# Chapter 9

# Strategies for Enhancement in Food Production

## Introduction to Animal Husbandry

## "DOMESTICATION OF ANIMALS"

ANIMAL HUSBANDRY' is Science of rearing, improvement and caring of domesticated animals.

Fig: Animal Husbandry

- Livestock Cattle in particular are very useful in Indian agriculture.
- Cow, Buffaloes, goats & Sheep are domesticated for milk.
- Many animals as horse cattles, mules, asses, camels, elephants & reindeers are used for transport.
- Sheep, rabbit and silkworms provide wool, fur & silk respectively.
- The first animal to be domesticated was dog followed goat.
- Huskies are thick coated dogs used by eskimos to draw their sledges.

**Livestock**

Domesticated animals, especially the farm animals, kept for profit are collectively called live stock. eg. Cattle, buffaloes, sheep, goat, pigs, horses, camel.

Fig: Live Stock

**a. Agriculture operations-** They are main source by pulling carts & wagons. They are also helpful in agriculture operations like ploughing, harrowing, levelling etc.
**b. Milk-** They provide milk which is an important food having all essential nutrients.
**c. Transport-** They are used in driving carts for transportation of men & materials.
**d. Manure & fuel-** The dung provided by them acts as a valuable manure for maintaining the fertility of soil.
- It is also used for preparation of biogas.
- Dung cakes provide cheap fuel.

**e. Leather-** Hides obtained from these animals are used for the preparation of leather goods.
**f. Glue & Gelatin-** Their bones, horns and hoofs yield glue & gelatin.
**g. Meat-** Beef & Buffalo meat are eaten by certain people.

**Breeds of buffaloes**
Surti, Niliravi, Nagpuri (ellichpuri), Jaffrabadi, Bandawari, Murrah, Mehsana.


Fig: Breeds of Buffaloes

**Breeds of cattle**

- There is a variety of breeds of cattle & buffaloes in our country.
- All of them differ in general body build, colour, forehead, form of horns and geographical distribution.
- The best cattle breeds occur in the drier region of the country. There are 26 breeds of cattle.

- The most important breeds of milk cows are Holstein-Friesian, Jersey, Quernsey, Ayrshire, Brown swiss, Red Dane.
- Depending upon the utility, the cattle are classified into the following groups -
  i. Milch breeds
  (Milk producing animal)
  ii. Draught breeds
  (Used for working)
  iii. General utility breeds
  (Used for safety)

**Important breeds of Indian Cattle**

| MILCH BREEDS | Distribution |
|---|---|
| 1. Gir | Raj, Gujrat |
| 2. Sahiwal | Punjab, Haryana, U.P. |
| 3. Red Sindhi | Andhra Pradesh |
| 4. Decani | Andhra Pradesh |
| **DRAUGHT BREEDS** | **Distribution** |
| 1. Malvi | Raj.,M.P. |
| 2. Hallikar | Karnataka |
| 3. Naceri | Haryana, Delhi, U.P. |
| 4. Kangayam | Tamilnadu & other parts of South India |
| **General Utility Breeds** | **Distribution** |
| 1. Haryana | Haryana, Punjab, M.P. |
| 2. Ongole | Andhra Pradesh |
| 3. Kankrej | Gujrat |
| 4. Thaparkar | Gujrat , Ardhra Pradesh |

**Feeding of Cattle:** In order to get good results cattle should be given a balanced feed containing sufficient quantities of carbohydrates, proteins, fats, vitamins minerals & water.

Fig: Feeding of Cattle

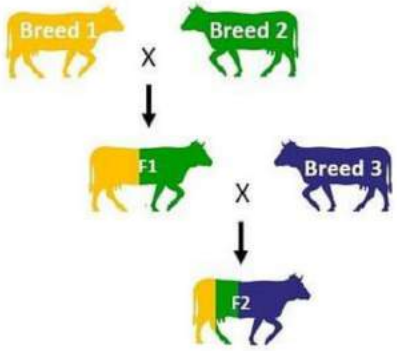
Feed constitutes two main components i.e.,
(i) Roughage
(ii) Concentrate

- Roughage contain large amount of fibre which include hay fibre and silage.
- The concentrate is a mixture of cereal broken grams, rice polish, cotton seeds gram bran and oil take moisted in water.
- These are rich in proteins highly palatable & digestable
- In our country, paucity of food & fodder is responsible for low milk production.
- Along with underfeeding & overfeeding also affect the productivity of animals.

**Animal Breeding**

**Breeding of Cattle :**

- Cattle breeders select & mate best type of cattle for a particular purpose.




3-way Cross Breeding

- The breeding of cattle is done by two methods

**1. Natural Breeding**
a. Random breeding
b. Controlled breeding
**2. Artificial breeding**
**1. Natural breeding** - It is further of two types –

**a. Random Breeding**
- Here some pedigree bulls are kept along with the grazing cows.
- Bulls not selected for breeding are castrated and changed to bullocks.

**b. Controlled breeding -**
- In this type of breeding native cows are crossed with superior quality of imported bulls in natural breeding.
- Foreign dairy breeds like Jersey (England), Holstein-Freisian (Holland), Brown Swiss (Switzerland), Ayrshire (Scotland) have been important to give better results.
- Hybrid cows require special environment & yield more milk.
- Hybrid oxen is also comparatively more active & energetic.

**Some improved hybrids are :**

– Jersey Sindhi,
– Brown Swiss Sahiwal,
– Ayrshire Sahiwal etc.

**2. Artificial Breeding -** The introduction of semen (sperm) in the body (vagina) of females, by artificial means is called **ARTIFICIAL INSEMINATION.**
- Several cows can be inseminated by semen of a single bull.
- Gestation period of cows is about 9 months & buffaloes is about 10 months.
- Cows give 8-10 calves in complete life span.
- Buffalo in actual sense is called water buffalo (Bubalus bubalis).
- Cow is more adapted for dry conditions.

**Super Ovulation & Embryo Transplantation**

- Superovulation is a technique where in a cow is made to ovulate more ova by injection of hormones. Lutinizing harmone (LH)
- High quality cow (e.g., more milk producing ) is chosen, & is given hormonal injections to induce super ovulation.
- Fertilization is achieved by artificial insemination
- From this cow 4 to 10 embryos are collected at a time.
- Each of the embryo is transplanted into carrier cow (Surrogate mother).

- By deep freezing (-196$^0$C) it is possible to preserve the seven days old foetus for several years and transplanted when required.
- The embryo can be cut into two & Monozygotic twins can be obtained.
- This embryo transplantation technique can also be used for other live stocks like sheep & goat etc.
- Fertility in local breeds of cattle has been overcome through the use of pregnant mare serum gonadotropin. (LH + FSH)
- Sterile & immature cows can be induced to lactate through **stilbesterol.**

**Plant Breeding**

**Plant Breeding**

**Genetic Improvement and Development of New Varities**

**Trait :** Trait or character is any morphological, anatomical, biochemical or behavioural feature of an organism.
**Variety :** A group of plant that has the same genotype, but it differs for one or more characters from other varieties of the same crop. An improved variety is superior to the other existing varieties of the same crop in one or more characters.

**Plant breeding :-** The branch of agricultural sciences which leads to development of new and improved variety of crop plant. It is the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yield and have disease resistance.
It was started about 9000-11000 year ago.
1871 – Department of Agriculture, I$^{st}$ time organized.
1905 – Imperial Agriculture Research Institute Pusa (IARI), Bihar.
1936 – Rebuilt in Delhi with same name.
1946 – Name changed to Indian Agriculture Research Institute, Pusa

**Objective of plant breeding :**

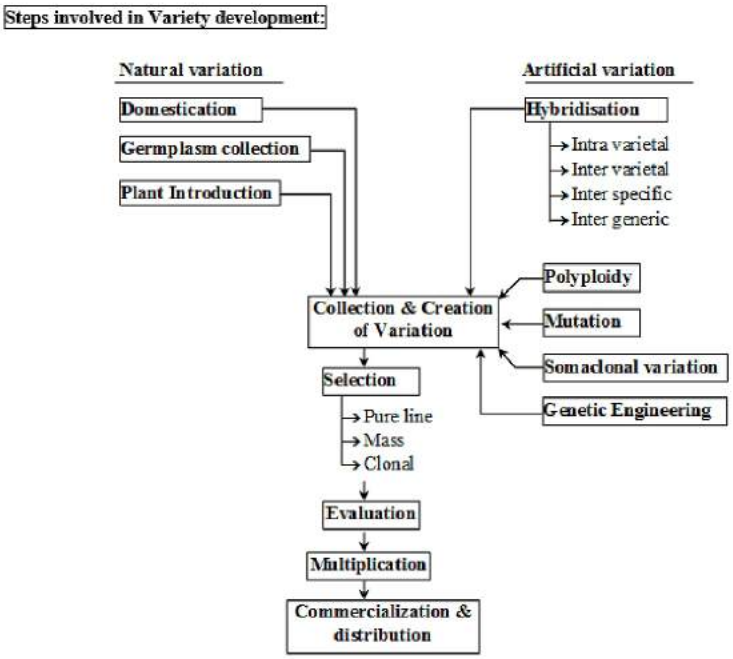
1. Development of high productivity crop variety.
2. Development of variety with high nutritional quality.
3. Development of variety with high water use efficiency.
4. Development of variety with high mineral use efficiency.
5. Development of abiotic stress (Drought, Salinity) tolerant variety.
6. Development of biotic stress and insect pest resistant variety.
7. Development of early maturing variety.
8. Development of variety with less post harvest loss.

**Some plant breeding institute**

1. I.A.R.I. - Indian agricultural research institute, Pusa, New Delhi
2. C.P.R.I. - Central potato research institute, Shimla
3. C.R.R.I. - Central rice research institute, Cuttack
4. I.S.B.R.I. - Indian sugarcane breeding research institute, Coimbatore
5. C.A.Z.R.I.- Central arid zone research institute, Jodhpur
6. N.B.R.I. - National botanical research institute, Lucknow
7. N.B.P.G.R. - National bureau of plant genetic resources, New Delhi
8. I.I.S.R.- Indian institute of spice research, Calicut
9. I.R.R.I. - International rice research institute Manila
10. I.C.R.I.S.A.T. - The International Crops Research Institute for the Semi-Arid Tropics
11. C.Y.M.M.I.T. - International Maize and Wheat Improvement Center

**Some plant Breeder :**

1. **Normon E. Bourloug : Father of green revolution.** He developed semi dwarf varieties of wheat **Sonara 64** and **Lerma rojo.** He got Nobel Peace Prize in 1970.
2. **N.I. Vavilov : Father of centre of origin concept** for cultivated plants.
3. **M.S. Swaminathan : Father of green revolution in India. Father of mutational breeding** in India.
He developed semi dwarf varieties of wheat **Sharbati Sonara** and **Pusa Lerma** through mutation from **Sonara 64** and **Lerma rojo,** respectively. He was the I$^{st}$ Winner of World Food Prize.
4. **Gurdev Singh Khush : Former director of IRRI.** He is a rice breeder. He developed high yielding rice variety **IR-36**. He got **World Food Prize.**
5. **S.K. Vasil :** Maize Breeder. He developed **biofortified maize varieties (QPM)** which are having high concentration of **Tryptophan** and **Lysine**. He got World Food Prize.




1. Collection of variability.
2. Evaluation and Selection of parents.
3. Cross hybridization among the selected plant.
4. Selection and testing of superior recombinants.
5. Testing release and commercialization of new cultivar.

(1) ***Collection of variability:*** Genetic variability is the root of any breeding programme. In many crops pre-existing genetic variability is available from wild relatives of the crop. Collection and preservation of all the different wild varieties, species and relatives of the cultivated species (followed by their evaluation for their characteristics) is a pre-requisite for effective exploitation of natural genes available in the population.
The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called **germplasm collection.**

(2) ***Evaluation and selection of parents:*** The germplasm is evaluated so as to identify plants with desirable combination of characters. The selected plants are multiplied and used in the process of hybridisation.

(3) ***Cross hybridisation among the selected parents:*** The desired characters have very often to be combined from two different plants (parents). This is possible by cross hybridising the two parents to produce hybrids that genetically combine the desired characters in one plant. This is a very time-consuming and tedious process since the pollen grains from the desirable plant chosen as male parent have to be collected and placed on the stigma of the flowers selected as female parent.

(4) ***Selection and testing of superior recombinants:*** This step consists of selecting, among the progeny of the hybrids, those plants that have the desired character combination. The selection process is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny. This step yields plants that are superior to both of the parents. These are self-pollinated for several generations till they reach a state of uniformity (homozygosity), so that the characters will not segregate in the progeny.

(5) ***Testing, release and commercialization of new cultivars:*** The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance, etc. This evaluation is done by growing these in the research fields and recording their performance under ideal fertiliser application irrigation, and other crop management practices. The evaluation in research fields is followed by testing the materials in farmers' fields, for at least three growing seasons at several locations in the country, representing all the agro-climatic zones where the crop is usually grown. The material is evaluated in comparison to the best available local crop cultivar – a check or reference cultivar. If material is superior than best crop cultivar, then it is released for cultivation by ICAR.

**Wheat and Rice :** During the period 1960 to 2000, wheat production increased from **11 million tones** to **75 million tonnes** while **rice** production went up from **35 million tonnes** to **89.5 million tonnes**.
This was due to the development of **semi-dwarf varieties of wheat and rice.** Nobel laureate Norman E. Borlaug, at International Centre for Wheat and Maize Improvement in Mexico, developed semi-dwarf wheat. In 1963, several varieties such as ***Sonalika*** and ***Kalyan Sona***, which were high yielding and disease resistant, were introduced all over the wheat-growing belt of India.
Semi-dwarf rice varieties were derived from **IR-8**, (developed at International Rice Research Institute (IRRI), Philippines) and **Taichung Native-1** (from Taiwan). The derivatives were introduced in 1966. Later better-yielding semi-dwarf varieties ***Jaya*** and ***Ratna*** were developed in India.
**Sugar cane :** ***Saccharum barberi*** was originally grown in North India, but had poor sugar content and yield. Tropical canes grown in South India. ***Saccharum officinarum*** had thicker stems and higher sugar content but did not grow well in North India. These two species were successfully crossed to get sugar cane varieties combining the desirable qualities of high yield, thick stems, high sugar and ability to grow in the sugar cane areas of North India.
**Millets :** Hybrid maize, jowar and bajra have been successfully developed in India. Hybrid breeding have led to the development of several high yielding varieties resistant to water stress.

**Methods of New Variety Development:**

(1) Domestication
(2) Germplasm collection & conservation
(3) Plant introduction
(4) Hybridisation
(5) Polyploidy
(6) Mutational breeding
(7) Genetic engineering

**(1) Domestication :-** All the present species of cultivated plants are of wild type species in origin. Process of cultivation of wild species in order to fulfill human need is called domestication of plant. Many present day crops are the result of domestication in ancient times.

- Genetic diversity is the occurrence of large number of varieties, biotypes, variations and alleles.
- Greatest genetic diversity of plants is found in their natural home lands.
- Germplasm collections are made mostly from an area, where wild relatives of crop plants still live.
- Genetic diversity refers to intra-specific and inter-specific variation.
- **Vavilov (1926)** proposed that different crop plants originated in different areas, where their **wild relatives are present** and **genetic diversity is maximum.**
- **Vavilov** proposed 8 centre and 3 subcentre (11 centre) of origin. He collected 26,000 varieties of wheat.
- Presently, 12 centre of origin is present. Australia is the 12$^{th}$ centre.
- Cotton has developed in both old and new world.
- The original homeland of some important crops are listed below :-

| CENTER OF ORIGIN | MAJOR CROP |
|---|---|
| **NEW WORLD** | |
| (1) Peruvian andes | Potato, tomato Capsicum |
| (2) Brazil | Pineapple, rubber, Cashew |
| (3) USA | Sun flower |
| (4) Mexico and Central America | Maize |
| **OLD WORLD** | |
| (5) Asia minor/Afghanistan | Almond, Apple, Pear, Lentil, Rye, pomegranate |
| (6) Ethiopia | Barley, Sorghum Coffee |
| (7) Mediterranean sea | Cabbage, Beet, Lettuce, Oat, Olive |
| (8) China | Soyabean, Tea, Onion |
| (9) South-West Asia | Wheat |
| (10) South-East Asia | Rice, Banana, Mango, Orange, Black pepper, Brinjal, Pigeon Pea, Sugar Cane |
| (11) European Siberia | Cherry |
| (12) Australia | Mecaderq Nut |

**Natural home :-** It is the centre of origin of a crop, which often abounds in its wild relatives and maximum genetic diversity.

**Secondary home :-** It is the major centre of production of a crop plant, which is away from centre of origin and lacks wild relatives.

| Important crop | Centre of Origin | Centres of Production |
|---|---|---|
| (1) Cocoa | Brazil | Africa |
| (2) Coffee | Ethiopia | Brazil & Central America |
| (3) Maize | Mexico and Central America | Mid West USA |
| (4) Pineapple | Brazil | Hawali |
| (5) Monterey pine | California | Australia |
| (6) Potato | Peru | Eastern Europe |
| (7) Wheat | Central Asia | North America, Asia |
| (8) Rubber | Brazil | Malaysia, Indonesia |
| (9) Oil plam | Tropical Africa | Malasiya |
| (10) Ground nut | Peru, Brazil | India |

**Wild relatives :-** Species related to cultivated plant that occur in the wild in areas of their origin.

**(2) Germplasm collection & conservation :-**

**Germplasm** is the sum total of all the alleles of the genes present in cell of a crop species and its related species. The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called germplasm collection.

It is consist of –

(i) Cultivated improved varieties.

(ii) Improved varieties that are no more cultivated.

(iii) Old local or desi varieties.
(iv) Varieties produced by plant breeders (undistributed).
(v) Wild species related to the crop species.
The sum total of different types of all the genes and their alleles present in a population is called **gene pool.** The gene pool of a population is not static.
**Genetic erosion –** The loss of genes from a gene pool is called genetic erosion.
Genetic erosion occurs due to **deforestation, urban expansion, damage to ecosystem and adoption of genetically uniform modern variety of crops.**
11 million hectares of tropical forest disappear every year.
**There are four basic way to conserve plant germplasm.**
(i) Conservation of plant in wild state i.e. in natural habitat like forests.
(ii) Conservation of plant in botanical gardens.
(iii) Introduction of plant for cultivation in agriculture and horticulture.
(iv) Preservation of plants in seed form or some other suitable form.

**Method of genetic conservation :**

**(i) In-situ conservation –** It means maintenance of biological diversity in natural habitats like forests and natural reserve like national park, wildlife sanctuaries and bio-sphere reserves. In situ conservation of wild plants help in protecting species threatened with extinction.

**(ii) Ex-situ conservation –** It is the conservation of selected or rare plant in a place outside the natural home. In this conservation rare or selected plant material are grown in specific gardens.

**Ginkgo biloba** plant is preserved by Ex-situ conservation.
Ex-situ conservation includes offsite collections and gene bank.
**(a) Offsite collection :** They are living collections of wild and domesticated species in botanical garden, zoo etc.

**(b) Gene bank :** The place or institution, where different plant material (genes) are kept or preserved, is called **"Gene bank".**
In gene bank, storage of germplasm is done either in the form of seed or vegetative material, but best and convenient way is storage of seed.
Seed means, any plant part that is used to grow a crop. Thus 'seed' would include grains of wheat, rice, tubers of potato, stem of sugarcane etc. which are used for producing new plants.

**Cryopreservation :-** Preservation of germplasm at ultra low temperature at –196° C (liquid nitrogen) called cryopreservation.

Storage of dry seeds is done at low temperature (–10 to –20°C), because under these conditions the metabolic activities are minimum, prevent their germination.

**Seeds are of two types-**

**(a) Orthodox seed :-** The seeds cannot be killed or damaged as a result of decrease in moisture content& temperature. e.g. seeds of **wheat, rice, maize, oat barley** (Cereals) and also different pulses or legumes.
**(b) Recalcitrant seeds :-** The seeds which can be killed or damaged as a result of drying and decrease in temperature. These can be stored for a short span. eg. seeds of **rubber, tea, coconut, Jack fruit** (Artocarpus), **litchi, oil palm** etc.
Conservation of crop with recalcitrant seed, can be made by in situ conservation method and also by tissue culture method.
Plants with recalcitrant seed are grown in **orchard,** where all possible strains and varieties are maintained.

**Storage of germplasm by tissue culture :**
The tissue culture technique for storage of germplasm is used in case where :-
(a) No seeds are produced (banana, sugar cane).
(b) Non viable seeds.
(c) Crop with recalcitrant seed.
(d) Specific clone is to be maintained.
Best method of tissue culture for germplasm storage is **"Shoot tip culture".**
Shoot tip culture rapidly, becoming preferred material for international exchange of germplasm as they are more stable, easier to regenerate in to whole plants and produce virus free clonal plants.
Nowadays germplasm of potato, Cassava, and banana are exchanged by this method.
The main advantage of tissue culture storage of germplasm are :-
(a) Economical
(b) Requires small area for storage of many genotype
(c) Can be used for multiplication of rare and endangered species.

**Significance of germplasm of wild species :**

It is very important to conserve wild species of plant as these are highly resistant to insects, pests, disease and unfavourable growth conditions, which are necessary for survival of plants.
The loss of wild plants, will reduce the genetic variability and will be a great loss to gene pool.
Potato and sugarcane has been improved by use of germplasm of wild species having many characters like disease resistance and resistance to environmental stress.

In potato (***Solanum tuberosum***) gene for resistance to **potato virus-X** and **potato leaf roll virus** have been obtained from a wild species "***Solanum acaule***".
Resistance to wilt fungus **(Fusarium)** and cyst nematode **(Globodera)** has been introduced from ***"Solanum spegazzini"***.
Potato got resistant gene to **potato virus–Y** from a wild relatives ***"Solanum stoloniferum"***
Resistance to **late blight of potato** (Caused by fungus ***Phytophthora infestans***) has been derived from "***S.demissum***"
Similarly, sugarcane (***Saccharum officinarum***) got resistance to **red rot of sugarcane** and adverse environment from a wild species ***"Saccharum spontaneum".***
**INTERNATIONAL EFFORTS FOR UTILIZATION OF CROP – Germplasm**

Cereals (rice, wheat, maize, rye, sorghum, bajra etc.) are the main sources of food for human population in the world and rice alone constitutes staple food of more than 50% world's population.

**Improvement in rice production :**

Dwarfing gene of rice "dee-geo-woo-gene" was obtained from Taiwan.
This gene was incorporated to produce high yielding early maturing IR-8 and IR-24 varieties by IRRI, Manila.
**Gurdev S.khush** and his team crossed 13 varieties of rice from six countries and wild rice ***Oryza nivara*** (from India) to develop IR-36 variety of rice.
**IR-36** variety of rice is resistance to **grassy stunt virus.**
**IR-36** is the high yielding variety of rice and has solved major food problem in Asia.
**Improvement in wheat production :**
**Dr. N.Borlaug** (Mexican wheat breeder) develop many dwarf wheat varieties like **Sonora-64** & **Lerma rojo** by incorporating **Norin-10** (Japanese dwarf gene) gene.
**(3) Plant introduction –**

**This is the most rapid method of crop improvement.**

The process of introducing plants with specific characters from one area to a new and changed climatic condition is called **"Plant introduction".**
(a) If plants are introduced from foreign country, it is called "exotic collection (EC).
(b) If plants are brought from same country then it is called **"indigenous collection"** (IC).

