Assignments- (2nd Yr), Academic Session, 2021-22

Sl. No.	Admission No.	Name of the Student	Topic
1	2020-V-01	Anisha Gurung	History of Animal Breeding
2	2020-V-02	Ashma Banu Ym.	Classification of breeds
3	2020-V-03	Arentila	Economic characters of livestock and their importance
4	2020-V-04	Aniam Sangyu	Economic characters of poultry and their importance
5	2020-V-05	Baby Lalruatkimi	Selection
6	2020-V-06	Boji Dobin	Types of selection
7	2020-V-07	Bintu Gadi	Response to selection
8	2020-V-08	BasantaNongmaithem	Factors affecting selection
9	2020-V-09	Chonyurso Zimik	Bases of selection
10	2020-V-10	Chename Ch.Marak	Individual selection
11	2020-V-11	Chekkim D. Shira	Pedigree selection,
12	2020-V-12	C. Lalhunhlua	Family and sib selection
13	2020-V-13	C Lalrinnunga	Progeny and combined selection
14	2020-V-14	C Runremmawii	Indirect selection
15	2020-V-15	Chowdary Md. Junaid	Indirect selection
16	2020-V-16	Deepria Khumukcham	Method of selection
17	2020-V-17	Delightfulson Pale	Single and Multi trait selection
18	2020-V-18	Derrick I Sangma	Classification of mating systems
19	2020-V-19	DighaDatta	Inbreeding coefficient
20	2020-V-20	Gaiphungamliu G.	Coefficient of relationship
21	2020-V-21	HisseyLepcha	Genetic and phenotypic consequences of inbreeding
22	2020-V-22	Haniah Nyarecomdir	Inbreeding depression
23	2020-V-23	HibuAsha	Application of inbreeding
24	2020-V-25	Ibanjoplin Synjri	Out breeding and its different forms.
25	2020-V-26	Jogita Moirangthem	Genetic and phenotypic consequences of outbreeding
26	2020-V-27	Joshua Zorintluanga	Application of outbreeding
27	2020-V-28	J Mariana	Heterosis.
28	2020-V-29	Keiningpou Kamei	Systems of utilization of heterosis
29	2020-V-30	K Laldinmawia	Selection for combining ability (RS and RRS)
30	2020-V-31	LaishramKabita Devi	Breeding strategies for the improvement of dairy cattle
31	2020-V-32	Lalhriatrengi	Breeding strategies for the improvement of dairy buffalo
32	2020-V-33	Lalbiaksangi	Breeding strategies for the improvement of sheep
33	2020-V-34	Lalrempuii	Breeding strategies for the improvement of, goat
34	2020-V-35	Lallawmsanga	Breeding strategies for the improvement of swine
35	2020-V-36	Lalpekhlui	Breeding strategies for the improvement of poultry
36	2020-V-37	Lobsang Drema	Sire evaluation.
37	2020-V-38	Marilyn Darthangpui S.	Open nucleus breeding system (ONBS)
38	2020-V-39	Majhar Ul Islam	Development of new breeds or strains.
39	2020-V-40	Nisin Thong	Current livestock breeding policies and programmes in the state and country
40	2020-V-41	Nibedita Pal	Current poultry breeding policies and programmes in the state and country
41	2020-V-42	Nisha Reang	Methods of conservation

42	2020-V-43	OyimangSiram	Livestock conservation programmes in the state and country
43	2020-V-45	Ruben Tamang	Poultry conservation programmes in the state and country.
44	2020-V-47	Rahul Debnath	Application of reproductive and biotechnological tools for genetic improvement of livestock
45	2020-V-48	Rana Das	Application of reproductive and biotechnological tools for genetic improvement of poultry.
46	2020-V-49	Kyongtherpa Sonam Chomu Bhutia	Breeding for disease resistance.
47	2020-V-50	Sanjay Guragai	Breeding of pet animals
48	2020-V-51	Sevika Ghatani	Breeding of zoo and wild animals
49	2020-V-53	Siba Adasou	Classification of dog breeds
50	2020-V-54	Silencegist Sanglyne	Classification of cat breeds.
51	2020-V-55	Sarmistha Barman	Pedigree sheet of dog
52	2020-V-56	SengiRiba	Pedigree sheet of cat
53	2020-V-57	Saptarnab Das	Selection of breeds and major breed traits of dog and cat
54	2020-V-58	Soumyadeep Goswami	Selection of breeds and major breed traits of cat
55	2020-V-59	Shaal Debbarma	Breeding management of dogs
56	2020-V-60	Srideepa Roy	Breeding management of cats.
57	2020-V-61	Sakib Ahamed Sarkar	Common pet birds seen in India
58	2020-V-62	Taddo Pertin	Breeding management of pet birds
59	2020-V-63	Tamal Datta	History of Genetics
60	2020-V-64	Tutan Barma	Mitosis and Meiosis
61	2020-V-65	Visela L Sangtam	Overview of Mendelian principles
62	2020-V-66	Viyieno Neikha	Modified Mendelian inheritance
63	2020-V-67	Victoria Tamuk	Pleiotropy
64	2020-V-68	Greesh Kumar	Penetrance and expressivity
65	2020-V-70	Swapna Sahu	Lethals; sex-linked, sex limited and sex influenced inheritance
66	2020-V-73	Nishant Sharma	Multiple alleles
67	2020-V-75	Aman Meena	Sex determination
68	2020-V-76	Atul Kumar	Linkage and crossing over
69	2020-V-77	Pynshailang Marbaniang	Mutation

HISTORY OF ANIMAL BREEDING

2020-V-01

What is Animal Breeding?

- Animal Breeding is the branch of animal science that addresses the evaluation of the genetic value of livestock.

What is its use?

- Animal breeding, controlled propagation of domestic animals in order to improve desirable qualities.
- Origin of Animal breeding **start in the 18-th century**
- Founder of Animal Breeding- Robert Bakewell (1725 – 1795)
- Until roughly the 1700's animal breeding, as in selective breeding, did not really exist. Of course people mated their animals with animals in the neighbourhood that they liked.
  It was Sir Robert Bakewell who introduced animal breeding keeping accurate records of performance of animals so that objective selection became possible.

The work of Robert Bakewell

- Bakewell was an agriculturist. Who revolutionized sheep and cattle breeding in England. He was the first to improve animals for meat production and carcass quality

In 19th century

- In 1859, Charles Darwin (1809 – 1882) published his book 'On the origin of specie', based on the findings that he collected during his voyage on 'the Beagle.
- Discovered the forces of natural selection.
- Still, Darwin did not know about the basic laws of inheritance. It was the monk Gregor Mendel, who in 1865 published the results of his studies of genetic inheritance in garden pea.
- His findings had no immediate impact on animal breeding and were not recognised as important until 1900.

In 20th century

- The statistician R. A. Fisher together with Sewall Wright (1889 – 1988) and J.B.S. Haldane, were the founders of theoretical population genetics.
- Jay L Laurence Lush (1896 – 1982), who is known as the modern father of animal breeding. His book 'Animal Breeding Plans' that was published in 1937 greatly influenced animal breeding around the world.
- **How the domestication started**.
- Domestication: it is the process of conversion of wild animal to domestic use.
- The first animal species to be domesticated was the dog. Estimates of when this happened vary a lot, but it was approximately 12,000 years ago.
- Other types of animals may have been domesticated more forcefully. They were captured and put in an enclosure or tied up, at least during the night, and were only allowed out to graze or scavenge under supervision of a herdsman.

CLASSIFICATION OF BREEDS

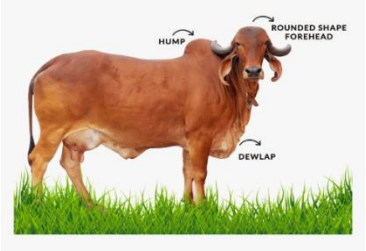
(Cattle, Buffalo, Sheep, Goat &Pig)

2020-V-02

According to ICAR – National Bureau of Animal Resources, Karnal (Haryana), total number of indigenous breeds now in the Country is 202, which includes:-

Cattle – 50
Buffalo – 19
Goat – 20
Pig – 10
Sheep – 44

BREEDS OF CATTLE



1.GIR (Milch breed)
*Gir forest of South Kathiawar of Gujarat.
* The breed is known for its hardiness and disease resistance.

2.RED SINDHI (Milch breed)
* Karachi and Hyderabad (Sind of Pakistan).
* High milk yielders.

3. SAHIWAL (milch breed)

*Montgomery district of present Pakistan.

* Best dairy breeds in India.

4.AMRIT MAHAL (draft)
* Found in Karnataka.
* Increase the milk productivity.

5.THARPARKER (Dual)
*Originated in Tharparker district of Hyderabad.
* Known for its both milking and draught potential.

6. VECHUR (draft breed)
*Vechur in kottayam district of South Kerala.
* Smallest cattle breed in the world.

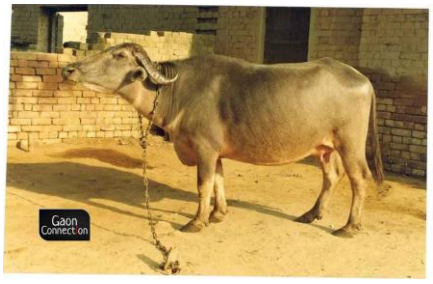
7. THO THO
*Found in Nagaland.
* Mainly used for meat, draught and manure.

BREEDS OF BUFFALO

1.JAFFARABADI
*Gir forest of Kathiawar in Gujarat.
*Known for its milk production and ability to fight.

2.MURRAH
*Found in Haryana.
*Highest milk production breed in India.

3. NILI RAVI
*The breed is found in Sutlej Valley in Ferojpur district of Punjab
* Good for heavy trotting work and for dairy use.



4.BHADAWARI
* Home tracts of this breed is Agra and Etawah districtof Uttar Pradesh and Gwalior district of Madhya Pradesh.

*This breed is known for its high butter fat content.

BREEDS OF SHEEP

1.CHOKLA
* Found in Churu, Jhungjhuna, Sikar and bording areas of Bikaner, Jaipur and Nagpur district of Rajasthan.
*Known for their utilisation as carpet wool.

2.NELLORE
*Found in Northern Andhra Pradesh.
*Tallest breed of sheep.

3. MERINO
* Found in Australia, New Zealand,Chile, Uruguay, and South Africa. In India, it found in Hissar Region.
* Produce the finest and most valuable wool type.

4. MADRA SHEEP
* Found in few villages around Bikaner.
*Known for its high quality meat and skin.

BREEDS OF GOAT

1.JAMUNAPARI(milch breed)
* Biggest breed.
* Found in Uttar Pradesh.
* It has Roman nose.

2. BEETAL(milch)
* Found in Punjab and Haryana.
*It is known for its milk production.

3. CHANGTHANGI(fibre breed)
* Found in LehLadakh.
*Mainly used for their fine quality cashmere wool Production i,e Pashmina shawls.

4. BLACK BENGAL
*Found in West Bengal.
*Excellent meat production.

5. MEHSANA(dual breed)
* Found in Gujarat.
*Primarily raised for milk and meat production.

BREED OF PIGS

1.ZOVAWK
*Originated from Mizoram.
*Black body white sport on forehead.
*White patches on belly, white boots.
*Long bristles on mid-line are characteristics of Zovawk

2.TENYI VO
*Found in Nagaland.
*Black in colour, small erect ears.
* Straight tail ending with white marking reaching the hock joint, white stocking, white marking.

3. NIANG MEGHA
* Found in Meghalaya.
*They have typical wild looks.
* Body coat solid black to black with white Patcheson forehead and legs

4.MALI
*Found in Tripura.
*Black colour, pot belly.
*Short erect ears lying perpendicular to the Body.
*Short legs, long tails.

ECONOMIC CHARACTERISTICS OF LIVESTOCK AND THEIR IMPORTANCE

2020-V-03

ECONOMIC CHARACTERISTICS

To determine the economic value of livestock the following characteristics are looked upon-

1.LACTATION YIELD

- The lactation yield in a lactation period is known as lactation yield.
- After parturition, the milk yield per day will be increased and reaches peak within 2-4 weeks after calving.
-This yield is known as peak yield.

2.LACTATION PERIOD

-The length of milk producing period after calving is known as lactation period.
- The optimum lactation period is 305 days.

3. PRESISTENCY OF YEILD

-The maintenance of peak yield for long period is known as persistency, slow decrease in dairy milk yield after reaching peak yield in necessary.
-High persistency is necessary to maintain high level of milk production.

4. AGE AT FIRST CALVING

-The age of the animal at first calving is very important for high life time production.
-Prolonged age at first calving will have high production in the first lactation but the life time production will be decreased due to less no of calving.

5. SERVICE PERIOD

- It is the period between date of calving and date of successful conception.
- If the service period is too prolonged the calving interval prolonged, less no. of calving will be obtained in her life time and ultimately less life time production and vice versa.

6. DRY PERIOD

- It is the period from the date of drying (stop of milk production) to next calving.
- If the dry period is not given or too low dry period, the animals suffer from stress and in next lactation, the milk production drops substantially and also it gives weak calves.

7.INTERCALVING PERIOD

- This is the period between two successive calving.
- If the calving interval is more, the total no. of carvings in her life time will be decreased and also total life production of milk decrease.

8.REPODUCTIVE EFFICIENCY

- The reproductive efficiency means the more number of calves during life time, so that total life time

production is increased, the reproduction or breeding efficiency is determined by the combined effect of hereditary and environment.

9. EFFICIENCY OF FEED UTILIZATION AND CONVERSION INTOMILK

- The animal should take the feed more and utilize efficiently to convert into the milk.

10. DISEASE RESISTANCE

- Indian breeds are more resistant to majority of disease compared to exotic cattle.
- Cross breeding helps to get this character.

IMPORTANCE OF LIVESTOCK

Food: The livestock provides food items such as milk, meat and eggs for human consumption. India is number one milk producer in the world.

Fibre and skins: The livestock also contribute to the production of wool, hair, hides, and pelts.

Cultural: Livestock offer security to the owners and also add to their self-esteem especially when they are owning prized animals such as pedigreed bulls, and high yielding cows/ buffaloes etc.

Sports / recreation: People also use the animals like cocks, rams, bulls etc. for competition and sports. Despite ban on these animal competitions the cock fights, ram fights and bull fights (jalli kattu) are quite common during festive seasons.

Draft: Bullocks are the back bone of Indian agriculture. The bullocks are saving a lot on fuel which is a necessary input for using mechanical power like tractors, combine harvesters etc.

Dung and other animal waste materials: Dung and other animal wastes serve as very good farm yard manure. In addition, it is also used as fuel (bio gas, dung cakes), and for construction as poor man's cement (dung).

Weed control: Livestock are also used as biological control of brush, plants and weeds.

Storage: Livestock are considered as "moving banks" because of their potentiality to dispose off during emergencies. Livestock serve as an asset and in case of emergencies they serve as guarantee for availing loans from the local sources such as money lenders in the villages.

ECONOMIC CHARACTERS OF POULTRY AND THEIR IMPORTANCE

2020-V-04

ECONOMIC CHARACTERS OF LAYERS

1) Age at sexual maturity:
   -21st week of age
   -If laying starts early, the eggs laid are smaller
2) Body weight at maturity:
   -wt. of layers at start of lay should ideally be 1.2-1.3kg
   -this chc. decides feed efficiency, egg number and egg weight
   -low bd wt.: poor growth of reproductive tract
   -high bd wt.: If it is due to high abdominal fat, the same will obstruct infundibulum and effect egg production
3) Egg production:
   -310-320 eggs
   -Egg production indices:
   Hen-housed egg production=no. of eggs laid on that day/no. of birds at start x 100
   Hen-day egg production=no. of eggs laid on a given day/no. of live birds available on that day x 100
4) Egg weight:
   -egg wt. vary between breed and age of the bird.
   -heavier birds produce heavier egg
   -55-60g on an average(chicken)
5) Egg quality:
   -defines those characters of an egg that effect consumer acceptability and preference
   -color: brown colored eggs fetch a premium price
   -texture: hens that lay rough eggs with thin shells are usually not selected
   -Breaking strength: it is measured by shell thickness and should be fairly high in commercial eggs
   -thick albumen is preferred to thin albumen, so also eggs with high proportion of yolk
   -although the nutritive value is not affected by blood and meat spots their presence is not pleasing
6) Feed efficiency:
   -efficiency of conversion of feed into egg.
7) Livability:
   -livability=no. of birds alive/initial no. of chicks x 100

ECONOMIC CHARACTERS OF BROILERS

1)Body weight at market age:
-the av. live wt. of a broiler when sold to market
-higher bd wt. fetches higher price
2)Feed efficiency:
-feed involves 70% of the cost of production, feed efficiency of broilers determines profit margin
-FCR(feed conversion ratio)=total feed consumed/total bd wt. gained
-optimally FCR is 1.6-1.8
3)Carcass traits:
-it is the proportion of edible meat to total live wt. which varies from 72 to 76%

4)Livability at market age
5)Fertility and hatchability:
-Fertility: refers to the capacity to reproduce
-%fertility= no.of fertile eggs\total no.of eggs x 100
-Hatchability:the percent of chicks hatched out of total no. of egg set

SELECTION

(2020-V-05)

The selection is a process of giving preference to certain individuals to certain individuals in a population to reproduce than other individuals which are denied the opportunity to produce next generation.

TYPES OF SELECTION

• **Natural Selection-**

The process in nature by which organisms better adapted to their environment tend to survive and reproduce more than those less adapted to their environment.
Eg; The origin of giraffes long necks.

• **Artificial Selection-**

Artificial selection is a process in which humans select the desired trait to pass in next-generation offspring of plants or animals.
Eg; Cross-breed dog is a dog that was the offspring of two different types of purebreds.

FACTORS AFFECTING RESPONSE TO SELECTION

· Additive genetic variability in the traits.
· Intensity of selection (i).
· Accuracy of Selection (rAP).
· Population size.
· Generation interval.

BASIS OF SELECTION

· **Individual Selection or Phenotypic Selection.**

It is the selection of animals on the basis of it's own phenotypic performance. It is the easiest, quickest and commonly used basis of selection.

· **Pedigree Selection.**

It is the selection of Individuals based on the information of it's pedigree.
Eg; Selection of heifers on the basis of her dam's performance.

· **Family Selection.**

It is defined as the selection of individuals on the basis of information of it's collateral relatives such as full sibs and half-sibs commonly known as family members.

· **Sib Selection.**

It is type of family selection where the information of the individual to be selected is not included in the estimation of family mean. Eg; Selection of males for carcass traits on the basis of information available of his full-sibs or half-sibs.

· **Progeny.**

A variant of family selection in which individual is selected on the basis of mean performance of its progenies. Best basis of selection.

· **Combined or Index Selection.**

Selection of individual on the basis of more than one source. Eg; Information from the individual, it's parents, it's FS, it's HS, it'

Selection Unit: It is unit on which the selection is based. Eg. A cow producing 15kg milk. Here, a cow is a selection unit.

Objective of Selection: To bring genetic improvement in a character of interest and hence, the character under selection is known as selection objective.

TYPES OF SELECTION

2020-V-06

Selection is of two types

1. Natural selection

1.Stabalizing selection 2.Disruptive selection 3.Directional selection

2. Artificial selection

NATURAL SELECTION

Natural selection is a process whereby organism better adapted to their enivironment tend to survive and produce more offspring. The main force of natural selection is “survival of fittest” in a particular environment. The natural selection acts through variation produced by mutation and recombination.

Many factors determine which individual will reproduce .These factors are :-

1. Difference in mortality in the population or overpopulation-more offspring are born than can survive.

2. Difference in duration of sexual activity.

3. Difference in degree of sexual activity.

4. Adaptation - some variation allow a better chance of survival. Example of natural selection -
1. Darwin’s Finches, 2.Resistant to antibiotic, 3.Resistant to pesticides,etc.

Examples

1-variety of beaks of finches that Darwin found in Galapagos island From the original seed eating features many other forms with altered beaks arose,enabling them to become insectivorous and vegetarian finches.
2 - evolution by natural selection in giraffe Through random variation that some giraffes had longer neck than other,enabling them to reach leaves high up in the trees in their environment

Types of natural selection The frequency of one particular phenotype in relation to another will be product of the type of selection that isoccurring.

1) Stablising selection 2)Disruptive selection 3)Directional selection

1. Stablizing selection- Population stabilized and favours intermediate trait's over extremes. Operates when environmental condition are stable and competition is low. example- Human birth weights(too large =birthing complications,too small =risk of infant mortality)

2. Disruptive selection- Population split into two groups favouring the extreme traits. This occurs when fluctuating environment conditions favour the presence of two different phenotypes. example - prolification of black or white moths in region of contrasting colour extremies

3. Directional selection Population tend to move in a specific direction and a single phenotypic trait is favoured. operates in response to gradually or sustained changes in environmental condition. Directional selection will typically be followed by stabilising selection once an optimal phenotype has been normalised.
Example - development of antibiotic resistance in bacterial populations.

2. Artificial selection Artificial selection is the process by which animals are chosen by breeders. to produce desirables and inheritable characters in successive generation. Allows only selected traits to be inherited over successive generation. This can also defined as the efforts of man to increase the frequency of desirable genes

Steps in artificial selection

- decide which characteristics are important enough to select
- choose parents that show these characteristics
- choose the best offspring from parents to produce the next generation
- repeat the process continuously

Natural selection vs Artificial selection

Natural selection	Artificial selection (Selective breeding)
In natural selection, nature selects the individuals with favourable variations for better survival in an environment	It is the selective breeding of domesticated plants and animals to produce offspring's with characters desirable to humans
The nature selects the best or the most favourable variation.	Man selects the desirable characteristic that is to be passed on to the next generation.
Selection pressure is exerted by environmental factors.	Selection pressure is exerted by humans
It always increases the species chance for survival in its natural environment	It may not always increases the species chance for survival in its natural environment
It takes about hundreds of years for new species to emerge.	It leads to the formation of new species in a much shorter time, may be in a few years.
In operates on a wide scale in natural populations	It involves selective breeding of economically important plant and animal populations only
It leads to great diversity in nature.	It promotes evolution of a few economically important plants and animals only.
Genetic diversity remains high	Genetic diversity is lowered
Out breeding is common, leading to hybrid vigour.	Inbreeding is common ensuring preservation of desired trait, leading to loss of vigour in offspring
Proportion of heterozygous in the population remains high.	Proportion of heterozygous in the population is reduced as inbreeding increases homozygosity
Examples: Insecticide resistance, Giraffes long neck, beaks of Darwin's Finches	Breeding of cows, sheep other domesticated animals high yielding varieties of wheat, rice etc.

Difference between natural and artificial selection

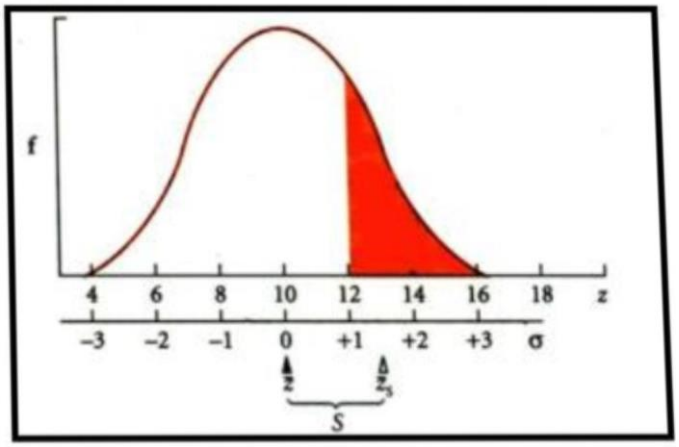
TOPIC:-RESPONSE TO SELECTION

2020-V-07

●It is the change of population mean in the offspring.It is denoted by R
●Response to selection can be defined as the difference of mean phenotypic value between the offspring of the selected parents and whole of the parential generation before selection
●It is also called as the expected genetic gain(deltaG)

■RESPONSE TO SELECTION DEPEND ON:-
●The response to selection is directly porptional to the amount of genetic variation in the character
●Generation interval:The average age of the parent when the offspring is born.It varies between species and selection procedure.

R or $\triangle G = h^2 S$	where, h^2 = heritability S = selection differential
R or $\triangle$ G/year = h^2 S / GI	where, h^2 = heritability S = selection differential GI = generation interval



●the relationship between fitness and phenotype.
●the phenotype variance.
●to the degree upto which it is heritable ,if it is highly heritable the selection of phenotype will permit an average estimation of breeding value and if low there might be many error .
●selection limit:- when selection is continuous the response to selection will be more for few generations then it slows down and finally stop.

FACTORS AFFECTING SELECTION

2020-V-08

Selection is the process of choosing parents with particular characteristics to breed together and procedure offspring with more desirable characteristics.

