproductive material for commercial forestry. Although costly, multi-site stands can ensure further adaptations to a range of different environmental conditions and prevent unexpected losses of genetic material.

Static ex situ.

Seed orchards, clone banks and clonal archives are examples of static ex situ conservation units, in that no changes will naturally occur in the genetic structure of the collection. These plantings are established with the sole purpose of preserving the genetic diversity of a valuable population, to safeguard endangered species that otherwise might be lost or to conserve/increase the genetic diversity of rare species of those with scattered distribution.

LECTURE 108-109: Laws & Legislation

Laws

The systeŵ of rules which a particular country or community recognizes as regulating the actions of its members and which it may enforce by the impossible penalties.

- A person could be held guilty if he breaches Law

Legislations

The process of making or enacting laws.

Laws for Environmental Resources in Pakistan

Some major laws dealing with different resources present in environment are as follow;

- Pakistan Environmental Protection Act, 1997
- Pakistan Penal Code, 1860
- Forest Act, 1927
- Pakistan Terrestrial Water & Maritime Zones Act, 1976

1. Pakistan Environmental Protection Act, 1997

PEPA provides for;

- Protection,
- Conservation,
- Rehabilitation and
- Improvement of the environment;
- PEPA provide framework for prevention and control of pollution
- Helps in protection of sustainable development**.**

2. Pakistan Panel Code, 1860

The polluter of the environment can be punished under this code for certain types of pollution.

These punishment are of following types;

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

3. 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.

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

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

➢ 109**Some major laws dealing with different resources present in environment are as follow;**

- West Pakistan Fisheries Ordinance, 1961
- The Cutting of Trees (Prohibition) Act, 1992;
- The Wild Birds and Animals Protection Act, 1912
- The Prevention of Cruelty to Animals Act, 1890

1. 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

2. 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.

3. 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.
- Whoever does or attempts to do, any act in contravention of section 3 of this act, shall be punishable with fine which may extend to fifty rupees.

4. The Prevention of Cruelty to Animals Act, 1890

- An act for the prevention of cruelty to animals.
- If a person beats, overdrives, binds or keeps it in starvation or thirst he will be punished.
- If any person overloads any animal, he shall be punished with fine which may extend to fifty rupees, or with imprisonment for a term which may extend to one month.
- If any person employs in any work or labour any animal which by reason of any disease, infirmity, wound, sore or other cause is unfit to be so employed, or permits any such unfit animal in his possession or under his control to be so employed, he shall be punished with fine which may extend to one hundred rupees.

LECTURE -110: International Treaties

"**Treaty,** a binding formal agreement, contract, or other written instrument that establishes obligations between two or more subjects of international law"

- Treaties do not need to follow any special form.
- A treaty often takes the form of a contract, but it may be a joint declaration or an exchange of notes.

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

- Convention on biological diversity, 1992
- Cartagena protocol on Bio Safety, 2001
- CITES, 1973
- Ramsar Convention, 1971
- Convention on the conservation of migratory species, 1981

1. Convention on Biological Diversity, 1992

- CBD 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
- Pakistan ratified it on 26th July 1994.
- The Convention on Biological Diversity covers biodiversity at all levels:
- Ecosystems,
- Species
- Genetic resources
- It also covers biotechnology, including through the Cartagena Protocol on Biosafety.
- In fact, it covers all possible domains that are directly or indirectly related to biodiversity and its role in development, ranging from science, politics and education to agriculture, business, culture and much more.

Objectives of CBD, 1992

The three inter-related objectives are:

- The conservation of biological diversity;
- The sustainable use of its components;
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate
- Access to genetic resources,
- Transfer of relevant technologies,
- Funding.

Facts & Figures of CBD, 1992

According to CBD;

- Ecosystems, species and genetic resources should be used for the benefit of humans, but in a way that does not lead to the decline of biodiversity.
- Substantial investments are required to conserve biodiversity, but it will bring significant environmental, economic and social benefits in return.
- The Ecosystem Approach, an integrated strategy for the management of resources, is the framework for action under the Convention.
- The precautionary principle states that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat

LECTURE 111: Nagoya Protocol

Fair and equitable benefit-sharing

1. Benefits arising from the utilization of genetic resources as well as subsequent applications and commercialization shall be shared in a fair and equitable way with the Party
2. Each Party shall take legislative, administrative or policy measures, as appropriate, with the aim of ensuring that benefits arising from the utilization of genetic resources that are held by indigenous and local communities,
3. To implement paragraph 1 above, each Party shall take legislative, administrative or policy measures, as appropriate.
4. Benefits may include monetary and non-monetary benefits.