**Primary introduction :-** If introduced plants may be used directly for cultivation, it is called primary introduction.

**Secondary introduction :-** If introduced plants may be used for cultivation after subjecting to selection/hybridization, it is called secondary introduction.

**Acclimatization :**

It means adaptation of introduced plant material in the changed or new climatic conditions is called acclimatization.

**Plant Quarantine :**

Introduced plant material are subjected to "Quarantine laws/plant protection inspection. To check the entry of pathogen, all the introduced plant materials is thoroughly inspected for contamination of weeds, diseases and insect pest. This testing is known as plant quarantine.
If the plant material is found suitable, phytosanitary certificates are issued and only then the plant material is introduced in our country.
Uncontrolled plant introduction in the past are responsible for introduction of hazardous diseases like **late blight of potato, leaf rust of coffee, fire blight of apple, bunchy top of banana etc.**
Many weeds like ***Argemone maxicana, Eicchornia crassipes*** and ***Parthenium argentatum*** etc. introduced in our country due to uncontrolled plant introduction.
New plants like potato, groundnut, coffee, rubber, guava, grapes, papaya, litchi, gulmohar, bougainvillea etc are the result of plant introduction.
Wheat variety **"Ridley** was introduced in India from Australia.
Many improved varieties of different crop plants are also outcome of these introduction e.g **Sonora-64** varieties of wheat, **Plametto** varieties of soyabeans, **Kent** variety in Oat, **Tiachung native 1 (TN1)** of rice etc.

**Fisheries**

**Fisheries**

- Fishes & other aquatic animals are reared and caught for food which is rich in protein vit A & D
- Pisciculture is rearing catching & management of fishes.

Pisciculture

Culture fishery is the raising of fishes in tanks & ponds.
- Capture fishery is management of catching of fish without actually raising them.
- The per capita consumption of fish in India is estimated at 1.52 kg/ yr.
- India is at present the 6th foremost sea food producing nations in the world.

**Blue Revolution is** an effort to increase fish yield in India.

**Cultivable species. of fresh water fishes**

-

*** Indigenous species ***

1. **Labeo rohita** (Rohu) – most common carp
2. **Labeo calbasu** (Calbasu)
3. **Catla catla** (Catla)
4. **Wallage attu** (Malli)
5. **Clarias betrachus** (Magar)
6. **Mystus singhala** (Singhara)
7. **Heteropneustes heteropneusts** (Singhi)
8. **Channa** (Murrels)

**Exotic sps.**

- Cyprinus carpio (Common carp)
- Ctenopharyngodon idella (grass carp)
- Hypopthalmicthys molitrix (chinese carp/silver carp)
- Osphronemus goramy (gaurami)
- Tilapia mossambica

**Marine fishes –**

1. Hilsa (Hilsa) - Coastal India
2. Aluitheronema (Salmon) - East & west coast
3. Sardinella (Sardine) - West & south coast
4. Harpodon (bombay duck) - Coastal Maharashtra
5. Stomaleous (pomphret) - Indopacific coast
6. Anguilla ( Eel), Mackerel
7. Chanos chanos (Milk fish)
8. Mugil (grey mullet)

* For efficient utilization of different type of food in the pond it is necessary to cultivate 2 or 3 types of fishes together. This is called composite or mixed farming The major carps catla, rohu & Mrigal form a satisfactory combination in the ratio of 3 : 3 : 4. Selection of cultivable fish species is an important aspect of fish culture. Culturable fishes should have a high food value (both in quantity and quality), high reproductive and growth rates, higher disease resistance capacity, tolerance against the environmental fluctuations, an easy acceptance towards natural and artificial food and should be well compatible to the other fishes present in the pond or the aquatic habitat.

The above criteria are fulfilled only by a few species of fishes, which are called as major carps. Therefore, the culture of these fishes are practiced in India at a large scale. At present three main species of the indigenous carps in India are included as the category of major carps. The three species are- Labio rohita, Catla catla and Cirrhinus mrigala. These species along with certain exotic carp species are cultured together in a fish pond. This technique is called composite fish culture. An appropriate ratio among the individuals of various species is observed at the time of stocking the pond with fishes.

**Important Steps of Fish culture**

The major steps followed in the fish culture practice are briefly described in following lines

**(i)** In the beginning of the culture programme, a suitable site for the establishment of a fish farm, is selected in accordance to the standard criteria. a number of ponds of different types are then constructed and a dependable source of water is ensured to supply water into the nursery ponds, rearing or raising ponds and stocking ponds. The size, shape and depth of water in these ponds differ from each other.

**(ii)** Fishery ponds are usually Treated with lime to maintain an appropriate pH of pond water, Organic and inorganic manure and fertilizers are supplied in the pond to encourage the growth of planktons and other organisms that serve as natural food for fishes (this is called fertilization of pond). It is quite essential to remove the

harmful aquatic weeds, predatory fishes and the harmful insects from the pond before introducing fish seed into the pond.
**(iii)** Fish seed is procured from the natural breeding places of fishes or may be collected from rivers during monsoon season.
**(iv)** In order to obtain pure seed of the desirable fish species, healthy males and females of a superior fish species are selected. These are then induced to breed artificially by **(Hypophysation)** giving in them the injections of pituitary extract (containing FSH or LH) or of a synthetic hormone like human chorionic gonadotropins (HCG). This stimulates females for spawning and the males to emit milt (containing sperms) on the ova to fertilize them.
**(v)** The fertilized eggs from the breeding pond are collected and transferred into hatcheries or hatching pits where they hatch to give rise to small hatchlings or sac fry.
**(vi)** The Juvenile sac fry are now transferred from the hatcheries into **nursery ponds**, where they develop into fry. These **fry** by feeding on zooplanktons and phytoplanktons, present in nursery ponds, grow in size and change into fingerlings. Fry are also fed by artificial food.

**(vii)** The fingerlings in next step, are transferred into **rearing** or **raising ponds** (this is called thinning), where they feed on both natural and artificial food. In rearing ponds, the fingerlings grow upto a size of 15-20 cm long. Now these are transferred into **stocking ponds.**

**(viii)** In the stocking pond the fingerlings soon become adult and attain table size (edible size) in about 6-9 months. These are given adequate food in these ponds and due care is given to protect them from diseases and other hazardous agents.

**(ix)** When the fish in pond have attained a suitable table size, the fishes are captured by using fish gears like hooks and lines, drag net, gill net , cast nest. This is called **harvesting**. These fishes are then taken to landing centres from where they are disposed off by selling into market. Our country has sufficient water resources including thousands of the ponds in rural areas, These ponds may be used for fish culture together with the piggery, duck rearing, goat. which this along with providing employment to rural people, may also be an additional source of income.(Integrated fish culture) Certain premier institutes in India viz., Central Inland Capture Fisheries Research Institute (CICFRI), Barrackpore (W.B.); Central Marine Fisheries Research institute (CMFRI), Kochi (Kerala); Central Institute of Fresh water Aquaculture (CIFA), Bhubaneshwar (Orissa) and many other institutes, are continuously engaged in the research and extension studies in the field of fisheries to make it more beneficial.

**By-Product of fishing industry :-**

**1. Isin glass :** It is a high grade collagen produced from air bladder or swim bladder of certain fishes like cat fishes & carps. The is in glass prepared in Russia is of best quality.

**2. Fish oil –**

– Dry oil is obtained from Salmon & Hersing.

– Semi dry oil from carps. Liver oil contains vitamin A, D, E & C.

**3. Fish meal –** It is prepared from wastes of fish oil. Wastes of cod industry is called "White fish meal". It contains Calcium (5.36%) phospholipeds (3.42%) and iodine. for younger animals it has proved to be a good nutritive diet.

**4. Fish protein :** Used in preparation of ice cream, pharmaceuticals, paints, varnishes, textile, paper and cosmetus.

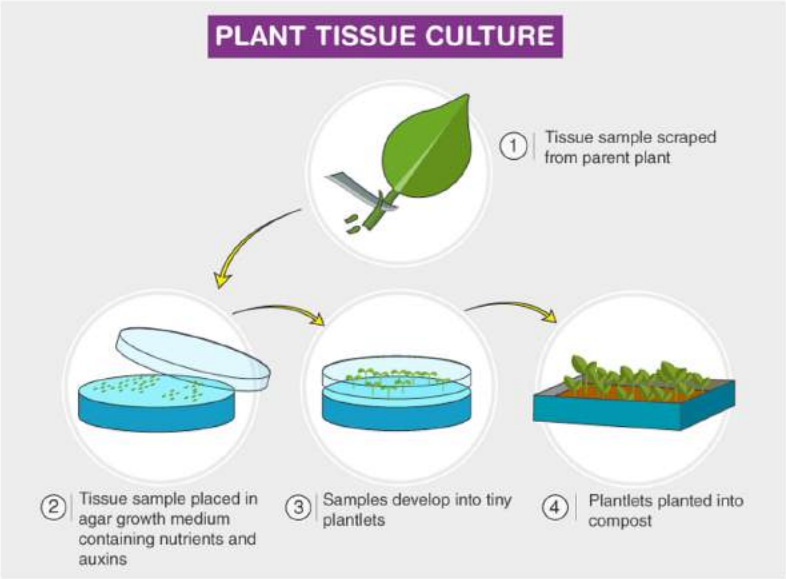
**5. Fish flour :-** It is highly nutritive food and prepared by solvent extraction process easily digested by infants of 3-4 months.

**6. Fish skin –** of some fishes like shark & rays are used for covering card cases, jewel boxes, scab-boards etc. The skin of cod salmon and other fishes are also tanned and converted into leather.

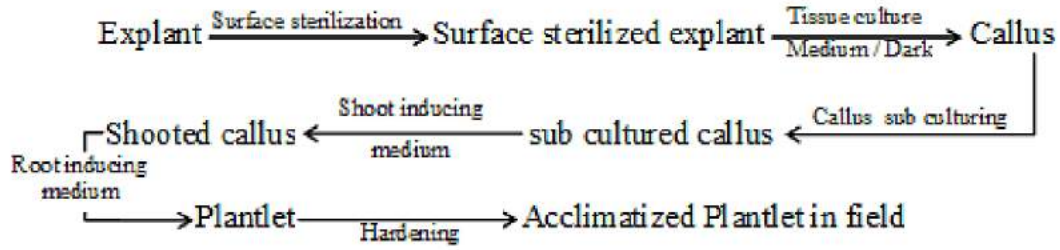
## Plant Tissue Culture

## PLANT TISSUE CULTURE

Tissue culture technique is based on totipotent nature of plant cell.




Plant tissue culture is the technique of maintaining and growing plant cells, tissues and organs in sterilized culture medium, under controlled aseptic conditions in vitro.




**Ex-plant :**

Plant part that is excised from its original location and used for initiating a culture. It may be root tip, shoot bud, anther, embryo, ovule etc. Normally undetermined cells of plant are used as explant.

**Surface Sterilization :**

The process of treatment of explant with specific antimicrobial chemicals like sodium hypochlorite, $H_2O_2$, $C_2H_5OH$, Mercuric chloride etc.

**Autoclaving :**

Sterilization of culture media, plastic ware and glass ware by moist heat (steam) at high pressure. It is performed at 120ºC for 15 psi pressure for 20 minute.

**Culture medium or nutrient medium :**

Medium, which provides nutrition to explants which is required for normal growth and development of explants.
Standard culture medium contains inorganic Salts, Vitamins, Sucrose (as a source of energy and carbon), growth regulators (2,4–D, Cytokinins, BAP-benzylaminopurine) Growth regulators are required for cell division and organogenesis in explant.

**Murashige and Skoog's culture medium is the most commonly used culture medium (MS medium).**

**Axenic culture :**

Culturing of cell under complete aseptic condition is known as Axenic culture.
**Callus :** Group of undifferentiated or dedifferentiated cells, which are produced through invitro culture.

**Types of Cultures –**

(1) Callus culture & suspension culture.
(2) Meristem culture
(3) Embryo culture
(4) Anther culture
(5) Protoplast culture

**(1) Callus & Suspension culture –**

**Callus culture –** In callus culture when an explant is placed on a agar containing medium. Many of the cells become meristematic and begin to divide and giving rise to callus in 2-3 week. The agar medium contain growth regulator like auxin 2, 4 –D and cytokinin like BAP.

**Suspension culture –**In case of suspension culture a single cell or small group of cells placed on liquid medium. The medium normally contains the auxin 2, 4-D. These cells divide and form small groups of cells.
The suspension cultures are continuously agitated to break the cell mass in to smaller clumps and single cells and also maintain uniform distribution of cells and cell clumps in the medium.
It also allows gaseous exchange.
Suspension cultures grow much faster than callus culture.

**With passage of time in a culture : -**

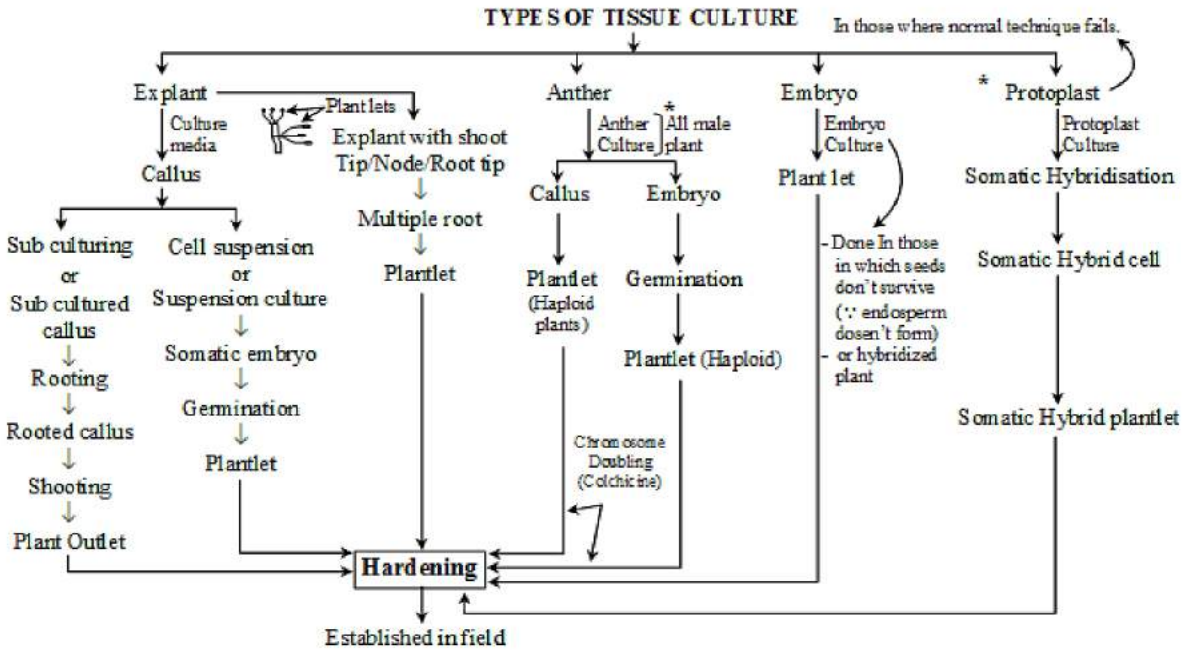
(a) Cell tissue dry matter (biomass) ↑
(b) The level of nutrients in the medium ↓
(c) The medium volume declines due to evaporation.
The process of transferring the cell culture into a fresh culture medium is called **Subculturing.** It is normally done after 4-6 week when callus develops to its maximum. During subculture only a part of the culture from a vessel is transferred into the new culture vessel.

**Haberlandt** was first one who grow isolated leaf cells in plant tissue culture medium.

**Totipotency : -** The ability of a plant cell to regenerate into complete plant.
The concept of totipotency was given by "Haberlandt" and practical applications of totipotency was demonstrated by **"Steward".**

**Steward** developed a complete carrot plant from a single cell obtained from root of wild carrot.
**Shoot and root formation :**

The regeneration of root and shoot is controlled by two types of growth regulators. The auxin **NAA (Naphthaline Acetic Acid)** promotes root regeneration whereas **cytokinins BAP** promotes shoot regeneration.
Callus is first kept on medium containing BAP, which initiates shoot formation from the callus.
When shoots become 2-3 cm. long, the culture is transferred to a medium containing auxin. Roots develop from the lower ends of these shoots and develop into young plant called plantlet.




**(2) Embryo culture :** Culturing of immature young embryo in in-vitro medium.
**Applications :-**

**Significance of Embryo Culture :**

(i) In some inter-specific crosses or distant hybridization the endosperm of developing hybrid seeds degenerate very early or not formed so young hybrid embryo which gets devoid of nutrition also dies. In such cases the young hybrid embryo is excised and cultured in vitro to obtain hybrid seedling.
(ii) Seeds of some plants like orchid lack stored food. In such cases embryo culture allows seedling development from the embryos. This method is also used for rapid clonal propagation in orchid.
(iii) In some species seeds may remains dormant due to inhibitors present in the endosperms/seed coat. Embryo culture in such cases allows embryo development by eliminating the inhibitors responsible for dormancy

(3) **Meristem Culture**

**Significance of Meristem Culture : -**

- Rapid clonal multiplication.
- Production of virus free plant.
- Conservation of germplasm.
- Production of transgenic plant.

(4) **Anther Culture**

**Significance of Anther Culture : -**

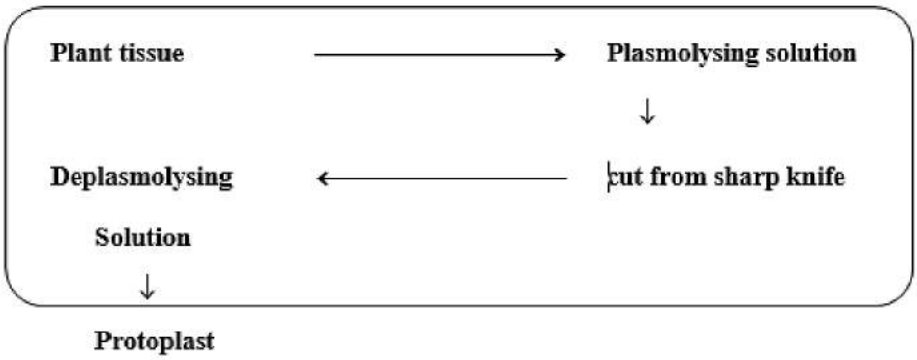
(i) They have single set of chromosome, so even a very small change or mutation can be detected in haploids.
(ii) These haploids are used to produce homozygous diploids (by **colchicine treatment**) and these homozygous diploids are used as parents in crossing.s
(iii) Use of haploids in producing pure lines has reduced the period required for developing new varieties from 10 years to 5 years.

(5) **Protoplast culture : -**

**Somatic hybrid :** A hybrid produced by fusion of somatic cells of two species or varieties.
The process of production of somatic hybrid is **somatic hybridization.**
**Protoplast :** Cell wall less plant cell is called protoplast.

**STEPS OF SOMATIC HYBRIDIZATION**

**(A) Removal of cell wall** → 2 method
(i) **Mechanical method** → Old method



**(ii) Enzymatic method** → New method
Discovered by-Cocking.
In this method cell wall is digested by using pectinase & cellulase enzyme.
**(B) Fusion between protoplast** → 2 methods
**(i) Spontaneous fusion : -**

- During enzymatic treatment some protoplast fused together and form multi-nucleated structure which is called homokaryons or homokaryocytes.
- This is a intraspecific fusion.
- Not very useful in study.

**(ii) Induced fusion : -**

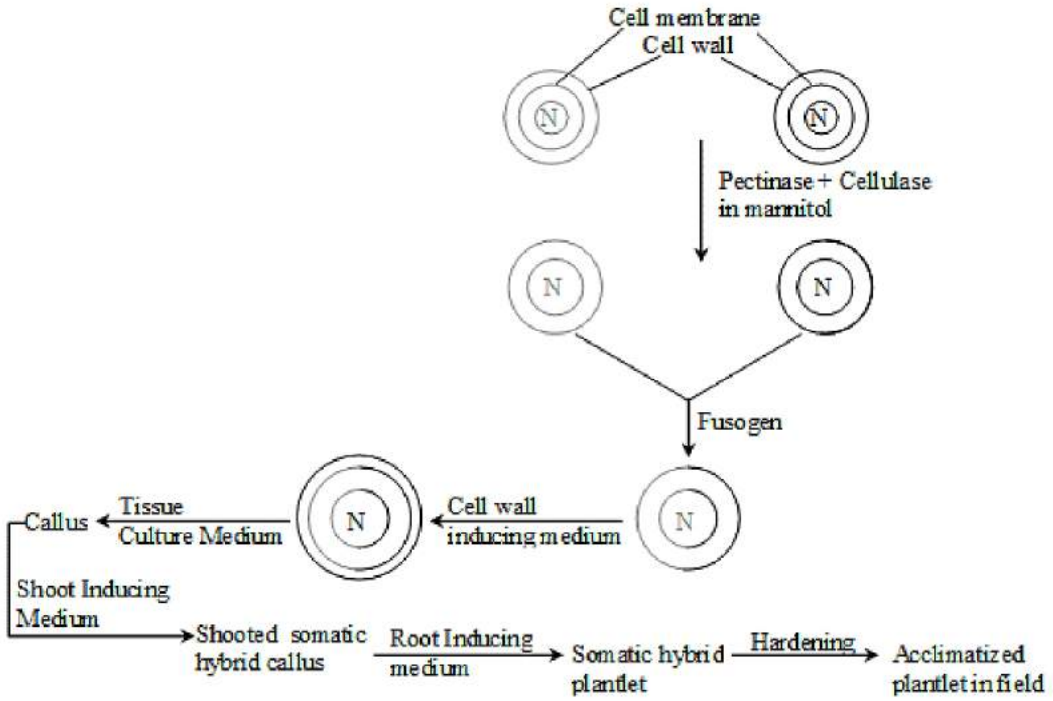
- Protoplast of two different species are fused together by induced fusion.
- Substance which induced the fusion of protoplast are called fusogen or fusogenic agent.

**Fusogenic substance and condition : -**

- By treatment of $NaNO_3$
- By treatment of $Ca^{+2}$ ions at high pH
- By treatment of polyethylene glycol [PEG]
- By high voltage electric shock

**Culture of the fused protoplast : -**

- Product of fused protoplast of two different species is called heterokaryon.
- Heterokaryons are mainly used in tissue culture.
- When the fused protoplasts are cultured on a suitable medium they regenerate cell wall and begin to divide ultimately to produce plantlets.




**Importance of somatic hybridization :**

**(i)** It allows the production of hybrids between different lines and species that can not be produced normally by sexual reproduction.
**Pomato** is a somatic hybrid between **potato** and **tomato.**
Bromato-**Brinjal & tomato**
**(ii) Use of somatic hybrid :**
For gene transfer.
Transfer of cytoplasm.
Production of useful allopolyploids.

**SPECIAL POINTS**

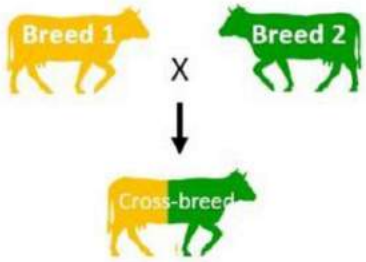
Somatic hybridization is also called **parasexual hybridization.**
First somatic hybrids were obtained between two species of tobacco ***Nicotiana gluca*** and ***N.langsdorfit*** by Carlson et. al.

**Inbreeding & Cross Breeding**

**ANIMAL BREEDING**

Animal breeding aims at improving the genotypes of animals to make them more useful to us.