Selection differential (S):

It is the difference mean performance of the selected group over the population mean. This provides a greater opportunity to identify animals for breeding. Animals with higher selection differential increase the rate of genetic progress and are more selected.

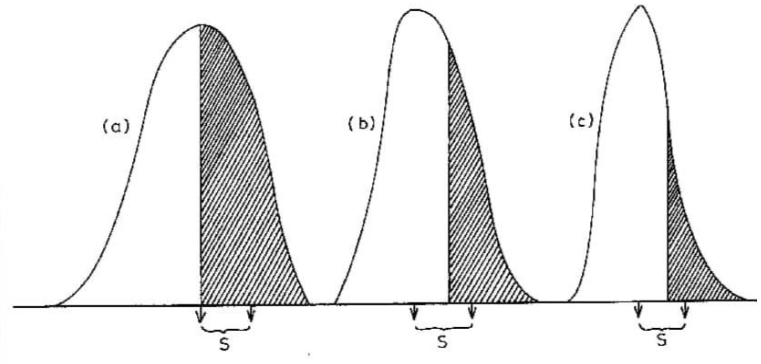
Factors which influence the selection are:

1)Proportion of animals selected (p):

It is inversely related with the selection differential. With increase in the proportion selected, the S will be decrease and vice versa. The portion selected will be large if it is required to increase the herd size.

2)**Phenotypic Variability (σp):**
It is very important to influence the S and hence R. The S is small if the character is less variable and vice versa. Animals with more selectable characters are more likely to be selected. The σp depends on the breeding program of the herd.

The dependence of these two factors on selection differential is illustrated diagrammatically represented here.



Selection Differential

Here, all the individuals in the shaded area are selected.

In graph,

a) Half the population is selected and the S is rather small.
b) Only 20% of the population is selected and the S is much larger.
c) 20% is again selected, but the character represent is less variable and the selection differential is consequently smaller.

3**) Sex of Animal:**
The S is large in case of males. This is because fewer males are required for breeding and hence S will be higher in case of males.

4) **Number of traits under selection:**
The increase in the no. of traits under selection reduces the selection differential. This is because an animal may not be outstanding in all the character.

5) **Accuracy:**
Any error in recording a trait also influences the selection differential.

Basis of selection

2020-V-09

The source of information based on which the breeding value of the individual is estimated are called as the **basis of selection**.

Selection unit: It is the unit on which the selection is based.

For example, a cow producing 15kgs of milk, here the cow is the selection unit.

3 types of basis of selection unit

1. Individual selection or phenotypic selection.

It is the selection of animal on the basis of its own phenotypic selection.

It is most commonly used basis for selective improvement of livestock.

In plants and lower organisms, it is known as mass selection as the selected individuals are usually put together "**en-masse**" for mating.

Merits of individual selection

It is the easiest, quickest and commonly used basis of selection.

It is also the natural method of selection.

It is used for high heritable traits.

Demerits

It cannot be used for sex limited traits such as selection of males for milk yield,egg production etc.

It is not preferable for traits which expressed after maturity or late in life as it will increase the generation interval.eg. milk yield only after sexual maturity.

It will give low genetic gain for traits having low heritability.

2. Pedigree selection and Family selection

It is the selection of individual based on the information of its pedigree.

For example:

Selection of heifer on the basis of her dam's performance.

Selection of young males on the basis of his dam's milk yield records.

Merits

Individual can be selected before reaching sexual maturity.

It can be used for sex limited traits. Example , selection of young male for milk yield on the basis of his dam's record or sister's record.

Demerits

In general the information of ancestors are not available.

It may mislead in selection of individual on the basis of remote relatives performance.

3. Progeny selection or progeny testing.

Progeny selection is the widely applied basis of selection in animal breeding.

It is a type of family selection.

In progeny selection, the selection of individual is done on the basis of mean performance of its progeny.

The mean performance of the progeny gives more reliable estimate of the breeding value of the individual to be selected.

Merits

It is the ideal basis of selection as the mean value of the progeny gives an accurate estimate of the breeding value of their sire.

Males can be evaluated for characters which are not expressed in male (sex limited trials). For example, bulls can be evaluated for milk yield.

Demerits

The parents by chance may give better than average or more than average genes to its progeny.

Only a few individuals can be selected at a time.

INDIVIDUAL SELECTION

2020-V-10

INDIVIDUAL SELECTION

Selection on the basis of individual phenotypic performance is called individual selection. It is the most common used basis for improvement in livestock. Characters like body type, growth rate are evaluated directly from individual animal performance.

It is an aspect of natural selection in which those traits of an individual that lead to increased reproductive success are more likely to appear in subsequent generations.

The breeding value (B.V.) of an individual can be estimated for one character (single trait selection) or for more than one character (multi trait selection).

ADVANTAGES OF INDIVIDUAL SELECTION

1. The information on individuals to be selected is easily available.
2. It can be applied earlier to progeny testing. This is used when pedigree information are not available.
3. The generation interval is shorter by this method compared to progeny testing.
4. This gives a direct estimate of B.V. rather than on the basis of relatives performance and hence it is more accurate.
5. This allows a greater selection differential because the B.V. of all the individuals can be estimated while in case of P.T. only a few individuals may be progeny tested as parents.
6. This method minimizes the environmental effects because the individuals for selection are tested in the same environmental conditions.

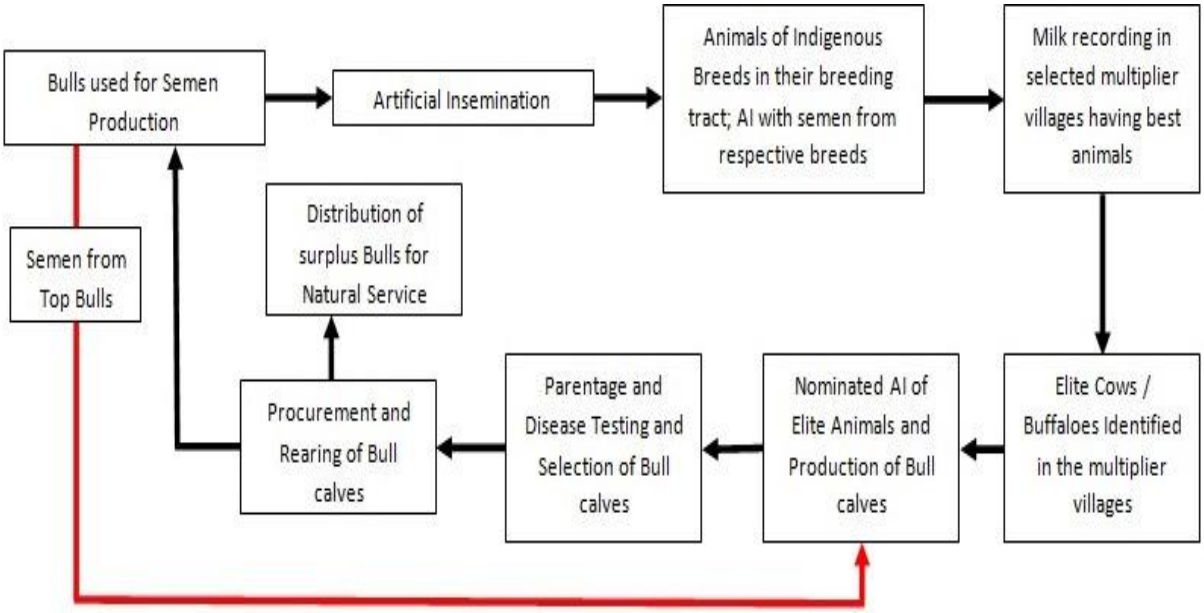
PEDIGREE SELECTION

2020-V-11

INTRODUCTION

The selection criteria based on performance of ancestors(parents and grandparents is called as the pedigree selection.

- ✓ The pedigree method was first outlined by Love in 1927.
- ✓ When Bulls are evaluated and selected only on the basis of their performance of their parents and grand parents.
- ✓ It is useful when the selection decision must be made before the expression of trait (like carcass quality, mature weight & sex limited traits-like milk yield) of an individual.



Practical difficulties to use pedigree selection:

- ✓ The ancestors records are always not available.
- ✓ The records may be faulty due to stray mating.
- ✓ The pedigree records are destroyed with passage of time.
- ✓ Most of the character have low heritability.

Breeding value based on records:

The B.V of an individual from its pedigree records is estimated by the selection differential of its relative (P) from their contemporary (Pc) mean times the regression of the genotype of the individual on the phenotypic mean of the relatives (bap) and added to the mean of the contemporary group as:

$$P.B.V = Pc + bap(P - Pc)$$

The bap is taken as rh2 where r is the coefficient of relationship between the individual and its relative. In estimating the PBV of individual ,the record of one parent or both parents or parents and grandparents can be used.

Merits of Pedigree selection:

- ➢ It is costly as only compilation of pedigree is required.

- Allows selection at younger age and provides first hand information .
- It is helpful in multistage selection.
- It is useful at sex limited traits and those expressed in later life or after death of animal.
- It is helpful when two individuals have similar performance but one belongs to better pedigree.

Demerits of pedigree selection:

- There is disadvantage of using pedigree selection that all animals of similar pedigree are culled out in spite of the fact that an individual may be of good merit and free from recessive allele causing the defect.
- Some pedigree gets undue favour irrespective of the true merit of the individual. Better environment is provided to the progeny of favoured pedigree.
- It introduces non random biases because pedigree records are for different environmental condition.
- Pedigree selection provides no basis of selection among indivduals which are descendants of the same anscestor.
- The accuracy is usually low.

FAMILY AND SIB SELECTION

2020-V-12

1.Family Selection

- Family names are used in at least two senses in animal breeding. The familyname has been traced through the dam and sires. Family, in animal breeding, includes full-sib and half-sib families. In a random mating population, half-sibs have a relationship coefficient of 0.25 and full-sibs have a relationshipcoefficient of 0.5. Such family members are collaterally related not directlyrelated. They are neither ancestors nor descendants. Because of their commonancestry, they would have some genes in common and thereby someperformance in common.
- If the records of the individual are included in the family average and used as acriterion for selection, it is known as family selection. If the individuals'records are not included in arriving at the average, then it is known as sibselection. When selection is carried out for market weight in swine, the marketweights of all males and females in the family are considered in the calculationof family average (family selection). But when selection is carried out forfertility traits and milk yield, the performance of males cannot be included butthey are selected on the basis of sibs' average (sib selection).
- The family selection can be represented as a part of pedigree selection. The families are ranked and based on this, the entire family is selected or rejected.Family/sib selection is used more frequently in swine and poultry where the number of progenies produced by females is high. The family selection does not increase generation interval. The informationfrom family/sib is combined with individual information in the form of index and selection is based on the index.
- Collateral relatives are those not directly related to an individualas ancestors orprogeny. The relatives are neither direct ancestors nor direct descendants of anindividual. They may individual's brothers, sisters, cousins, uncles, aunts,nieces, nephews, etc. The more closely they are related to the individual inquestion, the more valuable information they can supply for selectionpurposes.
- If information on collateral relatives is complete, then it will give an idea of thekinds of genes and combination of genes the individual is likely to possess. ItDrvet.in 2020will be of much useful in selecting traits that can be measured only after thesacrifice of the individual e.g. carcass traits. Similarly it is also useful inselecting dairy bulls, since milk production can be measured only in cowsthough bull possesses and transmits genes for milk production to his progeny.It is also used in selection of poultry for egg and meat production and also forall or none traits such as mortality, disease resistance and fertility. Selection onthe basis of sib tests (Half sibs or Full sibs) means that an individual id kept forbreeding or is rejected on the basis of the phenotype of its brothers and sisters.They may be maternal half sibs or paternal half sibs or full sibs.

2.Sib Selection

- Selection of an individual on the basis of family mean is called sib selection when individual's own performance is not included in the estimation of family mean.
    - An individual is selected on the basis of average performance of sibs.
    - Average performance of sibs is the criteria of selection.
    - Depending upon types of sibs, it is two types – Full-sib family selection and half-sib family selection.
- Sib selection is practiced for improvement of the following traits for which measurements of individual are not available:
    - Traits with low heritability and high reproductive rate – litter size
    - Sex-limited traits – milk production, egg production
    - Traits can not be measured on the individual – slaughter traits
- Advantages of family selection:
    - It is suitable for traits with low heritability and highreproductive rate. Eg. Litter size in pig, egg production.
    - It reduces generation interval.
    - It is an aid to individual selection because it is better to select an individual from a superior family.
- Limitation:
    - It leads to inbreeding
    - Full-sib family selection can only be applied in species with high reproductive rate to get large family size.
    - Family selection is costly since large number of families are required to be maintained.

Progeny and combined selection

2020-V-13

Progeny selection:

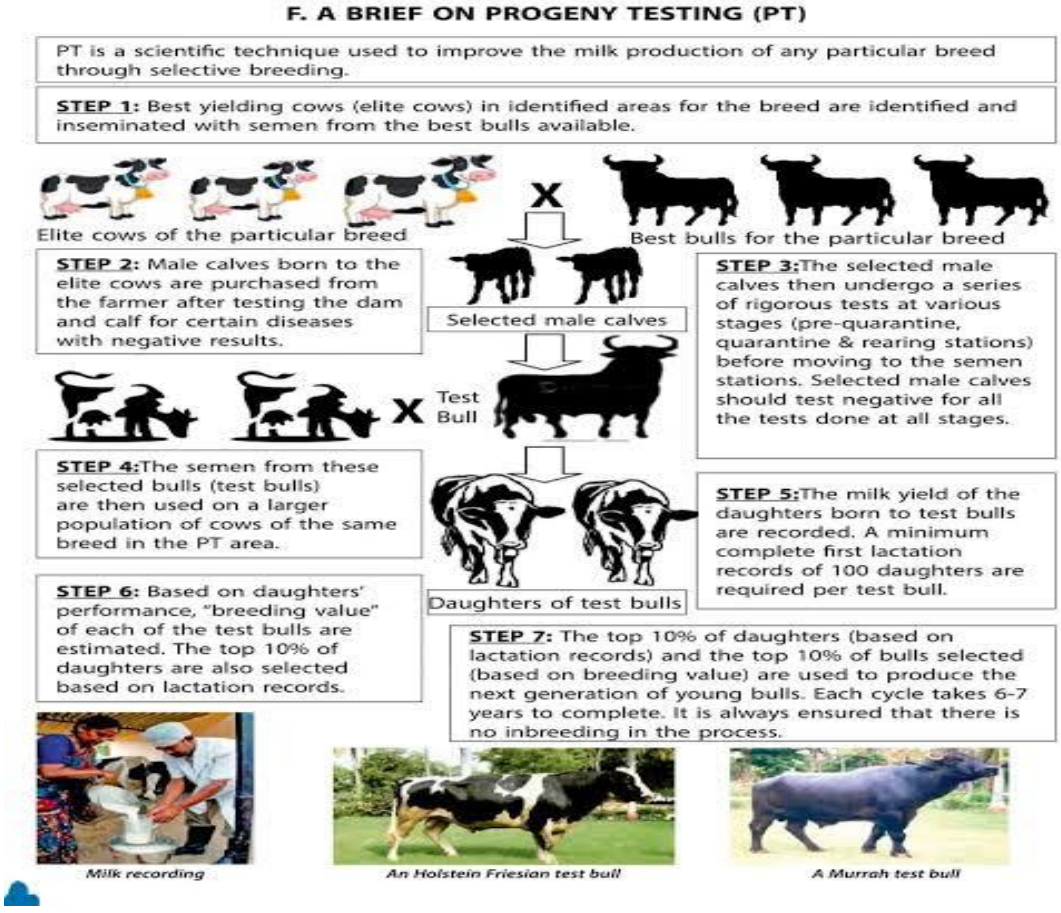
- **The selection criteria for evaluating an individual based on his progeny performance is known as progeny selection or progeny testing(P.T.).**
- **It is the most important basis of selection.**
- **It is regarded as a form of family selection because progenies are the family members of each other.**

Superiority of progeny selection over other criteria:

-Progeny Selection gives the best and most reliable information about the genetic merit of parent(individual). This is because progeny selection is based on mean performance of many progenies. This overcomes the limitation of Mendelian error of gene segregation and hence provides the true estimate of Breeding value (B.V.) of an individual.

Points to be considered before performing progeny testing:

· Test as many as sires possible (5 to 10 would be minimal)
· Make sure that dams are mated to sires at random, within age group if possible.
· Produce as many progeny per sire as possible.
· No progeny should be culled until the end of the test.



Advantages:

· For selecting sex limited traits.
· For selecting traits require sacrifice of the animal (carcass traits)
· For selecting traits expressed late in life.
· For testing animals for recessive traits.

DISADVANTAGES OF PROGENY TESTING:

- More number of animals must be progeny tested.
- It prolongs the generation interval.
- It is time consuming and expensive**.**

COMBINED SLECTION OR INDEX SELECTION:

- The selection of an individual on the basis of two or more sources of information(selection criteria) is called as the combined selection or index selection.
- The selection index is a total score that includes all the advantages and disadvantages of an animal for those traits considered for selection.
- The amount of weightage given to each trait depends on their relative economic value, heritability of the character and genetic correlation between characters.
- A trait, which is highly heritable, can be given greater score than a trait, which has a low heritability.

For example:

In dairy cattle, milk production is the most important economic trait, whereas the reproductive efficiency that is also important may not be as important in magnitude as milk production. Hence, higher economic value should be given to milk production and correspondingly lower economic value to the reproductive efficiency.

- The selection index method is the most efficient (best method) among the three methods of selection(Tandem, Independent culling and Selection Index) methods because it results in better genetic improvement.
- The index is the best estimate of an animal's breeding value.

Disadvantages of Combined selection or Index selection:

- The only disadvantage is that the traits vary in importance from time to time and the index built at one time will not be applicable for all times. Hence, it has to be constructed and modified from time to time.

INDIRECT SELECTION

2020-V-14

The concept of correlated response (C.R.) is extended to indirect selection. The indirect selection means the direction selection applied to the character (X) other than the one (Y) that is to be improved. For example, the improvement is required in character Y but the direct selection is not possible due to some reason (low h^2 of trait, not possible or difficult to measure the character, costly to measure the trait and the traits expressed at later ages or after death of animal). In this situation (when character Y can not be selected directly), it is better to select for the character X having desired genetic correlation with character Y, so as there is C.R. in character Y. Thus, direct selection is done for character X when change is required in character Y rather than to go for direct selection for Y.

Basis of indirect selection : It is the high genetic correlation between the character under direct selection (X) and the character for which no direct selection can be done but requires improvement (Y) and hence the C.R. is the basis.

Applications of indirect selection : The indirect selection is advantageous or applicable under the following conditions-

- When C.R. is higher than direct response (D.R) due to high genetic correlation and high heritability of the character under selection (h^2x) than h^2y.
- When it is more difficult to measure character Y than character X, or when it is costly to measure the character X (growth rate). Like wise, the sex ration in offspring is a parental trait and cannot be changed applying direct selection but the selection for blood pH may produce a correlated change in sex ratio.
- When desired character is sex limited but correlated character is measurable in both the sexes, a higher intensity of selection is possible by indirect selection.
- Indirect selection can be applied to reduce generation interval, e.g. selection based on part year production in poultry for egg production (X) will lead to a rapid genetic gain in annual egg production (Y).

Measurement of indirect selection : The character which is under direct selection (X) is called the secondary character because the primary character is one in which improvement is required (Y) through indirect selection. The relative efficiency of direct and indirect selection for character Y can be compared by calculating genetic gain and finding out the ratio of two gains (Q) as:

$Q = \frac{CRY}{DRY}$ = Gain by indirect selection / Gain by direct selection

$= \frac{rA\ hX\ hY\ iX\ \sigma PY}{hY\ iY\ \sigma AY}$

$= r_A \sqrt{(\frac{hX}{hY})}$

Therefore, when Q is greater thanone, the indirect selection is more effective. This is possible if the secondary character (X) has higher heritability than desired trait (Y) and also r_A is high.

Example of indirect selection : Some of the examples of indirect selection are –

- Selection of weaner fleece for increased adult fleece.
- Selection for birth weight or weight at early age for increased adult weight
- Selection based on par year record.
- Selection for yearling body weight in sheep to increase fertility (lambs born) because the fertility has low heritability for which direct selection for fertility will be slow.

INDIRECT SELECTION

2020-V-15

INTRODUCTION

The concept of correlated response (C.R.) is extended to indirect selection. The indirect selection means the direction selection applied to the character (X) other than the one (Y) that is to be improved.

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Example of indirect selection

• Selection of weaner fleece for increased adult fleece.

• Selection for birth weight or weight at early age for increased adult weight
• Selection based on par year recorD.

• Selection for yearling body weight in sheep to increase fertility (lambs born) because the fertility has low heritability for which direct selection for fertility will be slow.

Method of selection

2020-V-16

Selection is the action of carefully choosing something as being the best or most suitable.

The economic value of ban individual depends upon several characters.

Example:- A diary cow will be more economical to maintain if she produces more milk with higher fat content for a longer period during lactation and remained dry for a shorter time between successive calving. Thus, the net economic value of an animal depends upon several traits.

Selection is of 2 kinds namely Natural and Artificial selection.

Again the artificial selection is divided into different methods.

They are namely 1) Tandem method

2) Independent Culling method

3) Selection Index

Natural Selection

The main force of Natural Selection is the survival of fittest in a particular environment. The survival is for the particular environment in which the population lives. In nature, the animals best adapted to their environment survived and produced the largest number of offspring.

Natural Selection acts through the variations produced by mutations and recombination of genetic factors and eliminate unsuccessful genetic combination and allows nature's successful experiment to multiply.Natural Selection is a very complicated process and many factors determine the proportion of individuals that will reproduce.

Artificial Selection

Artificial Selection is the selection practiced by man. This can also be defined as the efforts of man to increase the frequency of desirable genes or combination of genes in his herd or flock by locating or ability to produce superior performing offspring when mated with individuals from other lines or breed.

Culling:-

Culling is the removal of inferior animals rather than the more positive selection of good ones. Culling decides which parents will no longer remain parents. It is easy to cull poor looking stock but genetically this achieves little if they are poor because of environmental reasons .

Thus, Selection and Culling go together.

Types of artificial selection:-

1) Tandem Method :- Selection for single traits at a time till the desired level of genetic improvement is reached. After achieving the genetic improvement upto a desired level. It needs to decide which trait has to be selected first according to their economic importance.
   It is least important of the 4 methods from the stand point of genetic progress made per unit time.
   The efficiency of this method is dependent on the genetic relationship among the traits .
   It's disadvantages is that it takes time and effort and it is least efficient method.
2) Independent culling level :- According to this method, selection is practiced simultaneously for several traits at a time but independently.
   It is the method of selecting 2/more traits but they both need to meet a minimum standards.
   The failure to meet the minimum standards for any one traits makes the animals to be rejected so mostly superior animals is used in this method.
   Selection base on independent culling method is easy to perform but becomes complicated when more traits are considered.
   Therefore only few important traits should be considered in this method.
   Its advantages is that it is more efficient than Tandem Method as selection is for more than 1 trait at a time.
   It's disadvantages is that it doesn't permit superiority in some traits to compensate deficiency in other traits.

Independent culling levels

Traits	Standard set	Cows Number	
		Cow 1	Cow 2
AFC (months)	40	**38**	**41**
Milk Yield (Kg)	1900	**1960**	2325
Fat (%)	4.60	**4.97**	**4.50**

On the basis of standard set in above, Cow1 will be selected in spite of low milk yield. Cow2 will be culled as it does not meet out all the standard set by breeder.

3) Selection Index or Total Score Method

The first application of the Selection Index to plant breeding was by Smith (1936) using the Discriminant Function of Fisher (1936).

Selection Index is also known as Discriminant Function, since it is in discriminating individuals with high and low scores.
The individual specifications for a number of traits can vary greatly and is combined into one values for animals is called total score.

It is the most effective method of selection when the breeders simultaneously select for several traits as it removes disadvantages of earlier 2 methods.
Selection Index is defined as a system of weighing values of several traits to arrive at a single score or numerical expression for use in determining which of a given group of animals to select for breeding use and which to cull .

The value of each traits was determined separately to add so that it gives a single total score for all over the traits.
Animals with highest scores are kept for breeding purposes.
The only disadvantages is that traits vary in importance from time to time and index built at one time will not be applicable for all times. Hence it has to be constructed and modified from time to time .
So in conclusion, the Selection Index is a total score that includes all the advantages and disadvantages of an animal for those traits considered for selection.

