Aakash + BYJU'S NOTES

# Strategies for Enhancement of Food Production

# Key Takeaways

1. Agriculture
2. Animal Husbandry
3. Dairy Farm Management
4. Cattle Breeds and Breeding
5. Poultry Farm Management
6. Sheep and Goat Management
7. Animal Breeding
8. Control Breeding Experiments
9. Apiculture

# Key Takeaways

10 Fishery

12 Plant Breeding

13 Plant Breeding for Disease Resistance

14 Plant Breeding for Resistance to Insect Pests

15 Plant Breeding for Improved Food Quality

16 Single Cell Protein

17 Plant Tissue Culture

## Summary

# Agriculture

A practice of **cultivating plants** and **livestock.**

## Components of agriculture

### Animal husbandry

### Plant breeding

# Animal Husbandry

- **India** and **China** have **70%** of the **world's livestock population**
- But they **contribute** just **25%** of **livestock product** yield globally


**Livestock :**
Domesticated animals, raised for use or profit

**Examples :**
Buffaloes, cows, pigs, horses, cattle, sheep, camels, goats, poultry farming and fisheries

**Domesticated for:**
Food - milk, meat, honey and egg
Clothing - silk, wool etc.
Labour - pulling, carrying load ploughing

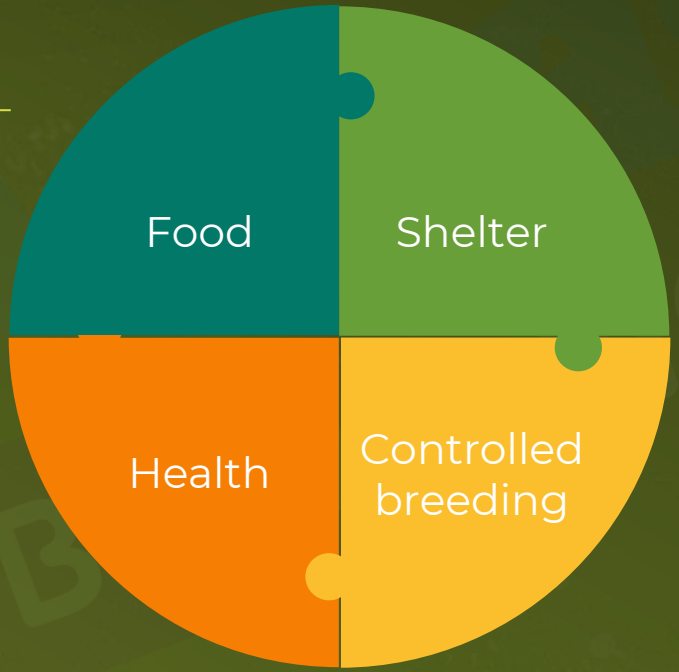
# Management of Farms and Farm Animals

**Food**

Proper nutrition to the animal

Shelter

Hygienic and appropriate shelter to the animal




Health

Regular veterinary care

Controlled breeding

Newer breeding techniques could be very helpful

# Dairy Farm Management

Management of animals for milk and its products for human consumption

## Dairy farm animals

### For milk

Cow

Buffalo

Goat

Sheep

For moving groups from one location to another

Shephard dog

For barns free from rodents

Cat

# Dairy Farm Management

Different kinds of milk products

| | |
|---|---|
| Cream | Prepared by churning milk. Fat layer skimmed from top of the milk |
| Curd | Milk fermented due to the bacterial activities |
| Butter milk | Left over liquid after removal of butter |
| Ghee | 100 % fat prepared after heating the butter |
| Condensed milk | Concentrated milk, with or without sugar |
| Cheese | Coagulated milk protein 'casein' with fat and water |
| Powdered milk | Powder form of milk |

# Dairy Farm Management

**Process and systems**
(To increase yield and improve quality of milk)

# Dairy Farm Management

**Process and systems**
(To increase yield and improve quality of milk)


High milk yielding female

Disease resistant male

High milk yielding and disease resistant breed

# Dairy Farm Management

**Process and systems**
(To increase yield and improve quality of milk)


- Cattle needs to be :
  - well looked for
  - provided with adequate water
  - housed well
  - disease free environment


- Cattle feeding carried out **scientifically**
- Focus on **good quality** and **quantity of fodder**
- Feed provided are :
  - **Roughage** with **high fiber content** (includes fodder, silage, hay and straw)
  - **Concentrate** with **high nutrient value** (includes cereals, millets, forage crops , oil cake, oil seeds and animal by-products)

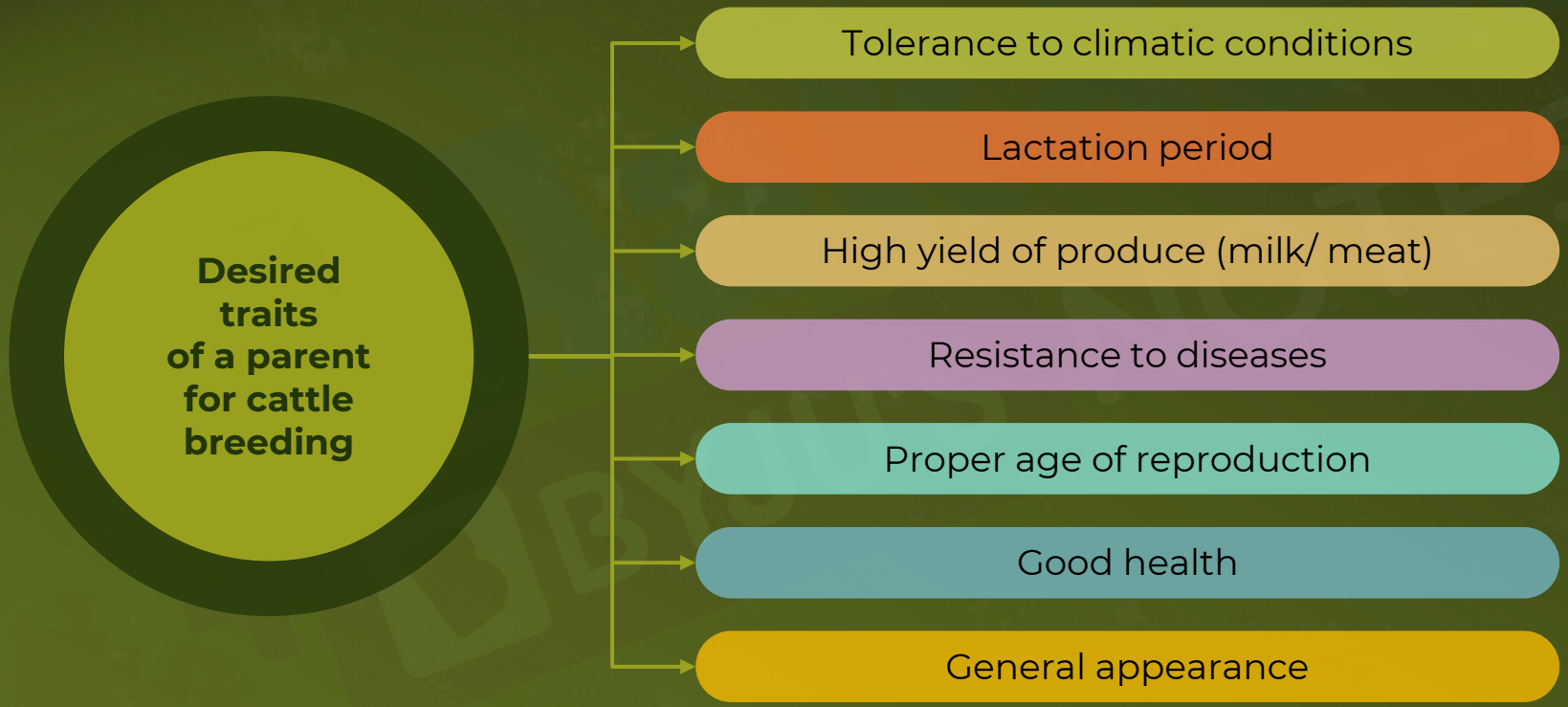
# Dairy Farm Management

**Process and systems**
(To increase yield and improve quality of milk)


- **Regular cleaning** of cattle
- Cleanliness and **hygiene of cattle and handlers** while
  - milking
  - storage
  - transport of the milk and its products


- Ensure housing, feeding and cleanliness **measures are taken**
- Regular **inspections**
- Proper **record keeping**
- Record keeping helps to
  - identify
  - rectify problems
- Mandatory visits of **veterinary doctors**

# Cattle Breeds and Breeding

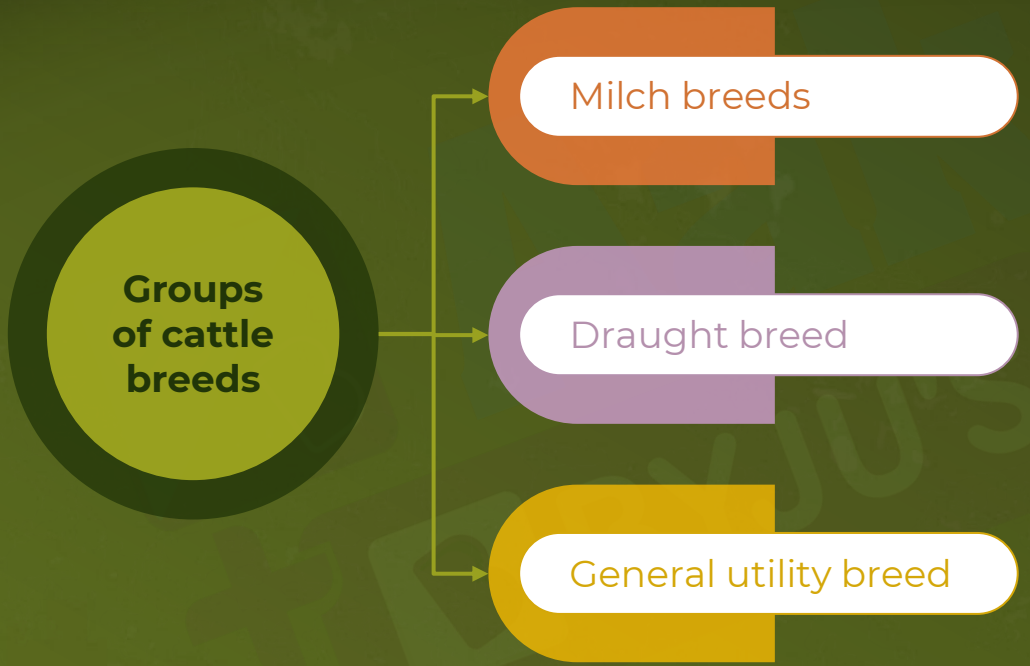


# Cattle Breeds and Breeding

## Cow vs Buffalo

| | Milk yield | Fat content | Disease resistance |
|---|---|---|---|
|  | Low | Low | Lesser |
|  | High | High | Greater |

# Cattle Breeds and Breeding




**Cows -** good in milk production
**Bullocks -** poor quality
**e.g.,** Gir, Sahiwal , Red Sindhi, Deoni etc

**Bullocks -** good for working
**Cows -** poor milk producers
**e.g.,** Malvi, Nagori, Hallikar, Kangayam

**Cows -** good milk producers
**Bullocks -** good draught animals
**e.g.,** Haryana, Ongole, Kankrej, Tharparkar

# Cattle Breeds and Breeding

## Bacterial diseases

### 01 Anthrax

- Caused by ***Bacillus anthracis***
- **Contagious** and affects cattle, sheep, buffaloes, horses and goats
- Spreads through contaminated food, water and pastures

**Prevention**

- **Vaccination** and **antiserum**

### 02 Mastitis

- **Inflammation** of udder in dry cows
- Due to *Corynebacterium pyogenes*

## Viral diseases

### 01 Rinderpest or cattle plague

- Caused by **Rinderpest Virus**
- **Highly contagious**
- Spreads rapidly by direct contact with infected animals
- Through contaminated food, water, workers, clothes and by flies