## 2-way (simple) cross-breeding




The chief objectives of animal breeding may be summarized as follows :
**(i)** improved growth rate.
**(ii)** increased production of milk, meat, egg, wool, etc.
**(iii)** superior quality of resistance to various diseases.
**(vi)** increased or, at least, acceptable reproduction rate, etc.
**(v)** increased productive life, and
A variety of strategies have been used for breeding of animals. The main approaches for animal breeding, viz., inbreeding, out crossing and inter-specific hybridization, are briefly described below, based mainly on the breeding work with cattle.

**Inbreeding :-**

All domesticated animals have male and female individuals. As a result, they are strictly cross-fertilised, and highly heterozygous. Each domesticated animal species consists of several distinct breeds that differ from each other in several morphological and other features. You are familiar with the important breeds of cows, buffaloes, poultry, etc. Animals belonging to a single breed differ from each other in genotype because of the mode of their reproduction and their heterozygous nature. Therefore, mating between animals of the same breed provides opportunities for genetic improvement.
The breeding strategy based on inbreeding is as follows. Superior cows and superior bulls of the same breed are identified and mated in pairs. The progeny obtained from such mating are evaluated and **superior males** and females are identified for further mating. A **superior female**, in the case of cattle, is the cow that produces more milk or lactation. On the other hand, a superior male is that bull, which gives rise to superior progeny as compared to those of other males.

**Inbreeding, as a rule, increases homozygosity.**
**Advantage :**

Inbreeding exposes harmful recessive genes that are eliminated by selection. It also helps in a accumulation of superior genes and elimination of less desirable genes. Therefore, this approach increases the productivity of inbred population. Practically every breed was developed by some type of inbreeding

**Disadvantage :**

But continued inbreeding, especially close inbreeding, usually reduces fertility and even productivity(inbreeding depression). Whenever this becomes a problem the selected animals of the breeding population should be mated with such superior animals of the same breed that are unrelated to those in the breeding population.

**Cross-breeding :-**

In this strategy, superior males of one breed are mated with superior females of another breed. Cross-breeding allows the desirable qualities of two different breeds to be combined in a single breed. The progeny animals may themselves be used as hybrids for commercial production. Alternatively, they may be subjected to some form of inbreeding and selection to develop new stable breeds that may be superior to the existing breeds. Many new animal breeds have been developed by this approach.
Progeny produced through cross-breeding may be mated according to various schemes to achieve specific objectives. For example, cows of an inferior breed may be mated to bulls of a superior breed. In each successive generation, the progeny cows are mated to the bulls of the same superior breed that was used in the original cross. Thus, in 6-7 generations, the progeny will be almost similar to the breed of bulls used for the mating. But these progeny would retain some original advantageous conditions, etc., of the other breed from which the cows were used in the original mating.

**Interspecific Hybridization :-**

In this strategy, male and female animals of two different species are mated. The progeny obtained from such a mating are usually different from both the parental species. In some cases, the progeny may combine desirable features of both the parents, and may be of considerable economic value. An example of this type is mule, which is produced from a cross between female horse (mare) and male donkey. Mules are sturdier and hardier than their parental species, that are well suited for hard work in difficult terrains like mountainous regions.

**Insecticides & Pesticides**

## AGRICULTURAL CHEMICAL – PESTICIDES

**Pesticides –** Pesticides are those substances, which are used to kill, control or repel pest.


c

Pesticide Spray

**Pests –** Pests are the organisms (viz - disease causing microbes, insects, mites, nematodes and weeds) those cause harm to human interests by destroying the agricultural crop, stored plant products as well as bring about diseases in domestic animal and human beings. Pests cause loss in agricultural productivity up to about 30%.

## TYPES OF PESTICIDES :-

**(1) Algicide :-** Destroy algal pathogens & algal bloom ***e.g*** Y copper sulphate

**(2) Fungicide :-** Destroy fungal pathogen ***e.g –***

- Bordeaux mixture (It is first discovered fungicide)
- Burgandy mixture ($CuSO_4$+ $Na_2CO_3$+ water)
- Mercuric chloride
- First pesticide to be used commercially was bordeaux mixture ($CuSO_4$ + $Ca(OH)_2$+ $H_2O$). It was discovered by **Millardet (1822)**.

At the university of Bordeaux, **France**. The fungicide was named after the name of university.

**(3) Weedicide/Herbicide :-** They kill weeds in agriculture. ***e.g*** Y Triazines Y 2, 4–D, 2, 4, 5–T(Auxin derivatives).
**(4) Insecticide :-** They kill insects. ***e.g.*** Y DDT, Malathion, Aldrin.
**(5) Nematicide :-** They kill nematodes ***e.g.*** Y Chloropicrin, Methyl bromide.
**(6) Rodenticide :-** They kill rodents ***e.g.*** Y Warfarine, Zinc sulphate, Zinc phosphide(Used against field rats).

**Classification Of Pesticides On The Basis Of Chemical Structure:**

**(1) Organochlorines :-** They are chlorine containing hydrocarbons. Some important organochlorines are :-DDT, Aldrin, Dialdrin, Endosulphan, BHC.

- Organochlorines are **lipophilic** in nature ; hence show great affinity for the fatty tissues of animals. These are non-biodegradable. They decompose very slowly, therefore get accumulated in environment and posing serious problems.
- **DDT** (Dichloro-diphenyl trichloro ethane) is the most famous pesticide of the world. DDT was discovered by **Dr. Paul Muller**.

**DDT is banned for agricultural use in India in 1985.**

- **BHC** (Benzene hexa chloride) is the most commonly used pesticide in India
- **Aldrin –** It is added to building foundation to prevent termites.

**(2) Organophosphates :-** These are organic esters of mostly phosphoric acid and triphosphoric acid.
These are most toxic pesticides to vertebrates. ***e.g*** Y Malathion Y Parathion
* **Malathion** is one of the most widely used organophosphate
- It is an ingredient of **"Flit"**.

It is widely used in antimalarial programmes.

- Organophosphate acts on central nervous system. They inhibit normal functioning of enzyme cholinesterase.

**(3) Carbamates :-** These are salts of carbamic acid.($NH_2COOH$)

- Structurally, these pesticides are similar to acetylcholine and therefore they bind with the enzyme **acetylcholinesterase.** They also affect the nervous system ***e.g.*** Y Carbaryl Y Propoxur (Baygon)
- Carbamates are effective insecticides, but derivatives of carbamates are used as fungicides and herbicides Fungicides ® dithiocarbamates like diethane – M – 22 Herbicide - phenyl carbamates & thio carbamates
- Methyl isocyanate gas (MIC) is raw material for synthesizing carbaryl, which caused Bhopal gas tragedy on **3 Dec, 1984**.

**(4) Pyrethroids :-** These are synthetic derivatives of "pyrethrin" - a chemical extracted from floral heads of ***Chrysanthemum cinerarifolium*** and ***C. marschallii*** (family Asteraceae).

- Pyrethroids are largest group of insecticides of plant origin. Used commercially now a days.

**(5) Triazines :-** This group of pesticides is derived from urea. eg. Atrazine, Simazine

- These are commonly used herbicides for controlling weeds in tobacco, tea and cotton plant

**(6) Auxin derivative :-** 2, 4 – D, 2, 4, 5 – T, Delapon, TCA (Trichloroacetic acid) etc. are used as a selective herbicide or weedicide **Mode of action of pesticides :-**

- Most of the herbicides have affect on photosystem-II of photosynthesis (disturbing the photolysis of water and oxygen evolution). Some herbicides block sieve tube thus disturb translocation of organic food.
- Most of the insecticides kill insects by affecting their nervous system. Some insecticides arrest the respiratory system and kill the insects.

**Advantages of pesticides:**

- Increase in yield of food and other crop plants.
- Pesticides control vectors or carriers of different disease causing organisms.

**Harmful effects(hazards) of pesticides :-**

**(1) Environmental pollution :-** As pesticides are non selective in their mode of action, so these also kill useful organisms along with harmful organisms thus equilibrium state of ecosystem is disturbed.

**(2)** As pesticides are poisonous or toxic, so cause serious health hazards.

**(3)** Excessive and prolonged use of pesticides lead to resistance in pest. Hence more money is to be spent in controlling to these resistant pest, this effect is called**"Pesticide treadmill"**

**(4)** Due to their non biodegradable nature, their concentration increases in the body of organisms with the rise in trophic level is called **biomagnification** or **bioconcentration.**

- Most organochlorines are fat soluble and undergo biomagnification.
- In India as a result of prolonged use of DDT, 13 – 31 ppm of DDT can be detected in the body fat of people of India (highest in the world).

- **Development of resistance to pesticides** :- When pesticides are sprayed, some pest individuals having :-

**(i)** Less permeable cuticle

**(ii)** Capability of faster storage of toxin in fat.

**(iii)** Better enzyme equipment for metabolising the toxin.

- So due to above reasons pest individuals develop resistance to pesticide

**Biological pest control :- biopesticide**

- Biopesticides are pesticides of biological origin. The living organisms used to destroy the undesirable organisms are know as biopesticides. They are of two types:

(1) Bioherbicides
(2) Bioinsecticides.

**(1) Bioherbicides :-**The first bioherbicide was **"Devine"** is a mycoherbicide. Devine is based on a fungus ***Phytophthora palmivora.***

- It is being used since 1981 to control ***Morrenia odorata***(milkweed vine) in **Citrus orchards.**
- Similarly "Collego" is an another mycoherbicide and is based on fungus Colletotrichum gloeosporioides.
- Prickly pear cactus (Opuntia) in Australia and India was effectively controlled by Cactoblastis cactorum (Cochineal insect).
- Eichhornoa crassipes has been successfully controlled in Florida (USA) with the application of a fungus Cercospora rodmanii.
- Smoother crop :- The crop which does not allow weeds to grow eg. sunflower, soyabean, barley, rye, sorghum.

**(2) Bioinsecticides :–**

**(I) Use of parasite, predators and pathogens**

- Control of aphid by use of praying mantis or lady bug.
- Insect affecting maize, cotton, cabbage, sunflowers etc are controlled by mutant strains of Bacillus thuringiensis bacteria.
- The bacterium, Bacillus thuringiensis produce protein toxin. eg. Thurioside Cry - protein.
- Thurioside is active against different group of insects.
- Sporeine :- First commercial bioinsecticide, developed in Germany.
- Sporeine kill, the insect by inhibiting ion transport in the midgut.
- Mosquito larvae can be easily controlled by fish Gambusia.

**(II) Sterilization technique :-** This is the modern method of biological pest control, In this technique male insects are sterilized with the help of radiations and these sterile male are released at the time of mating and hence their multiplication is checked. e.g. "Screw worm" and " Red weavil" was eradicated by this technique by Kipling.

**(III) Use of insect hormones (Sex attractants) :-** The insect hormones are called pheromones and these are useful in controlling insects. synthetic pheromones are used in different ways :-

**(a) Pheromone trap :-** Hollow cylinders coated inside with sticky substance and synthetic sex pheromones of the insect are kept at different places in the infected fields. The male of insect fly is trapped and get immobilized. Male insects are not available for reproduction, so that their population is controlled. Gypsy moth has been controlled by this method.

**(b) Confusion technique :-**

- In this technique large amount of hydrophobic papers containing the sex attractant are dropped over a cropped area.
- The male insects get confused and fail to locate their female. Thus population is checked.

**(c) Juvenile hormone and the moulting hormone (ecdysone) :-**

- These hormone are needed for proper metamorphosis of young ones to the adult insect.
- Use of juvenile hormones at inappropriate times results in the early death of insects pests

**(IV) Natural insecticide :-** These are insecticide of biological origin.

- They are generally obtained from plant and some times from microbes.
  (a) Rotenones :- Obtained from roots of Derris eliptica. Insecticidal properties of rotenones were first discovered by Chinese.
  (b) Nicotine :- Obtained from Nicotiana tobacum (Tobacco) leaves.
  (c) Pyrethroids :- (Pyrathrum & Cinerin).
- Obtained from "Chrysanthemum cinerarifolium".
  (d) Azadirachtin :- It is an antifeedant compound extracted from neem (Azadiracta indica) spray of neem extract repel Japanese beetles and leaf eating pests.
  (e) Thurioside :- Obtained from a bacterium "Bacillus thuringiensis".
- Thurioside is the microbial insecticide

**INTEGRATED PEST MANAGEMENT (IPM)**

- It is technique of pest control, which involves natural methods to a greater extent.
- IPM involves use of different pest control method, which are ecologically sound i.e. do not cause hazards to environment. e.g – biological control method, better agricultural practices like- crop rotation, sanitation etc., use of resistant varieties.

## Hybridization

## NEW AND UNDER-UTILIZED CROPS

- Out of 3, 50, 000 known plants at this time, a few i.e about 100 plants are being used for fulfilling man's daily requirement.
- Scientists are in search of less known and under-utilized crop plants, which can be used for food and other purposes. Such under-utilized and under-exploited plants are known as new crops.

**(1) *Triticale* (Muntzing) :-** It is the first man made cereal or crop.

- Triticale is not suitable for purpose of bread making due to low gluten content, but it is a good forage crop.

Triticale (Muntzing)

**(2) Winged bean :- (*Psophocarpus tetragonoloba*)**

- This is a herbaceous plant, which has capacity of nitrogen fixation.
- The ripe seeds contain about 34% proteins and 13% oils (similar to soyabean).

**(3) Jojoba = (*Simmondsia chinensis*) :-**

- This is a shrub, which is native of Mexican deserts. It is important drought desert plant and hence is being grown in deserts.
- The seeds of this plant contain about **50% liquid wax,** which is similar to sperm whale oil (spermaceti).
- This liquid wax was originally used in cosmetics, but now is also being used in high-performance lubricants required to withstand extreme pressures.
- So growing of this plant, can reduce the pressure on sperm whales, which are killed for their oil.

- ***Jojoba*** can thrive under poor soil and low moisture conditions. Its cultivation in arid regions of the world help in economic development of the poor.

**(4) Guayule = (*Parthenium argentatum*) :-**

- This plant commonly known as "Congress grass". It is a terrestrial weed in India.
- This plant is now a days used in obtaining rubber, which is called **"Guayule rubber"**.
- Guayule rubber is similar to **Para rubber** or **hevea rubber.**
- The plant contains 12-20% rubber on dry weight basis.
- This plant can be a natural source of rubber in future.

**(5) *Leucaena* or Subabul :-**

- ***Leucaena leucocephala*** (fam.leguminosae)
- This plant is nowadays being planted on a large scale under **"social forestry".**
- This plant is used as "wind breaks, fire break, shade plant for deforested tropical regions.

**(3) Plant introduction –**

- **This is the most rapid method of crop improvement.**
- The process of introducing plants with specific characters from one area to a new and changed climatic condition is called**"Plant introduction"**.
- If plants are brought from foreign country, it is called **exotic collection(EC)**
- If plants are brought from same country then it is called "**indigenous collection**"(IC).
- **Primary introduction :-** If introduced plants may be used directly for cultivation, it is called primary introduction.
- **Secondary introduction** :- If introduced plants may be used after subjecting to selection/hybridization, it is called secondary introduction.
- **Acclimatization :-** It means adaptation of introduced or transferred plant in the changed or new climatic conditions is called acclimatization.
- Introduced plant material are subjected to "Quarantine laws/plant protection inspection. To check the entry of pathogen (All the introduced plant materials is thoroughly inspected for contamination with weeds, diseases and insect pest)
- If the plant material is found suitable, phytosanitary certificates are issued and only then the plant material is introduced in our country.
- Uncontrolled plant introduction in the past are responsible for introduction of hazardous diseases like late blight of potato, leaf rust of coffee, fire blight of apple, bunchy top of banana etc.

- Many weeds like *Argemone maxicana, Eichornia crassipes* and *Parthenium argentatum* etc introduced in our country due to uncontrolled plant introduction.
- New plants like potato, groundnut, coffee, rubber, guava, grapes, papaya, litchi, gulmohar, bougainvillea etc are the result of plant introduction.
- Wheat variety "**Ridley**" was introduced in India from Australia
- Many improved varieties of different crop plants are also outcome of these introduction e.g **Sonora-64** varieties of wheat, Palmetto varieties of soyabeans, Kent variety in Oat, Bonneville var. in Pea, Taichung native 1(TN1) of rice etc.

| Important crop | Centre of Origin / Primary home | Centres of Production / Secondary home |
|---|---|---|
| (1) Cocoa | Brazil | Africa |
| (2) Coffee | Ethiopia | Brazil & Central America |
| (3) Maize | Mexico and Central America | Mid West USA |
| (4) Pineapple | Brazil | Hawaii |
| (5) Monterey pine | California | Australia |
| (6) Potato | Peru | Eastern Europe |
| (7) Wheat | Central Asia | North America |
| (8) Rubber | Brazil | Malaysia, Indonesia |
| (9) Oil palm | Tropical Africa | Malaysia |
| (10) Ground nut | Peru, Brazil | India |

(4) Hybridization – Mating between two or more individuals or lines, which are different in genotype.

- Hybridization is the most common method for creation of genetic variations.

Lines – A group of individuals related by descent and often similar in genotype.
Hybridization takes place between two different lines.

- The plants, which are crossed together may belong to the same species, or different species or different genera.
- Hybridization is divided in following categories

(1) Intra-varietal hybridization :- The cross between the plants of same variety
(2) Inter-varietal hybridization :-

- The cross is made between the plant belonging to two different varieties of same species (also known as intra-specific hybridization)

(3) Inter-specific hybridization :- The plants or two different species belonging to the same genus are crossed together.

Ex. All present cultivated varieties of sugar cane.

(4) Inter-generic hybridization :- The crosses are made between the plant belonging to two different genera. e.g. Triticale, Raphanobrassica, Rabbage are the example of intergeneric cross.

- First natural hybridization was reported in corn (maize) by Cotton Mather
- First artificial hybrid was obtained by crossing Sweet william and carnation by Thomos Fairchild(1717) and was known as Fairchild's Mule
- Hybridization was first of all practically utilized in crop improvement by kolreuter(1760)
- Hybridization or crossing leads to hybrid vigour or heterosis, which is defined as superiority of hybrid over it's parents
- The term heterosis was given by G.H.Shull in 1914.
- Hybrid vigour is due to heterozygosity
- Heterosis is lost by inbreeding
- Vegetatively reproducing plants are most suited for maintaining hybrid vigour because once a desired hybrid has been obtained, there are very few chances of losing it.

The main steps of hybridization are:

(a) Selection of parents

(b) Selfing of parents to induce homozygosity

(c) Emasculation i.e removal of anthers or male reproductive part from flower before maturity

(d) Bagging :- Female flowers are covered with bags, so that no undesirable pollen may fall on stigma.

(e) Crossing of desired & selected plants.

- Thus 2-main aspects of hybridization are :-
  (i) To combine characters of two plants in to one
  (ii) To utilize hybrid vigour Inbreeding – When two individuals of a species, which have common ancestory are mated together. Most extreme form of inbreeding is self pollination.

Inbreeding depression – Loss of vigour due to inbreeding.

- Cross pollinated species shows inbreeding depression, but self pollinated species do not show inbreeding depression.
- Plants of cross pollinated species are highly heterozygous, therefore they contain recessive alleles of most of the genes in heterozygous state.
- When these are subjected to inbreeding there is in homozygosity and many recessive harmful alleles also become homozygous.
- While in self pollinated crops alleles, become rapidly homozygous & then harmful alleles are removed by selection. So here inbreeding depression does not occurs.

(5) Polyploidy –

- The organism (plant) which contains more than two complete sets of chromosomes is called polyploid.
- Depending upon number of chromosomal sets, the individuals are given different names-monoploid, diploid, triploids, tetraploids pentaploids and hexaploid (eg- wheat)
- Polyploids are characterized by gigantism.
- These polyploids are used in crop improvement.
- Triploids are present naturally in different crop plants and generally triploid crop plants are seedless.
- Most of the varieties of banana are triploids, so their fruit are seedless.
- In sexually reproducing organism polyploidy is induced, as a result of fusion of egg with more than one male gametes.

- Polyploidy can be used artificially by Colchicine treatment.
- Colchicine is an alkaloid obtained from Colchicum autumnale(fam. Liliaceae)
- In some plants triploids are having much vigour and increased fruit size e.g: apple & pear.

(6) Mutation breeding – Plant breeding –It is the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.

- Plant breeding may be defined as "the branch which deals with improvement in heredity of crops and production of new varieties, which are superior to earlier ones in all respects.

Improvement may be in following respects :-

(i) Increase in yield of seed, fibre oil etc.

(ii) Resistance to disease, insects, pests, drought, frost & cold etc.

(iii) Adaptability to wider range of conditions etc.

(iv) Earliness or lateness in maturity period or change in maturity behaviour.

Important plant breeders :-

(i) N.E. Borlaug :- Famous Mexican plant breeder, who was awarded Nobel peace or prize (1970) for developing high yielding dwarf wheat varieties like Sonora-64 and Lerma rojo-64 etc. He is known as "Father or green revolution".

(ii) Dr. M.S. Swaminathan :- He is pioneer in mutation breeding. He has produced Sharbati sonora variety of wheat by mutation, which is responsible for green revolution in India. He is known as"Father of green revolution in India"

- Crop improvement means combining all the good characters in a single plant and multiplying them. The main aim of the plant breeder is to produce new superior crop varieties.

Mutation breeding – Use of induced mutations in plant breeding to develop improved varieties. Induced mutations are useful in specific situations, when the desired alleles are absent in the germplasm.

- Many important varieties in different crop plants have been produced by mutation breeding
- In wheat : Sharbati sonora and pusa lerma are two important varieties of wheat produced by gamma rays treatment of sonora-64 and lerma rojo (Mexican dwarf wheat varieties)
- Sharbati-sonora is amber grain coloured variety of wheat produced by Dr. M.S. Swaminathan and is responsible for green revolution in India.
- In rice : About 45 varieties up to 1992 have been produced by mutation breeding eg Remei & Atomita-2.
- In barley : Erectoids and erectiferum.
- In Castor : World famous variety Aruna has been produced in which life span has been reduced from 270 days to 102 days and also having high oil content and disease resistance.
- Penicillin production has been increased enormously by UV-rays treatment of Penicillium notatum & P. chrysogenum.

In mung bean, resistance to yellow mosaic virus and powdery mildew were induced by mutations.

Mutation breeding has some important limitations as :

(i) Most of the mutations are recessive.

(ii) Mutation rate is extremely low.

(iii) Most of the induced mutation are invaluable to the breeders and many of them are lethal.

(iv) Stability of mutant is sometimes doubtful, as some mutants have tendency to revert back to original type.

Breeding for nutritional quality –

- A crop product should provide the optimum nutrition to human and does not contain any anti-nutritional factor.

Anti-nutritional factors – Compounds that have harmful effects on animal's/human's growth & development.

Eg. Glucosinolates (present in oils and cakes of rapeseed and musturd), β–N oxalyl aminoalanine (BOAA) neurotoxin found in khesari dal (Lathyrus sativus).

- Cereals & millet proteins are deficient in lysine and tryptophan amino acid. (eg. Maize)
- Pulses are deficient in sulphur containing amino acid (i.e. cysteine & methionine).
- Three varieties of maize have been developed in India which are lysine–rich. Shakti, Rattan, Protina.
- Breeding is also useful to develop disease resistance in plants.