SINGLE AND MULTI TRAIT SELECTION

2020-V-17

INDIVIDUAL SELECTION

The breeding value of an individual based on its phenotypic value can be estimated for

i) One character i.e SINGLE TRAIT SELECTION

or

ii) For more than one character i.e MULTI TRAIT SELECTION

SINGLE TRAIT SELECTION

The phenotypic merit of the individual under selection is determined and compared with the average merit of other individuals of the population kept under similar environment conditions and that too at the same time. Therefore, the individuals are ranked relative to other under similar conditions.

ADVANATGES- Selection for a single trait is the quickest way to make progress in that individual trait.

DISADVANTAGES- However, because animals and the animals of livestock production are complex and can have unexpected and undesirable consequences due to genetic correlations or environment responses, this simple method is generally not practical.

Example- If we simply selected for individual weaning weight alone, we would most often select kids born and raised as singles, reducing fertility and twinning rate in the herd.

MULTI-TRAIT SELECTION

The economic value of an animals depends on several characters. This is known as overall performance of total breeding value (net breeding merit) of an animal.

For example- A dairy cow will be more economical to maintain if she produce more milk with higher fat content for a longer period during lactation and remained dry for a shorter time between two successive calving .

On the other hand if a cow produces more milk daily of low fat content with shorter lactation length and goes dry earlier during the lactation, it will not be economical to maintain.

It is therefore essential to estimate the total breeding worth (net genetic merit) of an animal based on several characters.

It is require to improve the overall economic value based for several characters . This is known as multi trait selection.

REQUIREMENT OF MULTI TRAIT SELECTION:

1. The economic value of traits- This is measured as the amount by which each unit of variation in it actually raises or an individual value, know as the relative economic value of trait.

2. The genetic significance of the trait in terms of the heritability of the trait and genetic correlations among the traits.

3. The method of selection chosen and the number of traits to be included in selection criteria also influence the efficiency of simultaneous selection of several traits.

DISADVANTAGES OF MULTI TRAIT SELECTION

1. We have to spread our selection efforts over several traits

2. Not all traits are equally important economically

3. Not all traits are equally heritable

4. There are correlations between traits i.e. selection of one trait also gives a correlated response for other traits.

However, multiple trait selection is more practical and common today. It is important to keep the number of traits as low as possible. The more traits being selected means that less progress is made in any one trait.

MATING SYSTEM

2020-V-18

Mating System

A mating system is a way in which a group is structured in relation to sexual behavior, .i.e. inn animals, the term describes how males and females mate- number of mates, etc.

Types of mating systems

- **Monogamy**: in this case, an animal has only one mate.
- **Polygamy**: in this case, an animal has more than one mates (it includes polygyny, polyandry, and polygynandry)

Monogamy

Monogamy is a type of mating system in which an animal has only one mate during their lifetime or only one mate at any one time. Monogamy is a rare phenomenon in animals.
There are three different types of monogamy:

- **Sexual monogamy:** it is the practice of having sex only with one mate at a time.
- **Social monogamy:** it is when animals form pairs to mate and raise offspring but still have "extra-pair copulations".
- **Genetic monogamy:** it is used when DNA tests can confirm that a female's offspring are from only one father.

An estimates 90 % of all birds are socially monogamous, living and raising young together, but many frequently mate with other partners. One famous experiment found that female blackbirds paired with sterilized males were still laying eggs that hatched.
A few animals stay with one mate for life, for e.g., the mouse-like prairie vole. A male vole will prefer to mate exclusively with the first female that he mates with. A mated male vole will even actually attack other females.

Polygamy

Polygamy is a mating system in which one individual mates with more than one individual of the opposite sex. It is of three types:

- **Polygyny**
- **Polyandry**
- **Polygynandry**

(1) Polygyny

- In polygyny, a single male mates with multiple females. It is the most common mating
- system in the animal kingdom. In polygynous systems, the males fight for dominance over
- a group of females, and whichever male is the biggest and strongest gets to mate with all
- the females. Lions and elephant seals use this type of mating system.

Advantages of Polygyny for Males

- The largest advantage for males in a polygynous mating system is the increased
- fitness and reproductive success of the lone male because he will father all the
- offspring.
- The male also passes on his genes to more individuals.

Advantages of Polygyny for Females

- Some females willingly choose polygyny to gain access to the best resources
- available. In these cases, the benefits from superior resource access must outweigh
- the opportunity cost of giving up monogamous parental care by a male.
- They also can get support from the same group of other females when in danger, like
- a female lion.
- It is harder for females to find a partner better than their mate in polygyny as compared
- to monogamy, unless he is beaten by another male (then that male is considered more fit).

Costs of Polygyny for Males

- In polygynous systems, there is less genetic diversity because one male fathers all of
- the offspring.
- It increases the chance of inbreeding and the passing on of genetic disorders.
- It is difficult for males to handle many females at once.

Costs of Polygyny for Females

- Females sometimes encounter infanticide, which is when
- a breeding male is overthrown and a new breeding male becomes dominant and kills all
- of their current offspring, as he has not fathered them. Because the females no longer
- have offspring to nurse, they will go into estrous sooner, which allows the new breeding
- male to mate with the females earlier.

(2) Polyandry:

- In polyandry, a single female mates with multiple males. It is much rarer as compared to
- polygyny. Polyandry has direct benefits for females allowing fertilization assurance,
- provision of resources, and parental care for their offspring. House mice (Mus musculus)
- have shown indirect, genetic benefits, where females have increased offspring survival through multiple mating, showing that practicing polyandry mating results in an increase
- in offspring viability (survivability).

(3) Polygynandry:

- In polygynandry, multiple males mate with multiple females, it is a combination of
- polyandry and polygyny.

Inbreeding Coefficient

2020-V-19

Inbreeding: It's Meaning, Uses and Effects on Farm Animal

- **Inbreeding** is defined as the mating of animals more closely related than the average relationship within the breed or population concerned.
- Mating closely related animals for example, parent and offspring, full brother and sister or half brother and sister is inbreeding.

Genetic consequences of Inbreeding

The basic genetic consequence of inbreeding is to promote what is technically known as **homozygosity.** This means there is an increase in the frequency of pairing of similar genes. Accompanying this increase, there must be a decrease in the frequency of pairing of dissimilar genes. This is called a decrease in **heterozygosity.**

Effects of inbreeding on different kinds of gene action

Increased homozygosity due to inbreeding may have a quite different effect on the phenotype depending upon the kinds of gene action involved.

a. Dominance and recessiveness
b. Overdominance
c. Epistasis

Measurements of Degree of homozygosity

The increase in proportion of homozygosity is an individual is measured in terms of breeding coefficient.

Inbreeding coefficient (F): It is defined as the probability that two alleles at a locus in an individual are identical by descent.

Methods of estimation of inbreeding coefficient (F):

i. Path Analysis Method
ii. Varience-covariance table
iii. Coefficient of coancestry or Kinship

Common ancestor: It is the individual who share his/her inheritance to the parents of the inbred individual.

Inbred individual: It is the individual whose parents are related.

COEFFICIENT OF RELATIONSHIP

2020-V-20

The coefficient of relationship is a measure of the degree of consanguinity (or biological relationship) between two individuals. The term coefficient of relationship was defined by Sewall Wright in 1922, and was derived from his definition of the coefficient of inbreeding of 1921.The measure is most commonly used in genetics and genetic genealogy.

IN general, the higher the level of inbreeding the closer the coefficient of relationship approaches a value of 1, expressed as a percentage, and approaches a value of 0 for individuals with arbitrary remote common ancestors. The value is accurate to within 1% if the full family tree of both individuals is known to a depth of seven generations.

IMPORTANT TERMS:

Common ancestor: It is the individual who share his/her inheritance to the parents of the inbred individuals.

Inbred individual: It is the individual whose parents are related.

Examples:

Relationships	Coefficient of relationship(r)
1) Identical twins; clones	100% (1)
2) Parent-offspring	50% (2)
3) Full siblings	50%
4) Half siblings	25%
5) First cousins	12.5%
6) Second cousins	3.13%
7) Third cousins	0.78%
8) Fourth cousins	0.20%

9) Great grandparent-great grandchild	12.5%
10) Aunt/uncle-nephew/niece	25%

USES OF COEFFICIENT RELATIONSHIP

1.To measure the strength of the relationship between two variables.

2.Pearson correlation is the most commonly used in statistics.

REFERENCES:

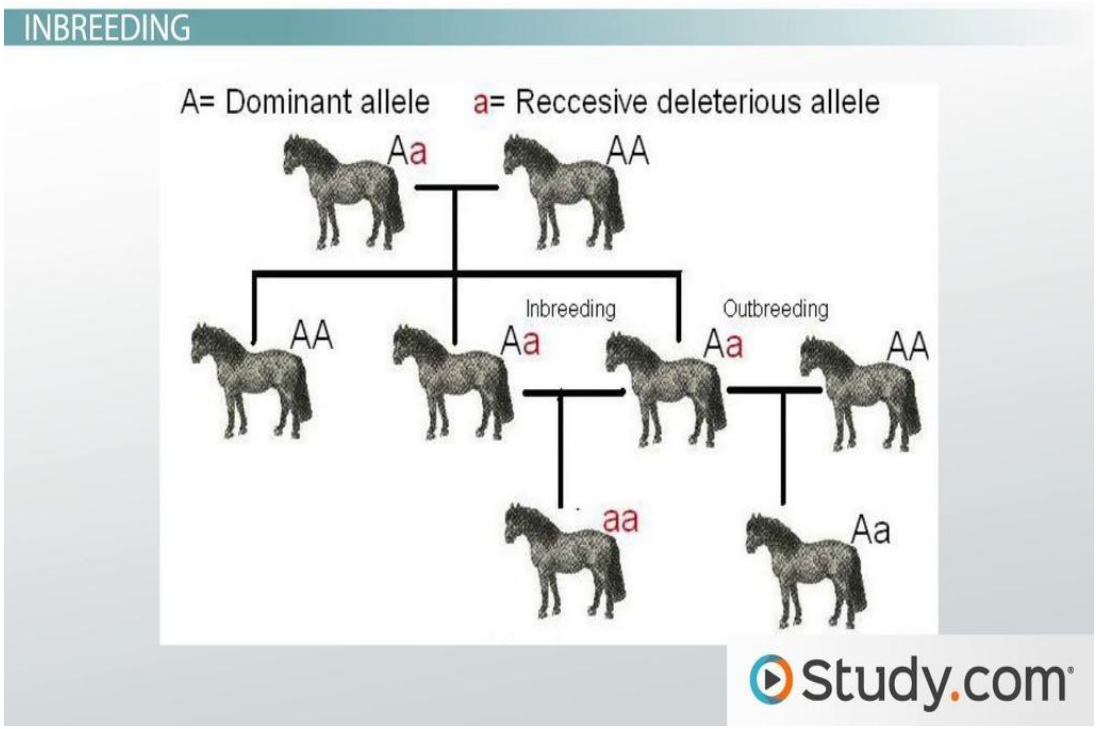
1. Strictly speaking, r=1 for clones and identical twins, but since the definition of r is usually intended to estimate the suitability of two individuals for breeding, they are typically taken to be of opposite sex.
2. A full family tree of seven generations (128 paths to ancestors of the 7th degree) is unreasonable even for members of high nobility. For examples, the family tree of Queen Elizabeth II is fully known for a depth of six generations, but becomes difficult to trace in the seventh generation.
3. By replacement in the definition of the notion of "generation" by meiosis". Since identical twins are not separated by meiosis, there are no "generation" between them, hence n=0 and r=1.
4. This degree of relationship is usually indistinguishable from the relationship to random individual within the same population (tribe, country, ethnic group).

Genetic and Phenotypic Consequences of Inbreeding

2020-V-21

INBREEDING

- The mating of individuals that are closely related through common ancestry.
- Mating between closely related animals up to 4 or 6 generation.
- It is common in all wild animals and plants.



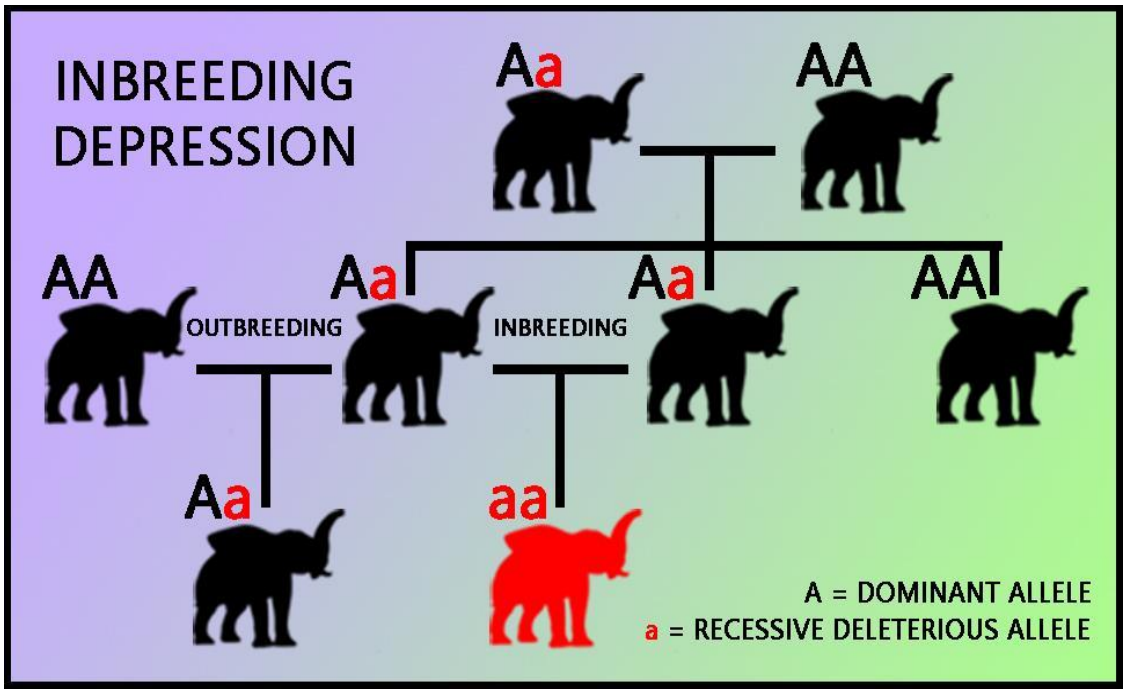
GENETIC CONSEQUENCES OF INBREEDING

1. Inbreeding generally results in an overall reduction in performance, which is known as Inbreeding Depression.
2. Poorer reproductive efficiency (reduced fertility both in litter size and sperm viability) including higher mortality rates, lower growth rates, smaller adult size loss of immune function and a higher frequency of hereditary abnormalities.
3. This has been shown by numerous studies with cattle, horses, sheep, swine and laboratory animal.
4. Most inbreeding studies suggest each successive unit increase in inbreeding results in a proportional decrease in performance.
5. In research with swine conducted at the Mid-west Regional Swine Breeding Laboratory, Dickerson and others (1954) point out that for each 10 per cent increase in inbreeding (of the pigs in the litter), there is a decrease of 0.20, 0.35, 0.38, and 0.44 pigs per litter at birth, 21 days, 56 days, and 154 days, respectively.

PHENOTYPIC CONSEQUENCES OF INBREEDING

1. It affects fitness traits like reproduction, vigor (vitality) and growth traits.

2. It reduces reproductive efficiency in farm animals.
3. It results in increased mortality rate of offspring and hence loss in vigor.
4. Despite the generally poor results obtained with inbreeding, it is a very useful tool in animal breeding.
    - Inbreeding can be used to determine the actual genetic worth of an individual
    - Inbreeding can be used as an aid to selection.
    - It may also be used for selection against genes that produce abnormalities or death.
    - It can be used for formation of inbred lines to exploit the heterosis.
    - It is used for development of prepotent animals.



CONCLUSION

- Inbreeding results in homozygosity.
- Leads to decreased biological fitness of a population. That's called Inbreeding Depression.

INBREEDING DEPRESSION

2020-V-22

INBREEDING

Mating of related individuals or within the same breed for 4-6 generations.

2 types

More closely related

example- sib mating (both male and female have same parents)

Less closely related

example-half sib (only one parents common)

INBREEDING DEPRESSION

Reduced in fertility and productivity due to continuous inbreeding.

The degree of inbreeding is measured by inbreeding coefficient (F)

Objectives/Significance of inbreeding:-

To concentrate or conserve the particular traits/desirable genes of a breed such that they are consistently transmitted to offspring

Develop a pure line in any animal.

Exposes harmful genes that can be eliminated by selection.

Helps in accumulation of superior genes.

However continued inbreeding especially closed inbreeding leads to inbreeding depression.

How to overcome inbreeding depression ??

Selected animals should be mated with unrelated superior animals of the same breed .This helps restore the fertility and yield of an animal this is called outcrossing.

OUTCROSSING

Same breed but unrelated individuals

Have no common ancestors for 4-6 generations.

APPLICATIONS OF INBREEDING

2020-V-23

Inbreeding is defined as mating of closely related individuals. For example, parthenogenesis in animals and self-fertilization in plants are the most extreme types of inbreeding.

Application:

- Inbreeding tends to decrease variations within the group, maintains homozygosity and stabilizes the type.Therefore, breeders have, developed a desirable genotype ina group by controlling the mating of the animals within a herd of flock. Registered breeds are obtained in this way.
- Inbreeding combined with selection over a period of time has resulted in many valuable breeds of domestic animals.

  Many valuable breeds of domestic animals have been developed by inbreeding like Merino sheep known for producing fine wool, modern race of horses is developed from Arabian stallion.
- to retain the desirable varieties of the individual.
- It can be used for selection against genes that produce abnormalities or death.
- It is used for production of seed stock.
- Used for determination of type of gene action.

OUTBREEDING AND IT'S DIFFERENT FORM

2020-V-25

Out Breeding: It is the opposite of inbreeding. The relationship of animals which are mated together is less close than the average relationship within the population. Mating between inbred lines or strains within the same breed is thus a form of outbreeding.

TYPES OF OUTBREEDING

1. Cross breeding
2. Out crossing
3. Grading up
4. Species Hybridization

CROSS BREEDING

It is the mating of two animals from two different established breeds. The mating of the pure bred sire of one breed to a high grade female and female of another breed with a high grade male are often included in the term crossbreeding.

TYPES OF CROSS

1. Single two way cross
2. Three way cross
3. Fourway cross or Double cross
4. Back cross
5. Sequential cross

a. Criss Crossing
b. Rotational crossing

I . 3wayrotations
II . 4wayrotations

6. Top crossing
7. Top Cross breeding
8. Recurrent Selection
9. Recurrent reciprocal Selection

OUTCROSSING

It is system of out-breeding in which then on-related individuals within the same breed are mated with each other. If a certain breed or family within a breed is deficient in certain characters, the quickest and the most certain method of improving that character is to introduce genes through unrelated mating to some stock known to be superior in that characters.

For example:

Crossing of a Sahiwal bull from Lucknow with a Sahiwal cow from PDC Meerut. These two animals have no common ancestor during their past4–6generationsoftheirpedigree

GRADING UP

It is the process by which the blood level of the pure breed sire are increased in the non-descript cows and their progenies, generations after generations so that the non-descript animals are almost similar genetically with the pure breed sire.

Grading up enable us to improve the mongrel or scrub or non-descriptor low producing native stock rapidly by mating them and their progenies in different successive generations with the pure bred males of highly productive strain. In the course of time i.e. After around 5 generations, the graded non descript animals will be indistinguishable in appearance from the improver breed. Thus the graded animals will have approximately 96.8-98.4 % hereditary materials of the pure bred sire. From genetic point of view, these graded animals are essentially the same as the pure bred.

SPECIES HYBRIDIZATION

It is define as the interbreeding of individuals from two populations or group of population that are distinguishable on the basis of more heritable characters.

By extension a hybrid is an individual resulting from such inter breeding.

For Examples:

Mule – It is an offspring of a male donkey and a female horse.

GENETIC AND PHENOTYPIC CONSEQUENCES OF OUTBREEDING

2020-V-26

Outbreeding is defined as mating of the unrelated animals.The unrelated animals are those which do not have a commonancestor for a least five generations in the pedigree.It is opposite or complementary to the inbreeding.

It is of four different types:

1)Outcrossing: It is the mating system when the mating occurs among the unrelated individual of the same breed.

2)Crossbreeding: The mating of animals from different established breeds is called crossbreeding.

3)Grading up: In this mating system, the females of non-descript scrub type are mated with the series of pure breed.

4)Species Hybridization: The mating is between the animals of two Species. This system is the widest possible type of outbreeding.

EFFECT OF OUTBREEING

1. Genetic effect:

The outbreeding tends to increase heterozygosity because the mated pairs are genetically unrelated having different alleles.The important and peculiar characteristics of outbreeding is that the maximum heterozygosity is attempt in first generation outcrosses and goes on decreasing in subsequent generations produced by random mating of outbreds.The decrease in heterozygosity in subsequent is due to the segregation of genes which consequently increases the homozygosity.

2. Phenotypic effect:

Heterosis: The word heterosis was coined by ‘Shull’ (1914)to described the increase vigour of outbreed relative to their parents.One of the purpose of outbreeding system of mating is to take the advantage of heterosis.The heterosis is defined as the amount by which the mean of F1 generation, produced by crossing two breeds, exceeds to its better parent. Thus, the heterosis (H) is indicate as:

$$H= F1>P1>P2$$

In animal breeding, the heterosis is taken as the surprising of F1 progeny relative to the average of their parents. Thus, the heterosis is the amount by which the F1 population mean exceeds to the mid-parent value. Therefore, the heterosis (H) is taken as the superiority of out-bred over the mean of their parents and hence.

$$H=F1>(P1+P2/2)$$

The heterosis is the measure of the effect of outbreeding.

ESTIMATION OF HETEROSIS

The amount of heterosis is estimated by comparing the mean value of purebred and crossbred animals as follows.

Heterosis= Mean of F1 progeny – Mean of parental breeds

%H= (Mean of F1 progeny – Mean of parentals breeds/ Mean of parent breed) *100%

PHYSIOLOGICAL BASIS OF HETEROSIS

The outbreeding changes the genotypic frequencies in favour of heterozygotes.It leads to an increase in more pair of heterozygous genes among outbred individuals and decrease in recessive homozygotes.

OUTBREEDING AND ITS APPLICATIONS

2020-V-27

Outbreeding

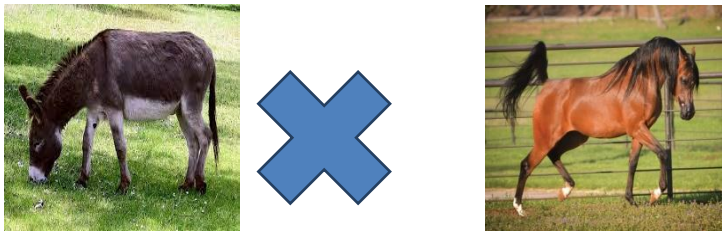
- The mating of unrelated individual is called as ***Outbreeding.***
- The outbreeding is opposite to inbreeding and hence its effect on the genetic structure of population as well as on population performance are also opposite to inbreeding.
- The outbreeding tends to increase heterozygosity and reduce homozygosity.
- This is because the mated pairs are generally unrelated (having different alleles).
- The change in heterozygosity depends on the degree of relatedness of the mating animals.

The important and peculiar characteristics of outbreeding is the maximum *heterozygosity*which attained in first generation outcrosses and goes on decreasing in subsequent generation by random mating of outbred.

APPLICATIONS OF OUTBREEDING

- By crossing two different species, sometimes we get good individuals.
- Outbreeding is often done in animals to obtain specific types suited to market purposes.
- For example, crossing the *White short horn* and *Black angus cattle*, a **Blue roan hybrid** is obtained. This hybrid is very useful because in produces high quality of beef and for utilization of food.
- It is also important for its vigourand rapid growth. Dairy cattle are sometime crossed with beef cattle in order to produce calves superior for meat production.
- Some hybrids of cattle are valuable for their tolerance of tropical heat.
- The animals of market value can be obtained after crossing. It can be more clear with the example of poultry. *Wyandottes,* two strains of which have been developed for cross breeding for the production of eggs.

The **Mule** is a good example of a commercially important species hybrid.



Jack (male donkey)Mare

Mule

Zebra stallionMare

Zorse

- Popular in tropics – docile – better disease and heat resistance.
- Like most other animal hybrids, Zorse is sterile.


American BisonCattle (hereford)

Beefalo

Characteristics of beefalo

- The breed was created to combine the best characteristics of both animals with a view towards beef production.
- Beefalo are better able to tolerate cold and need less assistance calving than cattle.
- They are also thought to produce less damage to rangeland than cattle.

Heterosis

2020-V-28

The superiority of F1 hybrid over both its parents in terms of yield or some other characters or Heterosis is increased Vigours, growth ,yield, or function of a hybrid over the parents,resulting from crossing of genetically unlike organism.