5. Each Party shall take legislative, administrative or policy measures, as appropriate, in order that the benefits arising from the utilization of traditional knowledge associated with genetic resources are shared in a fair and equitable way with indigenous and local communities holding such knowledge. Such sharing shall be upon mutually agreed terms.

Access to genetic resources

- Access to genetic resources for their utilization shall be subject to the prior informed consent of the Party providing such resources
- In accordance with domestic law, each Party shall take measures, as appropriate,vwith the aim of ensuring that the prior informed consent or approval and involvement of indigenous and local communities is obtained for access to genetic resources where they have the established right to grant access to such resources.

Access to traditional knowledge associated with genetic resources

In accordance with domestic law, each Party shall take measures, as appropriate, with the aim of ensuring that traditional knowledge associated with genetic resources that is held by indigenous and local communities is accessed with the prior and informed consent or approval and involvement of these indigenous and local communities, and that mutually agreed terms have been established.

Contribution to conservation and sustainable use

The Parties shall encourage users and providers to direct benefits arising from the utilization of genetic resources towards the conservation of biological diversity and the sustainable use of its components.

Global multilateral benefit-sharing mechanism

Parties shall consider the need for and modalities of a global multilateral benefit sharing mechanism to address the fair and equitable sharing of benefits derived from the utilization of genetic resources and traditional knowledge associated with genetic resources that occur in transboundary situations or for which it is not possible to grant or obtain prior informed consent. The benefits shared by users of genetic resources and traditional knowledge associated with genetic resources through this mechanism shall be used to support the conservation of biological diversity and the sustainable use of its components globally.

Scope

This Protocol shall apply to genetic resources within the scope of Article 15 of the Convention and to the benefits arising from the utilization of such resources. This Protocol shall also apply to traditional knowledge associated with genetic resources within the scope of the Convention and to the benefits arising from the utilization of such knowledge.

LECTURE 112-History and objective

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity, also known as the Nagoya Protocol on Access and Benefit Sharing (ABS) is a 2010 supplementary agreement to the 1992 Convention on Biological Diversity (CBD).

The protocol was adopted on 29 October 2010 in Nagoya, Japan, and entered into force on 12 October 2014. It has been ratified by 97 parties, which includes 96 UN member states and the European Union. It is the second protocol to the CBD; the first is the 2000 Cartagena Protocol on Biosafety

Development Goals

Acknowledging the linkage between access to genetic resources and the fair and equitable sharing of benefits arising from the utilization of such resources, recognizing the importance of providing legal certainty with respect to access to genetic resources and the fair and equitable sharing of benefits arising from their utilization.

Objective

The objective of this Protocol is the fair and equitable sharing of the benefits arising from the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components.

LECTURE -113: Cartagena Protocol on Biosafety

The Bio safety (Protocol to CBD) deals with;

- Safe handling,
- Storage
- Trans-boundary movement of the Genetically Modified Organisms (GMO).

Cartagena protocol was adopted on June 2001 in Cartagena, Spain. It entered into force on September 11th; 2003. Pakistan signed the Cartagena protocol in June 200. Pakistan has ratified it in May 2009

Objectives of Cartagena Protocol on Biosafety

The Protocol states that it aims to;

- Contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity,
- It takes into account risks to human health, and specifically focusing on transboundary movements.
- It seeks to protect biodiversity from the potential risks of living modified organisms (LMOs) resulting from modern biotechnology.

Cartagena Protocol areas

The Protocol covers:

- Transboundary movement, transit, handling and use of all living modified organisms that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account risks to human health.

It does not cover:

- •Products derived from LMOs (e.g. paper from GM trees)
- •LMOs, which are pharmaceuticals for humans that are addressed by other relevant international agreements or organizations

LECTURE 114: Quarantine Regulations

Quarantine legislation is in place in countries worldwide restricting the import of non-indigenous plant and animal pathogens. Those who wish to import such organisms must hold the relevant import permit, which can be obtained, from the relevant country Authority.

Quarantine practices in most countries have at least three common functions.

a. The first is exclusion or regulatory actions to prevent or reduce the risk of entry of exotic pathogens, pests, or parasites along artificial pathways.
b. Second is the containment, suppression, or eradication of pests or pathogens that have been recently introduced.
c. Third is the assisting of exporters to meet the quarantine requirements of importing countries.

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 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.