**(1) Breeding for disease resistance:**

| Crop | Variety | Resistance to diseases |
|---|---|---|
| Wheat | Himgiri | Leaf and stripe rust, hill bunt |
| Brassica | Pusa swarnim (Karan rai) | white rust |
| Cauliflower | Pusa shubhra, Pusa snowball K-1 | Black rot and curl blight black rot |
| Cowpea | Pusa Komal | Bacterial blight |
| Chilli | Pusa sadabahar | Chilly mosaic virus, tobacco mosaic virus and leaf curl |

(2) Plant breeding for developing resistance to insect pests –

| Crop | Variety | Insect Pests |
|---|---|---|
| Brassica | Pusa Gaurav (rapeseed mustard) | Aphids |
| Flat bean | Pusa Sem 2, Pusa Sem 3 | Jassids, aphids and fruit borer |
| Okra (Bindi) | Pusa Sawani Pusa A-4 | Shoot and fruit borer |

**(B) Selection –**

- This is the most primitive and simplest method for crop improvement.
- This is practised in crop improvement and it is selection of phenotypically superior plants from a mixed population.
- Selection acts on genetic variation, present in a population and produces a new population with improved characters.

Selection is of 3 types – (a) Pure line selection (b) Mass selection (c) Clonal selection

**(a) Pure line selection :-** The progeny of a single self pollinated homozygous plant is called pure line (term by Johanson) and these pure lines are used in selection method of crop improvement, which is called pure line selection

- Pure line selection is method of improvement in self pollinated plants (wheat) In this method a number of phenotypically superior plants are selected, these are harvested separately and their produce is maintained separately.
- The seeds so obtained from different plants are sown separately and selection is made for 4 or 5 generations till the desired improvement is achieved. About 10 years time is needed to develop a new variety by this method

**(b) Mass selection :-**

- This is practised in self & cross pollinated crops plants but more useful for self pollinated crops.
- The first step involves selecting plants having desirable character from a given population of plants based on phenotypic characters.
- The seeds of selected plants are then mixed and sown the same field (mixed cropping) to allow natural cross pollination.
- The plants are selected from this field by eliminating the undesirable ones and saving the best.
- It is done for 5 to 6 generations or more then desired improvement can be achieved.
- It takes about 8 yrs. time to develop a new variety by mass selection.

**(c) Clonal selection :-**

- This type of selection is applicable to vegetatively propagated plants eg. sugarcane, banana, potato.
- Clone :- Progeny of a single vegetatively propagated plant is called clone.
- Here selection is made between the clones and not within the clone Limitation of clonal selection :- (1) Only applicable for vegetatively propagated crops (2) Creates no new variation

**(C) Evaluation & Release of varieties –**

- A newly developed pure line, improved population or hybrid undergoes critical evaluation for yield, quality, disease and insect resistance and for other traits. In India, Indian Council of Agricultural Research, New Delhi (ICAR – New Delhi) carries out the evaluations.
- Ultimately a new pure line, population or hybrid that is superior to the existing varieties as well as to other new material may be released as new variety.

**Biofertilizers & Development of New Varieties**

**BIOFERTILIZERS**

- Fertilizers are used to increase soil fertility. Total consumption of chemical fertilizers in India is about 9.2 million tonnes.
- Nitrogen, phosphorus and potassium are primary nutrients or critical nutrients.
- Among the seventeen essential plant nutrients N, P, K are deficient in Indian soil.
- Fertilizers, which contain only one primary nutrient are called straight fertilizers or simple fertilizers.
- Fertilizers, which contain two or more primary nutrients are called compound or multi-nutrient fertilizers.

- Use of chemical fertilizers increase food production, but side by side there are many hazardous effect of these chemical substances on environment and organisms.
- Chemical fertilizers are highly expensive.
- So use of fertilizers of biological origin is an alternative for overcoming the harmful effects of these chemical fertilizers. Fertilizers of biological origin, they are two types :-(a) Manures (b) Bio-fertilizers

**(a) Manures :-**

- Manure is semi-decayed organic matter, which is added to the soil in order to increase soil fertility, aeration and water holding capacity.

**Organic Manure**

Three types of manures

(i) Farmyard manure :-

- This type of manure consists of cattle dung, farm refuse, fallen leaves and twigs. These materials are placed in heaps and allowed to decompose till they form a dark amorphous substance e.g. Y Product of gobar gas plant.

(ii) Composited manure (Compost) :-

- This manure consists of rotten vegetable matter, sewage sludge and animal refuse. Some chemical fertilizers are added in small amount.

(iii) Green manure :-

- These are fast growing herbacious crops, which are ploughed down and mixed with the soil while still green.

These provide both organic matter and nitrogen to the soil.

- The green manure check "soil erosion" by forming protective soil cover and also prevent "leaching" of minerals.
- Green manures increase crop yield by 30 – 50%.

- Some important green manure crops, which are mostly members of family leguminosae are as follows:

**Biofertilizers :-** These are the organisms like bacteria, blue green algae and fungi (mycorrhiza) which enrich the soil in nutrients. Some important bio-fertilizers are :-

| BOTANICAL NAME | COMMON NAME |
|---|---|
| (i) Crotolaria juncea | Sun–hemp |
| (ii) Sesbania aculeata | Dhaincha |
| (iii) Vigna sinensis | Cow pea |
| (iv) Trifolium alexandrinum | Berseem |
| (v) Lens esculenta | Lentil (Masur) |
| (vi) Cyamopsis tetragonoloba | Cluster bean |
| (vii) Melilotus parviflora | Senji |
| (viii) Sesbania rostrata :- In this plant both stem nodules and root nodules are found. It is used as a bio-fertilizer crop. | |

**(1) Bacteria as bio-fertilizers :-(a) Symbiotic nitrogen fixing bacteria :-**

- ***"Rhizobium leguminosarum"***
- **Frenkia,** a nitrogen fixing filamentous bacterium is associated symbiotically with the root nodules of non-legume plants like **Casurina, Rubus,** ***Alnus myrica*****.**

**(b) Free-living nitrogen fixing bacteria :-**

- ***Azotobacter, Clostridium, Beijerinckia, Bacillus polymixa.***

**(c) Loose association of nitrogen fixing bacteria :-**

- A bacterium ***"Azospirillum lipoferum"*** forms loose association with roots of maize and some Brazilian grasses, which increase crop yield**(Dobriner).**

**(2) Blue green algae (Cyanobacteria) as bio-fertilizers** :-

**(a) Free living nitrogen fixing BGA :-**

- Blue green algae like ***Anabaena, Aulosira, Tolypothrix, Plectonema*** are most common nitrogen fixing organism.
- ***"Aulosira fertilissima"*** is the most effective nitrogen fixer of rice fields.

**(b) Symbiotic nitrogen fixing cyanobacteria** :

- *"Azolla pinnata"* is a small aquatic fern inoculated to rice fields of South-East Asian countries. It's leaf cavities contain symbiotic **BGA-*Anabaena azollae.***
- ***A. pinnata*** is best bio-fertilizer for rice. Farmers have reported upto 50% - higher yield of rice by using **A.pinnata.**

**(3) Fungi as biofertilizer :-**
**(i) Mycorrhiza :-** Symbiotic association between roots of higher plants and fungal hypae is called mycorrhiza.

## GENETIC IMPROVEMENT

**Trait :** Trait or character is any morphological, anatomical, biochemical or behavioural feature of an organism.
**Variety :** A group of plant that has the almost same genotype, but it differs for one or more characters from other varieties of the same crop.
An improved variety is superior to the other existing varieties of the same crop in one or more characters.

## DEVELOPMENT OF NEW VARIETIES:

The 4 main steps in variety development are –
**(A)** Creation of variation
**(B)** Selection
**(C)** Evaluation
**(D)** Seed multiplication & distribution.
**(A) Creation of variation :-** Difference among individuals of a population or species for a given character is known as variation.
Variations are of 2 types –
**(i) Genetic variations :-** Differences in genotype of individuals.
- These are created by recombination of new alleles of different genes present in a crop.
- These are heritable variations.
- These are useful for selection.

**(ii) Variation due to environment :-**
- Aries due to environment.
- Not inheritable.
- Not useful for selection.

A species can be improved only when genetic variations are present. For the species success of breeding programme depends on creation of desired variation.
Genetic variation can be created by following methods –

(1) Domestication
(2) Germplasm collection & conservation
(3) Plant introduction
(4) Hybridisation
(5) Polyploidy
(6) Mutational breeding
(7) Genetic engineering

**(1) Domestication :-** All the present species of cultivated plants are of wild type species in origin and the process of cultivation of wild species in order to fulfill human need is called domestication of plant.

- Genetic diversity is the occurrence of large number of varieties, biotypes, variations and alleles.
- Greatest genetic diversity of plants is found in their natural home lands.
- Germplasm collections are made mostly from an area, where agriculture is still primitive, and where relatives of crop plants still live in wild areas like Peru, Bolivia, Middle east etc.
- **Vavilov (1926)** proposed that different crop plants originated in different areas, where their wild relatives are present and genetic diversity is maximum.
- **Vavilov** proposed 11 centers of origin. Australia is the 12th center. He collected 26,000 varieties of wheat.
- Cotton has developed in both old and new world.
- New world was discovered by **Christopher Columbus** in 1492, when he landed on island of Bahmas in Caribbean sea.

The original homeland of some important crops are listed below :-

| CENTER OF ORIGIN | MAJOR CROP |
|---|---|
| 1. Peruvian andes | Potato, Tomato |
| 2. Brazil | Pine apple & Rubber |
| 3. USA | Sun flower |
| 4. Mexico and Central America | Maize |

| CENTER OF ORIGIN | MAJOR CROP |
|---|---|
| OLD WORLD | |
| (5) Asia minor/Afghanistan | Almond, Apple, Pear, Lentil, Rye, Pomegranate |
| (6) Ethiopia | Barley, Sorghum, Coffee |
| (7) Mediterranean sea | Cabbage, Beet, Lettuce, Oat, Olive |

| | |
|---|---|
| (8) China | Soyabean, Tea, Onion |
| (9) South West Asia | Wheat |
| (10) Central asia | Rice, Banana, Mango, Orange, Black pepper, Brinjal, Pigeon pea, Sugar cane |
| (11) European Siberia | Cherry |

- Natural home : It is the centre of origin of a crop, which often abounds in its wild relatives and has maximum genetic diversity.
- Secondary home :- It is the major centre of production of a crop plant, which is away from centre of origin and lacks wild relatives.
- Wild relatives :- Species related to cultivated plants that occur in the wild areas of their origin.

(2) Germplasm collection & conservation :-Germplasm is the sum total of all the alleles of the genes present in a cell of a crop and its related species.
The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called germplasm collection.
It consists of –
(i) Cultivated improved varieties.
(ii) Improved varieties that are no more cultivated.
(iii) Old local or desi varieties.
(iv) Varieties produced by plant breeders (undistributed).
(v) Wild species related to the crop species.

- The sum total of different types of all the genes and their alleles present in a population is called gene pool.
- The gene pool of a population is not static.
- Genetic erosion – The loss of genes from a gene pool is called genetic erosion.
- Genetic erosion occurs due to deforestation, urban expansion, damage to ecosystem and adoption of genetically uniform modern variety of crops.
- 11 million hectares of tropical forest disappear every year.
- There are four basic way to conserve plant germplasm.
  (i) Conservation of plant in wild state i.e. in natural habitat like forests.
  (ii) Conservation of plants in botanical gardens.
  (iii) Introduction of plants for cultivation in agriculture and horticulture.
  (iv) Preservation of plants in seed form or some other suitable form.

**In–situ conservation** – It means maintenance of biological diversity in natural habitats like forests and natural reserve like national parks, wildlife sanctuaries and bio–sphere reserves. In-situ conservation of wild plants help in protecting species threatened with extinction.
**Ex–situ conservation –** It is the conservation of selected or rare plant in a place outside the natural home.

In this conservation rare or selected plant material are grown in specific gardens. eg. Ginkgo biloba is so common in United states, because the cultivation of this plant is taken up by gardeners.

- Ex–situ conservation includes offsite collections and gene bank.
  (a) Offsite collection :- They are living collections of wild and domesticated species in botanical garden, zoo etc.
  (b) Gene bank :- For plant breeding purpose (i.e. for improvement to plants) a large number of varieties with different characters are needed. Hence number of plant germplasm (both wild and cultivated) are collected and stored at suitable place.
- The place or institution, where different plant material (genes) are kept or preserved, is called "Gene bank".
- In gene bank, storage of germplasm is done either in the form of seed or vegetative material, but best and convenient way is storage of seed.
- Seed means, plant part that is used to grow a crop. Thus 'seed' would include grains of wheat, rice, tubers of potato, stem of sugarcane, which are used for producing new plants.
- Storage of dry seeds is done at low temperature (–10 to –20°C), because under these conditions the metabolic activities are minimum, prevent their germination.

**Seeds are of two types** –

(a) Orthodox seed :- The seeds which can not be killed or damaged as a result of decrease in moisture content & temperature. e.g seeds of wheat, rice, maize, oat, barley(Cereals) and also different pulses or legumes.
(b) Recalcitrant seeds :- The seeds which can be killed or damaged as a result of drying and decrease in temperature.
These can be stored for a short span. e.g seeds of rubber, tea, coconut, Jack fruit(Artocarpus) litchi, oil palm(elaies) etc.

- Conservation of crop with recalcitrant seed, can be made by in-situ conservation method and also by tissue culture method.
- Plants with recalcitrant seed are grown in orchard, where all possible strains and varieties are maintained.
- Storage of germplasm by tissue culture :- The tissue culture technique for storage of germplasm is used in case where :-
  (a) No seeds are produced (banana, sugarcane)
  (b) Nonviable seeds
  (c) Crop with recalcitrant seeds
  (d) Specific clone is to be maintained
- Best method of tissue culture for germplasm storage is "Shoot tip culture".

- Shoot tip culture rapidly becoming preferred material for international exchange of germplasm as they are more stable, easier to regenerate in to, whole plants and produce virus free clonal plants.
- Now a days germplasm of potato, Cassava and banana are exchanged by this methods.
- The main advantage of tissue culture storage of germplasm are :-
  (a) Economical
  (b) Requires small area for storage of many genotype
  (c) Can be used for multiplication of rare and endangered species.

**Significance of germplasm of wild species –**

- It is very important to conserve wild species of plant as these are highly resistant to insects, pests, disease and unfavourable growth conditions, which are necessary for survival of plants.
- The loss of wild plants, will reduce the genetic variability and will be a great loss to gene pool.
- Potato and sugarcane has been improved by use of germplasm of wild species having many defensive characters like disease resistance and resistance to environmental stress.
- In potato (Solanum tuberosum), gene for resistance to potato virus–X and potato leaf roll virus have been obtained from a wild species "Solanum acaule".
- Resistance to wilt fungus (Fusarium) and cyst nematode (Globodera) has been introduced from "Solanum spegazzini".
- Potato got resistant gene to potato virus - Y from a wild relatives "Solanum stoloniferum".
- Resistance to late blight of potato (Caused by fungus Phytophthora infestans) has been derieved from "S.demissum".
- Similarly, sugarcane(Saccharum officinarum) got resistance to red rot of sugarcane and adverse environment from a wild species "Saccharum spontaneum".

**Cryopreservation :-** Preservation of germplasm at ultra low temperature about – 196° C(liquid nitrogen) is called cryopreservation.

International efforts for utilization of crop-germplasm :-

- Cereals (rice, wheat, maize, rye, sorghum, bajra etc) are the main sources of food for human population in the world and rice alone constitutes staple food of more than 50% world's population.

**Improvement in rice :-**

- Dwarfing gene "dee-geo-woo-gen" was noticed in Taiwan.
- This gene produced many improved varieties in rice

- This gene was picked up by IRRI (International Rice Research Institute) Manila (Philipines) and incorporated to produce high yielding early maturing IR-8 and IR-24 varieties.
- Gurdev S. Khush and his team crossed 13 varieties of rice from six countries and wild rice Oryza nivara (from India) to develop IR-36 variety of rice.
- IR-36 variety of rice is resistant of grassy stunt virus.
- IR-36 is the high yielding variety of rice and has solved major food problem in Asia.
- Prior to green revolution a dwarfing gene of wheat named norin-10 , was noted in Japan and picked up by American plant breeder.
- Dr.N.Borlaug(Mexican wheat breeder) develop many dwarf wheat varieties like Sonora-64 and Lerma rojo-64
- N.Borlaug got Nobel prize for peace in 1970
- In 1963 two Mexican wheat varieties viz. Sonora-64 & Lerma rojo-64 and a Japanese variety Norin-10 were introduced in India, but these varieties could not adopt to Indian conditions, they were subjected to mutations and selections at Indian Agricultural Research Institute at New Delhi under the direction of Dr. M.S Swaminathan.

**Poultry Farm Management**

**Poultry**

- Poultry is the word used for the birds which can be bred for economic purposes.
- It includes ducks, geese, turkeys, guinea fowls, pea fowls, pigeons, gualis, partsidges etc. for their meat & eggs.

## Poultry Farm

Poultry and poultry products are a rich source of animal protein & right kind of fats for good health.
- In our country poultry mainly means domestication of chickens for meat & eggs.
- India stands at 6th place in poultry farming in the world.
- In India per capita consumption annually is only 19 eggs and 20 gm of meat.
- While the nutritional advisory committee of **ICMR** (Indian council for medical research) has recommended an egg/day i.e. 300 eggs/ annum/person & 180 gm meat/day/person

### Poultry Farming

1. Poultry birds are easy to raise & can acclimatise to a wide range of climate condition.
2. They are prolific (highly reproductive and have short life span)
3. Their products are rich source of money Indian breeds lay 60 eggs/year in comparision to exotic breeds lay 270 eggs/yr.
4. Poultry farming is advantageous over other enterprises.
- It yields quick return needs little space & easy to manage
- Chickens are bred in large colonies in special places, called poultry farms
- The poultry birds are kept in dry comfortable & well ventilated cages.
- Separate rooms or compartments are made for birds of different age groups.
- The floor housing is more common.
- The floor is covered with husk & straws
- The farm is rat proof with proper drainage system

* The feed of poultry birds consists of cereals, milletes oil cakes, fish & meat meal, minerals & green vegetables, fish silage, protein concentrate

### Hen

- Starts laying eggs at the age of 6 months
- Then number of eggs produced during winter are more compare than summer.(temp. effect)

Majority of the hens start laying eggs from the month of February and continue this practice till August. Monsoon period is considered to be the most of suitable time for obtaining chicken from eggs.

- The domestic fowl (gallus gallus) can be classified as –

### (1) Indigenous (Desi) or Indian breeds

Aseel, Ghagus, Karnataka, Brahma, Bursa, Black Bengal, Chittagong, Tellicherry etc.
Aseel is best game bird, it is used in cock fighting.
- Poultry birds exclusively grown for meat is called **broilers** (plymoth rocks).

- Indian breeds are slow growing, less efficient converters and produce fewer eggs (60/years)

**(2) Exotic Breeds**

- White leghorn, Rhode island red, Plymoth rock, New Hampshire, Sussex, Australorp, Minorca etc.
- **HH260** lays more than 260 eggs in a year & its mortality rate is low.
- The broilers (bird grown for meat), with high nutritive value have been produced by cross breeding (heterosis)

*** DUCK (Anas)**

- Ducks are abundant in southern & eastern parts of India.
- It has about 20 breeds.
- Common Indian breeds are Indian runner, Syhlet meta, Nageshwari - The exotic breeds include campbell, Pekin, Muscori & Ayleshbury

- **Geese (Anser)** - Two common varieties are brown & white
- **Turkey (Maleagris)** -It is a recently domasticated bird.

- The important breeds are British white, broad breasted bronze, Beltsiville small white Narfold.

**Common Diseases of Poultry**

Some of the commonly occurring disease of poultry are as follows

**(i) Viral Diseases of Poultry**

Fowlpox, infectious bronchitis, lymphoid leukosis and ranikhet diseases are common viral diseases of poultry.

– Ranikhet (New castle) disease is the most common disease of hens and fowls in which the affected individuals suffer from fever and diarrhoea. With the progression of this disease the birds show mucus secretion from their beaks, paralysis of wings and the birds repeatedly moving round.

**(ii) Bacterial Diseases** - Fowl cholera, Pullorum, Coryza, Mycoplasmosis and Spirochaetosis.

**(iii) Fungal Diseases** - Aflatoxicosis, Brooder pneumonia and aspergillosis.

**(iv) Parasitic diseases** :

**i. Internal Parasites** :- Round worms, tapeworms & threadworms

**ii. External parasites** : Fowlmite, chicken, mite, fleas, ticks etc.

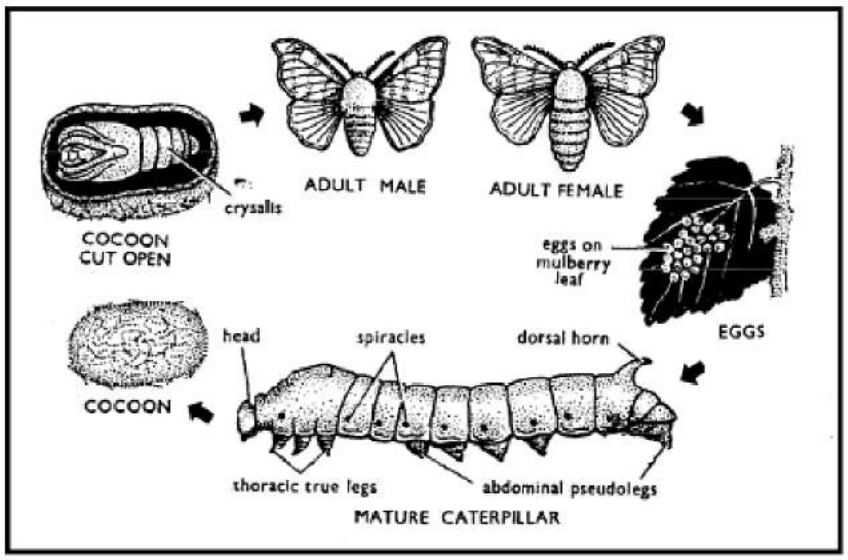
If any of the infectious disease has affected a mass proportion of the chicken & hens, then the best and safer decision, to avoid the fatal consequence, is to destroy the affected individuals. A poultry keeper must be awarded about the common diseases so as to ensure the well being of hens and also of man.

## Sericulture & Apiculture

### SERICULTURE

The production of silk from the silk worm by rearing practices on commercial scale is called sericulture. (Sericulture is the rearing of silk worms for the production of raw silk.)

- First of all the silk worm were discovered in china by LOTZU EMPRESS of KWANG Ti in 2697 B.C.
- In India sericulture is an ancient industry dating back at least to the second century B.C.
- In India major silk producing centers are in Assam, Bengal, Madras, Punjab, Kashmir and Karnataka
- Silk production in India is 2,969 tonnes per year
- India ranks 3rd in the production of silk. Mysore (Karnataka) is the leading silk producer state.




### Type of silk from silkworm

a. Mulberry silkworm (**Bombyx mori)** feeds on Mulberry- Mulberry Silk
b. Tasar Silkworm **(Antherea roylei)** - which feeds on oak - Tasar silk
c. Eri or Arundi silkworm **(Attacus ricini)** - feeds on castor - Eri silk d Munga silkworm (Antherea assama) feeds on oak and other forest trees
- Munga silk Thiopalia religiosa feeds on machilus & fucus species - Devmuga silk.
    - Silk fibre is a protein produced from silk glands of silkworm.
- Silk glands are modified salivary gland of the larvae of caterpillar of the insect Bombyx mori (Mulberry silk moth)

- These caterpillar form a cocoon around them
- The cocoon are cooked in hot water this process is called stiffing & the silk fibre is unwound from cocoons

- India is the only country in the world having all four varieties of silk.