The term heterosis was first coined by Shull in 1914
But in some cases, hybrid may be inferior to the weaker parent this is also regarded as heterosis

Generally used by the farmers to enhance the reproductive and production performance of
- catle,
- sheep,
- goats and
- other commercially farmed animals

This concept cannot be utilized in hybrid varieties production. – Opposite of inbreeding depression
Results from increase in heterozygocity
Reproduction–large advantage from heterosis
Growth–moderate advantage from heterosis
Carcass–little advantage from heterosis

Types of Heterosis A.On the Basis of Genotypes of the Parents

a.Individual heterosis–advantage of crossbred offspring.

It is the improvement in performance or vigour etc in an individual animal (relative to the m ean of its parents) that is not at tributable to either maternal,paternal or sex linkage effects.

b.Maternal heterosis–advantage of crossbred mother.

It refers to heterosis in apopulationatributable to using cross-bred instead of pure bred dam s (e.g. increased m ilk production, im proved prenatedenvironment,larger liter size etc)

c.Paternal heterosis–advantage of crossbredsire.

Which refers to any advantage in usingcross-bred versus pure bredsires on the performance of the progeny.

Methods for Estimation of Heterosis

Heterosis is estimated in three different ways

1.Mid parent heterosis
2.Better parent heterosis
3.Standard heterosis

Mid parent heterosis:

When the heterosis is estimated over the mid parent i.e. mean value or average of the two parents is known as mid parent heterosis. It is also known as average heterosis or relative heterosis.

Better parent heterosis:

When the heterosis is estimated over the better parent is known as better parent heterosis. It is also known as heterobeltiosis .

Standard heterosis:

It refers to superiority of F1 over the standard commercial check variety. It is also called as economic heterosis

Theories of Heterosis

Dominance Hypothesis

It states that the superiority of hybrids is due to the covering effect of undesirable(deleterious)recessive alleles from one parent by dominant alleles from the other.

Overdominance hypothesis

It states that some combinations of alleles(which can be obtained by crossing two inbred strains)are especially advantageous when paired in heterozygous individual.

Epistasis-interaction among loci, may also contribute to heterosis

SYSTEMS OF UTILIZATION OF HETEROSIS

2020-V-29

Introduction:

- **Heterosis:**the superiority of outbreeding/ crossbreds over the average of their parents is called heterosis/ Hybrids vigour.

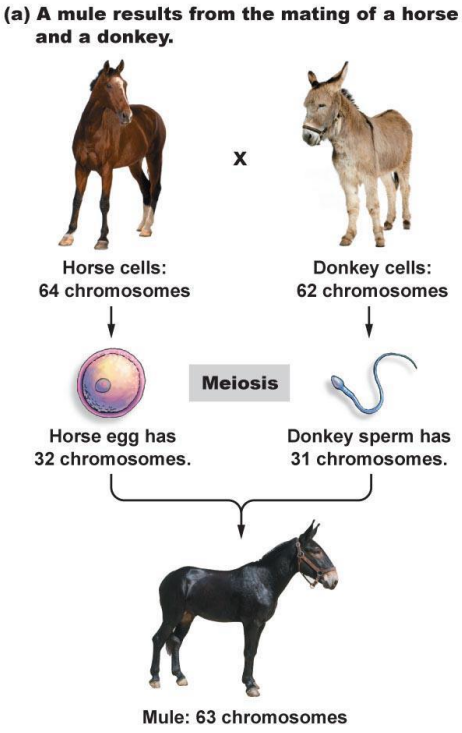
- The term coined by **Shull in1914.**

UTILIZATION OF HETEROSIS

- Increasing yield and nutritive value of crop plants.
- Increasing the growth rate and performance of domestic animal that is; races horses and domestic pigeon.
- Production of new combination of colours and scent in garden flowers.
- Enhancing the performance of various milk yield and egg production.
- Increasing the meat production.

Important terms:

- **Crossbreds:** when an animals or plants produced by mating/Hybridisation of two different species.
- **Outbreds:** Breed from parents not closely related.
- **Inbreeding depression:** Breed from closely related animals, especially for 4-5 generations.



Example:

- One of the best-known examples for hybrid vigouris MULE, which is proven for hard work in extreme climatic conditions.
- Hybrids between radish (Raphanus sativus) and cabbage (Brassica oleracea) exhibit extensive biomass heterosis.

Important point:

- Heterosis or Hybrids vigour is opposite to inbreeding depression.
- The outbred are heterozygotes in which the effects of undesirable recessive genes are hidden by the effect of favourable dominant genes.
- Heterosis can be positive or negative
- Here positive is called heterosis.

Combining Ability (GCA & SCA) & Recurrent Selection & Reciprocal Recurrent Selection

2020-V-30

Recurrent Selection (Hull, 1945)

- It is define as reselection of generation after generation ,with inter-mating of selected animals to produce the population for the next cycle of selection
- It consists of cross between an inbred tester line and a non-inbred or segregating population.
- **Tester line**: It may be of
  - Inbred line (Individuals of a particular species which are nearly identical to each other in genotype due to long inbreeding)
  - A single cross of two inbred lines

1st Yr.:

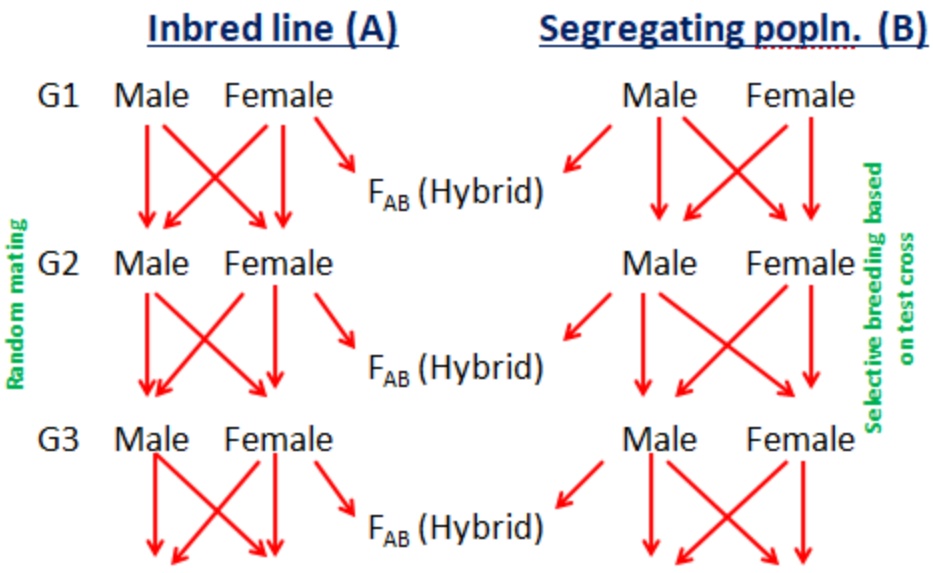
- Cross males of the segregating population with the females of the tester line.
-

2nd yr.:

- On the basis of the cross-bred progeny performance (F_{AB}), select best males of the segregating population and also select best females.
- Selected males and females are mated to produce the next generation (Pure bred).

3rd yr.: As in first year.

4th yr.: As in 2nd year.



Reciprocal Recurrent Selection (Comstock, Robinson and Harvey, 1949)

- It is also a system of progeny testing and selection of pure bred parents among two or more segregating populations on the basis of their cross-bred (hybrid) progeny performance in successive generations. It does not require a tester line.

Objectives: To improve the mean performance of a population

Steps:

❑ **First year:**

➢ Cross males of the population A with the females of the population B and also make reciprocal cross i.e. males of population B with the females of population A.

➢ Record the performance of the cross-bred (hybrid) progeny.

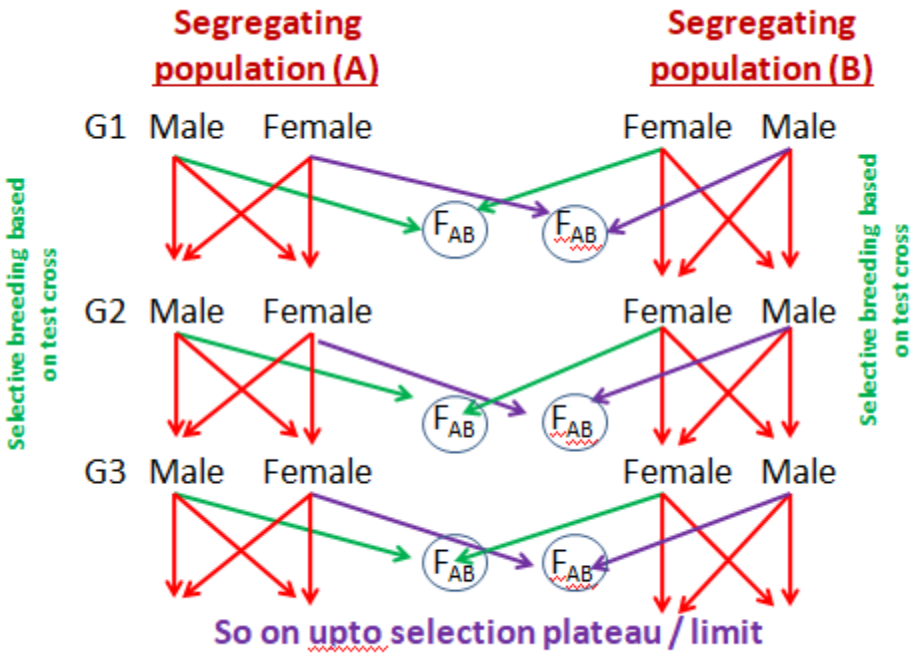
❑ **2nd year:**

- Select best males of population B & best females of the population A on the basis of cross-bred (F_{AB}) performance.
- Similarly, select best males of population A & best females of the population B on the basis of cross-bred (F_{BA}) performance.
- These selected parents are used to reproduce the pure line for subsequent crossing in next generation.
- Discard the unselected parents and all cross-bred progeny.

➢ **3rd year**: As in 1st year

➢ **4th year**: as in 2nd year

- Thus, each selection cycles takes two generations. This method of selection described above should be continued as long as improvement could be made in the performance of the test cross (cross-bred / hybrid) progeny.
- **Disadvantage**: It takes long generation interval.



BREEDING STRATEGIES FOR THE IMPROVEMENT OF DAIRY CATTLE

2020-V-31

Animal breeding is the process of selective mating of animals with desirable genetic traits, to maintain or enhance these traits in future generation.“Robert Bakewell” is remembered for setting the pattern of modern animal breeding and called the founder of animal breeding.

Breeding Improvement:

In view of poor genetic potential of indigenous livestock and poultry, it has been the challenge to the animal breeders to improve the production potential to a desired level without sacrificing the adaptational traits. The scientific breeding of animals based on formulation of breeding plan is required to change the genetic specifications of animals in accordance to human needs and hence to make the animals more useful to the man.

The selection and mating systems are two important components of breeding plan and the tools of animal breeder to work for bringing genetic improvement of a breed as well as to evolve a new breed to meet the human need.

The population size also plays its role mainly through selection. This is because the selection is more effective in a large population due to the reason of ample scope of selection in large population by culling the low producers, and secondly the large population is free from the effect of random genetic drift. Thus, there is low chance of being lost the best gene and the best genetic material and also there is no chance of inbreeding in large population.

Further, it is true that no mating system without selection is effective in changing the genetic structure of population. However, both selection and mating systems require the existence of genetic variability to bring genetic change The combination of selection and mating system to change the genetic structure is called the breeding plan.

The formulation of breeding plan involves the followings:

1. To decide the type of production required i,e, milk, meat, eggs, wool etc. This depends on the choice of owner and the market demand.

2. The choice of breed as a foundation stock. This depends on the availability, utility and adaptability of the breed.

3. To make a decision whether genetic improvement is possible within herd/ flock or introduction of superior genes from outside is required. The decision on this aspect (within herd improvement and introduction of superior genes from outside, migration) rests on the following factors:

a) Performance level of the herd in comparison to others herd of the same breed or of others breed. This requires the accurate measurements and records, and the estimation of average values of economic trait(selection objective),

b) Genetic variability present in the herd/ flock. This requires the estimation of heritability of the traits of importance, their relative economic values and genetic correlation among traits,

c) Comparative genetic value and adaptation of the introductions (G-E interaction),

d) Heterotic effect.

Selection:

The selection criteria for males and females are little different. The culling of low producing dams, selection of replacement young females born to high yielding dams and breeding them(replacements) by proven sires have been recommended. Therefore, genetic improvement can be made by selection of outstanding dams of future sire and by selection of males that will produce future cows and bulls.

Introduction to superior germplasm:

The introduction of new genes (migration) from outside is recommended when performance of a herd is lower than other herds and the genetic variability within herd is very low.

The non-descript animals with low performance can be improved by upgrading. The genetic improvement of well-known breeds can be done by selective breeding (within herd improvement) or by introducing the genes of the same breed from another herd of high genetic merit (outcrossing) or of other breed (crossbreeding). The crossbreeding in the present day context is the migration / introduction of genes of genetically superior exotic breeds in indigenous breed. This exploits the breed differences and heterosis for the reason that there are large genetic differences between two types of breeds (sub-species). Thus, the genetic superiority for milk production,meat and egg production and their quality traits can be combined with good qualities (adaptive traits) of indigenous breeds through crossbreeding (complementarity in crossbreeding).

Breeding strategies for Cattle may be of following types:

1. Grading of non-descript Cattle with improver breeds:

The bulls to be used or grading up should be the progeny of superior dams having lactation yield of more than 2000kg for those belonging to milch breeds and around 1500kg for dual purpose breeds. The different improver breeds should be used for different states i,e. Sahiwal and Tharparkar bulls to be used on local Cattle of Hariana,Pb, UP,MP and WB,Kankrej for local cattle of Gujarat, Ongole for MP and AP local cattle, Red Sindhi bull to be used on local cattle of HP, J&K, UP, Bihar, Orissa, etc.

2. Grading up or crossbreeding of non-descript cattle with exotic cattle:

In genera, HF Bulls should be used in irrigated plains (Delhi, Punjab, UP,Gujarat) in hills and coastal areas (Assam, Arunachal, Goa, HP, Haryana, Punjab, Manipur,etc.) The level of exotic inheritance should be restricted from 50-70%. Brown Swiss is being used in Kerala. A number of crossbred strains of cattle (Frieswal, Karan-Fries,etc.) have been developed in India as well as in other countries of the world like Ayrshire, Jamaika Hope, Guernsey, Brangus,etc.

3. Selective breeding within zebu breeds:

The milch and dual purpose breeds need to be improved genetically by selective breeding through PT programme, preferably in their home tract in associated herds. The selective breeding is expected to yield about 1% genetic gain per year in organized herds whereas the genetic improvement in farmers herd is expected to be higher around 10%. The indigenous breeds of cattle need to be improved by selective breeding in their home tract. The ONBS with or without MOET is a better technique. The cattle breeds developed by selective breeding in India are: Gangatiri breed of U.P. developed from Harianbreed, Rathi breed of Rajasthan developed from a mixture of Sahiwal, Red Sindhi and Tharpakar, and Krishna valley for Karnataka, etc.

Breeding Strategies for the Improvement of Dairy Buffalo

2020 – V – 32

India's diversity in buffaloes is multifarious. About 60% of the total population is non-descript and rest 40 % is descript or well-defined. Non-descript buffaloes had the highest share of milk production in the fiscal year 2020 helping our country to achieve top position in milk production in the world.
Even though various animal breeding and management programmes have contributed to this improvement, there are constraints hampering the growth, so some breeding policy strategies for the proper implementation of these programmes are recommended for adoption.

Breeding strategy is the integration or combination of different breeding program into a structured system for genetic improvement, with the aim to maximize an overall objective. The following breeding strategies are recommended for the improvement of buffalo –

1. **Selective breeding for well-defined breed.**

The relatively high yielding buffaloes of well-defined breeds are maintained under intensive management system in farmer's herds in the breeding tracts of different buffalo breeds.
Expected genetic improvement of 1 to 1.5 % per annum in milk production at organized farm and 8 – 10 % per annum at farmer's herd.
In Gujarat , Rajasthan and Karnataka Surti is recommended to be the breed of choice.
In Punjab, Haryana and western U.P Murrah is the breed of choice besides few parts in Punjab where Nilli Ravi has sizeable population and it also needs to be improved through selective breeding.

2. **Grading up for non-descript buffalo.**

The low producing , local non-descript buffaloes are generally reared under low to medium input production system in areas where food and fodder resources
are moderately available. The production potential of low producing non-descript buffaloes can be increased rapidly through mating with superior sires of improved breeds like Murrah, Surti and Mehsana.
Recommended improver breeds improver breed(s) for different regions are

States	Recommended improver breeds
Assam, Bihar, west Bengal, UP, Odisha, Andhra Pradesh, Tamil Nadu, Rajasthan, Haryana,Maharastra, Goa and Delhi	Murrah
Karnataka, Kerala, some parts of Gujarat and Rajasthan	Surti and Mehsanna
Punjab	Murrah and Nilli Ravi

Through grading up with superior breeds in five to six generation , the low producing non-descript Buffaloes can be replaced with relatively high producing Buffaloes conforming to the characteristics of well-defined breeds.

3. Conservation of indigenous breeds of Buffaloes.

Conservation of Padhapuri, Tarai, Bhabawari, and Nagpuri Buffaloes should be practised especially in their home tracts and in other areas having similar geo-climatic conditions. These breeds will be used for up-grading non-descript buffaloes if demanded by owners.

System of herd registration, suitably designed milk competition etc. will be introduced to identify the high yielder animals of Indigenous breed.

The Breeder's Association will not only be encouraged to get involved in conservation of Indigenous breeds but also will be allowed to function in accordance with principles of management under its articles of association.

BREEDING STRATEGIES FOR THE IMPROVEMENT OF SHEEP

2020-V-33

Introduction

Breeding Strategy means the tactics designed to integrate new technologies and to improve old ones, for the purpose of maximising performance of existing stock. The improvement of breeding plan necessitates the knowledge of

i. Economic traits
ii. Their performance level
iii. The phenotypic parameters
iv. Genetic parameters

The aim is to select what is best for the economic traits.

Genetic Progress

Genetic progress refers to the progress that is made when the average genetic value of the offspring is higher than the genetic value of the previous generation.

Economic Traits

Economic traits means the characters that are associated with the production, distribution and consumption of goods and services. In sheep, the main objective is high wool and meat production, the traits that are important economically are

1. AFL : Age at First Lambing
2. Tupping % : The percentage of the male sheep.
3. Twinning number of lambs weaned.
4. Lambing % : The number of lambs produced per one hundred ewes mated in a flock.
5. Mortality Rate : The number of deaths in sheep
6. Hog-get weight
7. ADG : Average daily gain
8. GFY : Greasy Fleece Yield.

Traits for wool production

The wool traits are greasy fleece weight, staple length, fibre diameter, medullation percentage, ratio between secondary to primary follicles (S:P ratio)

Primary follicles produce coarse fibre and secondary follicle produces fine fibre.

Traits for meat production

Body weight at different stages of growth, tupping percentage, conception rate, lambs born per ewe, etc.

Breeding plan for Sheep

Since the indigenous sheep of the country are of low production type in terms of wool and meat production, the fleece weight and quality traits have medium to high heritability, ‘Selective Breeding’ may be done based on fleece weight at yearling stage. Selection of the superior animals can be done on the basis of body weight as there is strong correlation of live weight with fleece weight.

The non-descript animals should be either upgraded with recognised breeds of the country or may be crossed with fine wool exotic breeds (Rambouillet and Merino) or mutton breeds (Suffolk and Dorset).
For fine wool, the native breeds like Nali and Chokla of Rajasthan, Patanwadi of Gujarat, Nilgiri of Tamil Nadu may be genetically improved by adopting 'Cross-breeding' with Rambouillet and Merino rams upto 50-75% of exotic inheritance. In carpet wool, 'selective breeding' is recommended for improvement in native breeds like Marwari, Magra, Jaisameri etc. The pelt production can be upgraded by crossbreeding of the native coarse carpet wool breeds with Karkul.

The mutton production traits have medium to high heritability hence genetic response is observed in selective breeding, but the rate of response is slow. Hence, the breeding strategies which depict to upgrade non-descript animals by suing superior native breeds or exotic breeds and to improve inferior native breeds by crossbreeding with superior native breeds or exotic breeds are suggested.

The emphasis shifted from wool to mutton as the main produce because maximum earnings comes from lamb production. Improving prolificacy and reproductive efficiency ie more number of lambs per sheep per productive spell can be helpful in increasing the profitability. The sheep production can be improved by establishing nucleus herd which has all old age, which are more than 7 years along with high performing elite males and developing suitable selection criteria and selection index.

'Breeding Strategies for the Improvement of Goat'

2020-V-34

Breeding strategies for Goat:

Traits of economic importance in goat-

Goat produce meat, milk, fibres (*Pashmina* and *Mohair*)and skins. The breeding strategies for improvement of indigenous goat populations should be of following types:

Non-descriptpopulation: Upgradation with superior recognised breeds of the country to improve the meat and milk production.

Well recognised breeds: Selective breeding is recommended to maintain the purity of the breed while improving genetically for economic traits.

Pashmina Production: Selective breeding should be done for genetic improvement of Pashmina production for breeds like *Chegu* and *Changthangi*.

- The implementation of their commended breeding strategies needs the involvement of different agencies such as State AH Dept., NBAGR, Karnal, CIRG, Makhdoom, Mathura and SAUs.
- One of the more important, if not the most important, aspects of the business of goat raising is breeding considering that the supply of goat milk, meat, and other goat produce, particularly profit, depends largely on its success.
  There are a lot of things to consider and a lot of information to learn before an aspiring goat raiser can embark on the process of ensuring goat reproduction. One of the said information for appreciation involves the following strategies in breeding goats:

  "**Line breeding** - Involves mating goats that are either distantly or closely related. The end result of this strategy is sameness of offspring particularly if taken in the long term with appropriate selection. The sameness or similarity of offspring could be on the negative or positive depending on the starting strain and selection routine.

  This is a common breeding strategy used to establish breeds considering its high predictability and uniformity. *Predictability* is an important factor in establishment of breeds as goat breeders want a specific type of goat, producing a specific offspring. *Predictability* and *homogeneity*, therefore, is the plus side of line breeding; surprises are eliminated. The downside, however, is loss of energy and ability to reproduce which could be compensated by selection.

  "**Crossbreeding** - Involves mating goats of two different breeds. Unlike line breeding where things are highly predictable, there are different things that could happen in crossbreeding depending on the stage. The consistency in line breeding is replaced by variability of offspring in this strategy.

  Variability could be advantageous as offspring could be of excellent type and performance, but this strategy, however, does not guarantee that the excellent qualities of the offspring could be passed on to the next generation. There is even a great chance that the goat with very good qualities would be the last one of its kind.

  The advantages of crossbreeding strategy include high energy and efficient ability to reproduce, which are the downsides of line breeding. While consequently, the benefits of line breeding are

the ones lacking in crossbreeding, that is consistency and predictability.

"**Line crossing** - Involves the crossing of different breed line within a breed. Its end result is somehow similar to that of crossbreeding strategy; however, since it is contained within a single breed, the level of variability of offspring is much lesser than crossing two breeds. Furthermore, this type of breeding strategy allows the achievement of the benefits of crossbreeding but without necessarily losing the breed character or type entirely. However, the consistency of production is still decreased; hence, the positive nor negative results could not be readily determined.

The abovementioned goat breeding strategies with their own unique characteristics and effect will definitely have different consequences for the herd and part of being an excellent goat raiser is having the ability to determine the most suitable breeding strategy for his herd.

The perfect strategy being, one that takes into account the goat raiser's goals and philosophies, not to mention the situation. As a good goat raiser knows that there is no single breeding strategy that works well in all kinds of situations.

Formulation of Breeding strategies for Improvement:

While formulating the breeding strategy for goat improvement , the formulators should take care of the following criteria:

- Adaptability of the breeds in the local agro-climatic conditions
- Socio-economic condition of the farmer
- Market demandsandConservation of indigenous breeds by preventing from rampant genetic dilution.

Breeding Strategies For The Improvement For Swine

2020-V-35

- Total population of pigs in India = 9.0 million
- Assam is the highest pig producing state
- There are ten(10) register pig breed in India
- They are found mostly in North East region.
- Pigs are an important domesticated animals especially for North East region

Introduction

Breeding or mating system are the approach taken to pairing a boar and a gilt or sow for breeding in order incorporate or maintain desired traits.

This had a great impact in its performance and meat quality.

This factsheet provides an introduction to pig breeding system and heterosis.

Five basic breeding systems

Inbreeding – Breeding individuals who are very closely related within the breed.

Linebreeding – A form of inbreeding which attempts to concentrate the inheritance of one ancestor or line of ancestor or line of ancestors within a herd.