LECTURE 115-Pakistan Plant quarantine act, 1976

Definitions

a) A protocol means the international Plant protection Convention, 1951.
b) "Crop" includes all agricultural and horticultural crops and all trees, bushes, grass or plants.
c) "Import" means the bringing or taking by sea, land or air cross and customs frontier as defined by the Federal Government.
d) "Infection" means infection by insect, fungus or other pest injurious to a crop or plant;
e) pest means any living stage of any or all insects, nematodes, slugs, snails, protozoa, or other invertebrate animals, fungi, bacteria, or other parasitic plants or reproductive parts thereof, virus or any organism, or any infections substance which may directly or indirectly injure or cause disease to any cop or plant; and
f) Plant means all species of plants or parts thereof whether living or dead including stems, branches, tubers, bulbs, corns, stock, bud-wood, cuttings, layers, slips, suckers, roots, green scum on stagnant pools, leaves, flowers, fruits and seeds.

LECTURE 116-Import of plant material

No person shall import any plant or plant material which may be a source be a source or medium of infestation or infection by diseases and pests destructive to agriculture or medium for the introduction of noxious weeds, except under a valid import permit obtained prior to such importation in Form issued by the Director or the Entomologist (Quarantine) and except through the ports or points of entry

Plant material for which special permit is required:

Plant material likely to carry new complex of pests or diseases may be imported into Pakistan in limited quantities by special permit in Form I for the purpose of introducing new varieties and propagating stock from countries which maintain regular plant quarantine and inspection service.

Application for permit to import plant material:

1) Before any plant or plant material is imported, an application for permit shall be submitted to the Director or to the Entomologist (Quarantine).

2) All such applications shall be signed by the person who intends to import the pant or plant material or his duly authorized agent and shall specify:

(a) the kind and quantity of plant or plant material;
(b) the country and locality of origin;
(c) destination;
(d) the name and address of the consignor and the consignee;
(e) means of transport;
(f) the prescribed port or point of entry;
(g) the prescribed for which the plant or plant material is proposed to be imported e.g., consumption propagation or processing.

Notice of arrival by the importer:

The importer shall inform the Director or the Plant Quarantine Officer, of the probable date of arrival of the plant or plant material at the prescribed port or point of entry

Refusal and revocation of permits:

A permit to import plant or plant material may b revoked if, in the opinion of the Director or the Entomologist (Quarantine), the importer has willfully contravened any provision of these rules or there is reason to believe that the plant or plant material will be imported in violation of the provision of these rules.

Freedom of plant material from San, Soil or Earth:

An imported plant or plant material shall be free from sand, soil, saw dust or earth and the plant roots, rhizomes and tubers shall be washed thoroughly.

Packing material

All packing material employed in the importation of nursery stock and other plants

Plant material imported by post:

Plant or plant material imported through the post shall be inspected by the Plant Quarantine Officer upon notification or their presence at the Post Office.

Exports

Inspection and Certificate for exports:

All persons who intend to export plant materials must submit to the Department, an application for inspection of plant or plant material before the dispatch of such consignments.
Application for inspection of plant material for export

1.

a) If the plant or plant material upon inspection are found to be free from plant diseases and injurious insects, a certificate shall be issued by the Director or Entomologist (Quarantine) to the exporter to accompany the shipment.

(b) If the Director, or as the case may be, the Entomologist (Quarantine) considers necessary he may, before issuing a certificate require the disinfestations or disinfection of plants or plant materials by fumigation 19 through a person, firm, agency organization or company registered with the Department.

c) The Department may register any persons, firm, agency organization or company for carrying out disinfestations or disinfection of plant or plant materials on such terms conditions and on payment of such fees as it may determine

d) No official certificate shall be granted for plant or plant material which have been from or mixed with other plants which are diseased or infested.

(e) The official certificate shall not be granted for any plant or plant material intended for shipment to a country in which their entrance is absolutely prohibited.

2. All risk or damages or any kind associated with or resulting from fumigation or other treatment shall be at the risk of the owner.

3. The certificate implies that the plant or other matter was inspected by a duly authorized officer of the Department and was fund to conform to the inspection standards or procedures associated with the issuance of official certificates tags or other documents.

LECTURE -117 The Pakistan Animal Quarantine Ordinance, 1979

To regulate the import, export and quarantine of animals and animal products in order to prevent the introduction or spread of diseases and to provide for matters connected therewith or incidental thereto

Definitions

A) **Animal includes all kinds of** Birds, cold-blooded creatures, creatures by means of which any disease may be carried or transmitted; crustacean, fish, four-footed beasts which are not mammals, mammals, except man; and reptiles.