**Life history of silk worm (Bombyx mori)**

- Adult silk worm is white creamy moth of 5 cm hairy body.
- Female lays 400-500 eggs upon leaves of mulberry plants, fertilization is internal.
- Hatching in summer takes about 10 days
- Larva (caterpillar) has five instar after four moultings (lifespan 25-30 days)
- It spines its own silken cocoon
- 5th instar caterpillar (develops salivary glands stops feeding & secrete clear viscous fluid. The secreted fluid comes out through spinneret (a narrow pore situated on the hypopharynx) and takes the form of long fine thread of silk (1000-1200 metres in 3 days) which hardens on exposure to the air and wrapped around the body of the caterpillar in the form of a covering called as COCOON.
- This secretion forms two cases of fibres, cemented together by sericin & carotenoid pigments.
- Entire cocoon is formed within 3 days
- Weight of cocoon is 1.8 to 2.2 gm
- During metamorphosis of pupa (chrysalis) histolysis & histogenesis occur
- Full grown pupa is called Imago.
- Adult moth comes out of cocoon after 10-12 days of pupa life
- Life span of adults 3-4 days only

**Reeling and spinning** :

– The process of removing the threads from the killed cocoon is called as reeling. (Post cocoon processing)

**Disease of silk worm :**

(1) Maggot disease : Caused by Tricholyga sorbillans (fly).
(2) Pebrine : Caused by Nosema bombycis (protozoa).
(3) Polyhedrosis : Caused by viruses.
(4) Flacherie : Caused by certains viruses and bacteria.
(5) Green muscardine : Fungal disease of silk worms.

- Central sericulture station : Berhampore (W. B.)
- Central research & training institute (Mysore)

## Apiculture

- The scientific method of care & management of honey bees is called **APICULTURE.**
- Although bees are very active throughout the year but in winter they become sluggish & are very active in spring.
- They show polymorphism & good division of work.
- The diameter of a normal bee hive is about 30-90 cm. In it the number of bees is about 50-60 thousands.
- Bees are pollinators for sunflower, Brassica, apple & pear.

## Social Organisation :

- A highly organised division of labour is found in the colony of honey bee.
- Each colony has more than 40,000 to 50,000 individual consisting of 3 casts –

## Important species of Honey-bees :

**(i) Apis dorsata (Rock bee)**- It is also named as saarang bee. It is of largest size and produces highest yield of honey. However, It is of highly aggressive nature and migratory species, which is not suitable for rearing by man.

**(ii) Apis indica (Indian Mona-bee)**- It lives across the whole country of India and is smaller in size than saarang-bee, It is mild in nature, so that it is easily manageable during rearing. Mona-bee yields about 3-4 kg. of honey per hive.

**(iii) Apis florea (Bhringa-bee)**- This bee is smallest in size and of timid nature. It only yields about 250 gms of honey every hive. Hence is not suitable for commercial purpose.

**(iv) Apis mellifera (European bee)**- This bee is of mild nature. It yields 9-10 times more honey than mona-bee. It is the most useful bee for commercial purpose. The Italian variety of this species is by far the most important variety.

**1. Queen** :- It is about 15-20 mm long and its body is about three times larger & 3 times heavier than a worker bee. The legs & wings are short but crop is long. It has ovary which is filled with eggs.
Only one queen develops from fertilized egg ( i.e., it has 32 chromosomes). It feeds on Royal jelly.
Its sole function is - Reproduction. It lays 2000 eggs everyday. One queen lays approx. 1500000 egg in its whole life time.

**2. Drones** :- About 100 male bees are present in one hive. These are approx. 7-15 mm long. In these salivary and wax secreting glands and stings are absent. Like the queen they also depend on worker bees for nutrition.
Their sole duty to fertilize the queen. Drones are developed from unfertilized eggs so there are only 16 chromosomes present in them.

**3. Worker** :- Their number is maximum in a hive. These are the smallest bees. Their wings and mouth parts are very strong. Their mouth parts & legs are modified to suck the nectar of flowers and to collect the pollen grains respectively. Pollen basket is present on hind leg (tibial) for collection of pollen.
Pocket like wax glands are present at base 2nd to 5th abdominal segment.
Worker bees are sterile females. These are developed from fertilized eggs. Due to high labour the life time of a worker bee is about 6-8 weeks.

**Modern method of apiculture**

Modern method of apiculture makes use of artificial bee hive. There are more convenient as these may be reused and can be shifted easily to safer place in adverse weather conditions. In addition to above, these are easy to handle and can be carried in a simple and easy manner.

**Procurement and rearing of honey**-bees -Male honey-bees (drones) are usually captured in the evening hours while they are swarming. After procurement, they are introduced in the brood chamber of the artificial hive. A queen and some workers obtained from a natural bee-hive are released into the artificial hive. Here they are fed with a artificial diet containing 2/3 parts of sugar and 1/3 part water, for some days. The queen of the hive needs to be replaced by a new one every year. The old queen is removed out of the hive. A small amount of the honey from this hive is applied on the fresh queen's body and the same is released into brood chamber. The artificial bee-hives prepared in such manner are placed in open fields or gardens or at some appropriate place.
The site where the hives are placed should be moist and clean. A good flowering crop and other plants as a source of nectar and pollen grains to the honey-bees must be available within the circumference of 1-2 kms from the hive. In the condition of overcrowding of males, some of them including a queen should be removed from that hive. A perennial source of clean water is also essential in the close vicinity of the hive. Honey bees produce honey and wax which are very useful commodities to man. They also play an important role in pollination of agricultural and horticultural fields.

**Life history of honey bee**

- After fertilization the queen lays about 2000/eggs/ days
- One egg in each broad cell
- The egg hatches in about 3 days
- After hatching a white larva (maggot) emerges which is fed by workers
- Worker larvae are full grow after 5 days

**Nurse bees**

– From the 4th day all the worker bees provides food which consist pollen & honey to all baby bees.
– From the 7th day Royal jelly is secreted from the maxillary glands of worker bees, Larva, pupa & queen bee are fed on this royal jelly.
From 12th to 18th day secretion of wax gland also starts.
– Propolis is a gum like substance which is used by bees to repair the old & destructed parts.
- Eggs destined to become drones are unfertilized & are laid in cells of slightly greater diameter than those of workers.
- The egg hatched in royal chamber is looked after by workers & fed with royal jelly so that it convert into queen.
- The time required to produce a queen from egg to adult is about 15-16 days, for a worker -4 days, & for a drone 24 days.

**Nectar collection & Honey preparation**

- One worker is ordered to collect 450 gms of honey, it needs 40,000 to 80,000 trips to flowers for nectar & pollen
- Nectar is a sugary substance in the flowers.
- Nectar is stored in the crop - Sucrose is acted upon by the enzymes present in the saliva & changed into glucose levulose & fructose
- The hydrolised nectar is regurgitated by the workers & is stored in the storage cells of bee hive
- Extra amount of water is evaporated by the fanners This concentrated product is called Honey

**Communication by dance :-**

Those bees which go out for search of food have highly developed visual & taste sense for correct recognition of route. Bees recognised their route with the help of position of sun & smell of flowers.

Bees communicate with each other so that all other members also find the food source.
Ernst spytzner 1788 explained that honey bees have a definite kind of communication medium. This special type of speed is called "Dance of honeybee." After that Karl Von Frish 1969 also explained the "Dance of honeybee" and he got noble prize for that.
– The following type of dances can be seen in honey bees.

**1. Round Dance :-** This dance indicates that the food source is about less than 75m from a hive. The direction of food source can be identify with the help of smell of flowers which is present on the body of a scout honey bee.

**2. Tail wagging Dance :-**
With the help of this dance bees give the information of that food source at a very far distance. In it direction & distance of food source are indicated according to the position of sun. When the honey bee is flying in a straight line it wagging its tail and wings to produce the sound. Distance of a food source can be identified with the help of speed of dance, speed of wagging tail & speed of sound.
– If the motion is in upper side of a straight line with wagging tail then food source will in the same direction of sun.
– If the motion is in lower side of a straight line then food source will be in opposite direction of sun.

- **Honey** - It is an aromatic viscid, sweet material consists of 17% water, sugar protein, minerals vitamins etc.

Its specific gravity is 1.45 to 1.48

| | | |
|---|---|---|
| i. Water | – | 17–20% |
| iii. Glucose | – | 32–37% |
| v. Enzymes & pigments | – | 2.21% |
| vii Vitamins | – | B, $B_6$, C & D |

**Bee Wax**

- It is very useful by product of bee keeping industry
- It is obtained from bee hives
- This is a secretion of workers bees abdominal glands
- It is prepared from a plant substance (pollen) called 'PROPOLIS'
- The propolis gives the wax a hardly nature

## LAC CULTURE

– Lac is resinous secretion of last segment of Laccifer (Tachardia) lacca or Lac insect
- The insect is parasite lives and breeds on the following host plants.
i Kusum - **Schleichera oleosa**
ii. Babul - **Acacia nilotica**
iii. Ber - **Zizyphus mouritanas**
iv. Palas - **Butea monosperma**
v. Peepal - **Ficus religiosa**
vi. Mango - **Mangifera indica**
vii. Sal - **Shorea robusta**
viii. Fig **- Ficus carica**
**Lac Insect :**-– They secrete a gum like substance which covered them from all the sides & after that a 1-2 inch thick layer is formed around the branches.
Branches of trees are cut down and then dipped into hot water so that the gummy substance can be separated. It is done for the preparation of Lac.
Now some chemical are also added to prepare the lac which is available in markets.
* In India the largest lac producing state is Jharkhand, followed by MP, West Bengal & Maharashtra
- India produces 75% of the total world production
- The lac is a secretory product of lac glands
- The secretion covers the body of insect
- Lac is used in printing industry, preparation of gramophone records, electrical appliances, in varnish, polish bangles cosmetics lac wax & lacdye.

### Salient Features of lac Insect

Lac insect has separate male and female individuals which exhibit sexual dimorphism. Males are 1.2-1.5 mm in length and have red coloured body. Males are smaller than females which measure about 5 mm in length. Female posses delicate body which is oval in shape. Head, thorax and abdominal regions in a female are not very much distinct. Further, the females are devoid of wings and have a bright red body, It lives in a chamber made of resin.
A female insect lays about 200-500 eggs in its resin chamber. After 6 weeks of egg laying, a first instar larva is hatched out of the each egg. It is also called **nymph**. These nymphs are active individuals, and eventually escape out from the resin chamber. Now these gather on the small twigs of succulent plants. The dermal glands present in the body of nymph secrete lac which dries after its contact with the air. Nymphs continuously derive their nutrition in the form of sap from the succulent plants. After 6-8 months of stable form the nymphs undergo metamorphosis. Now they develop into wingless females (about 70% of total nymphs) and winged males (about 30% of total nymphs). A lac insect, living on a

single host plant, repeates it life cycle twice, one during October-November, and the other during June-July every year.
Lac insect sucks the plant sap by introducing its mouth parts into plant tissue. The quality of lac depends on the nature of host plant. The best quality of lac is obtained by the lac insect which have been reared on ber and palas plants. This lac is named as Kusumic lac.

## Lac Cultivation

Lac is cultivated by both the methods, viz., natural and artificial methods. However, the artificial method is considered to be more developed and reliable method. In artificial propagation, small twigs of the host plant are tied with the other host plant, in a way that the twigs touch the later at many places. This facilitates easy entry of nymphs into another host through swarming. After the propagation, the lac secreted by the insects is obtained at adequate time. This is known as harvesting. The lac produced before swarming is called immature lac or **ari lac**, while that produced after swarming is called **mature lac.**
The lac initially collected is called seed lac which after purification gives **button lac. Kiri lacis** the lac with many impurities. (Obtained from Keria lacca)
In India about 2 crores kg of lac is produced every year, which is more than 6% of the total world production. Of the total production of India, 50% is contributed by the Chhota Nagpur region of Bihar. Lac is a very useful material which is used for manufacturing bangels, utensils, toys, polish, varnish and for electrical goods. Ladies in India use lac in colouring material, mahawar, as a cosmetic to make up their feet. Indian Lac Research Institute, Namkum (Ranchi) is engaged in the research and extension programmes to promote and improve the lac culture in India.

## Composition of Lac

| | | |
|---|---|---|
| 1. Resin | – | 68–90% |
| 3. Wax | – | 6 % |
| 5. Sugar | – | 4 % |
| 2. Dye | – | 2–10% |
| 4. Albuminous matter (Glue) | – | 5–10% |
| 6. Water | – | 3 % |

## Vegetables, Sugar, Spices & Rubber

### VEGETABLES

Vegetables contain a large quantity of carbohydrates and mineral salts like calcium, iron, phosphorus, iodine etc.; they are also rich in vitamins, therefore, are included in our daily diet.

**Vegetables**

Some of the important vegetables are as follows :-

**(1) Potato** ***(Solanum tuberosum-family solanaceae)*** :- Main vegetable crop is of **potato**. It is an erect, branched annual; tuber is modified stem, which have different shapes-round, oval and cylindrical; it is a native of **Peru**(South America) and was first introduced in India by the Portuguese in the early part of the 17 century; potato tubers are eaten as vegetable and in various other forms; they are also used in the production of starch and industrial alcohol.

**(2) Tomato** ***(Lycopersicon esculentum family Solanaceae)*** :- It is a native of **South Asia**; it is cultivated in warm countries for its fruits of various shapes and colours, which are used as vegetable. Tomatoes are also used in the preparation of ketchup, sauce,soup and juice.

**(3) Brinjal** ***(Solanum melongena - family Solanaceae)*** :- It is an erect, branched, annual herb, fruit is large, ovoid, purple or whitish berry; it is a native of India. The fruits are eaten as vegetable for its high protein content.

**(4) Okra (Bhindi)** ***(Abelmoschus exculentus - family Malvaceae)*** :- It is an annual herb with yellow crimson centred flowers; it is grown in warm countries for its mucilaginous fruits; it is a native of **tropical Africa.** The fruits are used as vegetables and also in soup.

**(5) Onion** ***(Allium cepa - family Liliaceae)*** :- It is a native of **South Asia**. The food is stored in the bulb; bulbs of onion are popular as vegetable and are also used for flavouring and pickling. The leaves are also eaten as vegetable.

## SUGAR

Sugars are the end products of photosynthesis in green plants. **Cane- sugar** or sucrose is the main commercial sugar used world over for sweetning various food products. Some of the important sugar yielding plants are as follows :-

**(1) Sugarcane** ***(Saccharum officinarum)*** :- It belongs to family Gramineae and is the chief source of sugar in India. The plant reaches a height of 6 to 12 feet and a diameter 1 to 2 inches: the stem is solid with many fibrous strands and contains juice; the stems are cut close to the ground and are then sent sugar mills for the extraction of sugar. **Molasses** is used in the manufacture of rum and industrial alcohol.

**(2) Sugar-beet** ***(Beta vulgaris)*** :- It belongs to family **Chenopodiaceae** and is the source of sugar in cold countries. The sugar-beet is a biennial herb with white tap root. Sugar is extracted from the fleshy roots which contain 15-20% of sucrose. In India sugar-beet is not much used as a source of sugar, but the roots and leaves are used as vegetables.

## FIBRES

The fibre crops of the world rank second in importance to the food crops. Fibres are thread-like **sclerenchymatous tissues** obtained from different parts of the plant body. They are usually long with thick walls and pointed ends; the thickening of the walls is either due to the deposition of lignin or cellulose. Some of the important commercial fibres are as follows :-

**(1) Cotton** ***(Gossypium sp. - family Malavaceae)*** :- Cotton is the most important commercial **textile fibres.** It is used for a variety of purposes, especially in the manufacture of a large proportion of the clothing.
Fibres are produced by the seed coats of various species of gossypium and when separated from the seed are known as**'lint'**. Fibres are also used for making ropes, twines and threads; raw cotton is also used for stuffing pillows and cushions.

**(2) Jute** ***(Corchorus capsularis and C. olitorius - family Tiliaceae)*** :- It is a very valuable bast fibre and is second in use to cotton. The fibres are extracted by the process of **retting** in which the branches of plants are dipped in water for few days; after retting fibres are separated. Jute fibres are used for making gunny bags, packing cloth, carpets, cordage, curtains etc.

**(3) Sunn hemp** ***(Crotolaria juncea - family papilionaceae)*** :- The plants are extensively cultivated in India.
The long fibrous strands are made up of lignified **phloem sclerenchyma** tous cells, which are obtained after **retting**. The fibres are used in manufacture of ropes, canvas, nets, cordages etc.

**(4) Flax** ***(Linum usitatissimum - family Linaceae)*** :- The fibres are very **strong, silky,** short in length and are formed in the**pericycle** of the stem. Flax fibres are used in the manufacture of linen cloth, carpets, canvas, cigarette paper, insulating materials etc.

**(5) Hemp** ***(Cannabis sativa - family Cannabinaceae)*** :- The fibres are obtained from the pericycle after retting. The hemp fibres are long, strong and durable but lacks flexibility. It is used for the manufacture of ropes, cables, nets, canvas etc.

**(6) Munj** ***(Saccharum munja*** **- family Gramineae)** :- The fibre is obtained from the stem. It is used for making chair, tables, baskets, mats and ropes.

**(7) Coir** ***(CoCos nucifera*** **- family palmae)** :- It is obtained from the **fibrous mesocarp** of the fruit; the fruits are dipped in marine water for many months and then beaten to separate the fibres. Coir is used for making brushes, doormats, carpets, sacs, bags, cordage etc.

**OILS**

Oils are the complex chemical compounds which consists of **hydrocarbons, esters, alcohols, aldehydes** etc. The oils are of two kinds –
**(i) Essential oils**
**(ii) Fatty oils.**There are several species of plants yielding both edible and industrial oils. Some of the important oils are –
**(1) Groundnut oil** is obtained from the seeds of *Arachis hypogea* -
Family **Papilionaceae**: refined oil is used in cooking and oil is converted into vegetable ghee by hydrogenation.
**(2) Gingelly or sesame oil** is obtained from the seeds of ***Sesamum indicum*** - family Pedaliaceae; oil is used in cooking, medicine, soap etc.

**(3) Coconut oil** is obtained from the dry kernel of the seed of *Cocos nucifera* - family **Palmae**; oil is used for cooking as hair oil, and in the manufacture of soaps, shampoo, cosmetics etc.

**(4) Mustard oil** is obtained from the seeds of ***Brassica campestris*** - family **cruciferae**; oil is chiefly used for cooking purposes.

**(5) Castor oil** is obtained from the seeds of *Ricinus communis* - family **euphorbiaceae**; oil is used in medicines, as lubricant and also in making soaps.

**(6) Soyabean oil** is obtained from the seeds of ***Glycine max*** - family **Papilionaceae**; raw oil is used in the manufacture of soap, varnishes, paints etc.; refined oil is used for cooking purposes.

**(7) Linseed oil** is obtained from the seeds of Linum usitatissimum - family Linaceae; oil is used in making paints, varnishes, soaps etc.

**TIMBER**

Timber is the wood used for various building purposes, for making plywood, railway sleeper, ceiling, partition walls, doors, furniture, packing boxes etc. The quality of timber depends on its strength, weight, hardness and presence of natural depositions like tannins, resin etc. Some of the timber yielding plants are as follows :-

(1) Indian Redwood (Sesham) (Dalbergia sissoo - family Papilionaceae) - The wood is dark- brown in colour and is very strong and durable. It is used for making good quality furniture, carts, boats, poles etc

(2) Teak (Tectona grandis - family Verbenacea) – It is the most important wood as it is extremely durable. It is used for making best quality furniture, houses, ship-building, for bridges, railway sleepers etc.

(3) Deodar (Cedrus deodara - family Pinaceae) :- The wood is light, extremely durable, yellowish-brown in colour. It is used for house-building bridges, railway sleepers, light furniture etc.

(4) Sal (Shorea robusta - family Dipterocarpaceae) :- The timber is very hard, heavy, strong and very durable. The wood is of brown colour and is used for beams, furniture, carts, bridges railway sleepers etc.

(5) Mahogany (Swietenia mahogoni - family Meliaceae) - It is a valuable timber tree. The wood is very hard and durable and is used for ,making boats, ships, furniture etc.

(6) Toon (Cedrella toona - family Meliaceae) – The timber is very light and is used for making furniture, houses, packing boxes etc.

(7) Mango (Mangifera indica-family Meliaceae) – The wood is strong, slightly lighter and grey or greyish brown in colour. It is used for door and window frames, packing cases and tea boxes.

## BEVERAGES

These are mild agreeable and stimulating liquors meant for drinking. Beverages may be either non-alcoholic or alcoholic. Non-alcoholic beverages do not contain alcohol but instead, contain caffeine which is an alkaloid nonalcoholic beverages are as follows -

(1) Tea (Thea sinensis or Camellia sinensis - family Theaceae) – It is the most popular beverage; Prepared from the dried leaves of this plant. The plant is a native of Assam in India and now cultivated in China, India, Pakistan, Japan, Ceylon, England and Indonesia. The tea plant is a shrub 3-4 feet high. The tea leaves are picked by hand which are processed for obtaining different grades of tea leaves.

(2) Coffee (Coffea arabica and C.robusta - family Rubiaceae) :- Seeds of these plants are the sources of coffee. The seeds are dried in sun or by artificial heat and then roasted to develop flavour, aroma and colour.

Coffee plant is a shrub or small tree 16 to 25 feet high. Main coffee plantations are in the hill slopes of South India - Karnataka, Kerala and Tamil Nadu. It is a favourite drink all over India particularly South India. America consumes the largest quantity of coffee.

(3) Cocoa (Theobroma cacao - family Sterculiaceae) – It is prepared from the seeds of this plant. The beans roasted in iron drums at a temperature of 125° C to 140° C. The seeds are finally ground to an oily paste to form the bitter chocolate. Sweet chocalate is made by adding sugar to the bitter chocolate Cocoa tree is a native of tropical Central and South America.

## RUBBER

Rubber is obtained from the latex of Hevea brasiliensis - family Euphorbiaceae, which is the main source of commercial rubber. The latex is collected by tapping the bark, which is processed for obtaining final rubber.

It is used as tyres, tubes, rubber sheets, insulation of electric wires etc. The majority of rubber plantations are in Kerala, Tamil Nadu and Karnataka.

## MEDICINAL PLANTS

Most of the medicinal plants are wild; these plants are collected and sent to the centres of researches to work out their medicinal value. A good number of them are cultivated on commercial basis. Some of the important drug yielding plants are -

(1) Opium (Papaver somniferum - family Papaveraceae) - The plant is an erect herb having large globose capsuls. Opium is the latex of unripe fruits. Opium contains several important alkaloids such as morphine, codeine, neopine etc. Opium has narcotic and sedative effect and is largely used to relieve pain as an intoxicant.
(2) Rauwolfia (Rauwolfia serpentina - family Apocynaceae) - It is an erect, perennial under shrub. The dried roots are an important source of an alkaloids pine and other alkaloids are serpentine, serpentinine, rauwolfine etc. The alkaloid reserpine is used in several patene drugs, as it has a depressant action on central nervous system and produces sedation and lowering of blood pressure.
(3) Cinchona (Cinchona officindalis - family Rubiaceae) – It is a famous quinine-yielding plant. Quinine is the most important drug obtained from the bark of this plant and also from other species i.e, C. ledgeriana, C. officinalisandC. cordifolia. Bark of these plants contains about 30 alkaloids including quinine, cinchonine, quinidine and cinchinidine, all of which are used in medicine. Quinine has been a great boon to mankind, as it is the only adequate cure for malaria.
(4) Belladona (Atropa belladona - family Solanaceae) – Belladona drug is obtained from the leaves of this plant. The plant is a perennial herb. Belladona is used extremely to relieve pain; besides it's leaves contain several alkaloids, chief among is atropine, used to dilate pupil of the eye.