Outcrossing – Breeding individuals that are less closely related within the breed.

Crossbreeding – A planned approach to mating pigs of very different genetics backgrounds which typically results in heterosis.

Selection

Selection is the process of choosing animals to be the parents of the next generation.

Selection of boar: A boar must possess both the genetic potential to improve the performance of his progeny, and the physical soundness to remain an active breeder.

Final selection for young boars can be carried out when they complete their performance testing between 20 and 30 weeks of age.

Selection of sow: In case of sow, one measures efficiency of rate of gain as shown by its weight for its age.

Effect of Inbreeding and Outcrossing

- Continuous inbreeding should be avoid
- Have a negative impact on offsprings
- Outcrossing leads to improvement of offsprings

Steps to be taken according to our environment

Knowing our environment make a lot of sense on breeding.

Crossbreeding

Best method to have the desire breed with high productivity.

BREEDING STRATEGIES FOR IMPROVEMENT IN POULTRY

2020-V-36

Poultry is one of the fastest growingsectors of agriculture sectors today in India. The poultry sector majorly maintains the requirements of protein and nutrition. India today is one of the largest manufaturers of eggs and broiler meat.In order to ensurethe continuous improvement in poultry birds, breeding strategies are implemented.

The formulation of breeding strategies require knowledge of the economic traits, their performance level, the phenotypic and genotypic parameters (phenotypic correlation, genotypic correlation, heritability, repeatability) of the different economic traits.In poultry, the economic traits favored for breeding differ with the type of poultry- meat producing, egg producing or dual purpose.

In broilers, traits such as body weight, growth rate, carcass qualities, meat bone ratio, FCE, FCR, disease resistance, etc. are favored.

In layers, traits such as age at first laying, clutch size, persistency, egg size, egg weight, fertility, hatchability, egg quality (yolk size, albumin index, shell thickness, shell colour), body weight and FCR are favored.

In dual the traits of both layer and broiler birds are taken into consideraion.

Breeding strategies involve the improvement of non descript or native birds by selective breeding between the individuals having high performance levels as well as upgrading by cross breeding with other exotic breeds to improve the performance of the offspringand attain superior genes.In already well established breeds, selective breeding and cross breeding is also practised. Crossbreeding is advantageous as it improves hatchability of eggs, viability of chicks, rate of growth and egg production. In many instances the stimulation is not great, but the cumulative gains from consideration of all these characteristics are all of these characteristics are of economic significance.For example of cross breeding for broiler birds, the Cornish crosses - a cross between Cornish breed and Plymouth Rocks is famous for its fast growth, carcass quality and taste. Also, Aseel and Leghorn are crossed to produce a new breed that has improved egg production, resistant to harsh climate,low maintenance, it is dwarf and so requires less space and food,with ability to utilise fibrous cheaper dietsformulated from agricultural by-products.

Cross breeding to produce sex linked birds that take advantage of recessive color traits to produce chicks that differ depending upon their sex which makes it easy to distinguish between the sexes and are good layers. For example, Black sex linked birds are a cross between Rhode Island Red or new Hampshire Red rooster with a barred Plymouth Rock female and the sexes can be easily identified by colour which makes them ideal for individuals rearing only hens for eggs as they are also good layers. Cross breeding between a Rhode Island Red and leghorn produces a breed called Golden comet which has the best characteristics from both parent as it lays earlier like leghorn and is nice tempered like Rhode Island Red.

SIRE EVALUATION

2020-V-37

It is a process of prediction of future progeny of a sire produced by mating with specified females and making their records in some specified environment.
sire's production transmitting ability can be estimated by mathematical means and expressed as a single figure known as **Sire Index.**

Why is it important?

In order to meet demand for increasing population
It can be done by applying various methods on selection and breeding of livestock like Artificial insemination and cryopreservation of semen therefore, selection of bull is very important .

Objective of sire evaluation: estimate the breeding value of a sire on the basis of all its progeny from different dams randomly mated to the sire.

SOME OF THE METHODS OF INDEXING SIRES

1. SIMPLE DAUGHTER AVERAGE INDEX

- The simplest way to evaluate a bull is by his daughter's production alone (Edward, 1932)
- Simplest measure in a single herd under same environment

$$Sí = Dí$$

Where
Dí = Average of all daughter of a sire under test

- This index when used for ranking sires would be subject to bias if the levels of production of dams allotted to different sites were unequal

2. EQUIPARENT / INTERMEDIATE / DAIRY BULL INDEX / YAPP'S INDEX

- Proposed by Hansson in 1913
- It is also known as Yapp's index(Yapp, 1925) and Mount Hope Index(First used, 1928)
- This index (Yapp, 1925) is based on the principle that the two parents contribute equally to the genetic make up of the progeny
- This index makes adjustment for the variation in production level of the dam

$$\mathbf{S = 2D - M}$$

Where,

D= avg. yield of daughters of the sire
M = avg. yield of dams mated to the sire

- In Yapp's formula, the potential transmitting ability can be expressed in terms of 4% fat corrected milk
- This index overestimates the breeding value of a sire mated to set of dams inferior on the average and underestimates if dams happen to be superior on the average to the general level of herd.

3. REGRESSION INDEX OR RICE INDEX:-

- Regression means the degree of relationship between parents and offspring when used as a measure of inheritance.
- Rice has proposed this index based on the daughter's records on those of their dams was approximately 0.5
- This index simply regresses the equal parent index half way
- **Regression index = 0.5(equal parent index) + 0.5 (breed average)**

4. TOMAR INDEX

- This index depends on dams- daughter comparison and on simulataneous use of the merits of the dams and the daughters over their contemporary herd averages

I = D + (De - Me)

Where,

D- avg. of all daughter of a sire under test

De - daughter's expected average

Me - dam's expected average

5. GIFFORD's index

Gifford (1930) suggested that the bull index can be estimated from the daughters' records ignoring the dams, provided the dams are not a selected group

SI = 2P - H

where,

H = herd average;

P = daughters average

CONCLUSION

- Since the sire control the 61 percent of the improvement, selecting the best sire is backbone of any genetic improvement programme
- Progeny testing is estimating the breeding value of a sire based on the average performance of its offspring
- Each offspring receives a sample half of genes from the sire. Therefore, the performance of large number of daughters will indicate the breeding value of sire on progeny testing.
- Progeny testing is usually conducted for males as more number of progenies can be produced for males and also proven bulls can be extensively used for production of more number of progenies
- The primary selection of the bulls is based on the sibs' average. The bulls with highest averages are selected and included in the progeny testing.
- Then the bulls are used on many females to produce many progenies.
- The performances of progenies are then studied to estimate the breeding value of each bull.
- It is the best way of determining the genetic makeup of an individual.
- The genetic principle behind progeny testing is that the more the number of progeny are tested the greater the accuracy of assessment of the parents, since the errors in sampling are reduced.

Open Nucleus Breeding System

2020-V-38

OPEN NUCEUS BREEDING SYSTEM

ONBS is a scheme where the sire breeding nucleus is open to some gene flow,usually through highly selected females,from the general population or base to allow increased rate of genetic gain.It was proposed by Irish animal breeder Cunningham in 1979.

NUCLEUS BREEDING SYSTEM:

- It works on the principle that in each herd,there is a small number of genetically very superior animals which if brought together will form a nucleus whose average genetic merit is far greater than that in any of the contributing herd.
- It employs the use of Molecular Ovulation and Embryo Transfer technology for sibling test instead of progeny testing.
- Two types-Open Nucleus Breeding System(ONBS) and Closed Nucleus Breeding System(CNBS)

OPEN NUCLEUS BREEDING SYSTEM

There is a two tier herd division consisting of the nucleus composed of genetically elite individuals and the base which forms the majority of the population.

Once established,replacement stock for the nucleus population may be either from the nucleus or the base populations.Genes can flow in two directions i.e. from nucleus to base and from base to nucleus.Thus,the nucleus is
open.

ADVANTAGES OF OBNS:

- Progeny testing in developing countries face problems like small herd size,uncontrolled mating,absence of pedigree and lack of proper recoding etc.
- ONBS helps to overcome these problems.
- In ONBS,the generation interval is reduced.
- Selection intensity is increased and there is concentration of breeding techniques.
- The possible use of extensive technologies makes more effective selection possible for economic merit.

DISADVANTAGE OF ONBS:

- Due to small herd size,there is increase in inbreeding.
- Risk of diseases and loss.
- There is also a risk from concentrating stock and resources in 1 unit.
- Possible genotype X environmental interactions in commercial production.

EXAMPLE:

In 1994,National Dairy Development Board initiated ONBS with MOET project on **Sahiwal x Holstein Friesian** crosses at Sabarmati Ashram Gaushala,Bidaj in Gujarat.24 Sahiwal cows were superovulated upto 5-6 times and made to breed with the semen of four Holstein Friesian bulls.In the F1 generation,three males and three females were produced and the progenies were evaluated.The top four bulls were used in the herd in second phase and the rest were sold.In the second phase,crossbred cows and F1 males produced in phase 1 were used for MOET and interbreeds were produced.The genetic gain per year i.e.increase in performance per year has been calculated as 1.48% of herd mean.Compared to progeny testing,the accuracy is lower however the shorter generation interval makes up for the low accuracy rate.

BREED DEVELOPMENT

2020-V-39

Plan for evolving a new breed of dairy cattle by crossing indigenous & exotic breeds

The main objective of evolving a new breed of dairy cattle through crossbreeding is to combine the high milk yielding potential of an exotic breed with the adaptation to extreme conditions of the native breed. [The plan would consist in obtaining the F_1 generation crossbreeds by using sires of a suitable exotic breed on females of an indigenous breed followed by inter se breeding and selection among the F2 and subsequent generations.]

1. Choice of breeds

Exotic breed

Of the various breeds which have been tried in the past, Jersey has been suggested as one of the most suitable. In its favour is claimed the advantage of having not too large size, a fair amount of milk yield with higher fat content than many other exotic breeds, and some heat tolerance. Holstein Friesian is a close contender to Jersey. Whichever the breed chosen what is essential that the bulls used should possess a potentiality for very high milk yield. It would also be necessary to ensure that the bulls are free from recessive genetic disorders. It is also important to ensure that the exotic semen comes from an adequate number of unrelated bulls to prevent rapid increase in inbreeding.

2. Indigenous stock

The indigenous cows [consistituting the foundation stock for raising crossbreed] should be essentially chosen for supplying genes for disease resistance, hardiness, and adaptation to local conditions. Viewed from the aspect of milk production only, it would be best to choose cows of a good milch breed such as Red Sindhi or Sahiwal. However, if draught capacity among male progeny were also a point to be considerd an indigenous breed noted for draught such as Hariana, Ongole, or Kangayam in their particular areas would be preferable

3. Level of Exotic Inheritance

The next question that arises is about the optimum level of exotic inheritance that should be stabilizes in the new breed. From the available studies on the large scale crossbreeding work done in India, it has been seen that half-breeds and five-eighths (62.5%) excel all the other grades of exotic inheritance irrespective of the exotic breed used in the crosses.

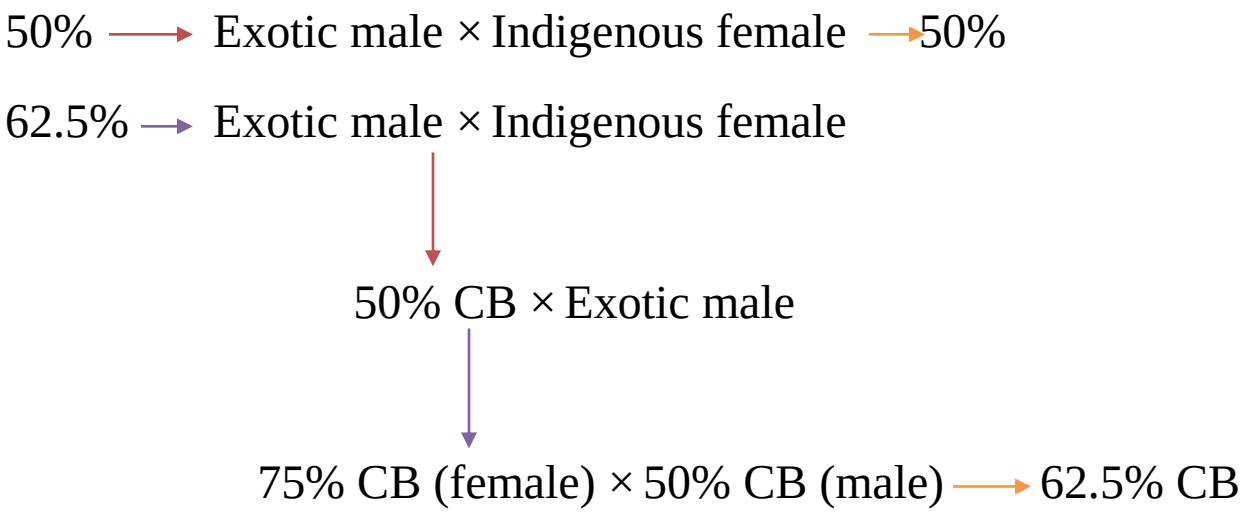
4. Breeding Plan

The breeding plan will consist of interbreeding the crossbred progeny coupled with intensive selection. From the second generation onwards selection will be made intensively in both sexes and not only for milk production but also for health and adaptation.

5. Initial herd strength

To permit sufficient scope for intensive selection among the females and also to enable the progeny testing of a fair numbers of bulls.

It is necessary to raise 200 to 300 F_2 adult females. This number should be maintained constantly from generation to generation.



Current Livestock Breeding Policies and Programmes in the State and Country

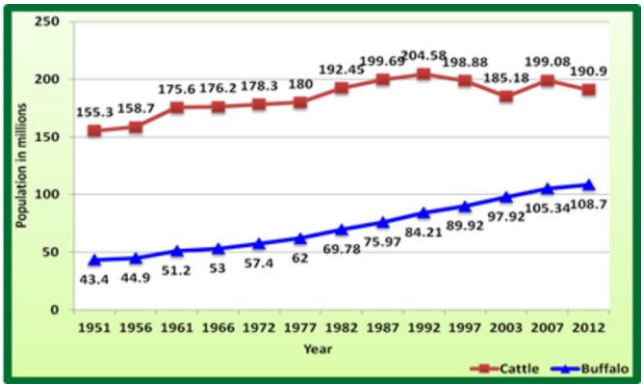
2020-V-40

Breeding Policies & Programmes in India

❖ Aims and Objectives of the National Livestock Policy

1. To improve the productivity of livestock and poultry by promoting and disseminating the technologies developed by the research system.
2. To promote conservation of animal bio-diversity; conservation and genetic improvement of important indigenous breeds of livestock and poultry in the country.
3. To increase availability of feed and fodder resources to meet the requirement of livestock to attain optimal productivity.
4. To strengthen overall animal health cover through prevention, control and eradication of various disease conditions and encourage/enable the dairy cooperatives to extend veterinary services to farmers.
5. To focus on production of quality livestock products as per the international standards for food safety.
6. To encourage value addition of livestock products like milk and milk products, eggs, wool and meat & meat products etc.

- **Breeding Policies of Cattle & Buffalo**



The first livestock census conducted in India in 1951 revealed a total cattlepopulation of 155.3 million, which gradually increased and stands at 190.90 millionin 2012.

The main objective of this Breeding policy document is to address the importance of rich biodiversity of cattle and buffaloes in India which are endowed with genetic variation in production types, adapted to tropical environments, feed resources and comparative disease resistance, and to propose a policy frame work for improvement and conservations of these animals. Compared to the actual production of 132.43 MT of milk in 2013, and a demand growth of 6.0 %, the requirement will be 203.85 MT in 2020 and 365.07 MT by 2030. In case of a demand growth of 8 %, this requirement will grow to 236.73 MT and 511.29 MT in the years 2020 and 2030, respectively. This is the greatest challenge in terms of the genetic capacity and capability to increase it, feed and fodder availability, the carrying capacity of the land and total environmental considerations.

- **Breeding Policy for Sheep and Goat**: This will aim to improve growth, body weight, reproductive efficiency, meat and wool quality and quantity, and to reduce mortality. Mainfocus will be to produce and distribute good quality rams/bucks of quality indigenous breeds which can thrive in different agro-climatic conditions.

- **Breeding Policy of Equines**: Breeding of horses, mules, and donkeys would be promoted to produce high quality stock for draft power and sports purposes.

Breeding Policies & Programme in Nagaland

The Nagaland Department of Animal Husbandry & Veterinary Sciences recently came out with the Nagaland Pig Breeding Policy. This Policy is the first of its kind in India.

Objectives

The pig breeding policy of Nagaland aims to:
(a) Improve productivity through genetic upgradation of the existing pig population of the state
(b) Maintain pure germ plasm of exotic breeds to meet the requirement of Nagaland
(c) Conserve Indigenous germplasm of Nagaland
(d) Ensure that the breeds propagated are adapted to local climatic conditions and emerging climatic challenges
(e) Strengthen support mechanism particularly feed, housing and health care to facilitate the above.

Pig statistics

The State pig population as per the 19th Livestock Census 2012 is 5,03,688, of which 75.59% (3,80,719) are crossbreds and 24.41% (1,22,969) are indigenous.

Some of the major pig breeds reared in Nagaland are

(i) Large Black (Purebred)

(ii) Large Black X Local

(iii) Hampshire (Pure bred)

Technical breeding programme

1. **Exotic nucleus herds**

Three nucleus herds (Large Black, Hampshire, Indigenous Naga Local) will be established under organised public/private sector to carry out pig development programme in the state.

2**. Multiplier farms**

Multiplier farms will be established under public/private sector to produce 50% crosses of Large Black x Local and Hampshire x Local, besides multiplication of pure line Large Black, Hampshire and Indigenous Naga Local. ☺

CURRENT POULTRY BREEDINGPOLICIES AND PROGRAMMES IN THE STATE AND COUNTRY

2020-V-41

- Breeding refers to mating poultry for either maintaining/increasing the current flock or for selecting specific individuals for improvement in one or more characteristics
  (eg: for size ,weight,egg production, meat quality, behavior, plumage, comb type, or a combination of factors)

- Breeding policy is a guideline to indicate what breed and breed combination or exotic blood level is most suitable in the given agro climatic condition of the state.

All India Coordinated Research Project On Poultry Breeding:

- AICRP on Poultry Breeding is one of the successful projects being operated at twelve centres .
- Twelve centresare :- KVASU, Mannuthy ; AAU, Anand; KVAFSU, Bengaluru; GADVASU, Ludhiana; OUAT, Bhubaneswar; ICAR-CARI, Izatnagar; ICAR Research complex for NEH Region, Agartala; NDVSU, Jabalpur; AAU, Guwahati; BAU, Ranchi; MPUAT, Udaipur; and CSKHPKVV, Palampur

The main objectives of the project are :-

i. development of location specific chicken varieties;
ii. conservation, improvement, characterization and application of local native, elite layer and broiler germplasm;
iii. development of package of practices for village poultry and entrepreneurships in rural, tribal and backyard areas

Ankleshwar

- Anand Centre evaluated the S-1 generation of *Ankleshwar*breed of chicken up to 40 weeks of age.

- ICAR-CARI, Izatnagarcentre evaluated the local native chicken, CSML and CSFL during the period 2020-2021.
- Bhubaneswar centre assigned to evaluate Hansli, CSML,CSFL and their crosses. Hansli birds were procured from the native tract to conserve and improve the flock in the farm.

(CSML:-Coloured synthetic male line
CSML:-Coloured synthetic female line)

Poultry Seed Project

- Poultry Seed Project was evolved with an objective to increase the availability of rural chicken germplasm in remote areas of our country.

- In this endeavour, the Indian Council of Agricultural Research has initiated "Poultry Seed Project" during the XI five year plan with six centres, three in the northeast region and three in different state veterinary/agricultural universities.

- At present the project is being operated at 12 centres across the country.

- The main objective of this project is :-

i. local production of improved chicken germplasm (fertile eggs, day old chicks and grownup chicks) and supply to various stake holders in the remote areas to target production enhancement of egg and meat for augmenting rural poultry production,

ii. socioeconomic condition of the target groups and linking smallscale poultry producers with organized market

Technical Programme for the year 2020-2021

i. Pedigreed hatching and evaluation of the local native Chicken.

ii. Procurement and evaluation of improved chicken germplasm in the local climatic condition and for development of cross.

iii. Production and evaluation of crosses of local native birds with improved germplasm.

iv. Development and evaluation of terminal crosses (location specific germplasm).

- **The Poultry development** work in Tripura was started in the year 1959 through establishment of Gandhigram Poultry Farm near Agartala.

- AICRP Tripura centre evaluated Tripura Black, Dahlem Red, broiler dam line and their crosses during the year. The 40-week egg production was 53.77 and 42.95 eggs under Farm and field condition.


AseelKadaknath

- **The Poultry development** work in Tripura was started in the year 1959 through establishment of Gandhigram Poultry Farm near Agartala.

- AICRP Tripura centre evaluated Tripura Black, Dahlem Red, broiler dam line and their crosses during the year. The 40-week egg production was 53.77 and 42.95 eggs under Farm and field condition.

- **A BND crossbreed variety of chicken** (Colour Broiler x Native Tripura Black x Dalhem Red) has been developed by the Tripura ICAR Centre through crossing and geneticcomposition of this variety comprises of :

i) 25% Colour Broiler ii) 25% Native TripuraBlack and iii) 50% Dahlem Red.
It is a dual purpose multi coloured breed developed mainly for rural areas in Tripura.

Chittagong

Methods of Conservation

2020-V-42

Introduction

In this age of competition,animal breeding and production system needs to be geared up to meet the market demands .Advances in animals breeding specially Artificial Insemination has introduced superior exotic breeds which are highly productive although the native breeds are better adopted to local agro-ecological conditions and are capable of producing on almost zero input.Yet they are facing decline . So they need to be conserved .Hence ,the need for conservation of these breeds is necessary as a part of genetic security and its integral to our ecosystem.

Methods of conservation

Ex-situ conservation :-

It involves the conservation of animals in a situation away from their normal habitat.
Example: Zoological gardens.
Ex-situ conservation can be done by :

- Deep freezing of sports and oocytes.
- Deep freezing of embryos
- Cloning of somatic cells
- Cryopreservation of semen at NBAGR

*Network project on Animal Genetic Resources, Karnal is the nodal agency.
Cryopreservation of 30,000 semen doses
-3 breeds of cattle viz. Nagori,Rathi,kangayam
-2 breeds of buffaloes viz.Pandharpuri and Nili-Ravi

In-situ Conservation:-

It involves all measures to maintain live animal breeding populations in their adaptive environment or close to it as is practically possible.
Example :National parks , wildlife sanctuaries.

i)National park:Example,Jim Corbett National Park Kaziranga, National Park.
ii)Wildlife Sanctuaries:Example,Bharatpur Bird Sanctuary, Chinnar wildlife Sanctuary

*It is very important to know the minimum population size of a breedfor conservation in-situ.

Objectives of conservation

- Conservation of genes such as genes for Trypanotolerance , polledness ,wool shedding, specific milk protein.
- Conservation of breed or population such as endangered species as well as breeds.

Category	Cattle	Buffalo
Normal	25000	30,000
Insecure	15,000-20,000	20,000-30,000
Vulnerable	5,000-15000	10,000-20,000

Endangered	2,000-5,000	5,000-10,000
Critical	<2,000	<5,000

Reasons for conservation:

A) Economic potentials:

Endangered populations should be conserved for their potential economic (suchmeat,milk,fibre,skin etc) use in future.

B) Scientific uses:

Endangered populations should be conserved for their possible Scientific uses such as :

- Use of conservation stock as control populations.
- Research on disease resistance.
- Identification of specific genes.
- Used as research model.

Conservation strategies

- Preventing the cutting of trees .
- Putting a ban on hunting of animals.
- Efficient utilization of natural resources.
- Protected areas should be developed for animals where no human activities are allowed .

Why a breed is in danger?

- Farmer's Holding and resource Availability
- Breed characterisation
- Suitability of selection of Breeds
- Economical Viability and Acceptance by Farmers
- Feed and fodder resources
- Changing pattern of agricultural operations
- legal issues

Conservation approach

- Evaluation of genetic resources in the natural habitat.
- Establishment of livestock conservation boards.
- Establishment of a national data bank.
- Establishment of breed societies and breed survival trust.
- Creation of public awareness.
- Human resources development programme.