**Prevention**

- **Vaccination**

# Poultry Farm Management

**Rearing of domestic fowls** (birds) called poultry, for their **eggs** and **meat**

## Poultry

Chicken

Turkey

Duck

Goose

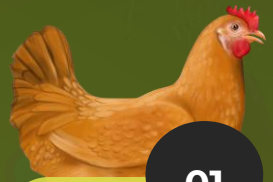
## Use

Meat

Eggs

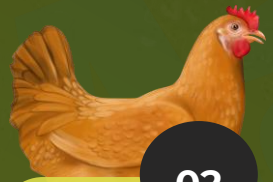
# Poultry Farm Management

Important components



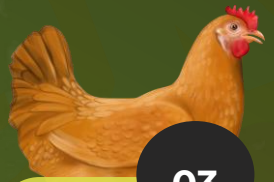
01

Selection of breed



02

Proper and safe farm



03

Proper feed and water

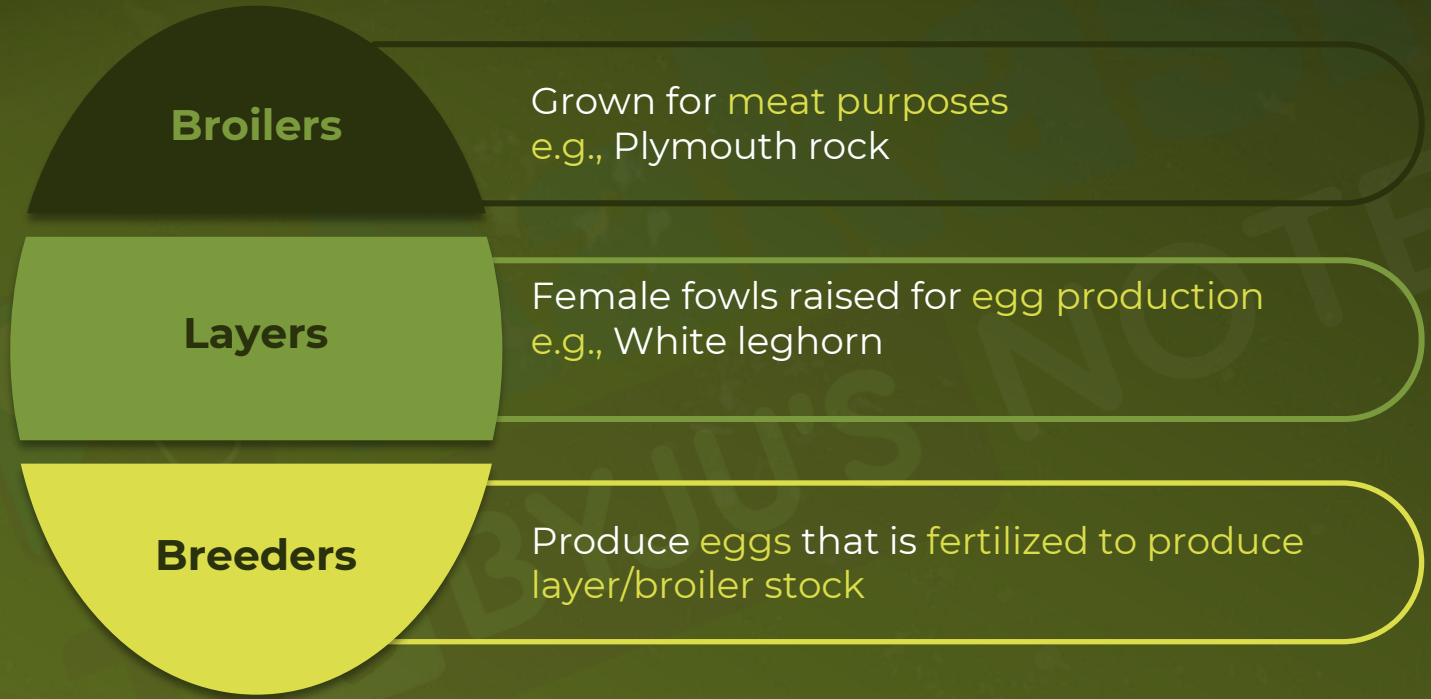
04

Proper hygiene and health care

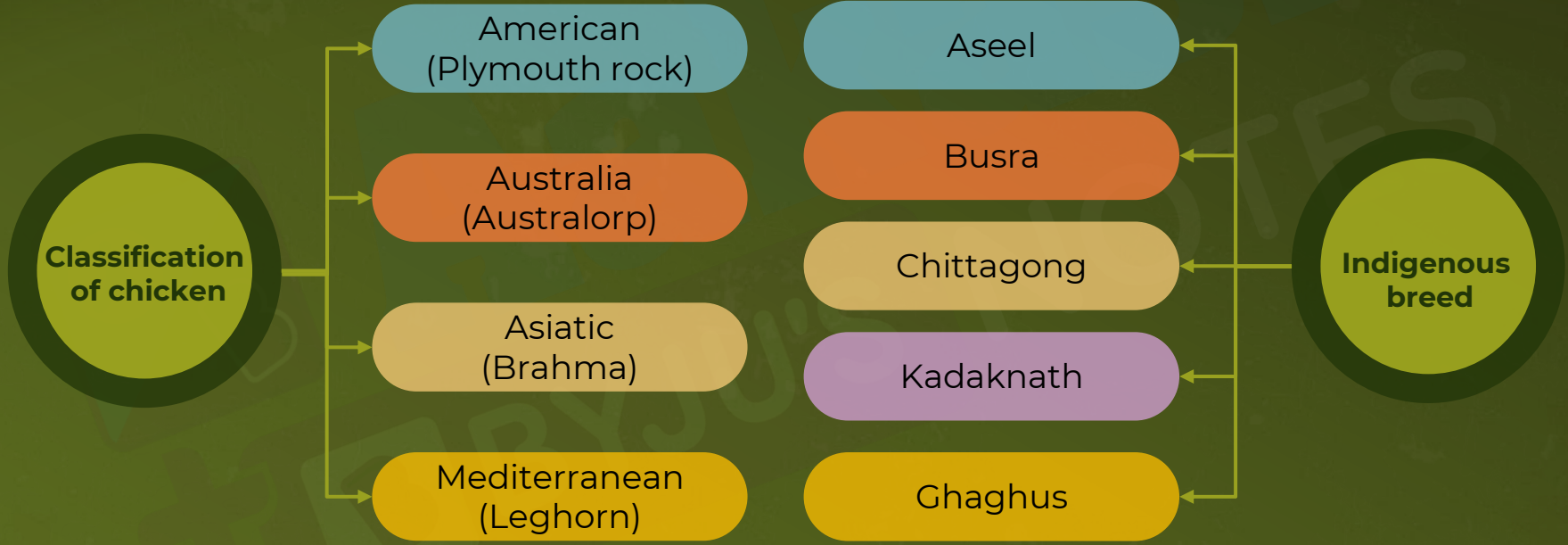
05

Regular inspection

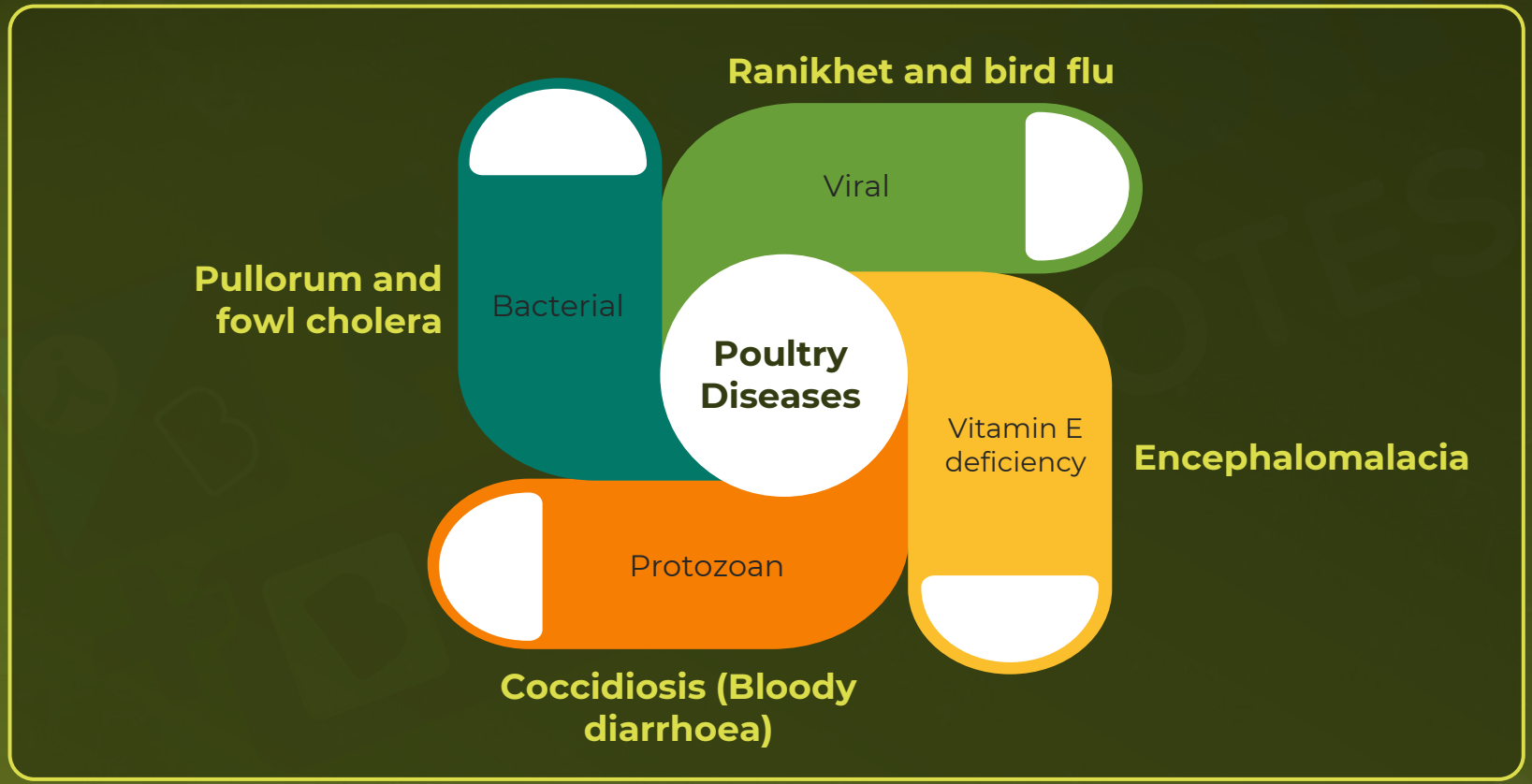
# Poultry Farm Management



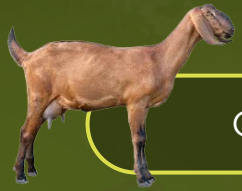
# Poultry Farm Management



# Poultry Diseases



# Sheep and Goat Management



## Goat

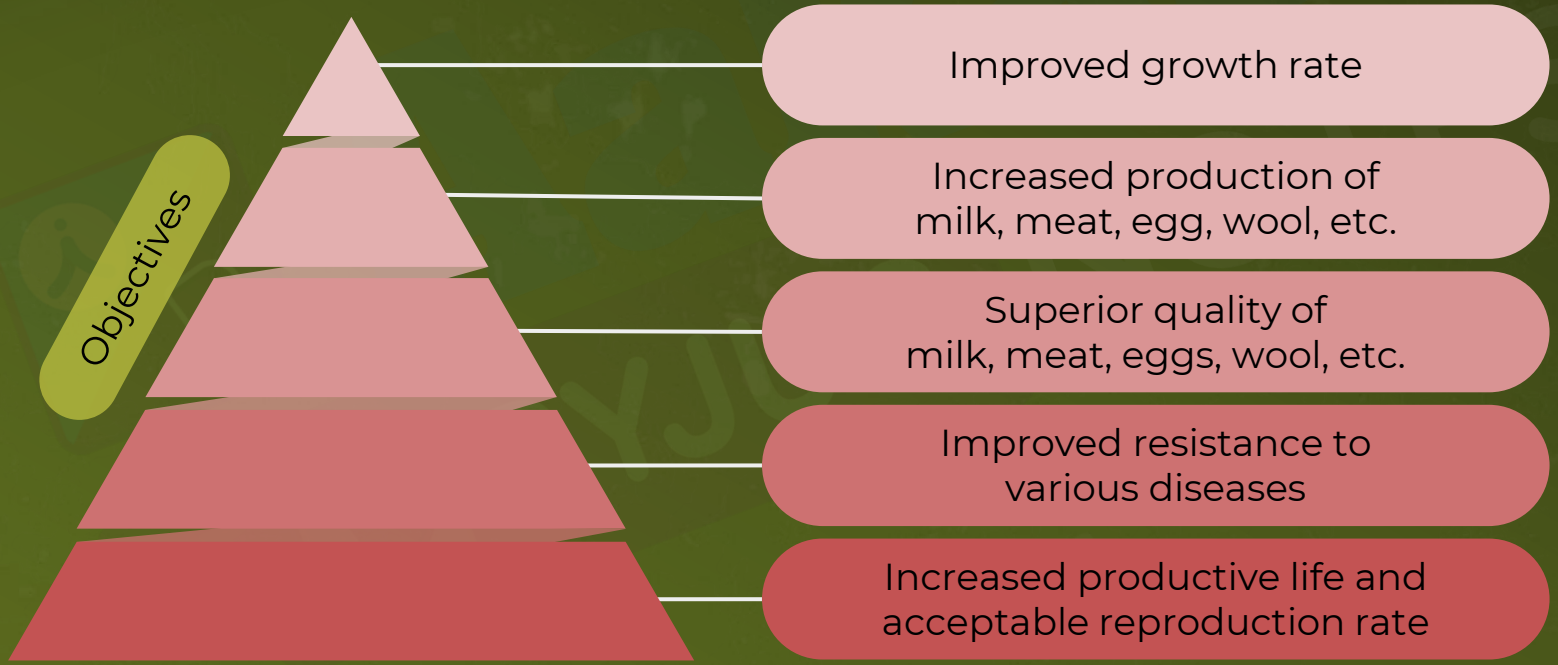
- Reared for
  - **meat**
  - **milk**
  - **hair**
  - **skin**

## Sheep

- Reared for
  - **wool**
  - **skin**
  - **meat**

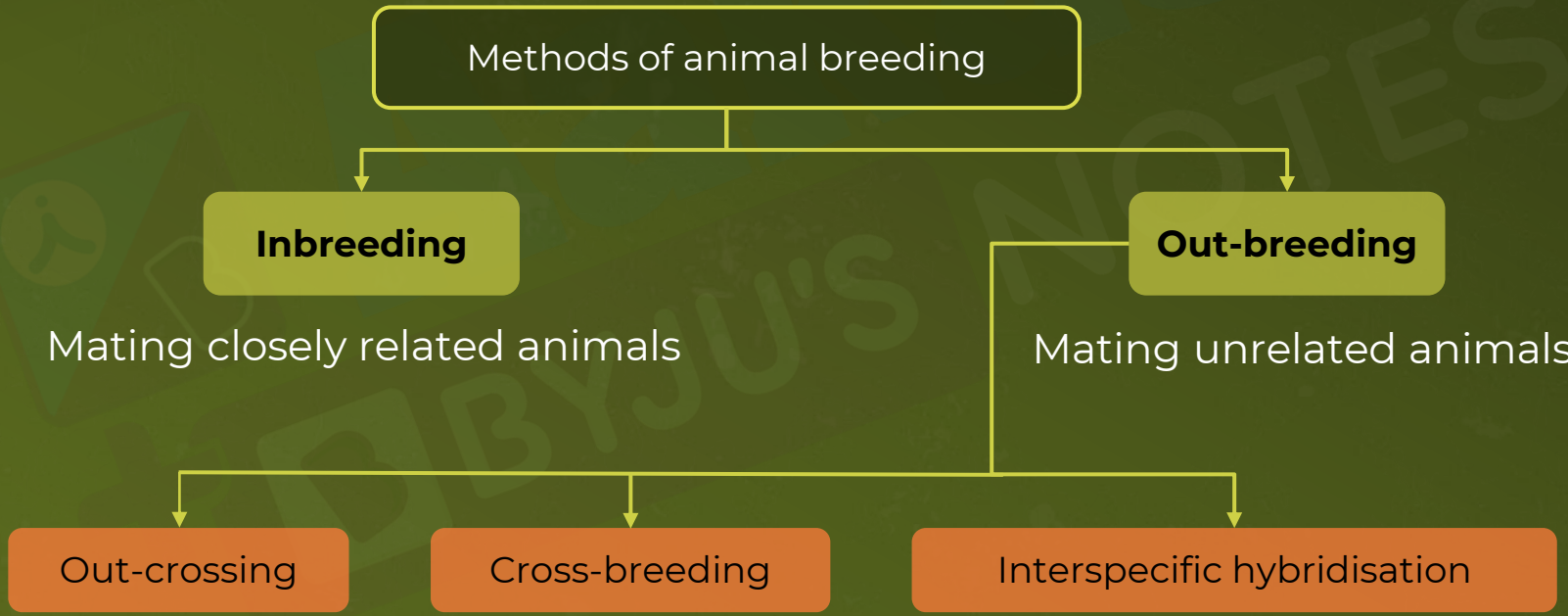
# Animal Breeding

**Selective mating** of animals to **produce offspring** with **desired qualities**



# Animal Breeding

Breed is a **group of animals** related by descent and **similar** in most **characters**