(5) Ephedrine (Ephedra equisetina and E. sinica - family Gnetaceae) – Ephedra is a leafless shrub. The entire plant is used in the extraction of this drug. Ephedrine is used to cure asthama, colds and hay fevers.
(6) Aconite (Aconitum napellus - family Ranunculaceae) – Aconite is obtained from the tuberous roots of this plant. A conite relieves pain due to neuralgia, rheumatism and inflammed joints; it is also used as a tonic and sedative.

**SPICES**

Spices cannot be grouped in food, as they have very little nutritive value. They give aroma and flavour to food.
They stimulate the appetite and increase the flow of gastric juices and for this they are often referred as food accessories. Some of the spices yielding plants are as follows –
(1) Clove (Laung) (Eugenia caryophyllus - family Myrtaceae) - It is a native of Eastern Indonesia. Cloves are unopened flower buds which on maturity become brown and brittle. They are aromatic and are used for flavouring pickles, curries etc.
(2) Cinnamon (Dalchini) (Cinnamomum verum – family Lauraceae) – It is a native of Sri Lanka. The bark of this tree is a Cinnamon of commerce. Cinnamon has a pleasing, fragrant odour and a warm, sweet, aromatic taste. It is used for flavouring foods.

(3) Red pepper (Chillies) (Capsicum annum – family Solanaceae) – It is a native of tropical America and West Indies. The fruits are pod-like berries with many, small, flat seeds. The green chillies are used as vegetable, while the ripe red chillies are powdered and then used as spice. The pungency or spicy taste of chillies is due to a substance known as Capsaicin ($C_{18}H_{27}NO_3$), which is used in the manufacture of ginger beer.
(4) Black pepper (Kali mirch) (Piper nigrum - family Piperaceae) – it is a native of South-Western India.
The black pepper is the dried unripe fruit. It is one of important spices and widely used as flavouring substance.
The characteristic aroma of pepper is due to the presence of a volatile oil and the pungency is caused by the non-volatile oleoresin fraction and various alkaloids; piperine ($C_{17}H_{19}NO_3$) is the chief alkaloid.

## Sheep, Pigs, Horses & Mules

### SHEEP (Ovis aries)

- Today sheeps are raised in all parts of the world.
- They are reared for wool & mutton, mostly in hilly tracts.
- Sheep graze on grass & herbs.
- Farm waste, mineral mixture, oil cake and other cattle feeds can also be given.
- High Quality soft wool shahtoosh is obtamed from the animal chiru
- A sheep lives for about 13 years.

### Breeding of Sheep

- Sheep begin breeding at the age of about two years & then have young ones every year.
- After that sheep feed on tender grass weeds of pasture & hill side.
- To improve the quality of a sheep cross breeding experiments are usually done.
- For this purpose, a good quality wool yielding or mutton producing sheep is chosen and cross breed with exotic breed like Dorset, Horn and Merino

### Breeds

- Deccani & nellore breeds are raised only for mutton.
- Patanwandi provides wool for army hosiery.

Patanwandi Breed
- Narwari yields coarse wool.

**Four breeds yields good wool –**

i. Rampur - Bushair ( Brown fleece for superior cloth)
ii. Lohi (Quality wool also milk)
iii. Bakharwal ( Undercoat for shawls)
iv. Nali (carpet wool)

**Some breeds of Indian Sheep**

| Breed | Distribution | Use |
|---|---|---|
| 1. Ichi | Punjab, Raj. | Milk, cpod duality wool. |
| 2. Rampur-Bushair | UP, HP, Raj., Punjab, Haryana | Superior Cloth, Brown Golour fleece |
| 3.Nali | Haryana, Punjab, Raj. | Superior carpet wool |
| 4. Bhakarwal | Jammu & Kashmir | Undercoat used for hiah Quality Shawl |
| 5. Deccani | Karnataka | Mutton, no wool |
| 6. IfeLlare | Maharastra | Mutton, no wool |
| 7. Marwari | Gujarat | Coarse wool |
| 8. Patanwadi | Gujarat | 'wool for army hosiery |

**GOAT (Capra capra)**

- It is also called poor mans cow because it yields a small quantity of milk and feeds on a variety of wild plants even prickly ones.
- Goat destroy vegetation & forests if not kept under control.
- About 19% of world goat population occurs in India
- Goats are reared in open sheds.

**Breeding of Goats**

- The wild goat Baluchistan and Sindh is the ancestral stock of all breeds of domesticated goats.
- An adult male goat is also called - billy goat or a buck and a female adult is a nanny goat or a doe. A goat less than a year is called **Kid .**
- The fine soft wool called **PASHMINA** is the underfur of Kashmir & Tibet goat.

**Some Goat Breeds**

| | | |
|---|---|---|
| 1 | Gaddi | Himachal Pradesh |
| 2 | **Kashmiri Fashmina** | Hills of Kashmir, Tibet, HP |
| 3 | Jamunapari | UP, MP |
| 4 | Beetal | Punjab |
| 5. | Marwari | Rajasthan |
| 6. | Besari | Maharashtra |
| 7. | Itelabari | Fferla |
| 8 | Bengal | Bihar, Orissa |

**Yak (Poephagus grunnies)**

- It is reared in high mountainous regions for meat, wool, hide milk, transport & tilling.

**PIG (Sus sacrofa)**

- Pig is the most economical source of meat for human beings.
- Pig's meat is called **PORK**.
- Pig's fat is used as cooking medium and for preparation of soap.
- Its hide forms leather & its bristles are used for making brushes.
- Pigs are susceptible to extremes of heat & cold.
- The care & management of pigs is called **PIGGERY**.

**Feeding of Pigs**

Indigenous pigs survive through scavenging on garbage & kitchen waste & farm by products & human faeces.
- Pig keepers raise them on grass. Straw roots and grains.
- As they can feed on human faeces, they serve as secondary host for tape worm.

**Breeds & breeding**

Pig breeding has now started on commercial scale. The improved exotic types, number of which is insignificant is maintained mostly at all the seven regional pig breeding stations of the country.

**Domesticated**

| Indigenous pigs | Distribution |
|---|---|
| 1. Deshi | UP, Bihar, Punjab, MP |
| 2. Ghori | Manipur, Assam, Meghalaya, Arunachal Pradesh |
| **Ercotic Pigs -** | |
| 1. Berkshire | U.K. |
| *2.* large white Yorkshire | U.K. |
| 3. Landrace | Switzerland & Denmark |

***Elephants (Elephas maximus)**

- They have poor sight but sense of hearing & smell is highly developed.
- African elephants have longer tusks than Asian elephants. - Elephant is the largest land animal.
    - The gestation period is 21-22 months.
- Puberty in elephants occurs at b/w 8 & 12 years.

**Uses** -.

i Elephants are used to lift & carry logs of wood across hilly patches and dense forests.
ii The tusks of elephants provides the precious ivory used for intricate carving by skilled craftsman.

- Elephants may live for upto 90-100 years.
- Feeding - Working elephants are fed straw hay and crushed grain as a supplement.

- Daily water consumption is 140-230 litres.

- **Horses (Equus equus)**

- Horse is firm footed fast runner, stout & intelligent.
- Initially it was used for hunting game.
- Later they were employed for pulling chariots transport & warfare.
- They are fast learners & faithful pests & able to adopt to all sorts of climatic conditions.
- They are reared for racing & polo.
- They are also used as laboratory animals for preparing vaccines.
- Horses are employed in circus too.
- Horses are fed on oats barley, grams & hay
- Common salt is also added to their diet.
- Green grass also be given

- As compared to other animals they have a low reproductive rate.

**Important breeds of Indian horses**

| Name | Regions | Name | Regions |
|---|---|---|---|
| 1. Kathiawari | Raj. & Gujarat | 2. Marwari | Raj. |
| 3. Zanskari | Ladakh | 4. Spiti | Hiirachal Fractesh |
| 5. Bhutia | Punjab & Bhutan | 6. Manipuri | North eastern mountains |

**Donkeys (Equus asinus)**

**Two kinds of donkeys are found in India**

i. Small grey
ii. Large white
- The wild ass of Ethiopia and Northern Africa is the ancestor of common domestic donkeys.

**Mules**

- It is a sterile hybrid b/w male donkey & female horse (Mule)
- In difficult terrain, mule is preferred because it is sturdier & more firm fooled than either of its parents.
- When a cross b/w a female donkey and a male horse (stallion) is called **HINNY**
- Army uses two types of mules
i General service type
ii. Mountain artillery type
    - Mules are fed on green fodder crushed gram, barley & salt

**Camel (Camelus)**

- Camel is used for riding, carrying loads ploughing, threshing grains pulling carts drawing water from wells.
- Camels hair is used for making warm garments cords & garments cords & brushes.
- Desert dwellers relish the camel's milk & meat
- Camel's hide is used for making saddles
    - There are two kinds of camel
i. Arabian, one humped (Camelus dromedarus)
ii. Bactrian, two humped (Camelus bactrians)
    - Disease like anthrax, pneumonia, camel pox & Surra affect camel.

## Adaptation in camel (Ship of desert)

1. It can easily lives in desert in sand where lot of food & water shortage persists.
2. It can easily move on hot & slippery sand because it uses whole of foot while walking
3. On sand it can run at a speed of 25 km. per hour.
4. The camel can cover about one hundred km. if needed.
5. It can live without food & water for about 10 days continuously
6. Hump at the back of camel contains fats in the form of reserve food.
7. When storage of water is less these passes very little urine (about 1/2 lit a day)

## Animal Diseases & Their Control

## ANIMAL DISEASES AND THEIR CONTROL

Domesticated animals suffer from a variety of **diseases.** In animals, disease may be defined as a state of discomfort associated with an abnormal function of the animal body. Diseases may be caused by mutant genes **(genetic diseases).** improper nutrition or pathogens. Genetically diseased animals are strictly excluded during animal breeding. Generally, animals are raised on properly balanced diets to avoid nutritional disorders and to ensure optimum performance.
Domesticated animals suffer from diseases caused by (a) viruses, (b) bacteria, (c) protozoa, (d) fungi and (e) animals, like worms. Such diseases are commonly known as **infectious diseases** because they are caused by pathogenic infections. Many of the infectious diseases are known as **contagious diseases** since they spread to healthy animals by contact with diseased animals, or with the materials that were in direct contact with the diseased animals. Some of the infectious diseases may spread to humans from the animals, e.g. anthrax.
Infections can occur through skin. digestive tract, respiratory tract, conjunctiva, urogenital tract, placenta, umbilicus and egg. It is a good policy to implement measures for the prevention of infectious diseases, some of which are as follows.
**(i)** Isolation of animals suffering from or suspected to be infected with an infectious disease:
**(ii)** Proper disposal of the waste and all materials that were in contact with the diseased animal.
**(iii)** Proper cleaning and disinfection of the animal house and other materials that were in contact with diseased animal.
**(iv)** Transfer of healthy animals to a pasture other than that used by diseased animals.
**(v)** Vaccination of animals.

**Veterinarian Vaccinating Animals**

**(vi)** Injection of antiserum into healthy animals whenever an epidemic is expected.
**(vii)** The authorities of the veterinary department should be immediately informed of cases of infectious diseases. This will allow them to initiate measures to prevent the spread of these diseases.

| Disease (s) | Pathogens | Symptoms |
|---|---|---|
| **A. Bacterial diseases** | | |
| 1. Anthrax | Bacillus anthracis | Bleed nixed frothy secretion from. external openings of body, increased respiratory rate. |
| 2. Hemorrhagicgic septicaemia | Pasteuiella nultocida | High fever, pneumonia, respiratory distress, lanrng (pain during walking), septoaria. |
| 3. Blade quarter | Clostridiini chauvoei | Fever, spelling in neck. |
| 4. Brucellosis | Brucella abcortus | Placantal swelling, abortion, reduced fertility. |
| 5. Serine tdoernulasis | Mycobacterium bovis | Tubercle nodes in lungs and lymph nodes respiratory distress. |

| | | |
|---|---|---|
| 6. Botulian | Clostridiun botulinum | Ehralysis of jaw, neck, leg, muscles, increased salivation, reuratnry bbocksge. |
| 7. tetanus | CLostridinn tetani | Stiffness in jaw and legs, ccds thot cres. (excessive strain in neck region) |
| **B. Viral diseases** | | |
| 1. Rinderpest | Parenryxo- virus | High fever, stomatitis, severe diarrhea |
| 2. Foot and Mouth Disease (ETD) | Picoma-virus | Fever, Lesions in mouth, hoof, marrmary glands and teats. |
| 3. Cowpox | Qrthrcpax-vixus low fever, reduced appetite. | Rashes on mammary glands and teats. |
| 4. Rabies | Rhabdo-virus madness, paralysis. | Changed behaviour, high essentially, |
| **C. Protozoa born diseases** | | |
| 1. Betesiceis | Babesia sps | Jaundice, urine red and frothy, high fever |
| 2. Trypanosomiasis | Trypanosoma evansi. | High fever, anaemia, animal lean |
| 3. Theileriosis | Theileriosis sps. | Spelling in lymph nodes, high fewer, anaemia. |
| **D. Helminth born diseases** | | |

| | | |
|---|---|---|
| 1. Ascariasis | Neoascaris vitulorum. | Liver damage and fibrosis, Swelling in lings, intestinal obstruction |
| 2. Fescolasis | Fasciola sps. | Bleeding from liver, sarnia, fibrosis of bile duct |
| **E. Fungal diseases** | | |
| 1. Ringworm | Trichophyton spa. | patches on skin, pus in infected area. |
| 2. Aspergillosis | Aspergillus sps. | leaders in lungs, respiratory system disorder, abortion. |
| 3. Aflatoxicosis | Aspergillus flavus | Decreased appetite, liver damage, bloody diarrhoea, anaemia. |

**BACTERIAL DISEASES**

Animals suffer from several bacterial diseases. For example, cattle suffer from anthrax. mastitis, pneumonia, etc. Here, anthrax is discussed in some detail.

**ANTHRAX**

Anthrax is caused by the bacterium, Bacillus anthracis. This disease is contagious and affects cattle, buffaloes, horse, sheep and goats ; it can also spread to human beings. In animals, anthrax spreads through contaminated feed, water and pastures.

**Symptoms and diagnosis**

In very acute cases, there is increased respiration, and blood-mixed foamy discharge from mouth, nose and anus. In such cases, the infected animals may die within minutes. But in sub-acute and chronic cases, the infected animals have high fever (up to 41.1°C), and increased pulse and respiration rates. There is discharge of black, shiny and foamy material from natural openings of animals. The infected animals die within 2 to 3 days.
The anthrax bacterium uses up the oxygen carried by the animal blood. As a result, the animals die due to a lack of oxygen.

Disease diagnosis can be confirmed by microscopic observation of the bacterium in the blood of patients, or by culturing the bacterium present in the blood on a suitable medium.

**Treatment**

In the case of human beings a suitable antibiotic like ciprofloxacin is quite effective, particularly if used in the initial stages of the disease. But in cattle, ciprofloxacin may be effective only in chronic cases. Streptopenicillin, sulphonamide, orytetracycline & Anthrax antiserum can also be used with good results. In any case, antiserum should be given to all healthy animals to protect them from the disease.

**Prevention and control**

The general measures for prevention of infectious diseases should be followed. The healthy animals should be vaccinated. Animals that have come in contact with diseased animals should be given anthrax antiserum to protect them from the disease.

**VIRAL DISEASES**

Animals suffer from a variety of viral diseases. For example, cattle suffer from rinderpest, foot and mouth disease, cowpox, etc.

**RINDERPEST**

This diseases is caused by a virus and is highly contagious. The virus is present in all the fluids and secretions from the body of diseased animals. The disease spreads rapidly by direct contact with patient animals, through contaminated feed, water , worker and their clothes, and by flies.

**Symptoms**

Initially, the infected animal developes fever (40.0 to 42.4°C), loses appetite, develops constipation, and passes hard faeces that often are covered with blood. In the final stages of the disease, animal suffers from loose motions, and gives off offensive odour. The body temperature declines and may go down below normal. The animal usually dies in about 7 days.

**Treatment** :-Treatment is effective only when it is started in the initial stages of the disease. Injections of sulphamethazine sodium is often effective. Injection of rinderpest antiserum is highly effective, especially when combines with injection of

sulphamethazine sodium.

**Prevention**

All the measures for prevention of infectious diseases should be implemented. It is highly desirable to vaccinate the animals against rinderpest. In 1954, a massive vaccination programme was initiated in India. This project has been highly successful, and rinderpest is not longer a dreaded disease.
Foot and Mouth Disease (F.M.D.) or Apthous Fever It is a fast spreading disease of ruminants and artiodactyla. It usually infects tetrapods viz., cow, buffalo, sheep, goat, pig etc. Although it is not a fatal disease, the milk and wool production and working capacity of the infected animals is reduced substantially. Therefore this disease is of economic importance. India suffers a great economic loss to this disease every year.
This disease is caused by the infection of Picorna virus group. Transmission of disease is mainly by contact with infected food and water. Air infected with this virus can also spread the disease. These viruses may survive even upto two years after the infected animals has been cured.

**Symptoms –**

Initially there is high fever (104°C-106°C) for 1-2 day the animal stops feeding and ruminating and becomes lethargic. The infected animal suffers from stomatitis, drooping salivation, vesicles appear on mouth, tongue, gums, feet and teats. The tongue of the animal drops out and the animal may suffer from mastitis and abortion.
The infected animal may die of heart failure. This disease is more dangerous in young cows.

**Diagnosis–** The disease is diagnosed by testing the vesicles and their secretion.
**Treatment–** There is no specific treatment of FMD. The vesicles are washed with potassium permagnate solution to prevent secondary infection. After washing some antibacterial powder an ointment is applied on wounds. During this time the infected animal should be fed on soft food. Treating the infected (diseased) animal with antipyretics and antibiotics viz., Tetracycline injection etc. is beneficial.
**Preventive Measures–** Healthy animals should be kept away from the infected animals. The calf should not be given the milk of infected cow. Calves should be vaccinated when they are four month old and later on booster doses should be given after consultation with doctor.

## DISEASES CAUSED BY PARASITIC ANIMALS

Animals are attacked by a number of parasitic animals, e.g., tapeworm, round worms, flukes, ticks etc.
These parasites are mainly of two types :(i) ectoparasites, and (ii) endoparasites
.
**Ectoparasites** live on the skin, e.g., ticks, while **endoparasites live** within the animal body e.g., round worm, tape worms, liver flukes, etc. Both types of parasites feed on animal fluids like blood, and interfere with their normal growth and development. Many parasites trasmit pathogens and, thereby, help in the spread of the concerned diseases. Some of these parasites, e.g., tapeworm. also infect human beings.

### Ascaris

It is an endoparasitic nematode that infects many animals, including humans. Ascaris larvae enter animal body through mouth along with contaminated feed. The larve enter into the intestine tissue, and migrate to liver. lungs, spleen, pharynx, and kidneys, and re-enter the alimentary canal via oesophagus. They caused damage to all those organs through which they pass during their migratory phase. By the time the larvae reach intestine again, they develop into adult male and female individuals. The adult nematodes cause wounds. In the intestine and interfere with animal digestion. The affected animals may show symptoms like constipation, diarrhoea and anaemia. In severe cases, the animal may even die.
The female adult of Ascaris lays numerous eggs. Which pass out along with the animal faeces. The eggs, in due course of time, hatch into larvae, which remain associated with grass. When cattle feed on these grass, the larvae enter alimentary canals of these animals.

### Treatment

Treatment of Ascaris is based on administration of specific medicines, such as piperax, piperazine adipate, wormex, etc

## DISEASES CAUSED BY PROTOZOA

Several diseases of animals are caused by protozoan parasites. Examples of such diseases are tick fever, coccidiosis, etc. Tick fever This disease is caused by several species of Babesia, a protozoan parasite, which is spread by ticks. In India, tick fever In caused mainly by Babesia bigemina. The parasite enters into red blood cells (RBCs) and destroys them.

**Symptoms** :- In the acute form of this diseases, animals develop high fever (41.1-41.7°C) and stop feeding. But in the chronic form of tick fever, there is irregular

fever, and constipation followed by diarrhoea. A clear diagnostic feature of the disease is the presence of pear-shaped protpzoan parasite within the RBCs.

**Treatment :-** The infected animals are administered a suitable medication, e.g., injection of trypan blue, acaprin, or berenil. A single injection of berenil is ordinarily sufficient to cure the animal. In addition, sanitation measures and a suitable insecticide treatment are implemented to eradicate the ticks.

**Prevention and control :-** Tick fever can be prevented by effectively controlling the ticks. Insecticide treatments are used to eradicated ticks from animals.

**Diseases Caused by Fungi** Several types of diseases in animals and birds are caused by different species of fungi. Aflatoxicosis or Mycotoxicosis is one such disease which has been described below.

**Aflatoxicosis** This is a fungal disease which occurs due to feeding on food infected with fungus. Scientists believe that these fungi produce a toxic substance aflotoxin (mycotoxin). Therefore the disease which arises due to these toxins is called aflatoxicosis or mycotoxicosis. toxic substance aflatoxin, is produced by Aspergillus flavus and some other species of Aspergillus. These toxins are insoluble in water and are not affected by heat (heat resistant). Aflatoxin is rapidly formed by fungi in groundnuts, cotton seeds and in some other grains. Infection of fungi occurs by a sudden change in humidity and due to rain. Aflatoxicosis affects almost all the animals and birds but the young ones of ducks resulting in death of the bird or animal.

**Symptoms**– Animals suffering from this disease show loss of appetite, decreased growth, bloody stool, anaemia, lazyness and blindness. Animals move around themselves and develop mental disorders, hydrocoel, ascites etc. A higher death rate is seen in the affected animals.

**Diagnosis**– The disease can be diagnosed by microscopic examination of the fungus.
**Treatment**– To detoxify aflatoxin, antifungal agents like propionic acid, calcium propionate should be mixed in food and the grain should be kept in sun for 2-3 days. The diseased animal should be given liver tonic, protein and methionine.

## ADDITIONAL INFORMATION

- Huskies are thick fur coated dogs and used by Eskimos to draw their sledges.
- India ranks first in milk output in world.
- Common silk is mulberry silk.

- Mulberry specially grown for silkworm is called moriculture.
- Marine animals are richer in Iodine
- Shark Liver oil and cod liver oil are very good source of vitamin A and D.
- Aquaculture is rearing and management of useful aquatic plants and animals like fishes, oyster, prawns mussel etc.
- Pisciculture is rearing, catching and management of fishes.
- Culture fishery is the raising of the fishes in tank and pond.
- Capture fishery is management of catching of fish without actually raising them.
- Broiler :-Chickens reared exclusively for meat.
- Angoora wool :- It is obtained from Angoora rabbit.
- NDRI(National Dairy Research Institute) was establised during first five year plan at Karnal (Haryana).
- Pinctada vulgaris is a common oyster for pearl culture industry in India

**Cybrid**

**CYBRID**

Cybrids posses a nuclear genome from only one parent but cytoplasmic genes from both parents. The process of protoplast fusion resulting in the development of cybrid is known as cybridisation / cytoplasmic hybrids

.