CONSERVATION OF LIVESTOCK IN INDIA AND STATE

2020-V-43

- Need for conservation
  1. Economic potential
     - Endangered populations should be conserved for their potential use in future
     - The economic potential may be production of meat, milk, fiber, skin, or draught power.
  2. Scientific use
     - Endangered populations should be conserved for their possible scientific use
     - This may include use of conservation stocks as control population, in order to monitor and identify advances and changes in the genetic makeup and production characteristics of selected stocks
     - This may include basic biological research into physiology, diet, reproduction or climatic tolerance at the physiological and genetic level.
  3. Cultural interest
     - In making of rugs, carpets, etc
     - Also for religious ceremony
     - Also conserved for aesthetic value

- Objectives for conservation
  1. Conservation of gene
     - Conservation of genes refers to actions to ensure the survival of individual genetically controlled characteristics inherent within a population or group of population .
     - Eg: wool sheeding , scientific milk protein etc
  2. Conservation of breeds or populations
     - The conservation of population of breeds refers to action to ensure the survival of a population of animals as defined by the range of genetically controlled characteristics that it exhibit.
     - This form of conservation is applied to endangered species as well as to breeds .

- CANDIDATES FOR CONSERVATION
  1. Unique populations
  2. Endangered population –species
  3. Endangered breeds
  4. Endangered population- genes
- MAJOR LIVESTOCK CONSERVATION PROGRAMME IN INDIA
  1. RashtriyaGokul Mission
  2. National Livestock Mission
  3. Livestock cencus and integrated sample survey
  4. National animal disease control programme
  5. Dairy infrastructure development fund

     ARUNACHAL PRADESH
     Mithun:
     - Population : 350,154
     - It endangered species

- It is a tradition for the major tribes of arunachal . It is a pride animal where its rearing indicated wealth in ancient times
- ICAR’s NRC mithun is the only institute in the world dedicted purely to research on conservation and improvement and conservation and improvement of this animal
- Programme :RGM,Pashudhan mission , pasuchikitayojna

CONCLUSION

- 4.11 %GDP of india is contributed by livestock
- Hence it is of utmost importance to conserve the Indian livestock

POULTRY CONSERVATION PROGRAMMES IN THE STATE AND COUNTRY

2020-V-45

Poultry in India

- India has one of the largest poultry markets in the world. 'Poultry' technically refers to many types of birds raised for meat, and India does raise geese, ducks, guinea fowl, turkeys, and even quail. But they are especially known for their variety of chickens, and meat and egg production.
- The world has over 600 varieties of chickens, and India and the surrounding Asian countries have 92 of those, making them one of the richest areas for poultry.

Indo-Japan project to work for preservation of Kadaknath chicken, other avian breeds

- Mostly jet black, these birds are mostly bred by the rural and tribal people. A native to Jhabua, it is also bred in Bihar's Gaya and tribal regions of Jharkhand in a limited way, though it is becoming more and more difficult due to its high mortality.
- With its germ plasm under threat due to changing environment, scientists are now working to preserve it before the very delicate bird, which lacks resistance to climatic changes, moves into the bracket of endangered species. Due to growing forest degradation, drought situation and long and intense spells of summer, it faces high mortality, as its heat resistance is low.
- Now Kadaknath is among four bird species under the India-Japan Cooperative Science Programme (IJCSP) selected for in-situ conservation of germ plasm. The other species from India taken up for research is Aseel Peela, another native chicken breed known for its fighting qualities and delicacy.

Thalassery Chicken conservation in Kerela

- *The Thalassery chicken lays twice as many eggs as chickens do on average. It has the potential to transform the state's rural poultry farming sectors*
- In 2015, a team of veterinary scientists in Kerala Veterinary and Animal Science University (KVASU) working in the All India Coordinated Research Project (AICRP) cell at Mannuthy decided to study and make efforts to conserve and promote the indigenous Thalassery chicken.
- The Kerala Veterinary and Animal Science University's (KVASU) conservation work on the Thalassery chicken, a bird indigenous to the state, recently marked a major milestone. The project won the prestigious Indian Council of Agricultural Research-National Bureau of Animal Genetic Resources Award 2021 for its work, with some even saying the revival and wider adoption of the breed could lead to a revolution in poultry farming in Kerala. The Thalassery breed is said to have almost double the average egg production, and to be ideal for rural poultry farming.

Conservation of red jungle fowl in Haryana2

- The Red Jungle Fowl is found in India and is distributed approximately along with the Sal forests in the country. It was also found in Malaysia, Indonesia and adjoining countries of the eastern region from where it is reported to be extinct.

- Of late concerns had been raised regarding the genetic integrity and the purity of RJF in the wild and those under captivity.
- This matter regarding the purity of the wild RJF is important because wild genes often hold the key to disease resistance. The dilution with the genes of domestic fowl results in the endangerment of RJF.
- The red jungle fowl (RJF) is one of the four jungle fowls found in the Indian Subcontinent belonging to the genus Gallus, the other three being grey, Ceylon and Green. RJF is distinct in its appearance; its strikingly colourful plumes and majestic red comb makes it a beautiful bird.
- With the decline in forest resources and rapid urbanization the population of many wildlife species has decreased to an alarming in low level. The need for the conservation of Galliformes species was highlighted at national and international level in the early part of 1990.
- The Haryana Forest Department, with a view to breed available local pheasant species and release them in nature established a pheasant breeding center at Morni, about 30 km from Panchkula during 1991-92 and 1992-93.
- Initially it was thought that the center would breed Red Jungle Fowls, Cheere pheasants, Kalij pheasants and Chakores. However, later the emphasis continued mainly on Red Jungle Fowls and Kalijpheasants.u

APPLICATION OF REPRODUCTIVE AND BIOTECHNOLOGICAL TOOLS FOR GENETIC IMPROVEMENT OF LIVESTOCK

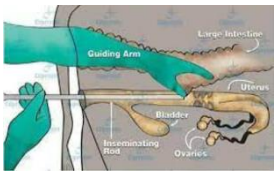
2020-V-47

INTRODUCTION

- To help feed growing populations, to increase the economy and to make good quality product
- There challenge to rapidly increase livestock productivity
- For these reasons there is need to add reproductive and biotechnological tools for genetic improvement of the livestock

Reproductive and biotechnological tools

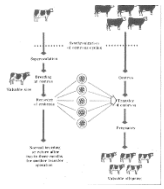
- Artificial insemination
- where new breeds of animals are produced through the introduction of the male sperm from one superior male to the female reproductive tract without mating.
- The A.I. gun loaded with semen
- Which is passed through the vulva to 'vagina and cervix
- Then observed with the hand in rectum that the A.I. gun reaches the cervix, then the semen is deposited by injecting the gun, and after depositing the semen the gun is removed, the empty straw and sheath are disordered.



Artificial insemination

Embryo transfer

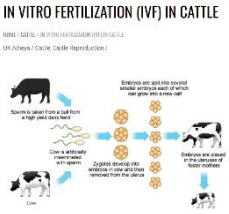
- Embryo is transfered from one mother to a surrogate mother which makes it possible to produce several livestock progenies from a superior female.
- The embryo transfer process begins with cows receiving a hormone treatment to produce more than one ovulation (egg) at a time.
- The cows are then artificially inseminated with bulls also possessing desirable genetics. Seven days later, a veterinarian recovers the embryos by using a catheter and recovery fluid.

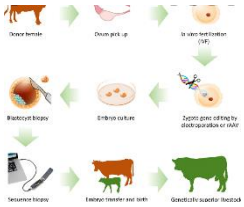


Embryo transfer

In-vitro Fertilization

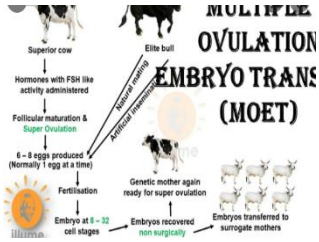
- The fertilization of the sperm and the egg is conducted in vitro at specific environmental and biochemical conditions
- In vitro fertilization (IVF) can be achieved in various laboratory animals by co-culturing oocytes and sperm.
- First, superovulation of female animals are induced by hormonal injections.
- Then, collected oocytes are fertilized by culturing them with sperm in vitro under appropriate conditions.

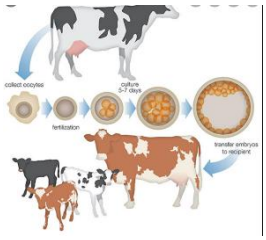




IN VITRO FERTILIZATION

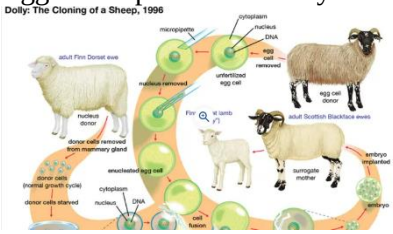
- Multiple ovulation embryo transfer
- MOET (Multiple Ovulation Embryo Transfer Technology) is the technique in which multiple eggs are fertilized in an animal and the embryo is collected on the 7th day, without any surgery. It is the traditional method of embryo production and is practiced in cattle.
- The animal is artificially inseminated and multiple eggs are fertilized in the reproductive tract. After 7 days, the embryos are collected and frozen to transfer later.
- They may also be transferred as fresh embryos.
- This embryos are then transferred to several mothers.

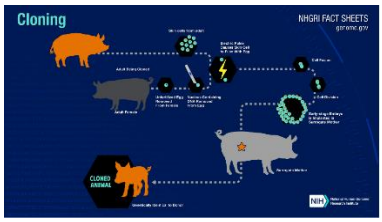




MOET

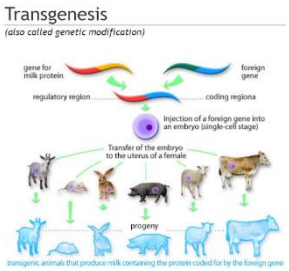
- CLONING
- Cloning is a technique scientists use to make exact genetic copies of living animals.
- Here identical twins are produced.
- Scientists transfer the DNA from an animal's somatic cell into an egg cell that has had its nucleus and DNA removed.
- The egg develops into an embryo that contains the same genes as the cell donor.

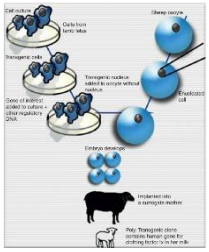




CLONING

- TRANSGENESIS
- Transgenesis is a mode of experimentation involving insertion of a foreign gene (gene of interest) into the genome of an organism, followed by germ-line transmission of the gene and analysis of the resulting phenotype in the progeny.
- Here the fertilized oocyte is taken and the of gene of interest is inserted in the oocyte.
- Then this oocyte is inserted in the animal.





Transgenesis

- <u>GENETIC ENGINEERING</u>
- A process that uses laboratory-based technologies to alter the DNA makeup of an organism
- Locating an organism with a specific trait and extracting its DNA.
- Cloning a gene that controls the trait.
- Designing a gene to express in a specific way.
- Transformation, inserting the gene into the cells of a animal.
- Cross the transgene into an elite background.

Application of reproductive and biotechnological tools for genetic improvement of poultry

2020-V-48

Progress in the selection of production traits in the poultry industry has been dramatic over the past 75 years.The poultry industry will need to adapt with more emphasis on the needs of the consumer as well as the needs of lower feed costs and higher fertility.These new traits are difficult and costly to measure by conventional genetic selection methods so the application of genomics is a possible solution.

Poultry genomics has benefited from the rapid technological advances in the genetics of model organisms and human.Functional Genomics is underway.Applications in biotechnology have and will continue to have a major impact on agriculture: in nutrition (vitamins, minerals) animal health (vaccines and antibiotics), transgenic animals (therapeutic proteins) and genomics (breeding).

ROLE of reproductive and biotechnological tools for genetic improvement of poultry

1. Artificial Insemination :

Artificial insemination (AI) has been defined as a process by which sperm is collected from the male, processed, stored, and artificially introduced into the female reproductive tract for the purpose of conception by using means other than sexual inter- course or natural insemination.Artificial insemination (AI) is used as a tool to enhance production efficiency in poultry.

AI involves the deposition of semen into female reproductive tract manually. It starts with the collection of the semen from the male and its evaluation in terms of motility, viability and concentration followed by its deposition into female reproductive tract.

2. *In vitro* Fertilization (IVF) :

The fertilization of the sperm and the egg is conducted *in vitro* at specific environmental and biochemical conditions. With IVF, a technician removes unfertilized eggs (oocytes) from the donor poultry's ovaries, usually recovering 6-8 useable oocytes. The oocytes mature in an incubator and are fertilized with sperm.

3. Cloning :

Cloning refers to producing genetically identical individual to donor cells and copying gene, that involves the creation of an animal or individual that derives its genes from a single other individual; it is also referred as "Asexual reproduction". Embryo splitting and nuclear transfer are methods of cloning.It is optimally performed at the 6-to 8-cell stage, where it can be used as an expansion of IVF to increase the number of available embryos and an additional tool to assist with conserving critically endangered wildlife species of poultry.

4. Transgenesis :

A transgenic animal is one that carries a foreign gene that has been deliberately inserted into its genome.Transgenic animals are genetically modified to contain a gene from a different species following gene transplantation.There are different methods of transgenesis such as DNA microinjection,DNA transfer into gametes,DNA Electroporation.

Transgenic farm animals can be used both in breeding and biomedicine.In breeding, transgenic individuals produced are equipped with disease resistance and improved quantitative and qualitative

traits.An important achievement was the production of transgenic Poultry's resistant to many viral and bacterial diseases.

1. First Step: Isolate DNA.
2. Second Step: Cut the DNA from the chromosome.
3. Third Step: Make millions of copies of the DNA.
4. Fourth Step: Put the DNA into a vector to carry to the organism.
5. Fifth Step: Put the DNA into the host cell and turn on.

Role of molecular biotechnological tools for the improvement of poultry :

1.Toll like receptors (TLR's) - in chicken which play a role in innate immunity. A range of TLR genes have been identified in chicken.TLR-15 discovered in chicken is distinct from any known and tends to be avian specific.Different TLR's are activated by pathogens and information on them helps to exploit innate resistance in birds.

2. Type-I DNA Markers - Type I markers include restriction fragment length polymorphism, or RFLP, which is a technique that exploits variations in homologous DNA sequences.In RFLP analysis, the DNA sample is broken into pieces (digested) by restriction enzymes and the resulting restriction fragments are separated according to their lengths by gel electrophoresis.

3. EST'S or expressed sequence tags - An expressed sequence tag or EST is a short sub-sequence of a cDNA sequence.They may be used to identify gene transcripts, and are instrumental in gene discovery and gene sequence determination.

4. Type-II DNA Markers - RAPD stands for 'Random Amplified Polymorphic DNA.It is a type of PCR reaction, but the segments of DNA that are amplified are random.RAPD creates several arbitrary, short primers (8–12 nucleotides).RAPD has been used to characterize, and trace, the phylogeny of diverse chicken species.

5. RNAi (RNA interference) - involves post transcriptional gene silencing through small interfering RNA (siRNA) and helps in analysing the role and effect of that particular gene in biological processing: silencing the myostatin gene which is a potent negative regulator of skeletal growth.

BREEDING FOR DISEASE RESISTENCE

2020-V-49

BREEDING FOR DISEASE RESISTANCE IS AN IMPORTANT STRATERGY FOR REDUCING LOSSES CAUSED BY DISEASES IN ANIMALS.

BENEFITS OF DISEASE RESISTENCE:

Improved animal health

- Increased return for breeders
- Helps in fighting and controlling epidemic diseases
- Increased product quality and volume by reducing loss due to disease.

DEMERITS OF DISEASE RESISTENCE :

1. It is a long term process which takes 10-15 years to develop agronomically acceptable variety even when the source of resistance are readily available.

2. In some cases, breeding for resistance to one pest leads to the susceptibility to another pest. This is because the host plant feature associated with resistance to one insect is associated with susceptibility to another insect. For example, hairiness ,in cotton is associated with Jassid resistance but confers susceptibility to whitefly and bollworms.

3. In many cases, genes for disease and insect resistance are available only in the related wild species. Interspecific gene transfer poses many problems. Moreover, resistant genes are associated with some undesirable characters. It takes a long time to discard undesirable

genes in a breeding programmes.

4. Breeding for disease and insect resistance is an expensive method which requires adequate financing for a long period being a long term process.

METHODS FOR RESISTANCE BREEDING :

1. SELECTION :
   Tandem Method
   Independent Culling Level
   Selection Index

2. MUTATION : Increases the genetic variability for desired traits.

3. HYBRIDIZATION : Mixing of two different species or breed together.

4. SOMACLONAL VARIATION : Variation seen in animals that have been produced by animal tissue culture.

5. GENETIC ENGINEERING : It involves altering the genetic material by adding,changing or removing certain DNA sequences in a way that does not occur naturally.

Disease resistance for cattle and buffalo

• Buffaloes were quite resistant to a majority of diseases, specifically systemic infectious diseases, compared with resistance evident in goats, sheep, and cattle. One of the most interesting observations is that a negligible number of buffaloes under study had systemic infections in terms of febrile reactions or any type of contagious diseases, especially footand-mouth disease in winter.

• Major histocompatibility complex (MHC) genes are linked to specific immunological responses. A region on chromosome 1 was associated with infectious keratoconjunctivitis (pinkeye) in cattle, which is heritable. Bos indicus breeds were observed to have better resistance to tick infestation and tick-borne diseases, as revealed through higher hemolytic complement activity

Disease resistance for sheep and goats

• Gastrointestinal nematode infection is a major problem in the small ruminant industry worldwide. Susceptibility to nematode infection seems to be related to genetic factors, and resistance may vary among breeds. Comparative studies have shown that goats are more susceptible to gastrointestinal nematodes than sheep. The recommended drug dosage to goats is the same as for sheep, but due to differences in the pharmacokinetics of drugs between sheep and goats, anthelmintics are less efficacious in goats and may lead to rapid selection of anthelmintic-resistant worms.

• MHC is a candidate gene considered important for the immune system and disease-resistant traits. MHC is a cell surface molecule involved in antigen presentation by glycoprotein receptors of immune cells (B lymphocytes, dendritic cells, and macrophages).

BREEDING OF PET ANIMALS

2020-V-50

What are pet animals

- A pet, or companion animal, is an animal kept primarily for a person's company or entertainment rather than as a working animal, livestock, or a laboratory animal.
- Types of pet animals

1. Dog
2. Cat
3. Fish
4. Mice
5. Birds
6. Snake

What is breeding

- **Breeding** is sexual reproduction that produces offspring, usually animals or plants. It can only occur between a male and a female animal or plant.

Importance of animal breeding

- Animal breeding plays an important part in progressing animal production systems, from conventional to organics. By improving the abilities of animals for certain traits entire populations can be enhanced, creating benefits for farmers, consumers, and the environment.

Methods of breeding

Basically, there are two methods of breeding which are as follows:

1. **Inbreeding:** Breeding of the related animals as sire (male) and dam (female) are known as inbreeding.
2. **Out breeding:** Out breeding of unrelated animals as male and female is known as out breeding.

Selection of breeding animals:

- Selection of good quality improved animals for breeding is done by allowing some animals to have offspring while preventing the animals with inferior quality from reproducing.
- The process allows producing genetically superior animals. Emphasis has to be given on several traits when selecting breeding stock.

Steps involved in breeding of dogs and cats

1. Prepare yourself for breeding litter
2. Breeds to improve
3. Understand the commitment
4. Choose a suitable mate
5. Perform pre-breeding health checks
6. Mating
7. Pregnancy and whelping preparation
8. Consult your veterinarian if complication arise
9. Keep your puppies warm, fed, and clean
10. Wean puppies or kitten from their mothers.

Feeding tips for pet breeders

1. Feed a highly digestible, nutrient-dense food formulated for growth.
2. Feed three to four meals per day until 4 to 6 months of age.
3. Feed to achieve an average rate of growth for a pet's breed and support a lean body condition.
4. Avoid overfeeding.
5. Provide regular exercise.

Regulation related to dogs breeding in India

1. Only normal and healthy mature female dogs that have reached 18 months shall only be bred
2. Male dogs should be healthy, mature, and only after he has reached his 18 months.
3. Out breeding and line breeding only allows in India.
4. Female dogs should not be mated after 8 years of age.
5. Health of all the animals to be maintained.
6. Breeder should be 18 years of age.
7. Inspection and report by the recognized veterinary should be submitted to the local authorities.
8. Welfare of animals should be maintained.

Don't breed or buy, while shelter animals die

Breeding of zoo and wild animals

2020-V-51

Breeding: it is the process by which animals breed and produce off springs.

Breeding of wild animals

Wild animals breed in their natural habitat, breeding locations are chosen as per the requirement of food and proximity to shelter, and breeding seasons are usually followed by mating rituals (it is more common in birds and the males usually have competition among themselves to attract the females for mating), climatic conditions like drought it increases the heat stress in animals and flood leads to increase in disease and death of many animals which ultimately affects the breeding in animals and geographical factors like human settlement, pollution burning of fossil fuels will all have a negative impact on the breeding of animals.

Breeding of zoo animals

Zoo is an ex- situ conservation of wild animals for entertainment, education, scientific research and species conservation, the animals kept in zoo are under captivity and the process of breeding them is known as captive breeding,
Captive breeding: the process of breeding animals outside their natural environment in restricted farms zoos or other closed facilities.

Aim of captive breeding

Conservation of species and endangered animals from extinction and disease threats,
to protect them from hunters, poachers and other illegal activities,
to improve animal living condition and for educational purpose.
Tools used for breeding in zoo
Artificial insemination: it is a process in which the semen is directly introduced into the cervix or uterus of the female in the hope of getting her pregnant
Cryopreservation: the process of conserving the semen in liquid nitrogen at -196 degree Celsius

Conclusion

Breeding of wild animals occur in their natural habitat and the breeding of zoo animal usually requires human interferences eg, Artificial insemination.

CLASSIFICATION OF DOG BREEDS

2020-V-53

❖ **Classification of Dog breeds**:

- Dogs have been classified into the following 7 main groups by the American Kennel Club (AKC) classification system as follows :

1)Sporting
2)Hound
3)Working
4)Terrier
5)Toy
6) Non-sporting
7)Herding1.

1) Sporting group

- Sporting dogs tend to be natural athletes, active and very alert dogs. Sporting dogs are well known for their instincts around water and woods and require regular exercise . Sporting dogs have increasingly made their way in as the family dog, but many still participate in hunting and field activities. The sporting group includes Retrievers,Setters, and Pointers.

2) Hound group

- Type of hunting dog used by hunters to track/chase prey.The hounds come in two basic types:

a)Scent Hounds-They tend to have long, drooping ears and large nasal cavities to enhance smell sensitivity
E.g.: Basset Hound, Beagle, Harrier.

b)Sight Hounds- they have long legs and slender bodies
E.g.: Afghan Hound, Fox Hound, Basenji

3) Working breeds

- They are used to perform practical duties, including acting as watch dogs and pulling carts
- Several of these breeds are Rottweiler as a cattle drover, farmers protector and Akitas as palace guards & hunters.
- Working dogs are susceptible to degenerative joint disease result of excess mechanical stress
  E.g.: Rottweilers, Siberian Husky,Akitas,Doberman.

4) **Terrier**

- They are also hunting dogs but their game is vermin, they control rat ,mice and other predatory animals that raided farmers grain ,shopkeepers and storage bins but they have become beloved watch dogs and pets.
  Example: BullTerrier, Manchester Terrier.

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Carnivora
Family	Felidae
Genus	***Felis***
Species	***domesticus***

5) **Toy breed**

- They are often smaller version of other breeds, developed as companions to ladies and gentlemen in various nations. They are small in stature but big on brains and affection
  Example: Pug, Chihuahua, King Charles Spaniel.

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6) **Non sporting**

- It is a unique dog group because it does not group dogs by a particular purpose or size- instead, it is a more of a catch-all group for dogs that don't fit in other groups.

Examples of dogs in the Non-sporting Group include Dalmatians, AmericanBulldogs, ShibaInus, Finnish Spitz.

7) **Herding Group**

- Originally bred to herd livestock, dogs in Herding Group are smart and energetic.

Examples of dogs in the Herding Group include Australian Cattle Dogs, BorderCollie, AustralianShepherds, Belgian Malinois and German Shepherds.