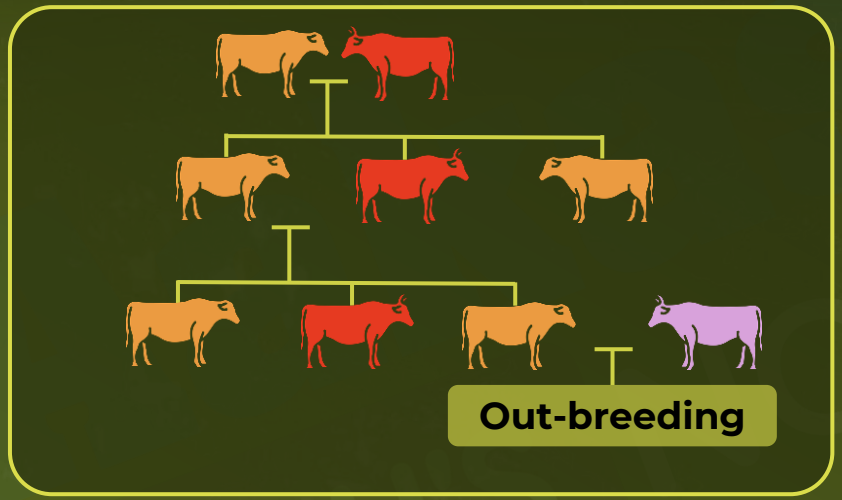
# Inbreeding

- **Mating of superior male** and **superior female** (closely related) of the **same breed for 4-6 generations**
- Superior male and female among their progeny are also **identified** and **mated**
- **Increases homozygosity**
- Helps in **accumulation of superior genes** and **elimination of less desired genes**
- On continued inbreeding, recessive genes accumulate leading **to inbreeding depression**
- **Reduces fertility and productivity**

Cow which
- **produces more milk** per lactation
- gives **good quality** of milk


Bull with
- **Strong immunity**
- **Vigour**
- **Virility**

# Out-breeding




No common ancestors for at least 4 - 6 generations

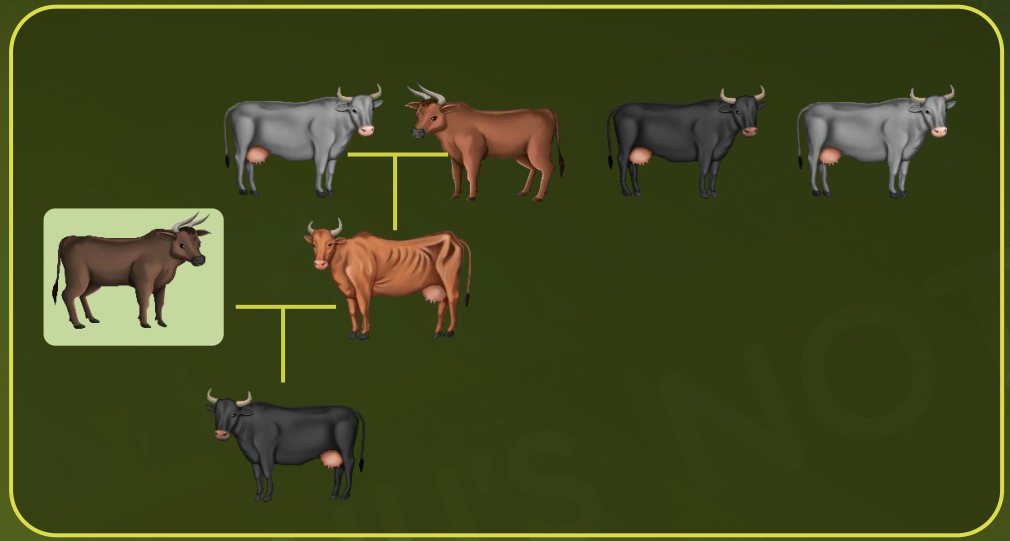
Breeding of **the unrelated animals** of

- **Same/ different breed or different species**

**Overcomes**

- Below average productivity
- Lower milk production
- Slow growth rate in beef cattle, etc.

# Out-crossing



- Mating **unrelated animals** within the **same breed**
- Offspring is known as **out-cross**
- **Best breeding method** for animals that are below average milk productivity
- **Single outcross overcomes inbreeding depression**

# Cross-breeding

- **Superior males** of one breed are **mated** with **superior females** of another breed

Bikaneri ewes

X

Merino rams

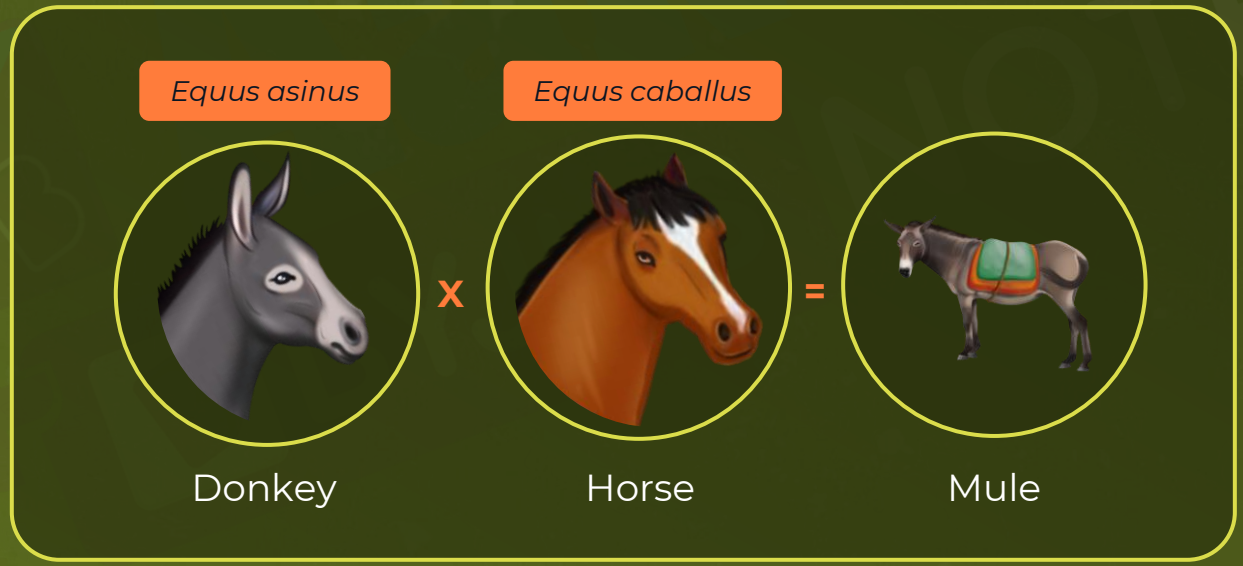
=

Hisardale


- Cross- breeding allows the **desirable qualities of two different breeds to be combined**
- Used for **increased commercial production**
- Inbred to develop **new** and **stable breeds**
- **Hisardale** produce brilliant white wool in large quantity

# Interspecific Hybridization

- **Mating** of animals from **two different but related species**
- The **sterile offspring** is called an **interspecific hybrid**
- Made for **economic** or **fundamental scientific purposes** only



# Controlled Breeding Experiments

Artificial insemination

It is a method where **semen** is **introduced** into **selected female animal manually.**

**Improves quality** and **quantity** of animal and its produce

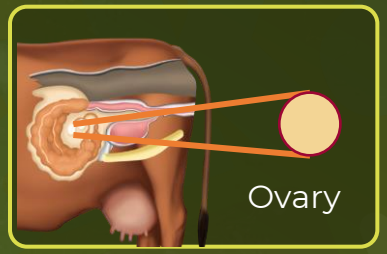
Sperms can be used **immediately** or **frozen** **Liquid nitrogen** ( -196℃) is used in the process of **cryopreservation**

# Controlled Breeding Experiments

## Multiple Ovulation Embryo Transfer Technology (MOET)

### Step 1: Hormone therapy

- **FSH induces** multiple **follicular maturation** and **super ovulation** in cow ovaries when induced
- Production of **6-8 eggs per estrus cycle** instead of one is called **superovulation**

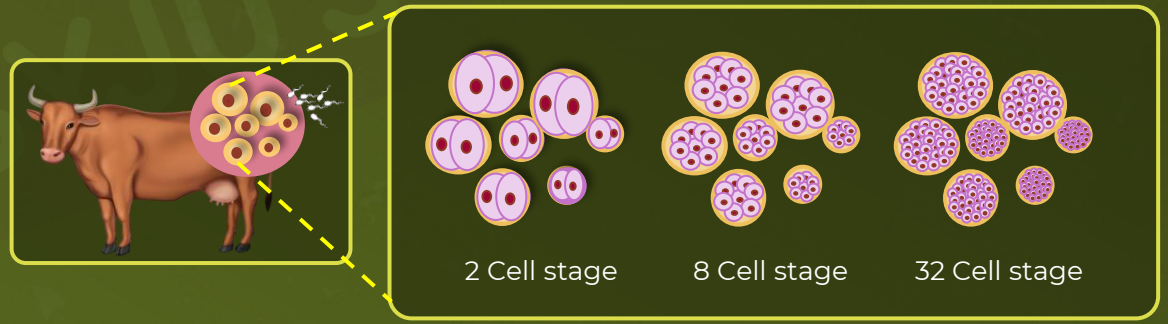




FSH causes follicle maturation

### Step 2: Fertilization

- The cow is either **mated** with elite buffalo or **artificially inseminated**
- The **eggs** are **fertilized** inside the body.

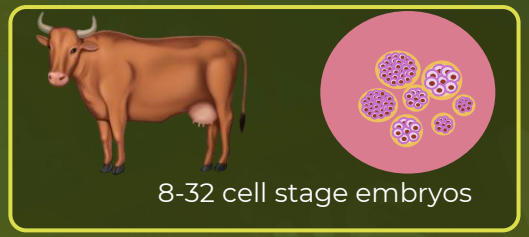


# Controlled Breeding Experiments

Multiple Ovulation Embryo Transfer Technology (MOET)

## Step 3: Mating

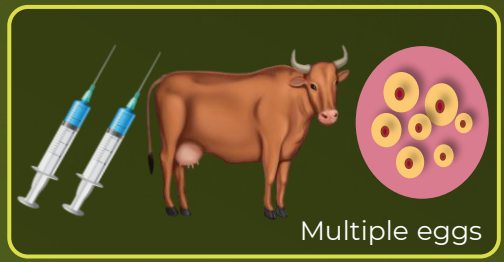
- **Embryos** (of 8-32 cell staged) are **non-surgically removed** from the cow.
- These embryos are
  - **implanted** into uterus of the **surrogate cows**
  - **grow** and **develop** into babies in the surrogate cow
- Embryos develop into **offspring of desired quality** same as genetic parents





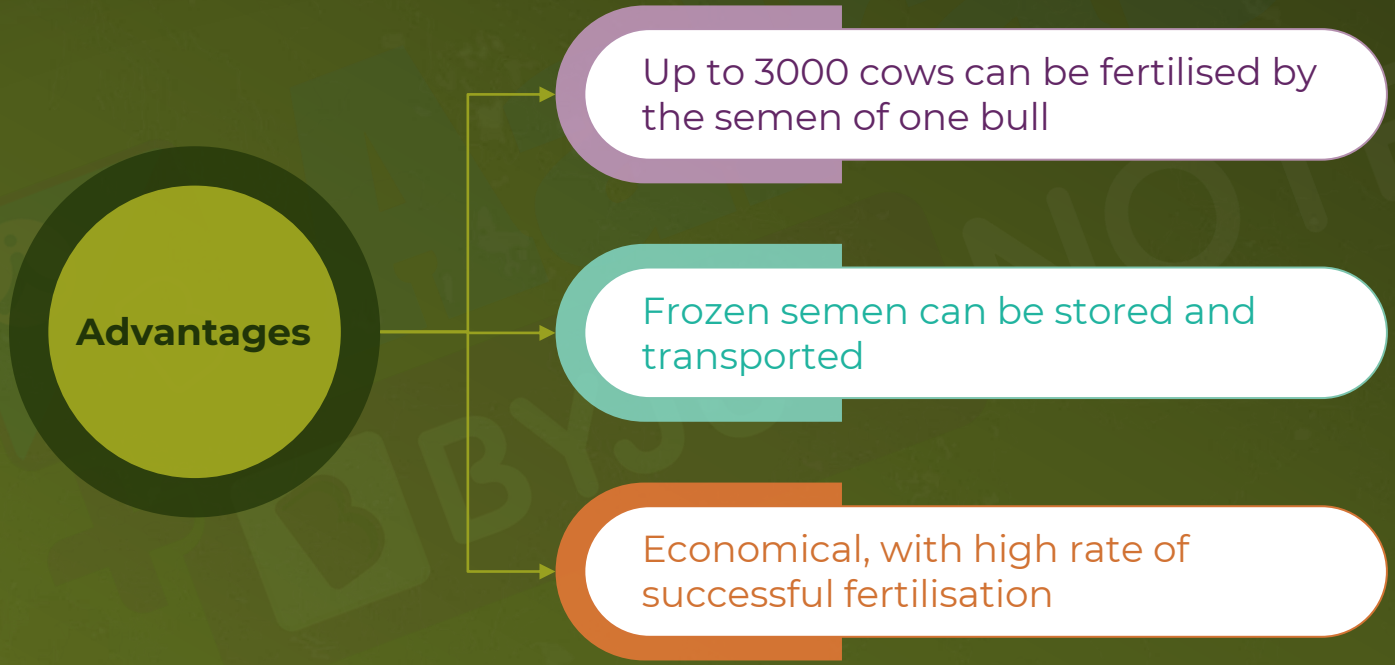
## Repeat Step 1 - 3

- Genetic mother is ready for **next round** of superovulation
- This technique has been successful in cattle-sheep, rabbits, buffaloes, mares, etc.