**Formation of cybrids : -** Two methods-

**(i)** By fusion of nucleated protoplast of one parent to enucleated protoplast of another protoplast.

**(ii)** By elimination of one nucleus form heterokaryon.

**Use of Cybrids :** In plant cell, some genetic factors are also present in cytoplasm. During cybridisation these factors fused together and perform cytoplasmic inheritance.

**eg. (i)** Streptomycin resistant gene is transfer from ***Nicotiana tabacum*** to ***N.silvestrise.***

**(ii)** Gene of male sterility is transferred in ***Nicotiana, Brassica*** and ***Petunia*** from one-another.

**APPLICATION OF PLANTLETS PRODUCED BY PLANT TISSUE CULTURE**

**(I) Rapid clonal propagation of superior lines ⇒ e.g. oil palm**

**Clone :** Group of individuals or cells derived from a single individual or cell by asexual reproduction.

Multiplication of genetically identical copies of a cultivar by asexual reproduction is called clonal propagation or cloning or micro propagation.
All the cells in culture are derived from a single explant by mitotic division, so all plantlets regenerate from a culture generally, have the same genotype and constitute a clone. These plantlets can be used for rapid clonal propagation of superior lines like oil palm.

**Two common types of micro propagation are :**

**(a) Multiple shootlet production**
**(b) Somatic embryogenesis**
**(II) Somaclonal variation :** Genetic variation presents among plants regenerated from tissue culture have been termed as **somaclonal variation**.

- These variations are originated by minor chromosomal aberration or by gene mutation.
- The variation which are stable and have agronomic characters like resistance to diseases and pests, stress tolerance, early maturation, better yields are used in agriculture.
- By somaclonal variations many useful varieties are developed.
- Rusts resistance in wheat.
- Resistance for tungro virus and leaf hopper in rice.
- Resistance for late blight in potato.
- High protein content in potato.
- Shortening of harvest duration in sugarcane.

**(III) To produce transgenic plants :**
Transgene : A foreign gene that is transferred in to an organism by genetic engineering.

**Transgenic plant/organism ⇒** plant/organism that contains and expresses a transgene. The cells containing and expressing transgenes can be easily selected in vitro and valuable plants can be regenerated from these cells.

**NEW AND UNDER UTILIZED CROPS**

1. Out of 3,50,000 known plants at this time, a few i.e about 100 plants are being used for fulfilling man's daily requirement.
2. Less known and under-utilized crop plants, which can be used for food and other purposes in future are known as new crops.

(i) **Triticale (Muntzing) :-** It is the first man made cereal crop, which has been produced by inter-generic hybridization between common wheat (***Triticum aestivum***) and **European rye** (*Secale*).
Triticale is **hexaploid** (When tetraploid wheat is used) or **Octa ploid** (when hexaploid wheat is used)
Triticale is not suitable for purpose of bread making because of low gluten content, but it is a good forage crop.

(ii) **Winged bean : (*Psophocarpus tetragonoloba*) :**This is a herbaceous plant, which has capacity of nitrogen fixation. It produces long pods with four prominent wings (So named winged bean).

- The tuberous roots, leaves, pods and seeds are highly nutritious due to rich source of proteins.
- The ripened seeds contain about 34% proteins and 13% oils (similar to soyabean)
- This plant can be used as a green manure plant, fodder plant.

(iii) **Jojoba = (*Simmondsia chinensis*) :** This is a shrub, which is native of Mexican deserts. It is important desert plant and hence is being grown in deserts.

- The seeds of this plant contain about **50% liquid wax,** which is similar to sperm whale oil (spermaceti)
- This liquid wax was originally used in cosmetic, but now is also being used in high-performance lubricants required to withstand extreme pressures.
- So growing of this plant, can reduce the pressure on sperm whales, which are killed for their oil.
- **Jojoba** can thrive under poor soil and low moisture conditions. Its cultivation in arid regions of the world help in economic development of the poor.

(iv) **Guayule = (*Parthenium argentatum*) :** It belongs to family *Asteraceae.*

- This is the **native of America.**
- This plant commonly known as **"Congress grass".** It is a terrestrial weed in India.
- This plant is a shrub and can grown on poor desert soil.
- This plant is now days used in obtaining rubber, which is called **"Guayule rubber".**
- Guayule rubber is similar to **Para rubber** or **hevea rubber.**
- The plant contains 12-20% rubber on dry weight basis.
- This plant can be a natural source of rubber in future.

(v) **Leucaena or Subabul :- *Leucaena leucocephala* (fam. leguminosae)**

- This is a fast growing **leguminous tree** and native of **Central America.**
- This plant is nowadays being planted on a large scale under **"social forestry"**
- This plant is used as **wind breakers, fire breaker, shade plant** for deforested **tropical regions.**
- It's leaves are used as fodder, wood as fuel and in charcoal formation, paper pulp, rayon and timber.

**OTHER UNDER UTILIZED CROPS**

**(a) Oil plants :-** Some potential oil yielding plants are there, which provide edible and non edible oils after suitable treatments. Some potential oil crops are as follow :-

**(i) Margossa or neem :-** ***Azadiracta indica*** **(fam. meliaceae)**
It is native of **Burma** and is widely grown tree in **India**. Seeds are source of **margossa** or **neem oil** with bitter taste, used in **soap making.**
**(ii) Buffalo gourd (*Cucurbita foetidissima*)** seeds of this plant provide oil.
**(iii) Bitter colocynth (*Citrullus colocynthis*)** seeds give oil.
**(iv) Mahua (*Madhuca indica*) :-** seeds give oil, used in soap making and also cooking purposes.
**(v) Pilu (*Salvadora persica*), Brihath pilu** (*S. oleoides*) **sal (*Shorea robusta*), karanj (*Pongamia pinnata*)** seeds of all these plants give oil.
**(b) Some non-alcoholic beverages (less known) :-**
**(i) Mate** or **Paraguay** tea :- Leaves of ***Ilex paraguariensis***
**(ii) Cola :-** Powdered seed of ***Cola nitida***
**(iii) Khat** or Arabian tea-From leaves of ***Catha edulis***
**(c) Fodder trees :-**
**(i)** ***Acacia nilotica*** (kikar or Babul)
**(ii)** ***Albizzia lebbec*** (siris)
**(iii)** ***Ficus religiosa*** (Peepal)
**(iv)** ***Morus alba*** (white mulberry)
**(v)** ***Sesbania grandiflora*** (Basna)

**PESTICIDES**

Pesticides are those substances, which are used to kill, control or repel pest.
**Pests :** Pests are the organisms (viz-disease causing microbes, insects, mites, nematodes and weeds) those cause harm to human interests by destroying the agricultural crop, storage of plant products as well as bring about diseases in domestic animal and beings.
Pests cause loss in agricultural productivity up to about 30%
.
**Type of Pesticide :**

## Chemical Pesticides

- **Algicides** Ex. Copper sulphate
- **Rodenticide** Ex. Warfairine, Zinc sulphate, Zinc phosphide
- **Nematicide** Ex. Chloropicrin Methylbromide
- **Insecticide** Ex. DDT, Malatonin, Aldrin Pyrethrin
- **Fungicide**, Ex. Bordaux mix ($CuSO_4 + Ca(OH)_2 + H_2O$) Discovered from disease downy Mildew in grapes by Millardet (France uni. of Bordaux)
- **Weedicide/Herbicide** Ex. Triazine Glyphoset Round up 2, 4-D and 2, 4, 5-T

## Classification of Pesticides [On the basis of chemical structure]:

### Pesticides

#### Chemicals

- **Organochlorine**
  Chlorine containing aromatic hydrocarbon,
  Lipophilic-deposit in fatty tissue, non biodegradable
  So cause biomagnification
  Ex. : DDT, BHC, Aldrin
- **Organophosphate**
  Ex. Malathion, Parathion, Fenitrothion, Trithion
  → organic esters of phosphoric & triphosphoric acid
  → Affects CNS, inhibits activity of cholinesterase so breakdown of Acetylcholine stop block nerve conduction
- **Carbamates**
  Ex. Carbaryl, Carbofuran, Aldicrab (temic), Propoxur (Baygon)
  Fungicide – Dithio carbamate
  Herbicide – Phenyl carbamates & Thiocarbamates
  MIC – Used in carbonyl synthesis
  Bhopal Gas Tragedy - 3Dec.1984
  → Similar to Acetylcholine, So binds with enzyme Acetyl Cholinesterase (Competitive inhibition)
  Affect : Nervous system
- **Pyrethroids**
  Derivative of Pyrethrin
  Obtained from – Chrysanthemum
  Sp. Cinererifolium,
  Sp. Marschelli
  Insecticides
- **Triazines** (Herbicide)
  Ex. Atrazine, Simazine,
  Derived from urea
- **Auxin derivatives** (Herbicide)
  2,4-D, 2,4,5-T, TCA-Dicot
  Dolapan – Monocot

#### Biopesticides

- **Bioherbicide**
  - **Mycoherbicide**
    Devine – Phytopthora, Palmivora
    Kill a vine Morrenia in Citrus Orchards
    Collego – colletotrichcm gloeosporioides
  - **Predators**
    → Cactoblastis cactorum insect eat prickly pear cactus, India, Australia
    → Fungi Cercospora rodmanii acts on Eichornia
  - **Smoother crops**
    Not allow to grow weed
    Ex.:Sunflower, Soyabean, BarleyRey
  - **Allelopathy**
- **Bioinsecticide**
  - Parasite, Predator & Pathogen control
    Ex. : Preying mentis eath Aphids
    Bacillus thuringensis
    Insect – Gambusia Fishes – eat mosquito larva
  - **Sterilization**
    Male sterilize by U.V. Ray using breeding season
    Ex.:Control of screw worm & Red weavil
  - Pheromone trap-male are trapping
  - Confusion technique
    Spray of sex attractants in field confuse male
  - Juvenile hormone use early development
  - **Natural insecticides**
  - Rotenone-Respiratory inhibitor from Derrisceliptica
  - Nicotine - Tobacco
  - Pyrethroids - Chrysanthamum
  - Azadirachtin - Neem
  - Thuriocides – Bacillus thuringensis
  - Sporeine

**Mode of action of pesticides:**

1. Most of the herbicides have affected on photosystem II$^{nd}$ of photosynthesis (disturbing the photolysis of water and oxygen evolution). Some herbicides block sieve tube i.e. disturb translocation of organic food.
2. Most of the insecticides kill insects by affecting their nervous system. Some insecticide arrest the respiratory system and kill the insects.

**Advantages of pesticides**

1. Increase in yield of food and other crop plants.
2. Pesticides control vectors or carriers of different disease causing organism.

**HARMFUL EFFECTS OF PESTICIDES**

**(1) Environmental pollution :** As pesticides are non selective in their mode of action, so these also kill useful organisms along with harmful organisms thus equilibrium state of ecosystem is disturb.
Excessive use of insecticide in crop, some time leads to decrease in productivity. Because pollinator insects are also killed.
**(2)** As pesticides are poisonous or toxic, so cause serious health hazards.
**(3)** Excessive and prolonged use of pesticides leads to resistance in pest. Hence high concentration of pesticides is to be used in controlling to these resistant pests; this effect is called **"Pesticide trademill".** Pesticide trademill leads to increase in $LD_{50}$ concentration of pesticides.
**LD 50 (Lethal Dose 50) :** It is the minimum concentration of pesticide which can kill 50% of total pest population.
**(4)** Due to their non biodegradable nature, their concentration increases in the body of organism of successive trophic level, with the rise in trophic level is called **biomagnification** or **bioconcentration.**
Most organochlorines are fat soluble and undergo biomagnification.
In India as a result of prolonged use of DDT, 13-31 ppm of DDT can be detected in the body fat of people. (highest in world).

**Development of resistance to pesticides**

When pesticides are sprayed, some pest individuals having :
**(i)** Less permeable cuticle
**(ii)** Capability of faster storage of toxin in fat.
**(iii)** Better enzyme equipment for metabolising the toxin.
So due to above reason pest individuals develop resistance to pesticide.

## INTEGRATED PEST MANAGEMENT (IPM)

It is technique of pest control, which involves natural methods to a greater extent. IPM involves use of different pest control method, which are ecologically sound i.e. do not cause hazards to environment. A complex system of check and balances and use of different methods to kept the pest population at manageable level and loss by pest at minimum level known as IPM.
eg. Biological control method. better agricultural practices like-crop rotation, sanitation, use of resistant varieties, etc.

## BIO-FERTILIZER

- Fertilizers are used to increase soil fertility.
- Among the sixteen essential plant nutrients, N,P,K are deficient in Indian soil.
- Fertilizers, which contain only one primary nutrient are called **straight fertilizer** or **simple fertilizer. eg. Urea, Mono ortho pottash (Mop).**
- Fertilizers, which contain two or more primary nutrient are called **compound** or **multinutrient fertilizers. eg. Di-ammonium phosphate, N:P:K etc.**
- Use of chemical fertilizers increase food production, but side by side there are many hazardous effect of these chemical substance on environment and organisms. Chemical fertilizers are highly expensive.
- Excessive use of chemical fertilizer requires more number of irrigation which leads to increase in salinity of soil.
- Use of fertilizers of biological origin is an alternative for overcoming the harmful effects of these chemical fertilizers-

### Fertilizers of biological origin.

They are two types :-
(A) Manures
(B) Biofertilizers.

**(A) Manures :-**
Manure is semi-decayed organic matter, which is added to the soil in order to increase soil fertility, aeration and water holding capacity.

### Three types of manures

**(i) Farmyard manure :** This type of manure consisting of cattle dung, farm refuse, fallen leaves and twigs. These materials are placed in heaps and allowed to

decompose till they form a dark amorphous substance. **e.g.** Product of gobar gas plant.

**(ii) Composited manure (Compost) :** This manure consist of rotten vegetable matter, sewage sludge and animal refuse. Some chemical fertilizers added in small amount.

**(iii) Green manure :** These are fast growing herbaceous crops, which are ploughed down and mixed with the soil, while still green. These provide both organic matter and nitrogen to the soil.

The green manure check **"soil erosion"** by forming protective soil cover and also prevent **leaching** of minerals.

Green manures increase crop yield by 30-50%

Some important green manure crops, which are mostly members of family leguminosae are as follow-

| | BOTANICAL NAME | COMMON NAME |
|---|---|---|
| (i) | **Crotolaria juncea** | Sun-hemp |
| (ii) | **Sesbania aculeata** | Dhaincha |
| (iii) | **Vigna sinensis** | Cow pea |
| (iv) | **Trifolium alexandrinuni** | Berseem |
| (v) | **Lens exculenta** | Lentil (Masur) |
| (vi) | **Cyamopsis tetragonoloba** | Cluster bean |
| (vii) | **Melilotus parviflora** | Senji |
| (viii) | **Sesbania rostrata** In this plant both stem nodules and root nodules are found. It is used as a biofertiliser crop. | |

**Medical Plants**

**MEDICINAL PLANT:**

The branch of science in which study of medical plants is done known as **Pharmacognosy**

.

**Hippocrates** is known as father of medicine. **"Discorides"** is known as father of pharmacognosy.

**1. CINCHONA OFFICINALIS**

**Cinchona Officinalis**

**(i) Hindi Name –** "Quinine" or "Jaisuitbark" or "Peruvian bark" or "Countess bark". Cinchona officinalis is dicotyledon and belong to **Rubiaceae** family.

**Distribution –** This plant is mainly found in Peru country. Its many species are grown in India. **Indonesia** and **Jawa Island.** The maximum amount of quinine (medicine) obtains from **Clidgerina.**

**(ii) Habit –** This is medium size plant and **perennial.** The credit goes on **"La-condamine"** for discovery of this plant. The name of Cinchona was coined by **"Linnaeus"** on the name of Mrs. of Vice Roy of Peru Island – **"Cinchon".** This plant first time introduced inIndia from Jawa-Island by **"Anderson".**

**(iii) Source of Medicine –** This quinine is obtains from the **bark** of plants of genus of cinshona. First of all bark removed from the stem, branches and root (mainly stem) during the rainy season. The bark almost contain approximately 25 type of alkaloids like **Quinine, Quinidine. Cinchonine** and **Cinchonidine.** The chemical formula of quinine is $C_{20}H_{24}O_2N_2$. The quinine is obtained in the form of quinine sulphate. All the alkaloids of Cinchona collectively known as **"Totoquine".**

**(iv) Medicinal uses –**

(i) The maximum uses of quinine is for treatment of **Malaria.** It is effective on asexual stage – (schizont of malarial parasite).

(ii) Quinine used in bacterial infection and **pneumonia** for their treatment because it is **antibacterial.**

(iii) Its application is also effective in the infection of **protozoans.** It is used in **ameobic dysentry.**

(iv) Quinine is **"insects repellent".** It uses for protection of costly clothes, fur and feathers.

(v) Exclusing quinine, Quinidine used as **"inhibit auricular stimulation"** [cardiac depressant].

(v) Quinine is also used for making **hair lotion**.

**(v) Precautions –**

(i) High-dose of quinine can causes **"blindness"**, **"deafness"** and **"giddiness"**.

(ii) It should not be given to pregnant ladies and heart patient.

## 2. CURCUMA LONGA

**"Haldi"** or **"Turmeric"** This is of family **zingiberaceae** and **monocotyledon** plant.

**(i) Distribution –** The cultivation of turmeric is mainly in **India** & **China**. But now a days it is also grown in **Pakistan**, **Sri Lanka**, **Indonesia** and **Peru**.

**(ii) Habit –** This is a perennial herbs which grows as **under ground rhizomes**.

**(iii) Source of Drug –**

(i) The medicine obtains from the under ground **rhizomes**.

(ii) First of all rhizomes boil in water for 10-12 hours, then after dries in sun light. By this process, the yellow colour oozes from the secreting cells and spread over the all parts of rhizome.

**(iv) Composition of Drug –** This is a **cellular** and in the form of powder. Turmeric is a type of tissues. (It contains **volatile oils**. The main coloured alkaloids are curcumine and zingiberine. The volatile oil usually is **umbelliferine**.

**(v) Medicinal Uses –**

(i) Turmeric used as a **carminative** (digestive). it remove **indigestion**. It increase the secretion of **bile juice**.

(ii) It is a **tonic** and **stimulant**.

(iii) It used as in the form of **antihelmintic**.

(iv) Its decoction is useful in **cold** and **cough**.

(v) It is also used as **blood purifier**.

(vi) It used with milk as pain killer for any type of injury. It also help in wound healing.

(vii) It used with milk as pain killer for any type of injury. It also help ion wound healing.

(viii) "Kumkum" which is the symbol's of Indian married woman's is formed from turmeric. When turmeric powder treated with concentrated sulphuric acid then it changed into red colour powder.

(ix) There is no side effect of turmeric. It is used as spices

## 3. FERULA ASAFOETIDA

**"Hing"** or **"asafoetida"** or **"Devil's dung"**

The family asafoetida is **Umbelliferae** or **Apiaceae**. It is dicotyledon plant. This plant is **perennial** herbs

**(i) Distribution** – It is extensively found in **India**, **East Iran** and **West Afganistan**. In India, only grown in **velley of Kashmir**.

**(ii) Source of Drug –** This drug obtains from the root. If the roots cut from the base of the stem then it give more medicine. The **resin** like material come out from the cut. It becomes dark brown in colour after dryness. This is very bitter in taste and it has **pungent smell**. the cut is made on the root in the month of April before flowering.

**(iii) Composition of drug –** Asafoetida is **acellular oleogum resin.** It contains **carbon disulphide**, **Penine**, **Umbelliferine** and **Ferulic acid**. Its pungent smell and bitter taste is only due to presence of carbon disulphide compound. It lack alkaloids.

**(v) Medicinal Uses –**

(i) It used as a **spasm releiver**. It cure **flatulent colic pain**.
(ii) It used in **Cholera, whooping cough** and **Jaundice**.
(iii) It is used in the disease who is suffering by **"fits"** or **Epilepsy**.
(iv) It is used in respiratory disease - **bronchitis.**
(v) It help to remove **worms** from alimentary canal.
(vi) It is used as spices in India
(vii) It is used to check abdominal swelling in the form of paste.
(viii) It is very useful medicine to remove **constipation**. [As powerful **anticonstipation agent**].
(ix) It has no side effect.

## 4. PAPAVER SOMNIFERUM

**Common name – "Post", "Poppy", "Apheem"**
This plant is dicotyledon of papaveraceae family.

**(i) Distribution** – It is extensively cultivated in India, Japan, China, Pakistan, Turkee and Iran. In India it is grown in district of **Rajasthan** such as **Banswara**, **Jhalawar**, **Chittore**; and **Faizabad** of Uttar Pradesh; **Ratlam**, **Neemach** and **Mandsor** in M.P. It is also known as **"Black Gold"**. The cultivation of poppy is under the control of Government. The 70% of opium of world is cultivated in India.

**(ii) Habit –** The plant is **annual herb.** The fruit is a capsule and persistant with stigma. The flowers are big, white, pink or red in colour.

**(iii) Source of Drug –** The drug obtains from the **unriped capsule**. The parallel cuts are marked on the capsule. From these cuts yellow coloured milk comes out. It is known as latex. When dries, it becomes dark brown or black in colour. This opium is bitter in taste and with smell. The cultivation of best quality or opium is in Mandsore district of Madhya Pradesh.

**(iv) Composition of Drug –** The drug is acellular latex. The latex of opium contains 25 types of alkaloids. Out of them the main alkaloids as follows –

| | | |
|---|---|---|
| Morphine | - | 09-14 % |
| Nascapine | - | 03-10% |
| Thebaine | - | 0.2-1% |
| Codeine | - | 0.5-02 % |
| Papavrine | - | 0.8-1% |
| Narcine | - | 0.2-4% |

**Other alkalloids** – The pseudomorphine, protopine cryptopine etc. narcotic substances obtain. Some of more dangerous substances obtain from the opium which have many times more effective than opium such as
– **Heroin** or **Diacetylemorphine**.

**(v) Medicinal Uses –**
(i) Morphine is a effective and **strong analgesic**. It is extensively used in all type of pain like burning, fracture of bones, kidney pain etc. (Visceral pain)
(ii) The opium has **sedative action** and induce **sleep**. It means it release all **anxiety** and bring a **sound sleep**.
(iii) Codeine used in **cough** and **cold**. It is an effective drug for cough.
(iv) This drug is used for treatment of **insomnia**. All the alkaloids of opium have effect on central nervous system.
(v) It is used in **dysentry**.
(vi) The paste of opium is used for **piles**.
(vii) It stops the possibility of **abortion** and it is also very useful to relieve the pain after the birth of child.
(viii) It is also very useful in **ulcers** and **gastritis**.

**(vi) Side effects –** The continuous use of opium a person becomes **addictive** and then after it has no effect. It reduce hunger and responsible for constipation. Chinese started a **opium-war** because there habitants were addicted.

**(vii) Precaution –**

(i) Opium should not be given to the child and old persons.
(ii) The person should not taken those who are suffering by **respiratory disease.**

## 5. RAUWOLFIA SERPENTINA

**(i) Common Name – "Sarp Gandha"** or **"Small Moon"** or **"Chnad Mukha"** or **"Serpent Root"** or **"Snake root"**. It is a dicotyledon plant of **apocyanaceae** family.

**(ii) Distribution –** It is naturally found in **Burma, Pakistan, Jawa, Nepal** and **Thailand.** It is distributed in **Assam**, **Sikkim**, **Bihar** and **U.P.** in **India** The name of this plant (Rauwolfia) coined by **"Charles Pluminger"** on a German Scientist – Leonard rauwolf

.