CLASSIFICATION OF CAT BREEDS

2020-V-54

CAT

- The cat is a small domesticated mammal.
- Pet animal. A cat's purr can calm the nervous system
- Lifespan: 12-18 years
- Distribution: Found all over the world, almost in every home

Population: ***Around 400 million***

Cat Breeds And Their Classification

- Cat Breeds
- Large Size
- Medium Size
- Small Size

Large Size Cat Breed

1.American Shorthair Cat

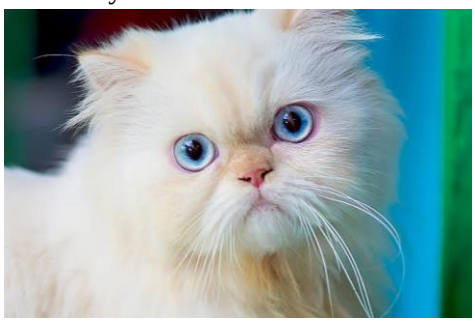
- ***Origin: North America***
- Size: Medium to Large
- Weight: Male= 6 kg, Female= 4 kg
- Coat : Short
- Lifespan: 15-20 Years
- ***Descended from European cats***

2.Somali Cat

- ***Origin: Somali***
- Size: Medium to Large
- Weight: M=5 Kg, F= 4kg
- Coat: Medium, fine soft
- Colour: Red, blue, fawn

- Lifespan: 9-13 years
- ***Looks like a small wild fox***
- ***Longhaired version of Abyssinian***

3.Himalayan Cat



- ***Origin: USA ,UK & INDIA***
- ***Also known as HIMMY***
- Size: Medium to Large
- Weight: M=6 Kg, F=5 Kg
- Coat: Long
- Lifespan:9-15 Years
- Colour: White to fawn body with various colours

4.Siamese Cat

- ***Origin: Thailand***
- Size: Medium
- Weight: M=6 Kg, F=5 kg
- Coat: Short, Fine, Glossy
- Colour: Chocolate point
- Lifespan:11-15 years
- ***First recognised Asian cat***

5.Maine Coon Cat

- ***Origin: Maine,USA***
- Size: Large
- Weight =6 Kg, F=5 kg
- Coat=Shorter on Shoulders,Longer on Stomach,smooth
- Colour:Brown but other colours and patterns are possible
- Lifespan: 10-13 Years
- ***Oldest breed in North America***

Medium Size Cat Breed

1.Bengal Cat

- ***Origin: USA***
- Size: Medium to Large
- Weight: M= 5 kg, F=4 Kg
- Coat:Medium
- Colour:Bright orange to light brown,with Dark spots or a distinctive marbling pattern
- Lifespan: 12-16 Years
- ***Related to Egyptian Mau,Abyssinianan and others(domestic) ,Asian leopard cat(wild)***

2.Burmese Cat

- ***Origin: Burma***
- Size: Medium
- Weight: 5 kg
- Coat: Short
- ***Colour:Champagne,Blue ,Platinum***
- Lifespan:10-16 Years

3.Japanese Bobtail Cat

- ***Origin:Japan***
- Size:Medium
- Weight:4 kg
- Coat: Long and short
- Lifespan:15-18 years
- ***One of the oldest cat Breeds***

4.Bombay cat

- ***Origin:United States,Thailand***
- Size: Medium
- Weight= 4 Kg
- Lifespan: 12-16 years
- ***Developed by breeding sable Burmese and black American Shorthair cats to produce Burmese type(panther-like black coat)***

Small Size Cat Breeds

1.Abyssinian cat

- ***Origin:Ethiopia,South East Asia***

- Size: Small to Medium
- Weight:4 Kg
- Coat: Medium
- ***Colour:Red,Blue ,Fawn***
- Lifespan:9-15 Years
- ***Breed is named for Abyssinia(now called Ethiopia),where it is originated***

2. Devon Rex Cat

- ***Origin:England***

Size : Small

- Weight:3 Kg
- Coat: Short and curly
- ***Colour: Variety of colours like white,black,red,brown,frost,platinum,faawn,chocolate***
- Lifespan: 9-13 Years
- ***Emerged in England in late 1950s***
- ***Known for their slender bodies,wavy coat and large ears***
- ***they should never be brushed because the fur is too fragile***

PEDIGREE SHEET OF DOG

2020-V-55

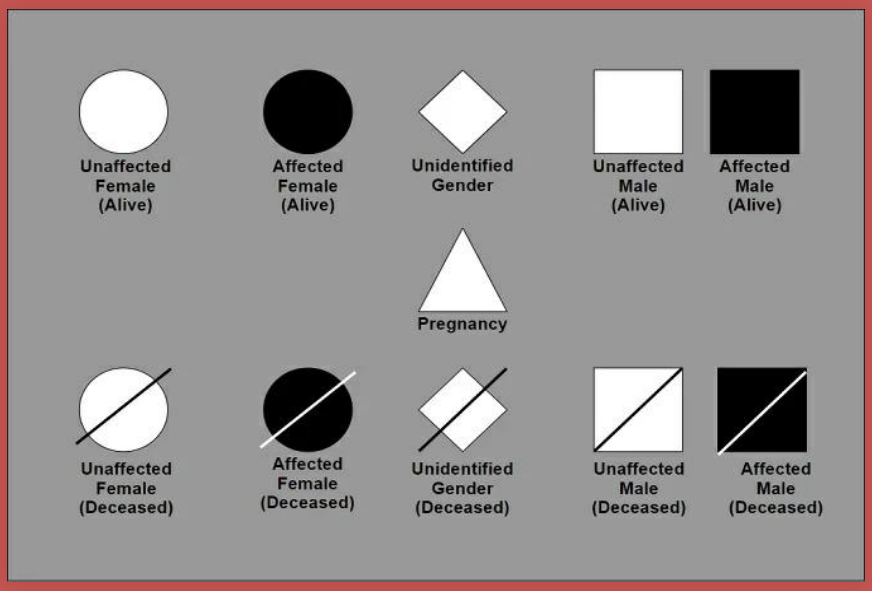
What is a PEDIGREE?

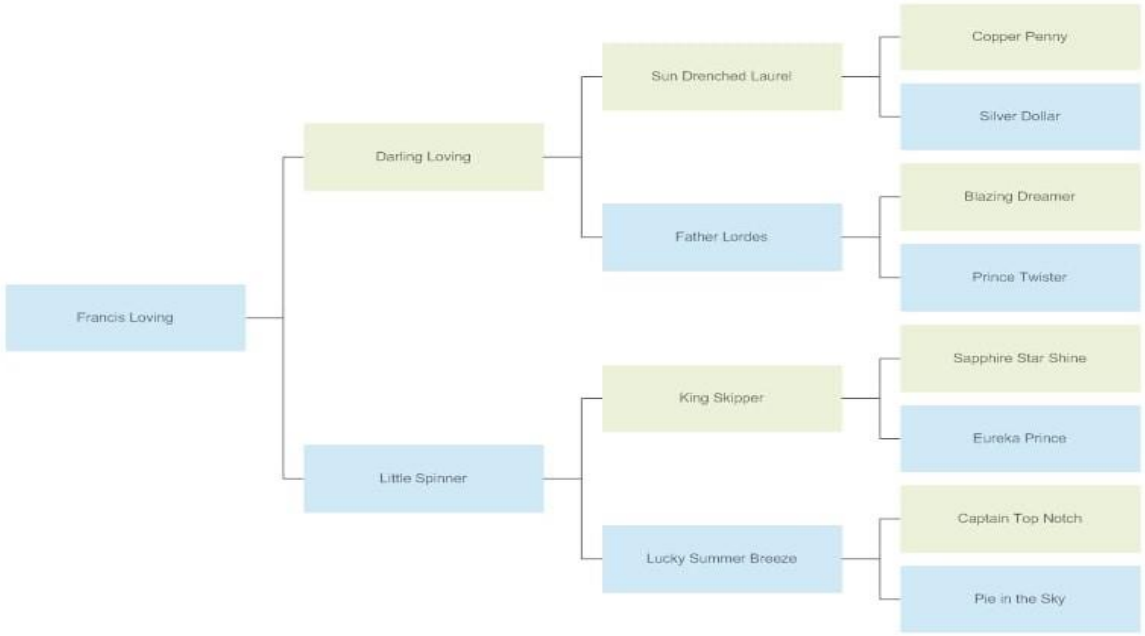
Pedigree sheet/chart results in the presentation of family information in the form of an easily readable chart. It can be simply called as a **"family tree".**

IN ANMAL HUSBANDARY:- In the practice of selective breeding (choosing parents with superior characteristics and produce desirable offsprings), pedigree charts are used to track the ancestry of animals and assist in the planning of suitable breeding programs to enhance desirable traits. Here, it commonly determines the quality of show dogs.

HOW TO MAKE A PEDIGREE:

1. Pedigree use a standardized set of symbolswhere represent males and represent females. If the sex of the person is unknown then a is used and if someone with the phenotype in question then it is represented by a darker symbol.
2. Relationships in a pedigree are shown as a series of lines. Parents are connected by a horizontal line and a vertical line leads to their offspring.
3. Each generation is identified by a Roman numeral (I, II, III, and so on), and each individual within the same generation is identified by an Arabic numeral (1, 2, 3, and so on).
4. Pedigree is analysed using the principles of Mendelian inheritance which can determine whether a trait has a dominant or recessive pattern of inheritance.





CONCLUSION:

There are various types of charts that feature genealogy {trace lines of ancestry/ line of descent} and Pedigree Chart is one such, Using this it gives us more details and insight to the past conditions that the entire family have experienced. On that note, making a pedigree should not be complicated.

Selection of Dog Breeds and Major Breed Traits

2020-V-57

How to select a dog breed:

- When deciding on a dog breed, it's important to consider the breed and not the group by which a dog falls into.
- A specific dog breed may fall into the hunting group, but the breeds traits can't be evaluated by that category.
- In addition, some breeds may fall into more than one group depending upon the size.
- For example, a toy poodle falls into the toy group, but standard poodles fall into the non-sporting group.
- While you wouldn't want to evaluate a breed exclusively by its group classification, it is important to understand a dogs group in order to fully understand their basic features.

Purebred or Mixed Breed:

Purebred dogs present many advantages. First, a purebred offers you a guarantee of what a puppy will look like as an adult – the size, coat type, actively level, and natural instincts have been passed down from generation to generation. Second, because you are more likely to meet and observe your puppy's mother, temperament can be better evaluated. When purchasing a purebred, find a responsible breeder to ensure that the dog is sound and certified free of certain heritable genetic diseases such as hip dysplasia, progressive retinal atrophy, night blindness, hypothyroidism, entropion, ectropion, overshot, undershot jaw (when incisors do not touch or mesh), wry mouth, two or more missing teeth, unilateral cryptorchid or full cryptorchid males.

Mixed breed dogs, or "mutts" as they are sometimes affectionately called, can also make great pets. There are thousands of dogs in shelters all over the United States just waiting to be adopted. Besides being abundant, mixed breeds, because of their varied backgrounds, may escape many of the genetic problems that purebred dogs face. To ensure that you get the best mixed breed for your family situation, find out as much about the dog's history, background, and former treatment as possible. Having this information can help in predicting the future problems and allow you to formulate a solution if they arise.

Male or female:

You will get different opinions about which sex you should choose. Some people swear that females are more easily trained and form closer emotional bonds with their owners. Others firmly believe that males have more character and more consistent temperaments. But the truth is that personality is subjective and varies from dog to dog.

Environment:

Dogs, even small ones, need space – space to play, grow, exercise and be alone when they want. The amount of space you can provide will determine which kind of dog is best for you.

Exercise:

All healthy puppies are playful, active, and full of energy. Puppies do grow up, however, and each breed will have certain exercise requirements that must be met for its physical and mental well-being. If you pick the right puppy, the level of activity that both of you enjoy should be a perfect match throughout your life together.

Grooming:

As dogs evolved over time, each group developed coats for protection from both the elements and predators – in other words, their coats became matters of function. Dogs with short, smooth coats were good hunters because they did not pick up burrs or become stuck in the field. Long coats helped dogs who were bred to work in colder climates.

Trainability:

How important is it to you that your dog can do tricks or learn obedience commands quickly? How much time are you willing to spend training him? Some dogs are more easily trained than others. There are great dogs out there who, try as they might, will need a lot more practice than others to learn how to roll over on command. And there are other dogs that can learn several tricks in one day, but they may not have certain other traits that you find desirable. You will have to decide what is most important to you.

1.	Alsatian / German Shepherd	11.	Pomeranian
2.	Beagle	12.	Poodle
3.	Boxer	13.	Pug
4.	Bull dog	14.	Labrador retriever
5.	Dachshund	15.	Golden retriever
6.	Dalmatian	16.	Cocker Spaniel
7.	Doberman Pincher	17.	Saint Bernard
8.	Great Dane	18.	Pointer
9.	Grey Hound	19.	Rottweiler
10.	Lhasa Apso	20.	Collie

SELECTION OF CATS AND MAJOR BREED TRAITS

Selection of cat breeds depend upon many factors. Some of the important factors are as follow:
Young or adult cat to be purchased

- For the busy family or elderly person,
    - it may be best to purchase an adult cat.

      It will not require as much time to care for as a young kitten.

- Adult cats should be taken to a veterinarian soon after obtaining them, because they may have parasites. This is especially true if the cat is a stray.

- Older cats may not live as long, which could be emotionally upsetting.
- Kittens adapt quickly to a new family; they can be fun to watch as they grow.
- The more attention a kitten receives, the closer it becomes attached to the family.

Male or female

- If one does not intend to breed the cat, it is best to have the animal spayed or neutered.
- It makes very little difference if the pet cat is male or female; both are equally intelligent, affectionate, & playful.
- A male kitten reaches sexual maturity at about 6 or 8 months of age; even if the owner lets it outside, it will start spraying areas to mark its territory.
- The smell is very strong & unpleasant; if one decides to keep a male cat, special housing may need to be provided.

Breed of choice

- If one is just looking for a pet, the common domestic, mixed –breed house cat will probably make a suitable selection.
- These animals have traits from several breeds and make affectionate, friendly pets.
- Pedigree animals usually have both good and bad characteristics; one needs to be aware of these traits before purchasing a particular breed.
- Some breeds are basically inactive, solitary animals, whereas others are more active, playful, and demanding.
- Long haired cats require more time for grooming.
- Also, the climate of the area is important; unless they have air conditioning, long haired cats may become uncomfortable in high temperatures.

→ AMERICAN BOBTAIL CAT
→ AMERICAN SHORTHAIR CAT
→ BRITISH SHORT HAIR CAT
-ONE OF THE MOST POPULAR CAT BREEDS IN THE WORLD.
→ SOMALI CAT
→ HIMALAYAN CAT
→ SIAMESE CAT
EXOTIC SHORTHAIR CAT
→ MAINE COON CAT
→ BENGAL CAT
→ BOMBAY CAT
-SMALLEST DOMESTIC CAT BREED

Breeding Management of DOGS

2020-V-59

Introduction

1. Female dogs can be bred naturally, or beartificially inseminated using fresh, chilled and shipped, or frozen-thawed semen.
2. The interestrous interval is normally 4–13 months,with 7 months the average. The anestrus phase of the estrous cycle is marked by ovarian inactivity, uterine involution and endometrial repair.

Luteinizing Hormone in Breeding Management of Dogs

- At the end of the follicular phase of the estrous cycle, a marked increase in LH over usual baseline values develops over 24–48 hours, followed by a return to baseline values

Progesterone in Breeding Management of Dogs

- Progesterone levels begin to rise at approximately the time of the LH surge (before ovulation).
- Rising progesterone acts synergistically with declining estrogen to reduce edema of the vulva and vagina.

Artificial Insemination in Breeding Management of DOGS

- Artificial insemination is becoming more common in canine reproduction, permitting the use of shipped semen, assistance for geriatric or subfertile males, coverage of dominant females, and advanced reproductive technology such as intrauterine deposition of semen.
- Insemination may be performed with fresh, chilled, or frozen semen.
- All instruments should be clean and free of any chemical contamination.
- After semen has been collected and evaluated, it can be deposited in the cranial vagina of the female using a rigid insemination pipette of appropriate length.

Breeding Management of Cats

2020-V-60

Breeding

The production of plants and animals especially for the purpose of developing new or better type.
The propagation and genetic modification of organisms for the purpose of selecting improved offspring.

Introduction

- Cats mating may seem simple to the casual observer;
- The female can be bred at any time during her active phase of her heat cycle because cats are induced ovulators.
- This means that the act of breeding stimulates the ovaries to release eggs.
- Once ovulation has occurred,the female cat will go out of heat within a day or two.
- Cats normally reach sexual maturity at:

  5-10 months(females) and
  5-7 months(males),this can be depending on breed.

Before considering for breeding,

cats should be 18 to 24 months old,and should be strong
Have a good body condition.
They are seasonally polyestrus,season begins in jan and end of oct oestrus cycle is 14-21 days

- Before the breeding season begins,make an appointment for-
  -a physical exam,
  -Vaccinations
  -stool check for internal parasites,and
  -any other necessary tests
- Both parents should be tested for FeLV and FIV before each breeding.

BREEDING OF CAT

- FOR female,Information like previous estrus period,breeding date and the outcome,health record,vaccination detail,disease history should be noted.
- The timing of breeding is best determined by queen's behaviour.
- As the queen enters estrus,she begins to show a coital crouch
- When in the presence of a male cat or in response to genital stimulation.
- Mating in cats occurs rapidly,lasting between 30 sec and 5 minutes.
- Estrus period will normally end abruptly by 24 to 36 hrs after initiation of mating.
- The female cat will not come to estrus until the kittens are weaned or until next breeding.
- If the female doesnot conceived,she will either enter pseudo-pregnancy or retrun to estrus cycle.

Common Pet Birds Seen In India

2020-V-61

Pet Birds

Birds serve as a tame and talking companion to all pet lovers.
The cost of keeping a feathered pet is much more less than that for cats and dogs and also they requires very less space.
They have long life span compared to many other pets.
Many birds are kept for their – talking ability ,singing ability,and sports purpose also.
Actually birds don't talk ,they are actually mimicking the sound by repetition.
Various species of birds are maintained by pet lovers.eg-

PARAKEETS

Generally, parakeets mean "parrot like birds".
In India, there is no parrot but only parakeets.
This is actually a group of birds having long tailed slender body ,belonging to the family Psittacidae.
They can learn to talk quite well and will develop elaborate vocabulary.

1.Indian Ring Neck Parakeet

Most beautiful parakeet among all parakeets.
Mainly found in the tropical regions.
Usually a black neck ring is present in case of males whereas ,in case of females or in immature birds there is no such rings in the neck.
The primary color is green.
The beak is red, an orange outer ring surrounds the eyes.

2.Blue winged parakeet

Main characteristic feature of this birds is- the wing and the tail feathers are dark blue.
They are endemic to the western ghats of southern India.
The birds bred during the dry season.

3.Plum Headed Parakeet

These are mainly found in the Pakistan ,India ,Sri lanka , Bangladesh.
The males have a dark red color head while females have a purplish gray head.

Mynah

There are 2 types of mynah 1) Hill Mynah 2)Common Mynah.
They are found in almost all Asian countries.
Color is black while the beak is yellow in color.
Noted for its ability to mimic the human sounds.
Keeping mynah as a pet bird is so time consuming as they mainly eats fruits so their cage needs to be cleaned once a day.

Pigeons and Doves

The pigeons and doves are almost same in outer appearance.

But the doves are slightly smaller than the pigeons.
These both are used as pet birds in India.

Koels

Koels never make their own nests ,they always lay eggs in the nests of other species.
They also have a monotonus voice.
They eats fruits and insects.

Finches

These are medium to small size birds ,used as pets.
Finches have a thick and hard beak adapted for eating seeds and nuts.

Love Birds

These are small, short tailed parrots.
Mainly founds in Africa and nearby regions.
Inspite of their names ,love birds can become extremely aggressive.
They are also used as pet birds.

BREEDING MANAGEMENT OF PET BIRDS

2020-V-62

PET BIRDS: Basically pet birds are those birds,other than poultry, reared or kept in captivity as pet.

SOME COMMONLY KEPT PET BIRDS:

Popular pet birds come in all different sizes to suit most types of homes. They may be-

-Small pet birds like finches,canaries,parakeets and lovebirds etc.are friendly low maintenance birds.

-Large pet birds include parrots,cockateils and cockatoos etc.

Breeding of pet birds:

-The breeding birds should be in good health condition during breeding season and the breeder should known the breeding season of particular birds.

-Age of breed bird is also important: too young old birds are not fit for breeding.

-All birds reproduce by laying eggs.

-In most species of pet birds, both parents are actively involved in incubation, feeding and caring for the chicks.

NEWBORNS AND YOUNG BIRDS:

-Chicks of most pet bird species are born blind and without feathers.Depending on type of birds,the eye open within 1 to 2 weeks.

-Feathering is complete in about 1 month for smaller birds but can take upto 5 months in larger birds , such as macaws.

BREEDING MANAGEMENT

- → Proper care during breeding,good sanitation and nutrition,nurserymanagement,and egg incubation can help reduce disease in newborn chicks.
- → Calcium for breeding- crucial for egg production and young chicks.
- → Liquid calcium supplement like Calcivet provide highly bio available forms of calcium which birds can easily absorb.
- → Be sure to keep the cage in warm spot.
- → In general, chicks should not be disturbed but should be closely monitored to ensure that they are receiving proper care from parents.
- → Loose bedding material is favourite for curious chicks.
- → If the newborns do not appear to be thriving,contact your avian veterinarian immediately for instructions on hand rearing.

HISTORY OF GENETICS

2020-V-63

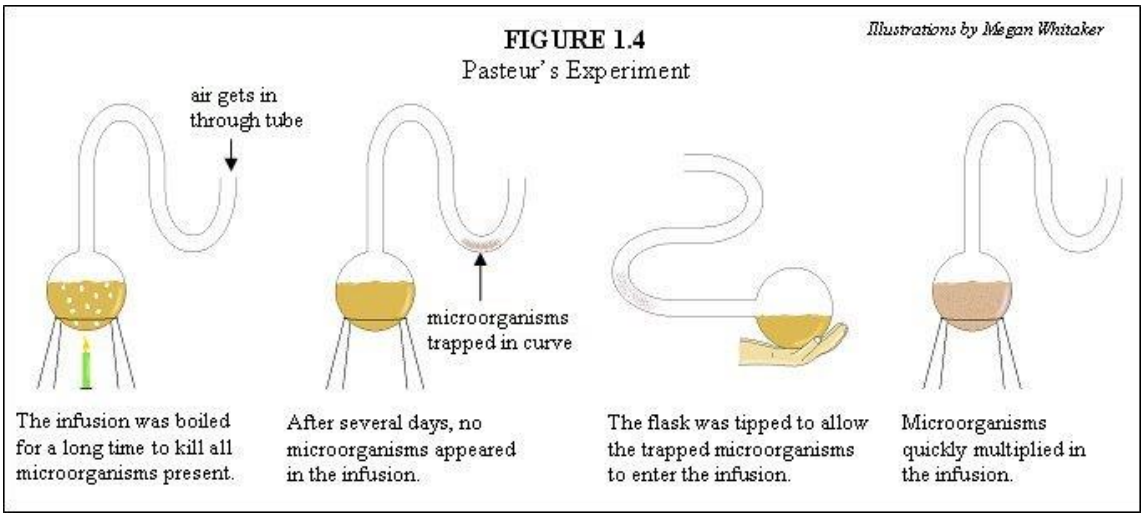
What is Genetics...?

Generally genetics is the science of study of inheritance.

By definition "genetics is the science that deals with the structure, organization, transmission and function of genes and the origin of variation".

Pasteur Swan Neck Flask Experiment:

Louis Pasteur: A French chemist and microbiologist



This demonstrates that microorganisms do not appear as a result of Spontaneous Generation. Instead, they are introduced into food through dust particles and other things that happen to land on the food.

EPIGENESIS

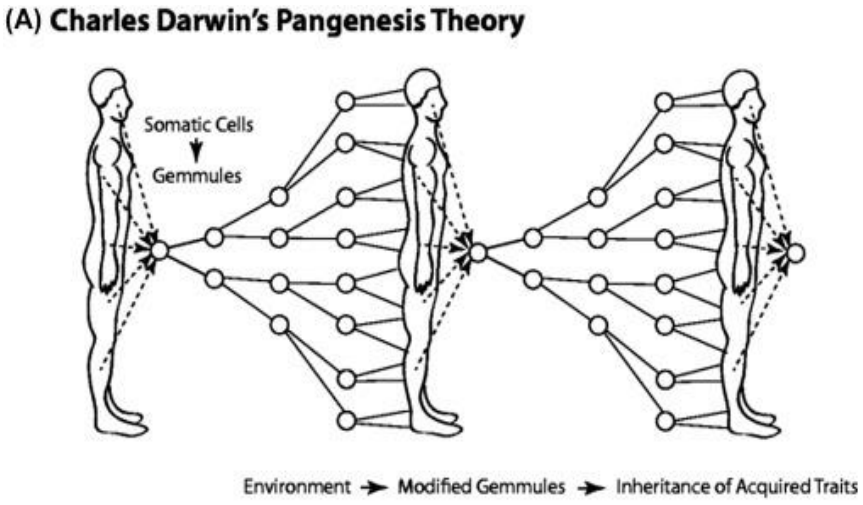
- organs and tissues arose through a process called differentiation.
- Praposed By Wolff.

Inheritance of acquired character

- Characters acquired in one generation is passed on to the next.
- Praposed By Lemark.
- Known as Lemarkism.