# Controlled Breeding Experiments

## Multiple Ovulation Embryo Transfer Technology (MOET)



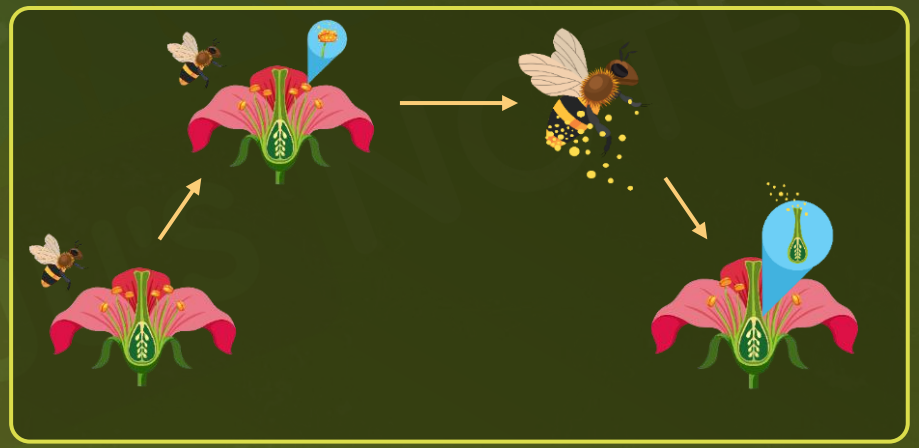
# Apiculture

Care and management of honeybees for honey and beeswax

*Apis indica* (Indian bee)

In India, this is **the most common** which is found in the wild

- Bees are the pollinators **(entomophily)** for crops like sunflower, Brassica, apple, pear etc.
- **Increases pollination efficiency** and **improves the yield of honey.**



**Artificial beehive** is an artificial structure, generally consists if wooden boxes to house a bee nest

# Apiculture

**Important points for the success of beekeeping**

- Knowledge of bees and their habits
- Suitable location for keeping beehives
- Management of beehives during different season
- Proper handling and collection of honey and beeswax
- Catching and rearing of bees

# Apiculture

Social organisation of honeybee (Polymorphic)

## Queen honeybee

- Larger
- **One queen** per hive
- Diploid, fertile female
- Lays both **fertilised** and **unfertilized eggs**
- Feeds on **royal jelly**

## Drone honeybee

- Smaller than queen
- **~200-300** per hive
- Haploid, fertile male
- **Fertilises the queen's eggs**
- Developed **parthenogenetically** from unfertilised eggs

## Worker honeybee

- Smallest
- **Maximum** in numbers
- Diploid, **sterile female**
- Housekeeping, feeding the queen, drones and larvae, **collecting the pollen and nectar,** and making the wax

# Apiculture

Honey and Beeswax

## Honey

- Tonic, laxative and sweetening agent
- Has water, minerals, vitamins, levulose, glucose, sucrose and dextrin.
- **High nutritive value**

## Beeswax

- Obtained from honeycomb
- Used in **cosmetics** and polishes

# Fishery

It is the **industrial practice** of **catching**, **processing** and **selling of aquatic animals**

There are broadly 2 types of fishes based on their habitat:

## Marine fishes


Hilsa


Sardine


Pomfret

## Freshwater fishes


Catla


Rohu


Singhara

# Fishery

| Aquaculture | **Pisciculture** |
| --- | --- |
| Farming of **flora** and **fauna** in water bodies | Farming of **only fish** in water bodies |

## Blue revolution

- **Increase in productivity** from fisheries and aquaculture, both inland and marine, resulted in this revolution.

| **Culture fishery** | **Capture fishery** |
| --- | --- |
| Raising of fishes in tanks and ponds | Method of catching fish without actually raising them |

# Plant Breeding

- **Traditional farming** methods could not fulfil the needs of exponentially growing population
- To produce enough food and to be a self-dependent in terms of food-grain production led to agricultural revolution known as **green revolution.**

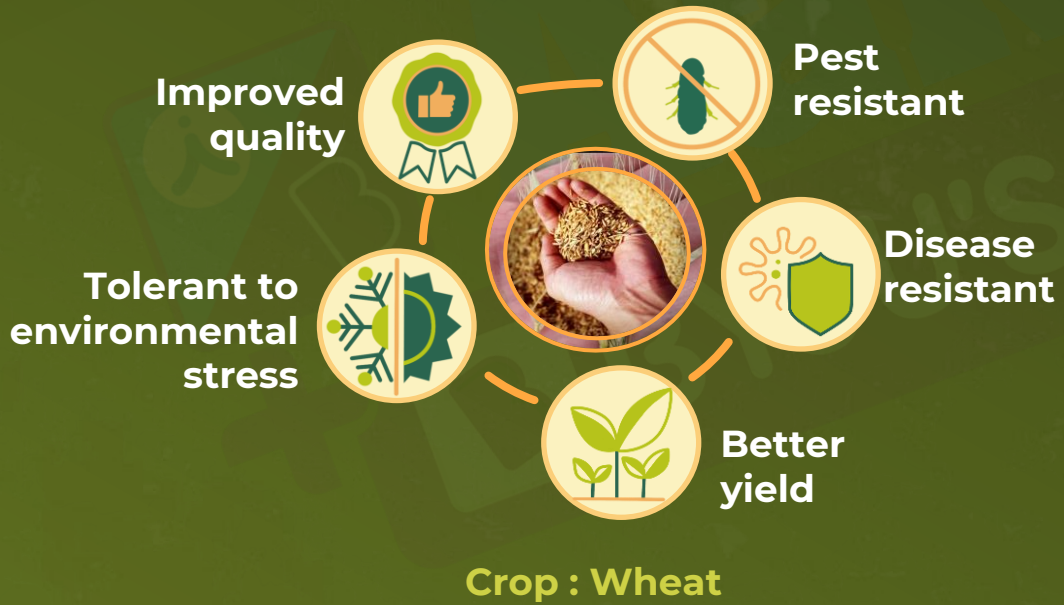
- **Green revolution** consists of a set of initiatives that helped **revolutionize agriculture** and **increase production of food crops**
- Methods used in traditional farming were replaced by modern technology such as
  - **natural manure** was replaced with **synthetic fertilisers** and **pesticides to increase yield**

- Green revolution was **dependent** to a large extent on **plant breeding** techniques for **development of high-yielding** and **disease resistant varieties in wheat, rice, maize, etc.**

# Plant Breeding

It is the **purposeful manipulation** of plant species to **create desired plant** types that are **better suited** for cultivation, give **better yields** and are **disease resistant**.

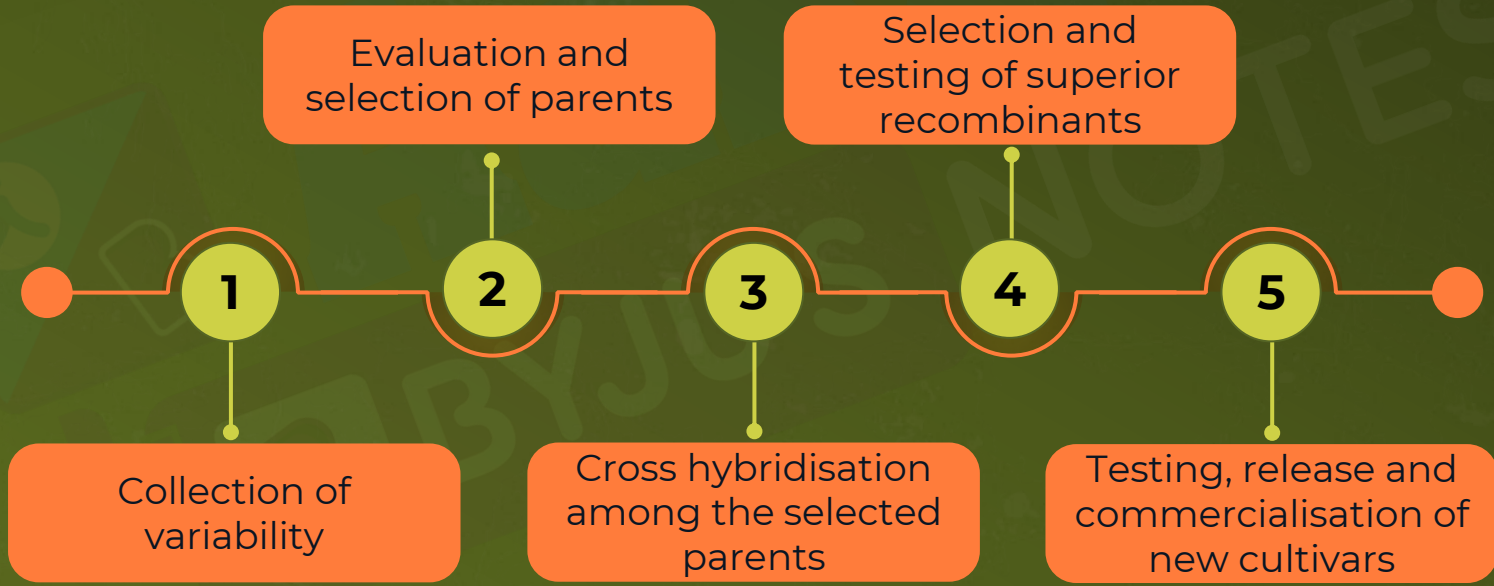
List of characters to incorporate into crop plants




- **Improved quality** of a crop plant includes:
  - Yield
  - Pest resistant
  - Disease resistance
  - Tolerance to environmental issues (salinity, extreme temperatures, drought)

# Breeding a New Genetic Variety

Following steps are performed to develop a new genetic variety :



# Breeding a New Genetic Variety

## Collection of variability

The first step is to collect, evaluate characteristics and preserve different wild varieties, species and relatives of all the cultivated species

- In many crops, **pre-existing genetic variability** is available in the **wild varieties of the crop.**
- The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called **germplasm collection**.
- It includes all the **diverse alleles.**
- **Example:** The wild variety along with the various types of wheat crops, together comprise the germplasm collection.

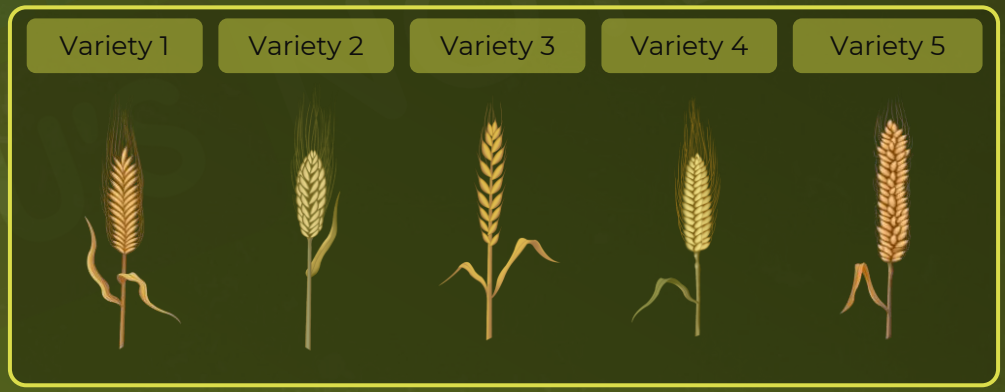



**Figure showing different varieties of a plant**

# Breeding a New Genetic Variety

Evaluation and selection of parents

- From the different varieties of crops, **two varieties** are **selected** that have the **desirable traits.**
- Example:
  - **high fibre content**
  - **resistance to mildew disease**
- These selected plants are grown in fields (multiplied).
- **Pure lines are created** wherever desirable and possible.