Animal product

B) animal product means anything originating or made, whether in whole or in part, from an animal or from a carcass
C) carcase means the carcase of an animal and includes any part or portion thereof

(d) Diseased means suffering from or carrying any infectious or contagious disease or such disease as may be declared by the Federal Government from time to time by notification in the official Gazette (e) fodder means hay, roughage, concentrate or any other substance used for feeding animal

Power to regulate and prohibit import and export of animals and animal products

The Federal Government may, by notification in the official Gazette, prohibit, restrict or otherwise regulate, subject to such conditions as it may think fit to impose, the import or export of any animal or class of animals or animal products likely to introduce diseases to any other animal, animal product or man.

Any condition imposed under this section may require

(a) the examination, inspection and detention in quarantine by the quarantine Officer of the animals or animal products brought in or to be taken out:
(b) the obtaining of health certificate:
(c) the treatment or detention , confiscation and destruction of diseased animals or animal products:
(d) that any animal or class of animals or animal products shall not be imported or exported except by a specified agency of the Federal Government.

Penalties

whoever contravenes or attempts to contravene any of the provision of this Ordinance or the rules or any notification issued thereunder , shall, without prejudice to any penalty to which he may be liable under the provisions of the Customs Act, 1969, be punishable with imprisonment for a term which may extend to three years, or with fine which may extend to five thousand rupees, or with both .

The principles of successful quarantine

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 aquarantine program. 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.
2. Animal and plant quarantine regulations are similar in that they may:

Require import permits issued by the quarantine service of the importing country (these may require the exporting country to certify that specified conditions have been met prior to shipment);

- Specify things that are prohibited from entry;
- Grant exceptions to the prohibitions for scientific purposes;
- Require inspection of imported materials upon arrival;
- Require appropriate treatment, if warranted, as a condition of entry; and
- Require, after arrival, quarantine or isolation in an approved facility.

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.

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

LECTURE 118: Management 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. Attack 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. Institute of Agricultural Biotechnology and Genetic Resources (IABGR). PGRP is regularly funded by the government of Pakistan.

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 Gene bank of Pakistan at Plant Genetic Resources Institute has two types of conservation facilities

- Active collection
- Base collection.

Seed stock in the Gene bank is periodically subjected to germination tests in Seed Preservation Laboratory. In vitro laboratory of PGRI has employed a variety of techniques for conservation of the germplasm of vegetative propagated species namely grapes, peach, pear, sweet potato, banana and sugarcane. 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.

Clonal repository is field Genebank where genetic resources of clonally propagated crops like fruits are preserved as living plants. 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
- livestock departments at provincial level
- 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, Rakh Dera Chahl, Lahore and Poultry Research
- Institute, Karachi

LECTURE -119: Future Perspective of Genetic conservation

Pakistan 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.

LECTURE 120: Improvements needed

Gaps and needs

Much progress has been made over recent years in linking the conservation and use of PGRFA with endeavors to increase food security and develop more sustainable agricultural systems. However, there are still many gaps in our knowledge and in the range of action required to improve the situation. Attention is needed, for example, in the following areas:

1. There is a need to step up efforts to conserve landraces, farmes' varieties and CWR before they are lost as a result of changing climates.
2. Special efforts are needed to identify those species and populations that are most at risk and that are most likely to harbour traits that will be important in the future;
3. There is a need for more efficient, strategic and integrated approaches to the management of PGRFA at the national level.
4. Links need to be strengthened between those individuals and institutions in both the private and public sectors who are primarily responsible for conservation and those who are primarily concerned with genetic improvement and seed production and distribution
5. At the international level there is also a need for greater coordination and cooperation among agencies and institutions concerned with international and intergovernmental aspects of the conservation and use of PGRFA and those concerned with agricultural production, protection, sustainability and food security, as well as related areas such as health and the environment.
    - Greater efforts are needed to estimate the full value of PGRFA, to assess the impact of its use and to bring this information to the attention of policy-makers and the general public so as to help generate the resources needed to strengthen programmes for its conservation and use.
    - There is a need for more accurate and reliable measures, standards, indicators and baseline data for sustainability and food security that will enable better monitoring and assessment of the progress made in these areas. Greater attention needs to be given to the development of more decentralized, participatory and gender sensitive approaches to plant breeding in order to more effectively generate varieties that are specifically adapted to the particular production environments and socio-economic situations of the poor in less favored environments.

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