**(iii) Habit –** It is perennial, erect bushes.

**(iv) Source of Drug –** It is usually obtains from the **root with bark** of the plant. First of all root taken with its bark after 2-3 years old plant. The roots are pungent and bitter in taste.

**(iv) Composition of Drug –** The drug obtains in form of cellular and powder. The root of Rauwolfia contains almost 70 types of alkaloids in which **reserpine** and **serpentine** is the main alkaloids. The other alkaloids are **Ajmaline**, **Rauwolfine**, **Riscinnamine** and **Yohimbine** etc. The chemical formula of Reserpine is $C_{33}H_{40}N_2O_9$. The first time reserpine extracted by **Muller** and **Schitler** from the plant. Reserpine is a most important drug.

**(v) Medicinal Uses –**

(i) Reserpine is used from ancient period for **snake's biting**, **epilepsy**, **insanity and insomnia**.
(ii) Reserpine reduce **high blood pressure**. It decrease high blood pressure during hypertension.
(iii) It is used to cure voice which is disturb due to drinking of alcohol.
(iv) It is used to cease the effect of high madness (mental imbalance or Schizophrenia) it is also very useful to release the **fear** and **anger** as well as reduced the **excitement**.
(v) It is called as **"medicine of insanity"** in India.
(vi) Reserpine increase the **peristalsis movement** and secretion of **gastric juice**.
(vii) The flow of blood increase in brain through the **ajmaline**. The juice of leaves of ajmaline removes the opacity of white region of eye.

(viii) The effect of L.S.D. (Lysergic acid di-ethylamide) on central nervous system, decreased by reserpine.
(xi) It is used to stop the **aggressive nature** of wild animals.
(x) It contract the uterus, so that it is used to stop the **excess bleeding** during birth.
**(vii) Precautions –** This drug should not be given to patient of **peptic ulcer**, **asthma** and **heart patients**.

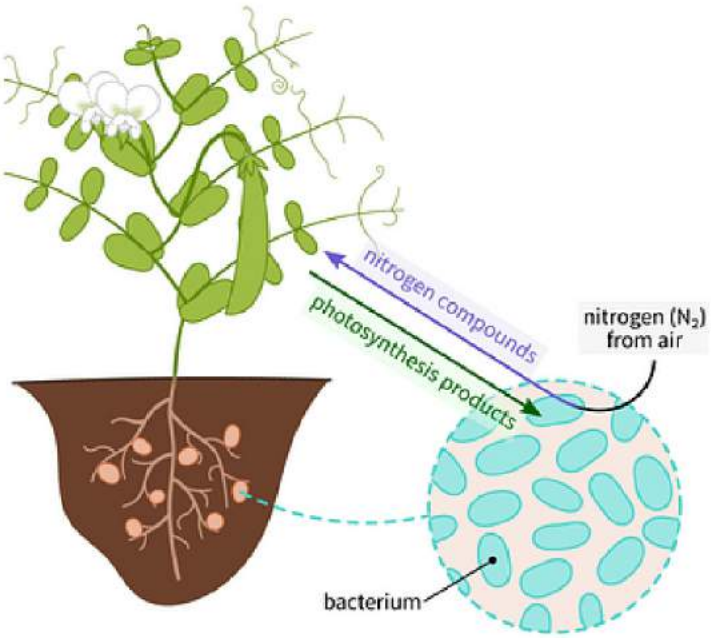
| Name | Family/Sub family | Products | Clinical use |
|---|---|---|---|
| Digitalis | Scrophulariaceae | Leaves of digitalis purpura | Cardiac stimulant and relieving dropsy |
| Belladona | Solanaceae | Dried roots leaves and tops of Atropa belladonna | Atropine dilation of pupil and Belladona – Pain reliever |

## Biofertilizers

**Biofertilizers :-** These are the organism like bacteria, blue green algae and fungi (mycorrhiza) which enrich the soil in nutrients. Some important bio-fertilizers are :-

**(1) Bacteria as bio-fertilizers :-**

**(a) Symbiotic nitrogen fixing bacteria :**



## Nitrogen Fixing Bacteria

**Rhizobium leguminosarum "**: bacteria lives symbiotically in root nodules of legumes. In root **nodules, Rhizobium** fixes atmospheric nitrogen in the presence of red pigment "**leghaemoglobin".**
Presence of phosphorus, is essential for nitrogen fixation.
One legume plant ***"Sesbania rostrata"*** has double symbiotic relationship with nitrogen fixing bacteria → **Rhizobium** in the root nodules and "***Aerorhizobium caulinodans***" in stem nodules.
**Frenkia,** a nitrogen fixing filamentous bacterium associated symbiotically with the root nodules of non-legume plants like **Casurina, Rubus, Alnus myric*a.***

**(b) Free-living nitrogen fixing bacteria :**
Some bacteria
like **Azotobacter** (aerobic) **Clostridium** (anaerobic), **Beijerinckia** (aerobic) are free living nitrogen fixing bacteria of soil, which increase fertility of soil.
**Bacillus polymyxa** is another example of free living nitrogen fixing bacterium.

**(c) Loose association of nitrogen fixing bacterium :**
A bacterium **"Azospirillum lipoferum"** forms loose association with roots of maize and Brazilian grasses, which increases crop yield **(Dobriner).**

**(2) Blue green algae (Cyanobacteria) as biofertilizers :**

**(a) Free living nitrogen fixing BGA :**
Blue green algae like **Anabaena, Aulosira, Tolypothrix, Plectonema** are the most common nitrogen fixing organism.
Blue green algae fixes Nitrogen with the help of **"heterocyst".**
Photosynthesis provides the energy for nitrogen fixation.
**"Aulosira fertilissima"** is the most active nitrogen fixer of rice field.

**(b) Symbiotic Nitrogen fixing cyanobacteria :**
**Azolla pinnata** is a small aquatic fern inoculated to rice field of South-East Asian countries. It's leafy cavities contain symbiotic **BGA-Anabaena, Nostoc, Oscillatoria.**
**A. pinnata** is best biofertilizer for rice. Farmers have reported 50%-higher yield of rice by using **A.pinnata.**
**(3) Fungi as biofertilizer :-**
**(i) Mycorrhiza :-** Symbiotic association between roots of higher plant and fungal hypae is called mycorrhiza. It is of two types:
**(a) Ectotrophic or ectomycorrhiza :-** Fungal hypae are present on the surface of root, It increases water and nutrient absorption, growth & yield of plant.

**e.g** Found in **Pinus, Oak, Eucalyptus. Hebeloma, Laccaria, Pisolithus** are fungi which formed ectomycorrhiza.

**(b) Endotrophic or Endomycorrhiza :-** Fungal hyphae are present inside or between the cells of cortex. It occurs in **coffee, pepper, cardamom. Glomus, Gigaspora, Sclerocystis** are fungi which formed endomycorrhiza.
In many grasses and orchid, the fungal hyphae penetrate to the cortical cells, which swell to form vesicles or arbuscules. So it is called **Vesicular Arbuscular Mycorrhiza (VAM).** It has significant role in phosphate nutrition of plants.

## ECONOMIC BOTANY

### CEREALS

These are the members of family Gramineae and grown for their edible seeds.
**(1) Wheat (*Triticum aestivum*)** : - Wheat is the chief cereal used by man as food from ancient times. It is an annual grass and the inflorescence is a terminal spike consisting of 15-20 spikelets. The important varieties of wheat, grown in India are **Kalyan sona, Sonalika, Sharbati Sonara, Lerma Rojo, Sonara 64** etc.

**(2) Maize(Zea mays) : -** It is the second important cereal crop. Maize is a tall annual grass with height of 4 to 10 feet ; plants are monoecious. In India common varieties grown are Sona, Vijay, Jawahar, Vivek-8, Amber etc. The maize grains are very nutritious ; they contain high percentage of easily digestible carbohydrates, proteins and fats; the grains are also used in the manufacture of corn starch, glucose and alcohol ; also used as a chief food for livestock ; the fibre from stem and spathe is used in paper industry.

**(3) Rice (Oryza sativa) –** Rice is the principal food crop of millions of peoples of the world. The rice plant is an annual grass having a height of 2-4 feet and produces a panicle, an inflorescence consisting of a number of fine branches. It grows best on damp soils, where it can be flooded . The rice grains are used as a food after cooking; stem, husk etc. are used as fodder; grain is also used in the manufacture of alcoholic beverages.

**(4) Sorghum (Sorghum vulgare) :** Sorghum is staple food for millions of peoples in Asia and Africa. It is a tall annual plant with a height of 6-12 feet; the stem is stout and the panicle much-branched. The grains are made into flour often mixed with wheat, forming a nutritious food. The plants are used as fodder, in the manufacture of brushes, syrup and also in the paper industry.

**(5) Barley(Hordeum vulgare) :** - Barley is an annual plant with a height of 3 feet. The inflorescence is a spike; the grains may be white, purple or red and are covered with husk. Barley is used in the preparation of bread, cakes after mixing it with wheat flour ; straw is used as a livestock feed ; also used as a source of malt, used in the manufacture of beer, whisky, alcohol etc.

**(6) Pearl millet** or **Bajra (*Pennisetum typhoides*)** : - It is cultivated almost throughout India. The plants attains a height from 6-12 feet and the dark-brown spikes, 15-25 cm in length occur in clusters. It is an important food for poor people in our country ; the flour is used for making chapatis ; the plants are also used as fodder.

**PULSES**

**(1) Pea(Pisum sativum) : -** It is grown all over India during winter months. The plant is an annual herb climbing by means of tendrils. The seeds are eaten after cooking as vegetable; plants are used as valuable fodder.

**(2) Gram(Chana)(Cicer arietinum) : -** It is cultivated all over India as an important pulse. The plant is a bushy annual and matures in about three months. The seeds are eaten as dal and the flour which is commonly called as besan is used in the preparation of sweets and other foodstuffs; the plants and seeds are also used as cattle feed.

**(3) Pigeon pea or red gram (Arhar) (Cajanus cajan) –** It is widely cultivated in India and is grown as a pure crop or mixed crop. The plant is a perennial shrub. Dry grains are used as dal; leaves form a valuable fodder. Branches are used for making baskets.

**(4) Ground nut (Moongphali) (Arachis hypogea) :** The plant is a bushy annual with underground fruits. Groundnuts are very nutritious as they are rich in proteins. Seeds are used after roasting for preparation of peanut butter ; groundnut oil is largely used as cooking oil.

**(5) Black gram (Urd)(Phaseolus mungo) :** It is the one of the best pulses grown all over India. The plant is a trailing annual. It is used as Dal ; flour is used in the preparation of papads and biscuits ; seeds and straw form a valuable cattle feed.

**(6) Soya-bean(Glycine max) : -** The seeds of this plant are the **protein richest, natural vegetable food** known. It is cultivated all over India. The plant is a small, bushy, erect annual. It has 30-60% protein content. Seeds are used, green or dry; soya milk, soya cheese etc. are prepared from the seeds ; soyabean flour is used in bakery, ice-cream etc.

**(7) Green-gram (Moong) (Phaseolus aureus) : -** It is cultivated as an important pulse crop in Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar and Bengal. The

green pods are eaten as vegetable and seeds are used as dal. The entire plant is used as cattle feed.

## VEGETABLES

Vegetables contain a large quantity of carbohydrates and mineral salts like calcium, iron, phosphorus, iodine etc. they are also rich in vitamins, therefore, are included in our daily diet. Some of the important vegetables are as follows : -

**(1) Potato (Solanum tuberosum-family solanaceae) :** Main vegetable crop. It is an erect, branched annual ; tuber is modified stem, which have different shapes-round, oval and cylindrical ; it is a native of Peru (South America) and was first introduced in India by the Portuguese in the early part of the 17 century ; potato tubers are eaten as vegetable and in various other forms ; they are also used in the production of starch and industrial alcohol.

**(2) Tomato (Lycopersicon esculentum family Solanaceae) : -** It is a native of South Asia ; it is cultivated in warm countries for its fruits, which are used as vegetable. Tomatoes are also used in the preparation of ketchup, sauce, soup and juice.

**(3) Brinjal (Solanum melongena-family solanaceae) : -** It is an erect, branched, annual herb, fruit is large, ovoid, purple or whitish berry ; it is a native of India. The fruits are eaten as vegetable.

**(4) Okra (Bhindi) (Abelmoschus esculentus –family Malvaceae) : -** It is an annual herb with yellow crimson centred flowers ; it is grown in warm countries for its mucilaginous fruits ; it is a native of tropical Africa. The fruits are used as vegetables and also in soup.

**(5) Onion (Alium cepa- family Liliaceae) :** It is a native of South Asia. The food is stored in the bulb; bulbs of onion are popular as vegetable and are also used for flavouring and pickling. The leaves are also eaten as vegetable.

## SUGAR

**(1) Sugarcane (Saccharum officinarum) : -** It belongs to family Gramineae and is the chief source of sugar in India. The plant reaches a height of 6 to 12 feet and a diameter of 1 to 2 inches ; the stem is solid with many fibrous strands and contains juice ; the stems are cut close to the ground and are then sent sugar mills for the extraction of sugar. Molasses is used in the manufacture of rum and industrial alcohol.

**(2) Sugar-beet (Beta vulgaris) :** It belongs to family chenopodiaceae and is the source of sugar in cold countries. The sugar-beet is a biennial herb with tap root. Sugar is extracted from the fleshy roots which contain 15-20% of sucrose.

## FIBRES

**(1) Cotton (Gossypium sp.-family malvaceae) :** Cotton is the most important commercial textile fibres. It is used for a variety of purposes, especially in the manufacture of a large proportion of the clothing. Fibres are produced by the seed coats of various species of gossypium. Fibres are also used for making ropes, twines and threads; raw cotton is also used for stuffing pillows and cushions.
**(2) Jute (Corchorus capsularis and C.olitorius– family Tiliaceae) : -** It is a very valuable bast fibre and is second in use to cotton. The fibres are extracted by the process of retting in which the branches of plants are dipped in water for few days ; after retting fibres are separated. Jute fibres are used for making gunny bags, packing cloth, carpets, cordage, curtains etc.
**(3) Sunn hemp (Crotolaria juncea-family papilionaceae) :** The plants are extensively cultivated in India. The long fibrous strands are made up of lignified phloem sclerenchymatous cells, which are obtained after retting. The fibres are used in manufacture of ropes, canvas, nets, cordages etc.
**(4) Flax (Linum usitatissimum-family Linaceae) :** The fibres are very strong, silky, short in length and are formed in the pericycle of the stem. Flax fibres are used in the manufacture of linen cloth, carpets, canvas, cigarette paper, insulating materials etc.
**(5) Hemp (Cannabis sativa – family cannabinaceae) :** The fibres are obtained from the pericycle after retting. The hemp fibres are long, strong and durable but lacks flexibility. It is used for the manufacture of ropes, cables, nets, canvas etc.
**(6) Munj (Saccharum munja-family Gramineae) :** The fibres is obtained from the stem. It is used for making chair, tables, baskets, mats and ropes.
**(7) Coir (Cocos nucifera-Family palmae)** : It is obtained from the fibrous mesocarp of the fruit ; the fruits are dipped in marine water for many months and then beaten to separate the fibres. Coir is used for making brushes, doormats, carpets, sacs, bags, cordage etc.

## OILS

**(1) Groundnut oil** is obtained from the seeds of **Arachis hypogea-Family Papilionaceae**; refined oil is used in cooking and oil is converted into vegetable ghee by hydrogenation.
**(2) Gingelly or sesame oil** is obtained form the seeds of **Sesamum indicum- family Pedaliaceae** ; oil is used in cooking, medicine, soap etc.
**(3) Coconut oil** is obtained from the dry kernel of the seed of **Cocos nucifera-family Palmae** ; oil is used for cooking, hair oil and in the manufacture of soaps, shampoo, cosmetics etc.
**(4) Mustard oil** is obtained from the seeds of **Brassica campestris- family cruciferae** ; oil is chiefly used for cooking purposes.

(5) **Castor oil** is obtained from the seeds of **Ricinus communis-family euphorbiaceae**: oil is used in medicines, as lubricant and also in making soaps.
(6) **Soyabean oil** is obtained from the seeds of **Glycine max-family Papilionaceae** ; raw oil is used in the manufacture of soap, varnishes, paints etc, ; refined oil is used for cooking purposes.
(7) **Linseed oil** is obtained from the seeds of ***Linum usitatissimum*-family Linaceae**; oil is used in making paints, varnishes, soaps etc.

## TIMBER

(1) **Indian Redwood (Sesham) (Dalbergia sisso- family Papilionaceae) :** The wood is dark-brown in colour and is very strong and durable. It is used for making good quality furniture, carts, boats, etc.
(2) **Teak (Tectona grandis-family verbenacea) – It is the most important wood as it is extremely durable. It is used for making best quality furniture, houses, ship-building, for bridges, railway sleepers etc.**
(3) **Deodar (Cedrus deodara – family Pinaceae) : -** The wood is light, extremely durable, yellowish-brown in colour. It is used for house, building bridges, railway sleepers, light furniture etc.
(4) **Sal (Shorea robusta-Family Dipterocarpaceae) : -** The timber is very hard, heavy, strong and very durable. The wood is of brown colour and is used for beams, furniture, carts, bridges, railway sleepers etc.
(5) **Mahogany (Swietenia mahogoni-family Meliaceae) –** It is a valuable timber tree. The wood is very hard and durable and is used for, making boats, ships, furniture etc.
(6) **Toon (Cedrella toona-family Meliaceae) –** The timber is very light and is used for making furniture, houses, packing boxes etc.
(7) **Mango (Mangifera indica-family Meliaceae) –** The wood is strong, slightly lighter and gray or grayish-brown in colour. It is used for door and window frames, packing cases and tea boxes.

## BEVERAGES

(1) **Tea (Thea sinensis or Camellia sinensis-family Theaceae) :** It is the most popular beverage ; Prepared from the dried leaves of this plant. The plant is now cultivated in China, India, Pakistan, Japan, Ceylon, England and Indonesia. The tea plant is a shrub of 3-4 feet high. The tea leaves are picked by hand which are processed for obtaining different grades of tea leaves.
(2) **Coffee (Coffea Arabica** and **C.robusta-family Rubiaceae)** : Seeds of these plants are the sources of coffee. The seeds are dried in sun or by artificial heat and then roasted to develop flavour, aroma and colour. Coffee plant is a shrub or small tree 16 to 25 feet high. Main coffee plantations are in the hill slopes of South India –

Karnataka, Kerala and Tamil Nadu. It is the favourite drink all over India particularly south India.

**(3) Cocoa (Theobroma cocoa-family Sterculiaceae) –** It is prepared from the seeds of this plant. The beans roasted in iron drums at a temperature of 125ºC to 140ºC. The seeds are finally ground to and oily paste to form the bitter chocolate. Sweet chocolate is made by adding sugar to the bitter chocolate. Cocoa tree is a native of tropical Central and South America.

**RUBBER :**

Rubber is obtained from the latex of **Hevea brasiliensis**-family **Euphorbiaceae**, which is the main source of commercial rubber. The latex is collected by tapping the bark, which is processed for obtaining final rubber. It is used as tyres, tubes, rubber sheets, insulation of electric wires etc. The majority of rubber plantations are in **Kerala,Tamil Nadu and Karnataka.**

**ECONOMIC BOTANY-AT A GLANCE.....**

- Basmati rice is mainly cultivated in U.P. and Haryana in India.
- The millets were the first cereals to be domesticated.
- Highest cultivation and production of cotton takes place in China, 2nd → USA, 3rd → India. In India it is max cultivated in Gujarat.
- Highest cultivation and production of jute fibre is in West Bengal of India. India is the largest producer of jute.
- Brazil is the largest producer country of sugar cane. 2nd → India
- About 80% of sugarcane of India is grown in North India (mainly in U.P.)
- India produces about 90% of gram (Chick pea) of the world.
- China is largest producer of groundnut (China > India)
- Richest plant food-Soyabean [36.5% protein, 17.5% fat]
- Largest wheat producing country is European Union.
- Botanical name of Pop-corn- **Zea mays** var. everta.
- Indian Grassland and Fodder Research Institute is located at Jhansi.
- The principal cereal crop in India is-Rice.
- Botanical name of Indian rye-**Brassica juncea**.
- Centre of origin of rice-India. [South-East Asia.]
- RR-21 is high yielding variety of wheat.
- Cereals are major source of carbohydrate.
- Margarine' is prepared from Groundnut.
- Sugarcane Breeding Research Institute (SBRI) is situated at coimbatore.
- Fish net is prepared from **Linum usitatissimum**.
- The largest fibre crop of East India is-Jute.
- Jute Agriculture research institute (JARI) is situated at Barrackpore (west bengal)
- Commercial jute is morphologically bast fibre.

- Largest newspaper industry is situated at Nepanagar.
- Long fibres of cotton seeds are known as lint.
- The coir industry in India is concentrated in Kerala.
- 'Gingelly oil' or 'Til oil' is obtained from the seeds of ***Sesamum indicum***.
- In ground nut (Arachis hypogea), oil is stored in cotyledons.
- Essential oils are those which are used in perfumes
- Highest sugarcane crop is grown in the world in Brazil. $2^{nd} \rightarrow$ India.
- Industrial toxicology research centre situated at Lucknow.
- 'Metha Jahar' which is useful in rheumatism is obtained from ***Aconitum napellus***.
- Chhattisgarh is also known as **'Dhann Ka Katora'.**
- Central Drug Research Institute is situated at Lucknow.
- Isbgol is obtained from seeds of ***Plantago ovata.***
- LSD is obtained from **Claviceps**.
- IARI, New Delhi is main centre of wheat breeding and research in India.
- Centre of origin of arhar/pigeon pea (Cajanus cajan) is south-east Asia.
- Centre of origin of groundnut is Brazil.
- Rabi crops are those, which grows in winter eg-wheat, Gram, Barley.
- Kharif crops are those, which grows in summer eg-Maize, Bajra, Moong.
- 95% of the world crop of red gram (pigeon pea) is produced in India.
- India is the largest producer of cardamon.
- Oat (Avena sativa) is the most nutritious among all cereals, because of their high fat, protein and mineral contents.
- Russian federation > Canada > USA leads the world in production of oats.
- Urease enzyme is obtained from arhar/pigeon pea/ red gram/Cajanus cajan is used in estimation of urea in urine and blood.
- India is the largest exporter of jute and jute products.
- Jute is a bast fibre and obtained from the secondary phloem.
- Max. Production of Tea-China > India.
- Essential oils or volatile oils are those, which evaporate in contact with air and have a pleasant fragnance.
- Banana **(*Musa paradisiaca* sub sp-sapientum, fam-musaceae)** : It is one of the oldest fruit called 'Adam's fig' and 'apple of paradise'. Banana is the cheapest energy rich fruit having high content of carbohydrates, some fats and proteins.
- Mango **(*Mangifera indica,* fam-Anacardiaceae)** : It is good source of vitamin A, C and K.

## COAL & PETROLEUM PLANTS

Chemically petroleum is a liquid of varying composition. Kerosene, gasoline, benzene and paraffin are some important petroleum products. Melvin Calvin was

first to identify few petroleum plants - the plants whose products can be used in place of petrol and oil. Most of such plants belongs to families-asclepiadaceae, euphorbiaceae, and apocynaceae. These plants are able to convert a substantial amount of hydrocarbon into latex. **Euphorbia lathyrus** contains a mixture like terpene, which can be converted into gasoline.