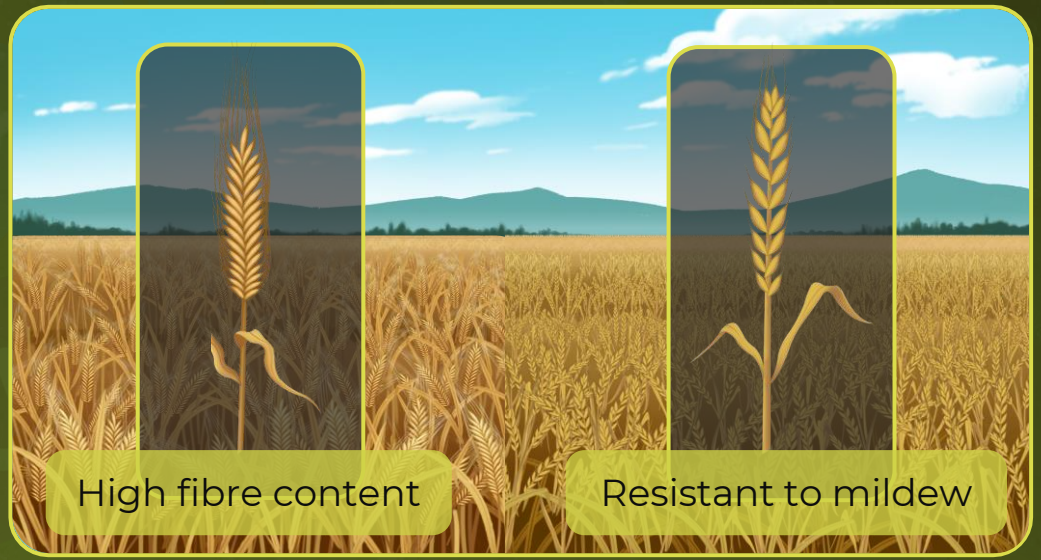



**Figure showing selected varieties that have desirable traits.**

# Breeding a New Genetic Variety

Cross hybridisation among the selected parents

- Parents are **cross hybridised** to produce offspring.
- These **offspring** are genetic combinations of the **desired characters** in one plant.
- **Example: T**he pollen from male plant with high fibre content is transferred to the female plant which is resistant to mildew

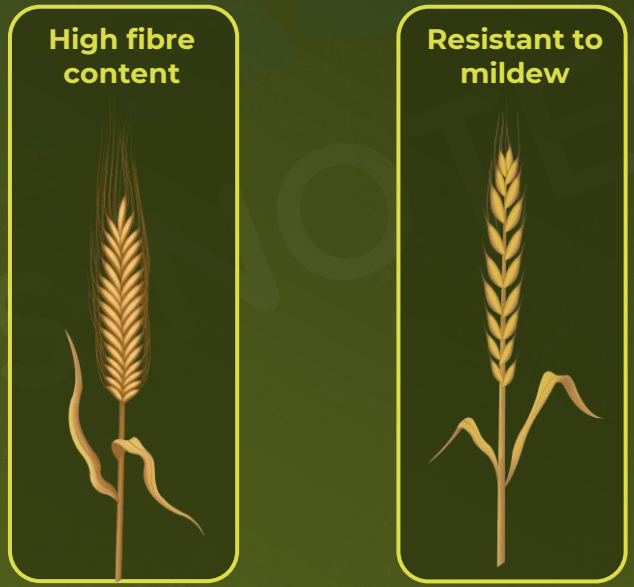



**Figure showing selected varieties that have desirable traits.**

# Breeding a New Genetic Variety

## Selection and testing of superior recombinants

Cross pollination leads to the production of progeny with different characters.

- The progeny with the **desirable traits** of both parents is selected.
- This is a very **important** and **tedious** process.
- These plants are **self-pollinated for generations until it becomes pure line** (i.e., the characters do not segregate in the offspring).

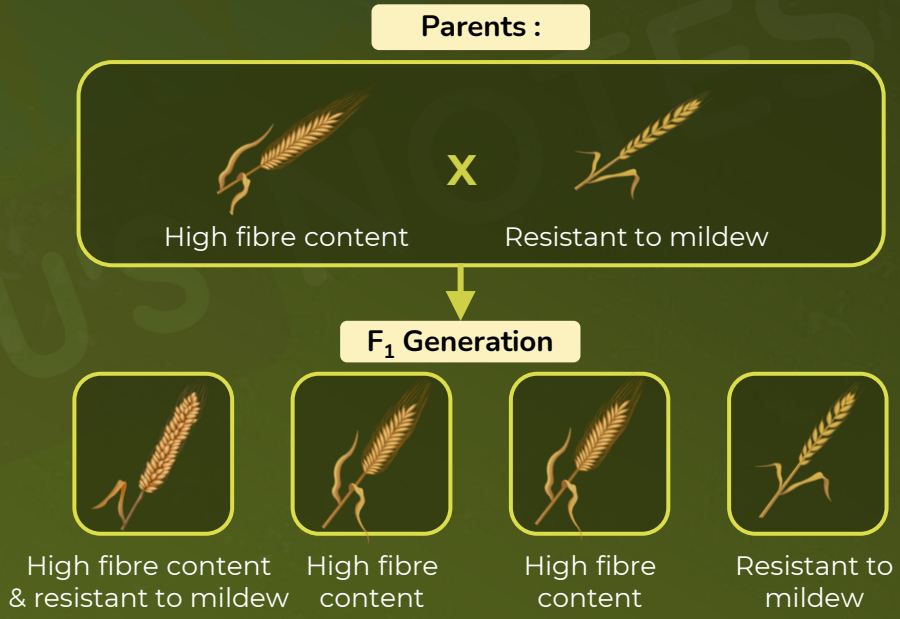



**Figure showing progeny with different characters**

# Breeding a New Genetic Variety

Testing, release and commercialisation of new cultivars

- The next step is to evaluate the hybrid crops (superior recombinants).
- The evaluation is done in **research fields.** These crops are **grown to test their performance** under:
  - ideal irrigation
  - fertiliser
  - other crop management practices

**Different crop management practices**

Comparison of the new variety against a reference variety is the final test. **Reference variety is generally the best available local variety in terms of quality and cost.**

# High Yielding Varieties

Semi- dwarf wheat

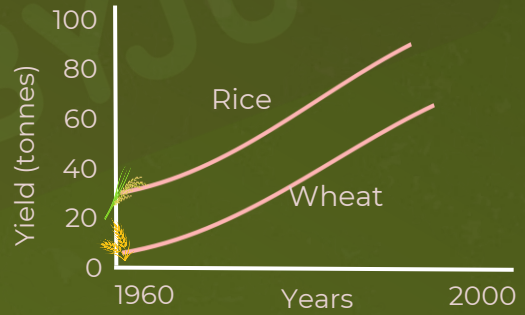
## Wheat

- **Kalyan Sona** and **Sonalika**
  - Resistant to wheat rust (fungal disease)
  - Short stature
  - Short maturity duration
- Cultivated all over wheat belt of India such as Punjab, Haryana, Uttar Pradesh, Bihar.
- As a result of green revolution, wheat production increased from **11 million tonnes to 75 million tonnes.**

## Rice

Jaya and Ratna

- **IR-8**, [developed at International Rice Research Institute (IRRI), Philippines] – a dwarf and high yielding variety
  - Later, a better yielding variety - **Jaya**
- **Taichung Native-1** (from Taiwan) – a semi dwarf and disease-resistant
  - Later, a better yielding variety - **Ratna**

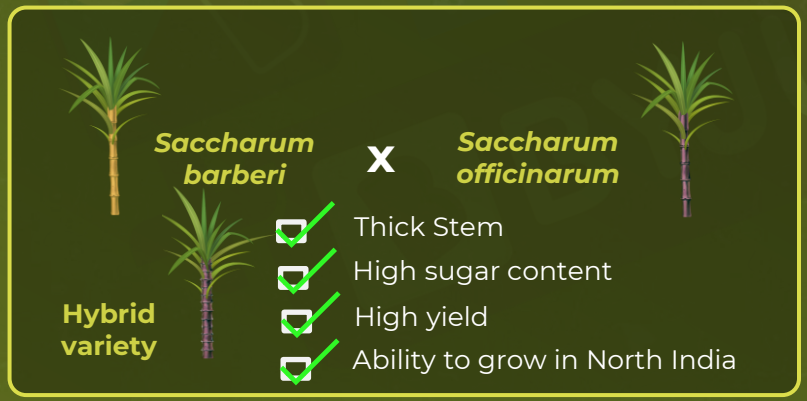



- As a result, rice production increased from **35 million tonnes to 89.5 million tonnes.**

# High Yielding Varieties

## Sugarcane

- *Saccharum barberi* was grown in north India
  - with poor sugar content and yield
- *Saccharum officinarum* was grown in south India
  - thicker stems
  - high sugar content
  - does not grow in north India



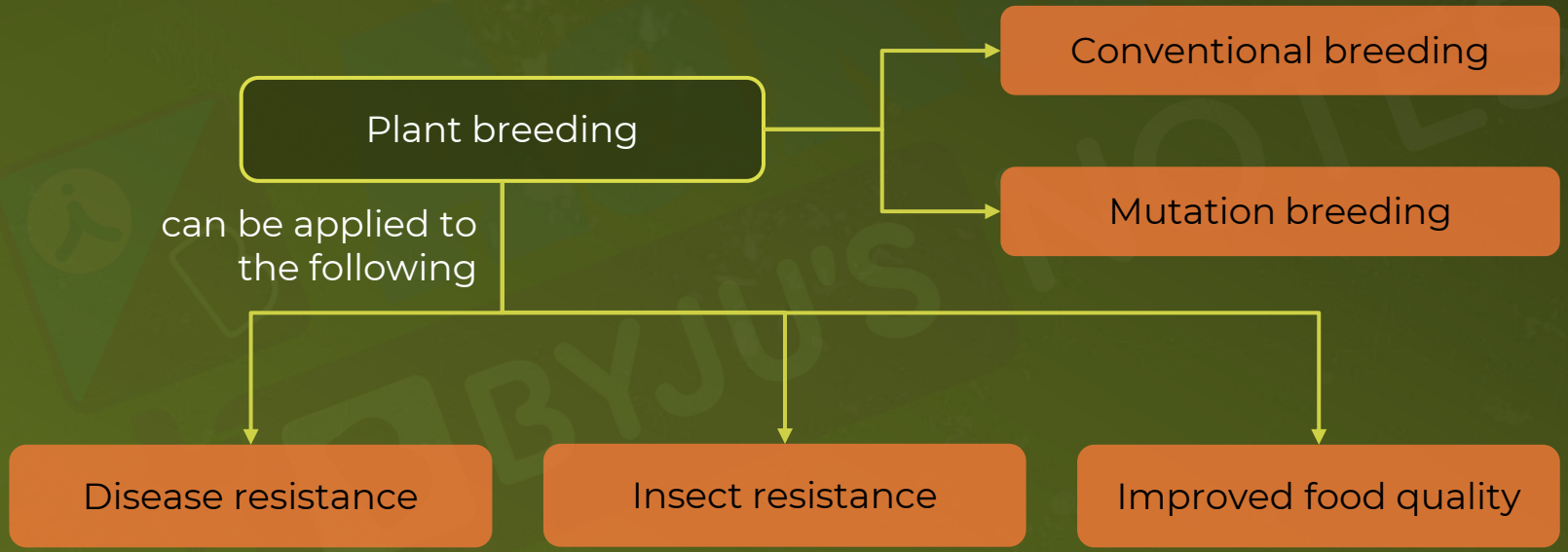

## Millet

- Millets grow in arid regions
- They include maize, jowar, bajra, finger millet, etc.
- Hybrid maize, jowar and bajra were successfully developed in India.
- Hybrid breeding have led to the development of
  - high yielding varieties
  - resistant to water stress

**Hybrid maize, jowar and bajra**

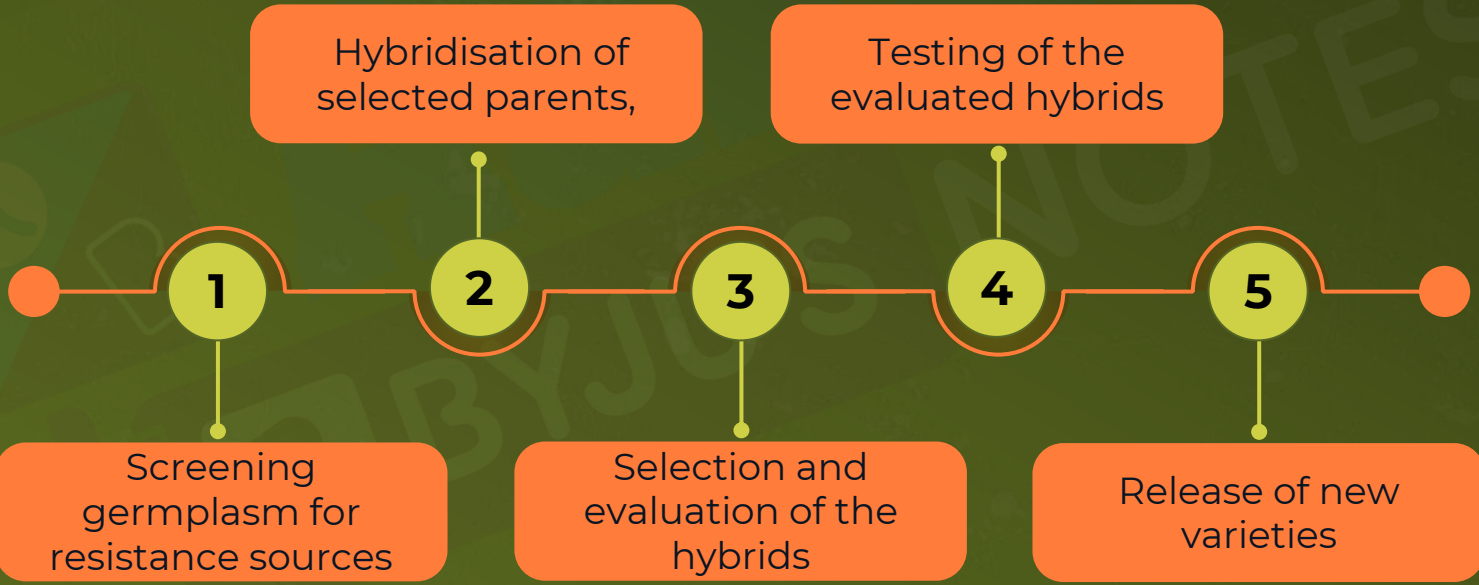
# Methods of Plant Breeding

Conventional breeding and mutational breeding techniques are used **to develop disease resistant crops.**



# Conventional Breeding

Following steps are performed for conventional breeding :



# Conventional Breeding

Following are the examples of few disease resistant crop varieties developed

| Crop | Variety | Resistance to diseases |
|---|---|---|
| Wheat | **Himgiri** | Leaf and stripe rust, hill bunt |
| *Brassica* | **Pusa Swarnim (Karan rai)** | White rust |
| Cauliflower | **Pusa Shubra, Pusa Snowball K-1** | Black rot and Curl blight black rot |
| Cowpea | **Pusa Komal** | Bacterial blight |
| Chilli | **Pusa Sadabahar** | Chilli mosaic virus, Tobacco mosaic virus Leaf curl |

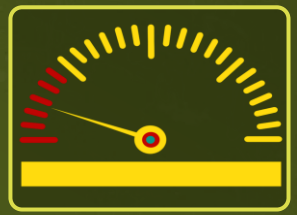
# Conventional Breeding

## Limitations

- Probability of **obtaining desired combination of genes** is **low in hybrid** crop
- **Time consuming**
- **Tedious** process
- **Limited number** of **disease resistance genes** are present and identified in the various crop varieties and wild relatives

**Time consuming and tedious process**

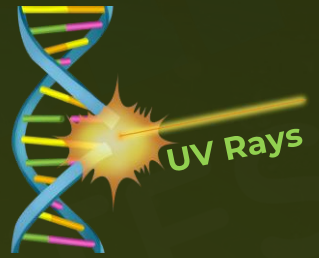
**Limited availability of disease resistance genes**



**Low probability of desirable combination**

# Mutation

- Mutation leads to **alteration of DNA sequences**.
- **It changes the genotype** and thus **phenotype**.
- The characters obtained through mutations are not found originally in the organism.




Causes

## Physical Agents

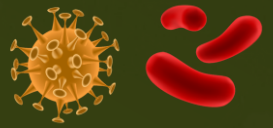
Example : Radiation like UV rays and X-rays

## Chemical Agents

Example : Cigarette compounds, Benzoyl peroxide


## Biological Agents

Example : Viruses and bacteria



# Mutation Breeding

Mutational breeding is a when **mutations** are

- **induced artificially** using chemicals or radiations (like gamma rays) on selected crop varieties that have desirable characters.
- **selected**
- use the plants that have the **desirable character** as a source in breeding

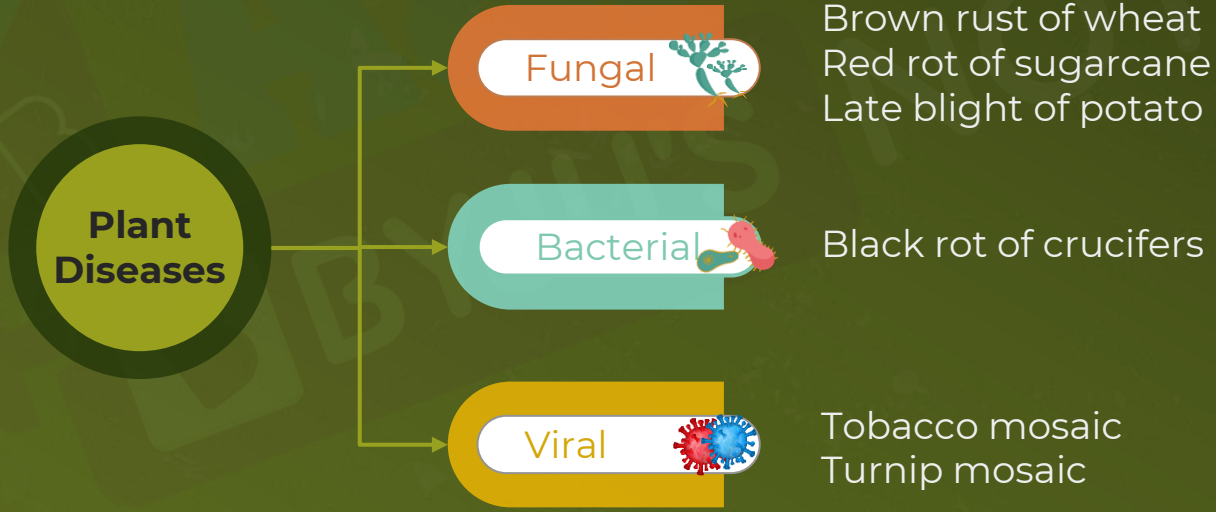
- Example:
  - In **Mung bean** and **powdery mildew,** resistance to **yellow mosaic virus** were induced by mutations.

- Examples are :

| Mexican wheat | Improved variety |
|---|---|
| Sonora 64 | Sharbati Sonora |
| Lerma Rojo 64 | Pusa Lerma |

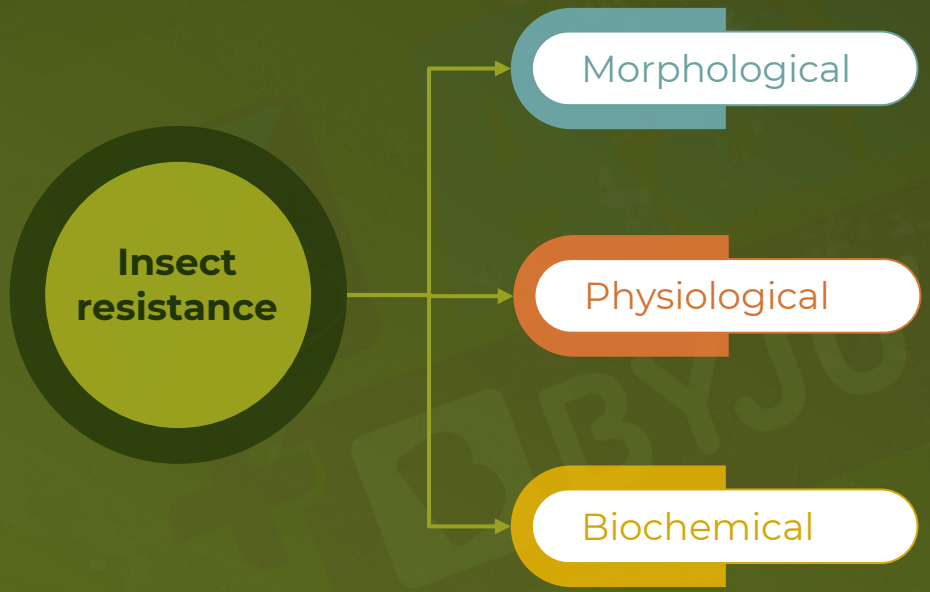
# Plant Breeding for Disease Resistance

Breeding and developing disease resistant cultivars
- enhances food production
- reduce the dependence on use of fungicides and bactericides



# Plant Breeding for Resistance to Insect Pests

Major cause for large scale destruction of crop plant and crop produce is insect and pest infestation




**Hair- like structures** on leaves of
- cotton plants help in resisting attacks from jassids
- wheat crop provide resistance against cereal leaf beetle

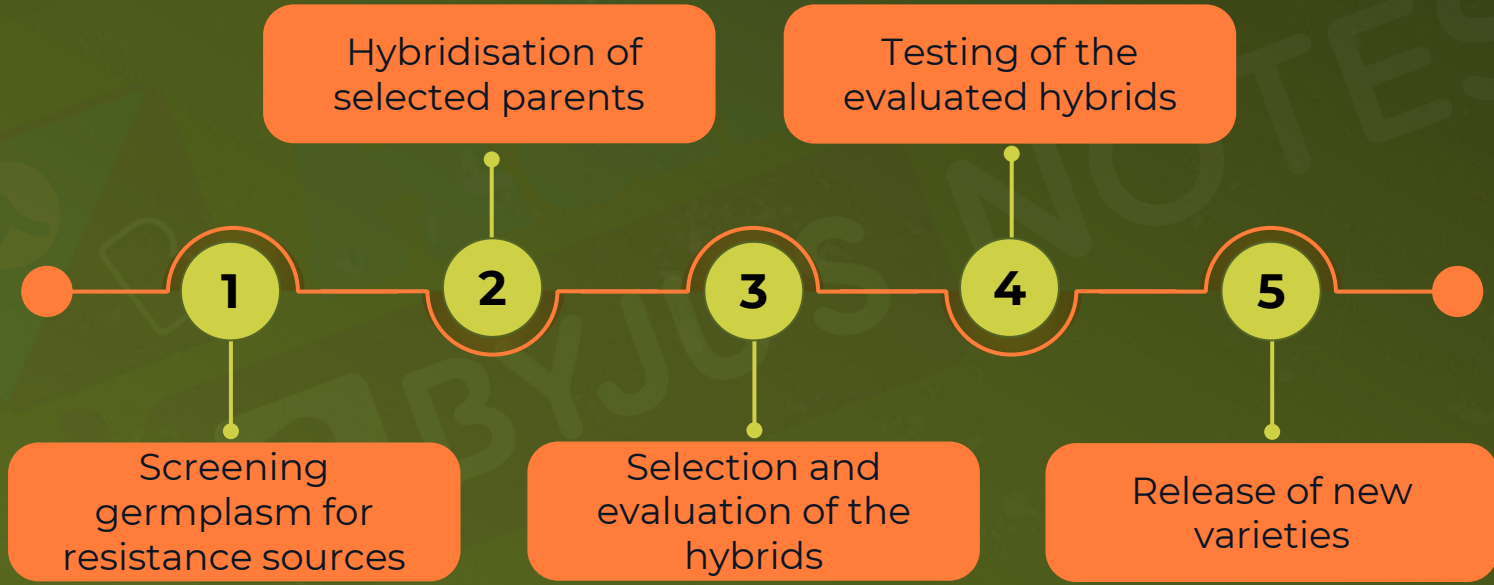
In cotton plants characteristics like:
- **nectar less flowers**
- **smooth leaves**

do not attract bollworms

Following characteristics in maize leads to resistance to maize stem borers :
- **high aspartic acid**
- **low nitrogen**
- **low sugar content**

# Plant Breeding for Resistance to Insect Pests

Following steps are performed to obtain varieties resistant to insect pests:



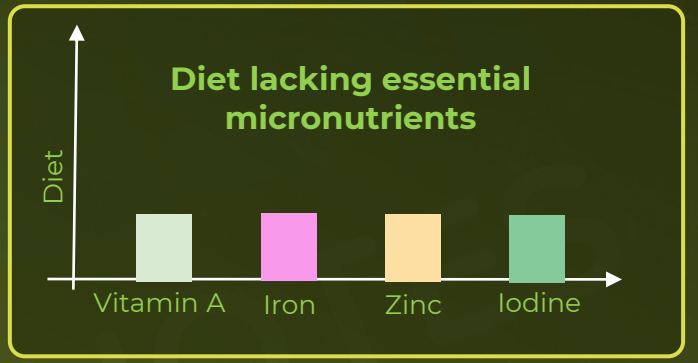
# Plant Breeding for Resistance to Insect Pests

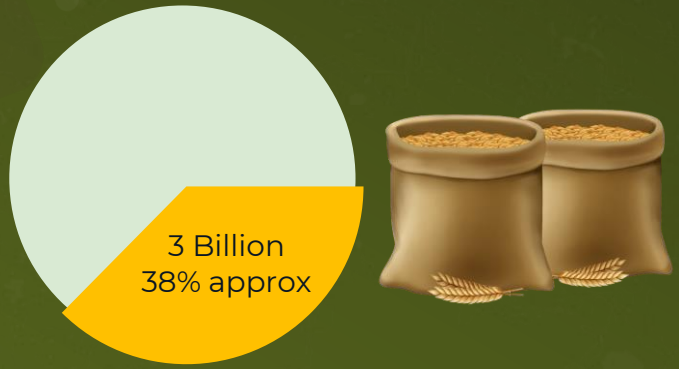
Following are few examples of insect resistant crop varieties developed

| Crop | Variety | Resistance to insects |
|---|---|---|
| Brassica | **Pusa Gaurav** | Aphids |
| Flat bean | **Pusa Sem 2, Pusa Sem 3** | Jassids, aphids and fruit borer |
| Okra (bhindi) | **Pusa Sawani, Pusa A-4** | Shoot and fruit borer |

# Plant Breeding for Improved Food Quality

- Presently, around **840 million** individuals in the world don't get
  - **adequate food**
  - **nutritional requirement**
- **Diet lacks essential micronutrients** like iron, vitamin A, iodine and zinc which has serious repercussions
  - **risk of disease**
  - **reduced lifespan**
  - **reduced mental abilities**
- Approximately **3 billion** people **suffer from hidden hunger**
  - economically weak, unable to purchase enough food
  - consume nutrient deficient food which also causes hidden hunger

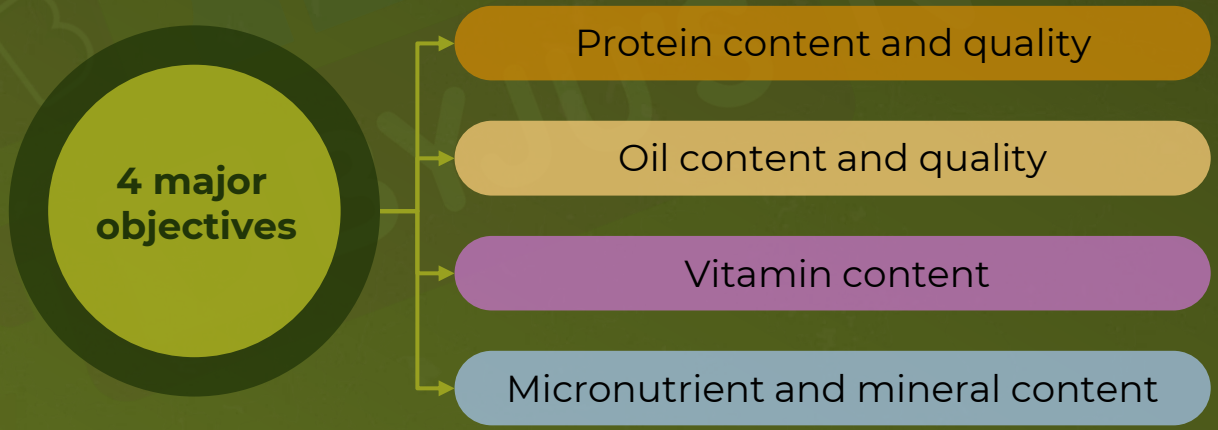


# Plant Breeding for Improved Food Quality

## Biofortification

- Biofortification is the process of **breeding crops** with **high levels of vitamins and minerals, or higher protein and healthier fats.**
- It is a great way to **improve the nutritional aspect of food** and hence public health.



# Plant Breeding for Improved Food Quality

**Biofortification :** Protein content and quality

**Hybrid maize:** 2 X **amount of essential amino acids** i.e., **lysine** and **tryptophan** can be developed

2 × TRP

2 × LYS

Maize

**Wheat variety:** was used as donor to cultivate new **protein rich variety** i.e., **Atlas 66**

Protein

Atlas 66

Protein rich variety

Protein fortified **Cassava** and **Sorghum** can also be developed



Indian Agricultural Research Institute **(IARI)** developed **protein rich beans**

Broad beans

Hyacinth/Lablab beans

French beans

Garden peas

# Plant Breeding for Improved Food Quality

**Biofortification :** Vitamin content

**Vitamin A enriched** rice was developed and named as **golden rice.**

Vit A

**Golden rice**

Indian Agricultural Research Institute (IARI) developed

**Vitamin A rich**

Spinach

Pumpkin

Carrot

**Vitamin C rich**

Bitter gourd

Tomato

Mustard

Bathua

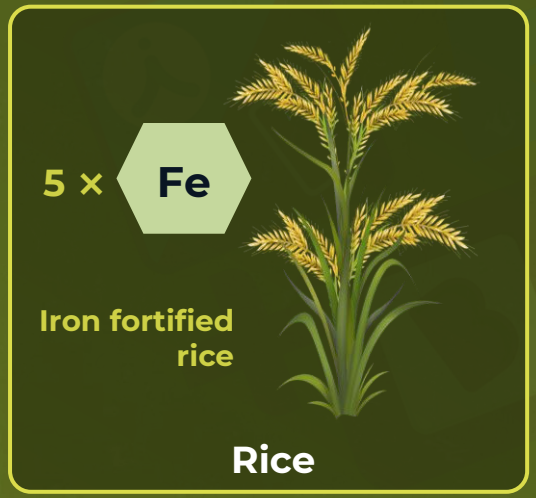
# Plant Breeding for Improved Food Quality

**Biofortification :** Micronutrient and mineral content

**Iron fortified rice** was developed with over **5 times the iron content**

**Iron** and **calcium** enriched

**Zinc** enriched crops




Spinach

Bathua

Wheat

Maize

Rice

Beans

# Single Cell Protein

**Cells from microorganisms** such as bacteria, yeasts, filamentous algae are **treated** and **used as food**

Bacteria

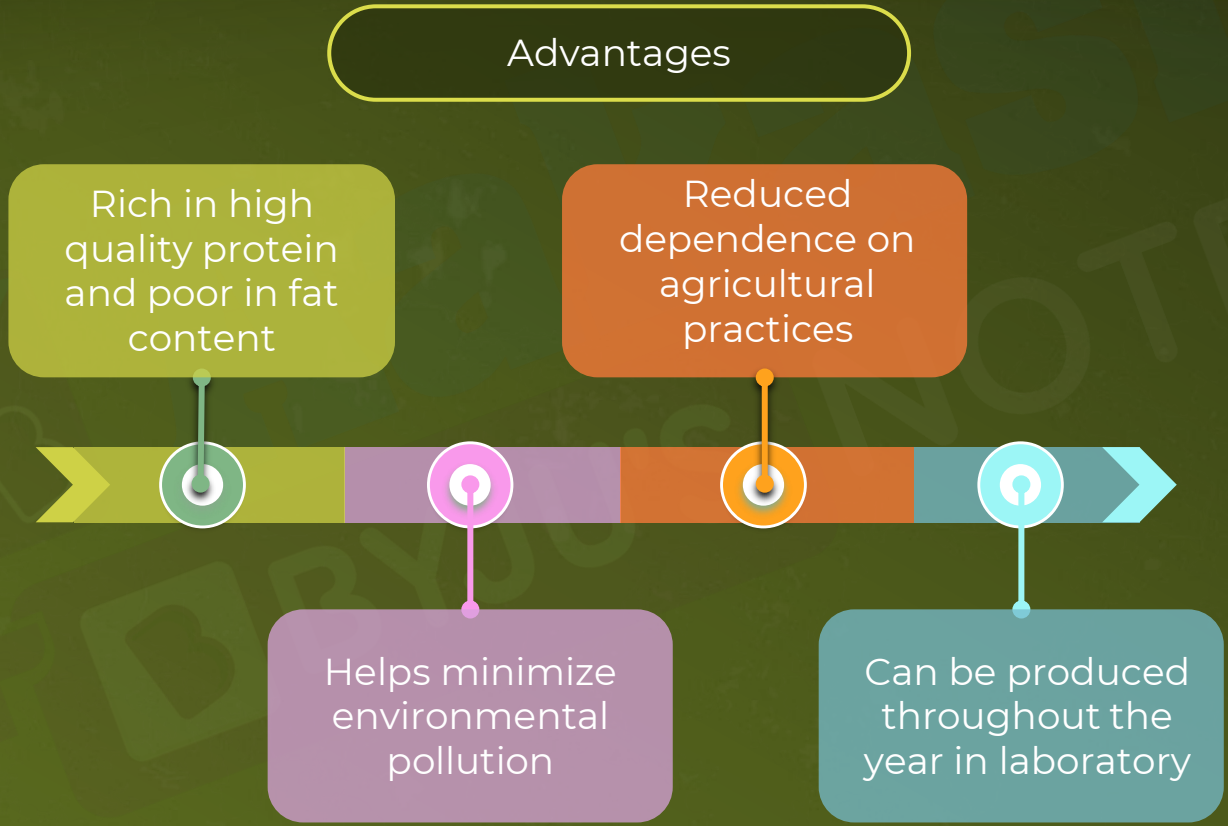
***Spirulina***

Can be grown easily on materials
like wastewater from potato processing plants (containing starch), straw,
molasses, animal manure and even sewage.

***Methylophilus methylotrophus***

High rate of biomass production and growth, can be expected to produce 25 tonnes of protein.

# Single Cell Protein



# Plant Tissue Culture

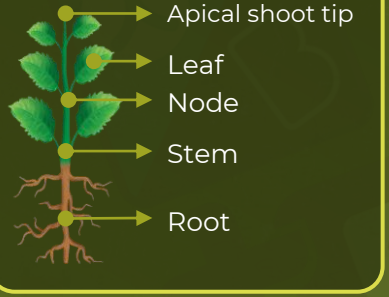
- **Plant tissue culture :** In vitro cultivation of all plant parts in nutrient medium under sterile conditions
- It is a technique wherein
  - we use plant parts (known as **explant**) to generate a whole new plant
  - complete sterility i.e., **aseptic conditions** are maintained.

**Totipotency :** Capacity to **generate a whole plant** from any cell/explant

**Plant cells** **Whole new plant**

# Plant Tissue Culture

Nutrient media must provide a
- carbon source such as sucrose
- inorganic salts
- vitamins
- amino acids
- growth regulators like auxins, cytokinins etc.




**Steps of plant tissue culture**

1. **Explant preparation**
2. **Nutrient media preparation**
3. **Inoculation**
4. **Incubation**

Explant is transferred to a nutrient medium in aseptic conditions.

The inoculated plant tissues are incubated for 3-4 weeks, where light, temperature and humidity is maintained.

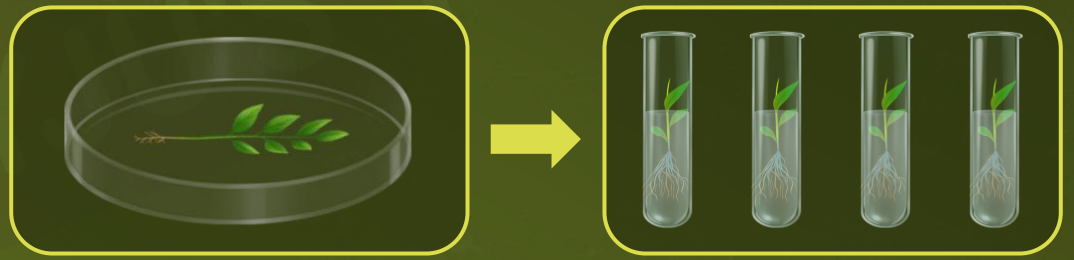
# Plant Tissue Culture

## Micropropagation

**Propagation** of **a large number of plants** in very **short durations** through **tissue culture**

## Somaclones

**Micropropagated plants** which are **genetically identical** to the original plant from which they were grown



# Application of Plant Tissue Culture

1. Disease free plants
2. Somatic hybrids

# Application of Plant Tissue Culture

**Disease free plants**

The **meristematic cells** of a plant are generally not affected by viruses

Infected area of diseased plant used as a explant

**Plant tissue culture** → Diseased plants

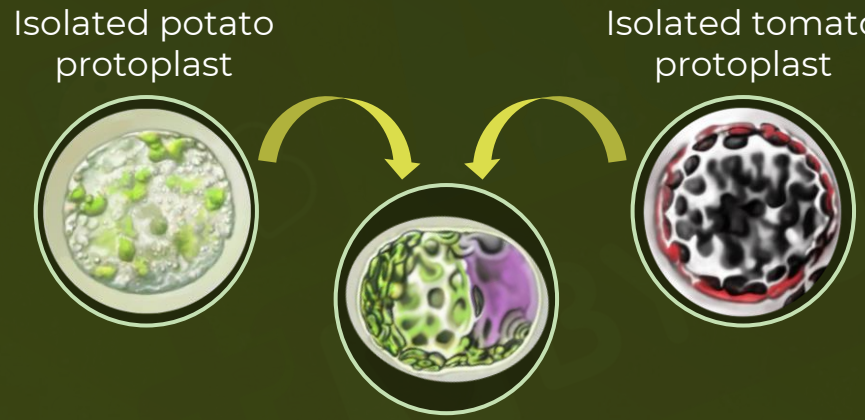
Non infected area / Meristematic part of the diseased plant used as a explant

**Plant tissue culture** → Disease free plants

# Application of Plant Tissue Culture

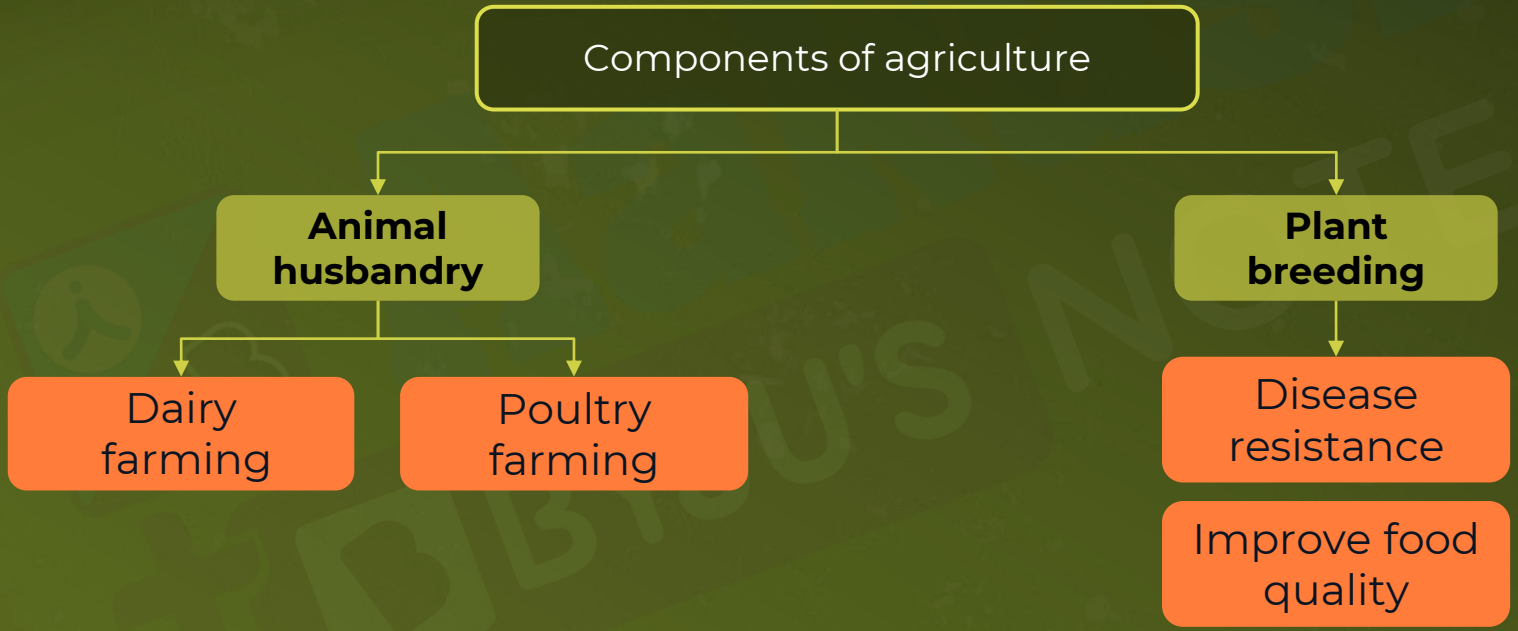
## Somatic hybrids

Production of **hybrids** (somatic hybrids) of **two distinct plants** via **fusion of somatic** protoplasts is called **somatic hybridisation**




Potato + Tomato = POMATO

# Summary

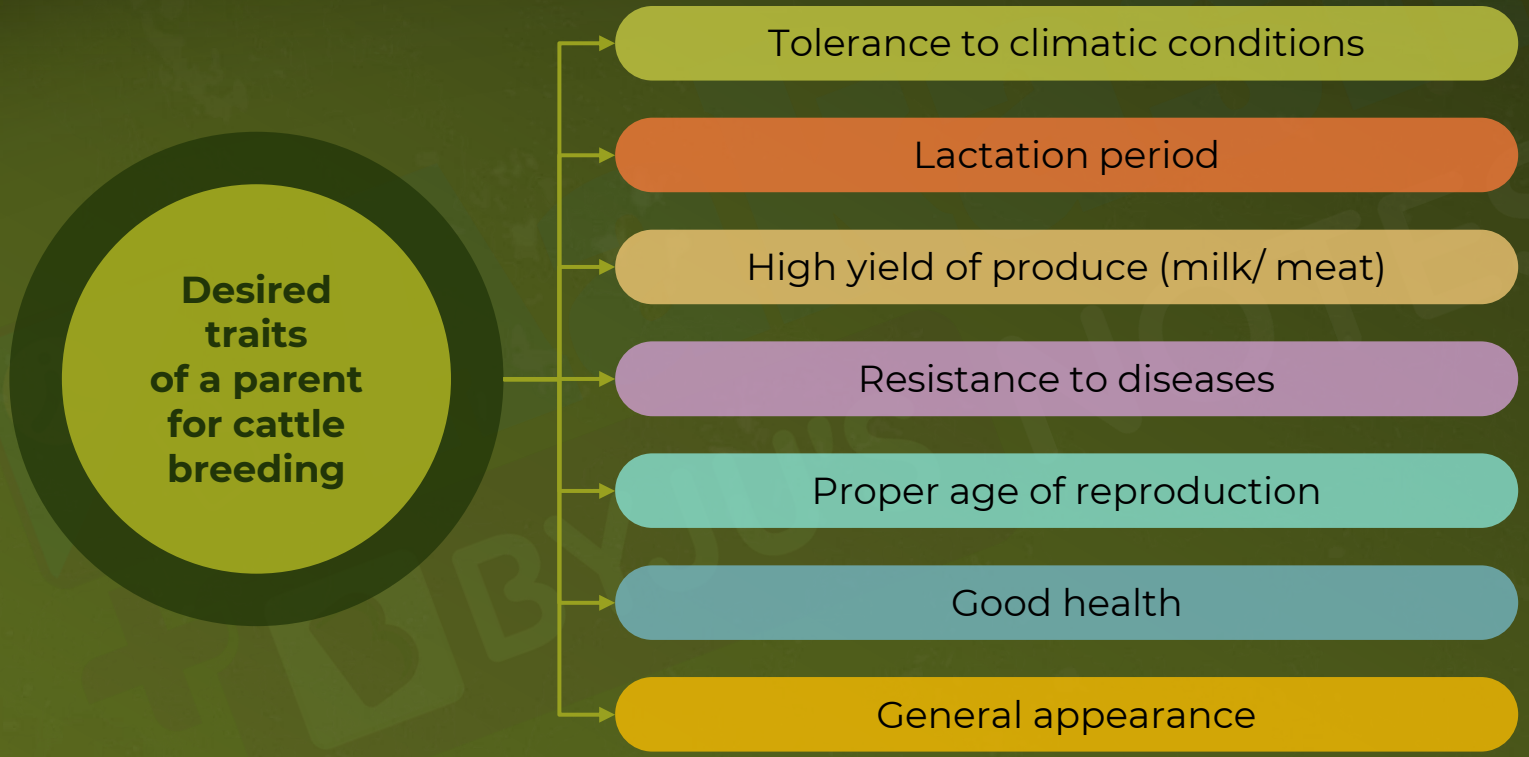


# Summary

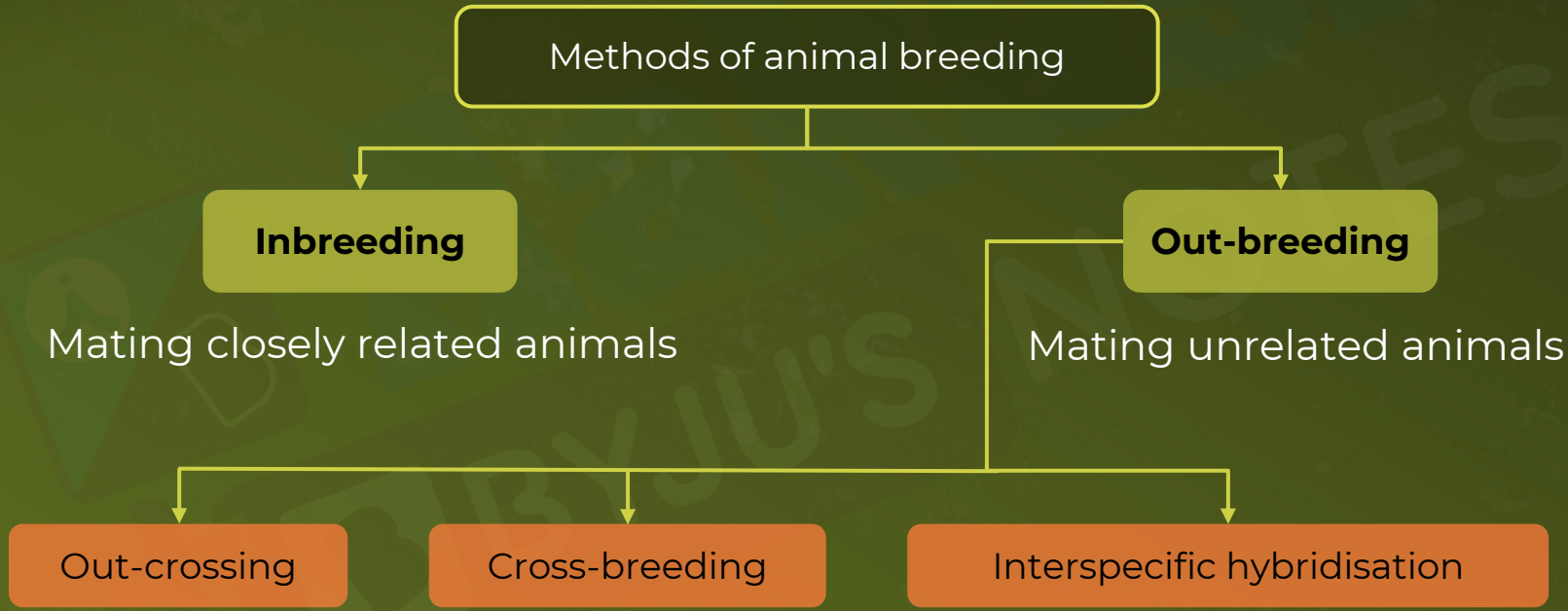
## Dairy Farm Management

**Process and systems**
(to increase yield and improve quality of milk)

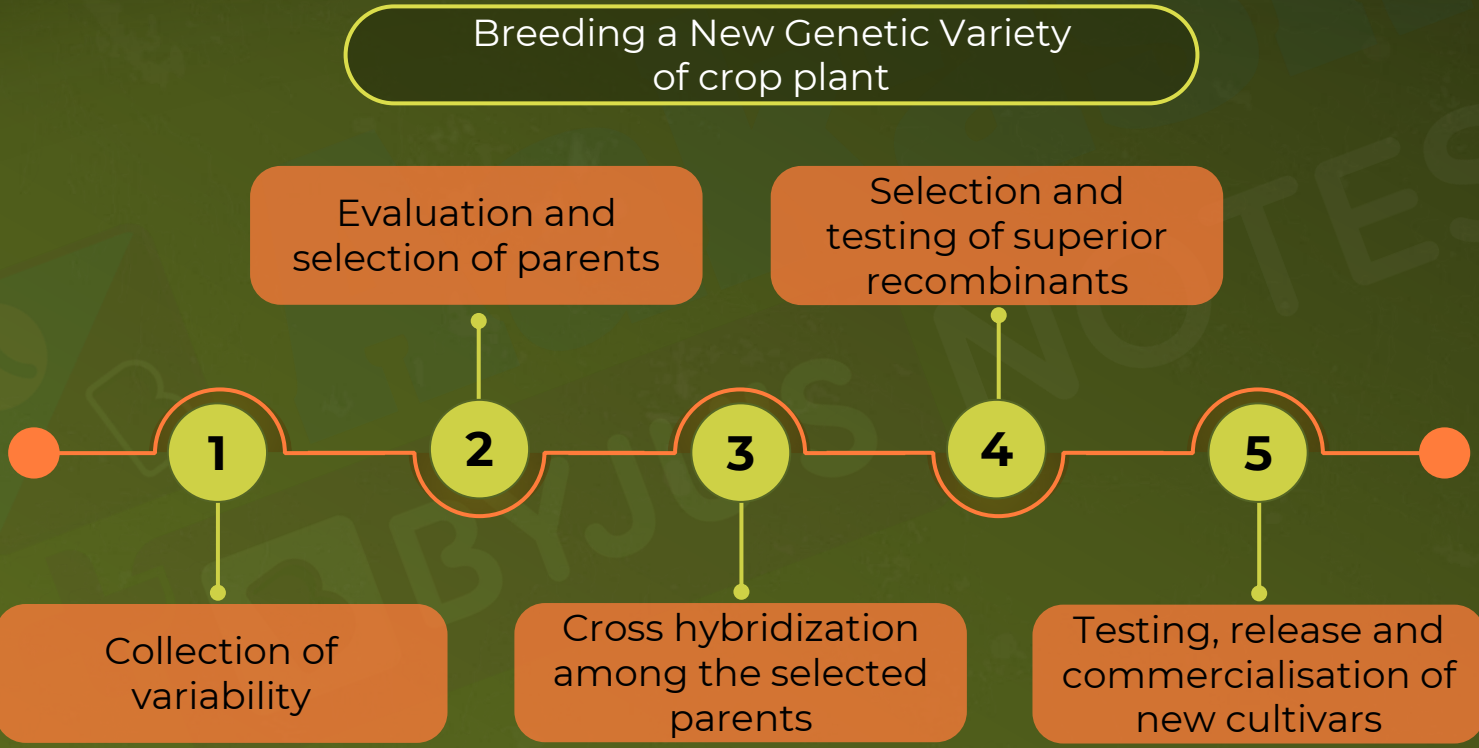
# Summary



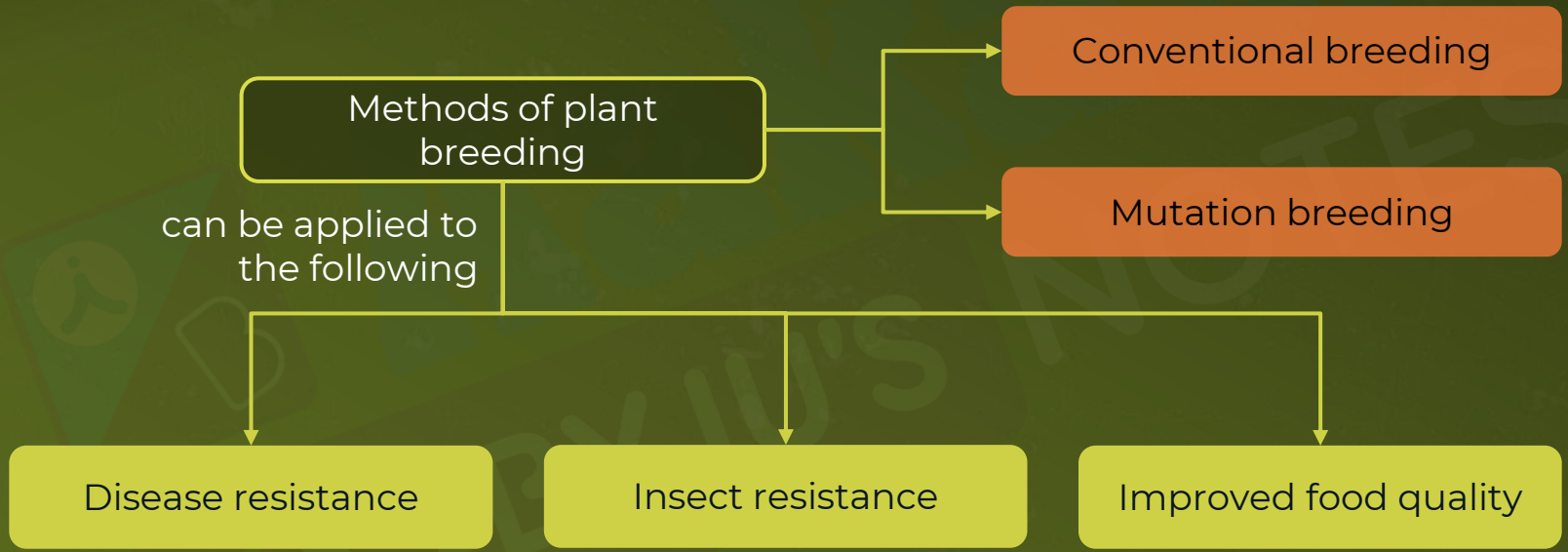
# Summary



# Summary



# Summary



# Summary

## Conventional Breeding

Following are the examples of few disease resistant crop varieties developed

| Crop | Variety | Resistance to diseases |
|---|---|---|
| Wheat | **Himgiri** | Leaf and stripe rust, hill bunt |
| *Brassica* | **Pusa Swarnim (Karan rai)** | White rust |
| Cauliflower | **Pusa Shubra, Pusa Snowball K-1** | Black rot and Curl blight black rot |
| Cowpea | **Pusa Komal** | Bacterial blight |
| Chilli | **Pusa Sadabahar** | Chilli mosaic virus, Tobacco mosaic virus Leaf curl |

# Summary

## Plant Breeding for Resistance to Insect Pests

Following are few examples of insect resistant crop varieties developed

| Crop | Variety | Resistance to insects |
|---|---|---|
| Brassica | **Pusa Gaurav** | Aphids |
| Flat bean | **Pusa Sem 2, Pusa Sem 3** | Jassids, aphids and fruit borer |
| Okra (bhindi) | **Pusa Sawani, Pusa A-4** | Shoot and fruit borer |

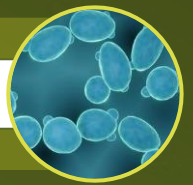
# Summary

## Biofortification

**4 major objectives**

- Protein content and quality
- Oil content and quality
- Vitamin content
- Micronutrient and mineral content

## Single Cell Protein

- Algae 
- Bacteria 
- Yeast 

# Summary

## Plant tissue culture

In vitro cultivation of all plant parts in nutrient medium under sterile conditions

## Micropropagation

**Propagation** of a **large number of plants** in very **short durations** through **tissue culture**

## Somaclones

**Micropropagated plants** which are **genetically identical** to the original plant from which they were grown