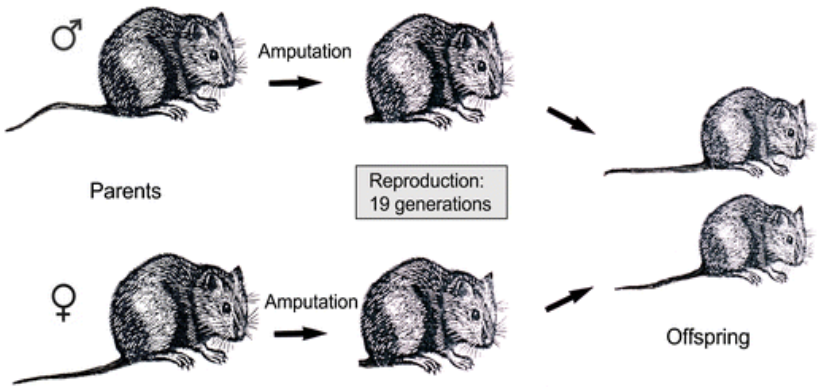
Pangenesis

- Praposed By Charles Darwin in his book 'Origin of species'.
- each part of the body continually emitted its own type of small organic particles called gemmules that aggregated in the gonads, contributing heritable information to the gametes**.**



Germplasm theory

August Friedrich Leopold Weismann in 1863.
Germ plasm (German: Keimplasma) is a biological concept developed in the 19th century by the German biologist August Weismann. It states that heritable information is transmitted only by germ cells in the gonads (ovaries and testes), not by somatic cells.



Gregor mendel(1822-1884)

- Father Of Genetics.
- Conducted a series of experiment and published his findings on pea in 1866.
- He referred as the unit of inheritance as "factor".

- Laws of Mendel.

Some important discoveries

- Nucleous- Robert Brown.
- Nucleic acid- Meischer (renamed by Altman)
- Mitosis-Fleming
- Meiosis-Farmer and Moore
- Chromosomal theory of heridity- Walter Sutton
- Genetics- Bateson
- White eye gene in drosphila: SEX LINKAGE –Morgan.
- One Gene One Enzyme Theory-Beadle and Tatum.
- DNA is a genetic merial- Avery, MacLeod and McCarty Watson and Crick- DNA double helix model(1953)
- Nirenberg and co workers discovered triplet genetic code.
- Genetic engineering, also called genetic modification, is the direct manipulation of an organism's genome using biotechnology.
- Father of genetic engeneering - Paul Berg
- Technique used to identify individuals by characteristics of their DNA.
- Professor Sir Alec John Jeffrey is the inventor of this.

Mitosis & Meiosis

2020-V-64

Mitosis

Division of **somatic** cells (non-reproductive cells) in eukaryoticorganisms.

A single cell divides into two identical daughter cells.
Daughter cells have same of chromosomes as does parent cell.

4 sub-phases:
1st – Prophase
2nd – Metaphase 3rd – Anaphase 4th – Telophase
*followed by***Cytokinesis**

1. Prophase

3 Major Events
- chromosomes condense
- spindlefibers form (spindle fibers are specialized microtubules radiating out from centrioles)
- chromosomes are captured by spindle

2. Metaphase

- chromosomes align along equator of the cell, with one kinetochore facing each pole

3. Anaphase

- sisterchromatidsseparate
- spindlefibers attached to kinetochores **shorten** and **pull** chromatids towards the poles.
- free spindle fibers**lengthen** and **push** poles of cell apart

4. Telophase

- spindle fibers disintegrate
- nuclear envelopes form around both groups of chromosomes
- chromosomes revert to their extended state
- cytokinesis occurs, enclosing each daughter nucleus into a separate cell

Meiosis

- The form of **cell division**by which **gametes,** with **half** the number of **chromosomes,** are produced.

- **Diploid (2n) → haploid (n)**
- **Meiosis** is **sexual reproduction.**
- **Two divisions** (**meiosis I** and **meiosis II**).
- The form of **cell division**by which **gametes,** with **half** the number of **chromosomes,** are produced.
- **Diploid (2n) → haploid (n)**
- **Meiosis** is **sexual reproduction.**
- **Two divisions** (**meiosis I** and **meiosis II**).

Meiosis I (four phases)

- **Cell division** that reduces the **chromosome** number by **one-half.**
- **four phases**:
  - **a. prophase I**
  - **b. metaphase I**
  - **c. anaphase I**
  - **d. telophase I**

Prophase I

- **Longest and mostcomplex phase (90%).**
- **Chromosomes** condense.
- **Synapsis** occurs: **homologous chromosomes** come together to form a **tetrad**.
- **Tetrad** is two **chromosomes** or four **chromatids** (sister and nonsister chromatids).

Metaphase I

- **Shortest phase**
- **Tetrads** align on the **metaphase plate**.
- **INDEPENDENT ASSORTMENT**

OCCURS:

1. Orientation of homologous pair to poles is random.
2. Variation
3. **Formula: 2^n**

Example: 2n = 4
then n = 2
thus 2^2 = 4 combinations

Anaphase I

- **Homologous chromosomes** separate and move towards the poles.

- **Sister chromatids** remain attached at their **centromeres**.

Telophase I

- Each pole now has **haploid** set of **chromosomes**.
- **Cytokinesis** occurs and two haploid daughter cells are formed.

Meiosis II

- **No interphase II**
  (or very short - no more **DNA replication**)
- **Remember: Meiosis II** is similar to **mitosis**

Prophase II

- same as **prophase** in **mitosis**

Metaphase II

- same as **metaphase** in **mitosis**

Anaphase II

- same as **anaphase** in **mitosis**
- **sister chromatids separate**

Telophase II

- Same as **telophase** in **mitosis**.
- Nuclei form.
- **Cytokinesis** occurs.
- **Remember: four haploid daughter cells produced.**
  gametes = sperm or egg

OVERVIEW OF MENDELIEN PRINCIPLES

2020-V-65

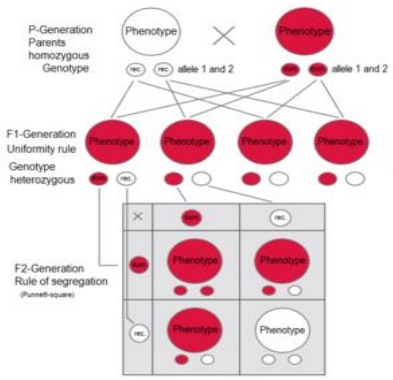
Mendelian inheritanceis a type of biological inheritance that follows the principles originally proposed by Gregor Mendel in 1865. The principles of Mendelian inheritance were named for and first derived by Gregor Johann Mendel who conducted his experiments with pea plants (*Pisum sativum*) he had planted in the garden of his monastery.

Between 1856 and 1863, Mendel cultivated and tested some 5,000 pea plants. From these experiments, he induced two generalizations which later became known as *Mendel's Principles of Heredity* or *Mendelian inheritance*

BASIC PRINCIPLES OF HEREDITY

MENDEL PROPOSED THREE LAWS WHICH ARE REFERED TO AS MENDEL'S "PRINCIPLES" OR "LAWS".

LAW OF DOMINANCE AND UNIFORMITY

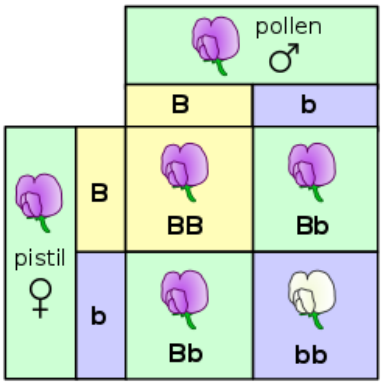


- IF TWO PARENTS ARE MATED WITH EACH OTHER WHO DIFFER IN ONE GENETIC CHARACTERISTIC FOR WHICH THEY ARE BOTH HOMOZYGOUS (EACH PURE-BRED), ALL OFFSPRING IN THE FIRST GENERATION (F_1) ARE EQUAL TO THE EXAMINED CHARACTERISTIC IN GENOTYPE AND PHENOTYPE SHOWING THE DOMINANT TRAIT

- THE PRINCIPLE OF DOMINANT INHERITANCE DISCOVERED BY MENDEL STATES THAT IN A HETEROZYGOTE THE DOMINANT ALLELE WILL CAUSE THE RECESSIVE ALLELE TO BE "MASKED": THAT IS, NOT EXPRESSED IN THE PHENOTYPE.

- ONLY IF AN INDIVIDUAL IS HOMOZYGOUS WITH RESPECT TO THE RECESSIVE ALLELE WILL THE RECESSIVE TRAIT BE EXPRESSED. THEREFORE, A CROSS BETWEEN A HOMOZYGOUS DOMINANT AND A HOMOZYGOUS RECESSIVE ORGANISM YIELDS A HETEROZYGOUS ORGANISM WHOSE PHENOTYPE DISPLAYS ONLY THE DOMINANT TRAIT.

- F_1 GENERATION: ALL INDIVIDUALS HAVE THE SAME GENOTYPE AND SAME PHENOTYPE EXPRESSING THE DOMINANT TRAIT (RED).
  F_2 GENERATION: THE PHENOTYPES IN THE SECOND GENERATION SHOW A 3 : 1 RATIO.



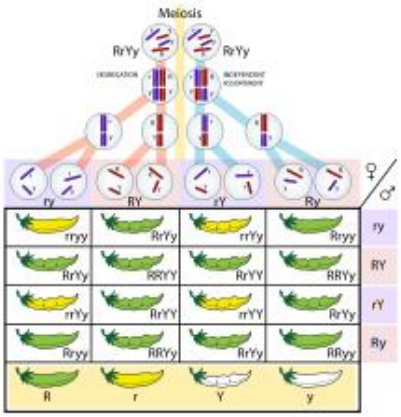
LAW OF SEGREGATION / PURITY OF GAMETES

- THE LAW OF SEGREGATION OF GENES APPLIES WHEN TWO INDIVIDUALS, BOTH HETEROZYGOUS FOR A CERTAIN

TRAIT ARE ***CROSSED***, FOR EXAMPLE HYBRIDS OF THE F_1-GENERATION.

- THE OFFSPRING IN THE F_2-GENERATION DIFFER IN GENOTYPE AND PHENOTYPE, SO THAT THE CHARACTERISTICS OF THE GRANDPARENTS (P-GENERATION) REGULARLY OCCUR AGAIN.
- IN THE PEA PLANT EXAMPLE, THE CAPITAL "B" REPRESENTS THE DOMINANT ALLELE FOR PURPLE BLOSSOM AND LOWERCASE "B" REPRESENTS THE RECESSIVE ALLELE FOR WHITE BLOSSOM. THE PISTIL PLANT AND THE POLLEN PLANT ARE BOTH F_1-HYBRIDS WITH GENOTYPE "B B". EACH HAS ONE ALLELE FOR PURPLE AND ONE ALLELE FOR WHITE. IN THE OFFSPRING, IN THE F_2-PLANTS IN THE PUNNETT-SQUARE, THREE COMBINATIONS ARE POSSIBLE. THE GENOTYPIC RATIO IS 1 *BB* : 2 *BB* : 1 *BB*. BUT THE PHENOTYPIC RATIO OF PLANTS WITH PURPLE BLOSSOMS TO THOSE WITH WHITE BLOSSOMS IS 3 : 1 DUE TO THE DOMINANCE OF THE ALLELE FOR PURPLE. PLANTS WITH HOMOZYGOUS "B B" ARE WHITE FLOWERED LIKE ONE OF THE GRANDPARENTS IN THE P-GENERATION.
- THE GENOTYPIC RATIO IS 1 : 2 : 1, THE PHENOTYPIC RATIO IS 3 : 1.
- IN SOME LITERATURE SOURCES THE PRINCIPLE OF SEGREGATION IS CITED AS "FIRST LAW".
- MOLECULAR PROOF OF SEGREGATION OF GENES WAS SUBSEQUENTLY FOUND THROUGH OBSERVATION OF MEIOSIS BY TWO SCIENTISTS INDEPENDENTLY, THE GERMAN BOTANIST OSCAR HERTWIG IN 1876, AND THE BELGIAN ZOOLOGIST EDOUARD VAN BENEDEN IN 1883. MOST ALLELES ARE LOCATED IN CHROMOSOMES IN THE CELL NUCLEUS.

LAW OF INDEPENDENT ASSORTMENT



- THE LAW OF INDEPENDENT ASSORTMENT STATES THAT ALLELES FOR SEPARATE TRAITS ARE PASSED INDEPENDENTLY OF ONE ANOTHER.
- THAT IS, THE BIOLOGICAL SELECTION OF AN ALLELE FOR ONE TRAIT HAS NOTHING TO DO WITH THE SELECTION OF AN ALLELE FOR ANY OTHER TRAIT. MENDEL FOUND SUPPORT FOR THIS LAW IN HIS DIHYBRID CROSS EXPERIMENTS.
- IN HIS MONOHYBRID CROSSES, AN IDEALIZED 3:1 RATIO BETWEEN DOMINANT AND RECESSIVE PHENOTYPES RESULTED. IN DIHYBRID CROSSES, HOWEVER, HE FOUND A 9:3:3:1 RATIOS.
- THIS SHOWS THAT EACH OF THE TWO ALLELES IS INHERITED INDEPENDENTLY FROM THE OTHER, WITH A 3:1 PHENOTYPIC RATIO FOR EACH.
- INDEPENDENT ASSORTMENT OCCURS IN EUKARYOTIC ORGANISMS DURING MEIOTIC METAPHASE I, AND PRODUCES A GAMETE WITH A MIXTURE OF THE ORGANISM'S CHROMOSOMES

- THERE ARE MANY DEVIATIONS FROM THE PRINCIPLE OF INDEPENDENT ASSORTMENT DUE TO GENETIC LINKAGE.IN INDEPENDENT ASSORTMENT, THE CHROMOSOMES THAT RESULT ARE RANDOMLY SORTED FROM ALL POSSIBLE MATERNAL AND PATERNAL CHROMOSOMES.

Modified Mendelian Inheritance

2020-V-66

1.Complete Dominance

It is a type of gene action in which one allele at locus completely masks the effect of another allele at the same locus.

All the allelic pairs that Mendel studied showed complete dominance/complete recessiveness relationships.

Eg. Inheritance of black and red colour in cattle

Female parent x Male parent

(Black) BB (Red)bb

Bb F1 generation (all black)

Interbreeding of F1

Bb x Bb

F2 Genotypes: ¼ BB, ½ Bb, ¼ bb

F2 Phenotype: ¾ black, ¼ red
Phenotypic ratio: 3:1 (black: red)

2. Incomplete Dominance

Incomplete or partial dominance is shown when the dominant allele is not completely dominant to the recessive allele and the phenotype of heterozygote is intermediate to the phenotype of the two types of homozygotes.
The genotypic and phenotypic ratios for monohybrid are 1:2:1 and 1:2:1.

4'o clock plant (Mirabilis jalapa)

Red flower x White flower

RR rr

↓

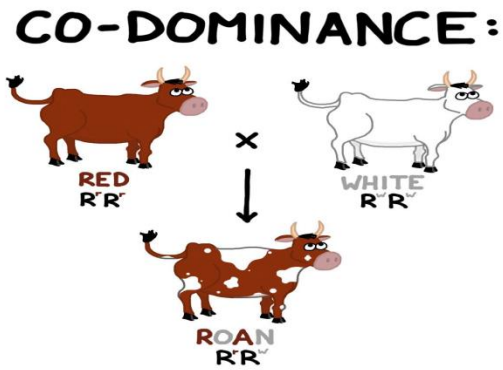
Rr(pink flower) F1 gen

Rrx Rr

In F2 – 1 red: 2 Pink: 1 white flower

3. Co-Dominance

In codominance both alleles of a pair are fully expressed in heterozygote individual, thus the F1 heterozygote exhibits the phenotypes of both homozygote parents.
There is no dominant or recessive allele. Both alleles contribute equally to the production of the phenotype.
Eg: The inheritance of red, white and roan coat colour in cattle and the ABO blood system.



4. Overdominance

It is the type of allelic interaction in which the phenotypic expression of the heterozygote exceeds the phenotypic expression of either of the two homozygotes.
Eg.Survival rate against malarial parasites in sickle cell anaemia.

Fruit fly (Drosophila melanogaster)

Red Eye x White Eye

W+W+ WW

↓

W+W(Bright red eye) F1 gen

PLEIOTROPHY

2020-V-67

- **WHAT IS PLEIOTROPHY?**

- When a single pair of gene exhibits more than one character, then it is called pleiotropy. The gene responsible for such phenomenon are known as pleiotropic gene.
- The term pleiotropic is derived from the Greek word pleio, which means many, and tropic , which means affecting.
- Mechanism of pleiotropy in most cases is the effect of a gene on metabolic pathways that contribute to different phenotype.

- **EXAMPLES OF PLEIOTROPHY IN ANIMALS**: -

A. Vestigial gene of Drosophila.

B. Frizzle Gene in Chicken.

- **EXAMPLES OF PLEIOTROPHY IN HUMANS:**

A. Phenylketonuria (PKU): - Genetic disorder that is characterized by an inability of the body to utilize the essential amino acid, phenylalanine.

~ This mutation also results in multiple other phenotypes associated with PKU, including mental retardation, eczema, reduced hair, lighter skin pigmentation.

B. Sickle cell anaemia: -

Penetrance & Expressivity

2020-V-68

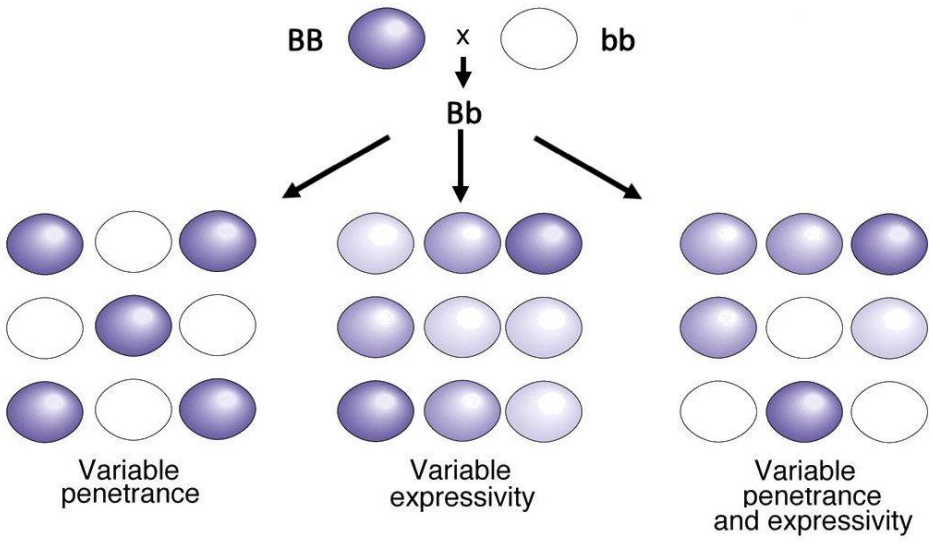
Penetrance *versus* Expressivity

Egg colour of the endangered Hawai'ian ***Oo'Aa* bird** is controlled by a single locus, ***BLU***, where the **B** allele is dominant to the **b** allele. As part of the recovery strategy, a pure-breeding **blue-egg bird** (**BB**) from one island is crossed with a pure-breeding **white-egg bird** (**bb**) from another island. Because all the offspring are **Bb** heterozygotes, they are all expected to show a uniform, blue phenotype like that of the **BB** parent. However, if **penetrance** and / or **expressivity** vary, three patterns of variation that differ from expectation are possible.

If **penetrance** varies [left], the **Bb** genotype sometimes does not *penetrate through to the phenotype*: some **Bb** eggs are blue just like those of their **BB** parents, others are white like those of their **bb** parents, despite presence of the **B** allele. "*Lack of penetrance*" is sometimes used to explain individuals whose phenotypes do not reflect their inferred genotypes

If **expressivity** varies [middle], the **Bb** genotype will not be *expressed uniformly in the phenotype*: all eggs are blue, but the exact shade of blue *varies among individuals with the same genotype*. Variable expressivity is frequently attributable to environmental factors or variation at gene loci elsewhere in the genome.

If **expressivity *and* penetrance** both vary [right], there may be a continuous gradient of phenotypes between white and blue eggs. Note that *lack of penetrance can be considered as an extreme from of expressivity*, in which the range of expression includes non-expression.



LETHAL, SEX-LINKED, SEX-LIMITED & SEX-INFLUENCED INHERITANCE

2020-V-70

LETHAL GENE(ALLELE)

An allele that has the potential to cause the death of an organism is called a lethal gene.Lethal alleles were first discovered by Lucien Cuenot while studying the inheritance of coat color of mice.

TYPES OF LETHAL ALLELE

Dominant lethal gene (Example)-Lethal gene in a mouse coat color.

Recessive lethal gene (Example)-Sickle cell anemia in African People.

Conditional lethal gene (Example)-Temperature sensitive allele in drosophila.

DOMINANT LETHAL GENE – They are lethal in homozygous condition.

Example-lethal gene in mouse cot color.

SEX INHERITANCE

Sex linked:-Sex linked gene are the genes which are located on the sex chromosome. It may be X-linked or Y-linked. It was discovered by T. H. Morgan 1910.The inheritance of a trade(phenotype) that is determine by a gene located on one of the sex chromosome is called sex-linked inheritance. Gene carried by the X-chromosome are said to be sex-linked. In mammal and drosophila male heterogametic(XY) and female is homogametic(XX).A sex-linked gene passes from male to female then back to male. Such as inheritance pattern is known as criss-cross inheritance. Example- Hemophilia , Hypertrichosis , in drosophila the red eye (W) is dominant over white eye(w) and it is sex linked.

Sex influenced -The trade which are influenced by sex of an organism is called sex influenced trait.The genes for sex influenced trade are carried on the autosome and their expression is influenced by the sex of the individuals. In the heterozygous the genes usually are expressed as dominant in the male and recessive in the female. The inheritance of coat color in Ayrshire cattle and the horns in sheep and baldness in human being are good example of sex influenced trait.

Sex limited Inheritance-Some hereditary traits in farm animal are limited to only one sex and therefore they are called as sex limited traits for example- bulls do not produce milk and cocks do not lay eggs but the males do possesses and transmit the gene for these traits to their offsprings. Practically when a polygenic trait is limited to only one sex it become difficult to locate the males carrying superior gene for such trait. The record close relative of the male help to determine his genetic potential for a trait. Such female include his mother ,sister and daughter.

PREFERANCE

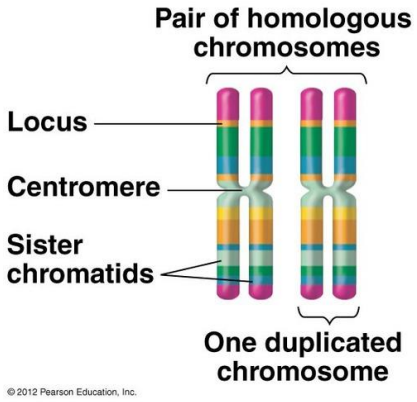
A textbook of Animal Genetics by Dr. P. Kanakraj.

Introduction to Veterinary Genetics by F. W. NICHOLAS Third edition.

MULTIPLE ALLELE

2020-V-73

More than two alternative forms of same gene are called as multiple allele.
Multiple allele is formed due to mutation.
Multiple allele are located on the same locus of homologous chromosome.



Multiple allele is a type of non- Mendelian inheritance pattern that involves more than just the typical two alleles that usually code for a certain characteristic in a species.

Example of multiple allele

1. **ABO** Blood group:- ABO blood group are determined by three alleles. IA,IB and i.
   IA= dominant
   IB= dominant
   i= reccesive

Blood group	Genotype	Antigen	Antibody
A	**IAIA , IAi**	**A**	**b**
B	**IBIB , IBi**	**B**	**a**
AB	**IAIB**	**A & B**	**none**
O	**ii**	**none**	**a & b**

We can caluculate genotype in multiple allele by using formula= n(n+1)/2.
Where n is number of allele.

2. **Colour coat in rabbits:- determined by 4 alleles.**
   C =wild type (brown colour)
   Cch = chinchilla (Blacked – tipped white fur.
   Ch = Himalayan (white fur with black paws , nose , ears , tail.
   cc = Albino (White fur)

Allele			
C	c^{ch}	c^{h}	c

Genotype			
CC	$c^{ch}c^{ch}$	$c^{h}c^{h}$	cc

Phenotype			
WILD TYPE: Brown fur	CHINCHILLA: Black-tipped white fur	HIMALAYAN: White fur with black paws, nose, ears, tail	ALBINO: White fur
			

SEX DETERMINATION

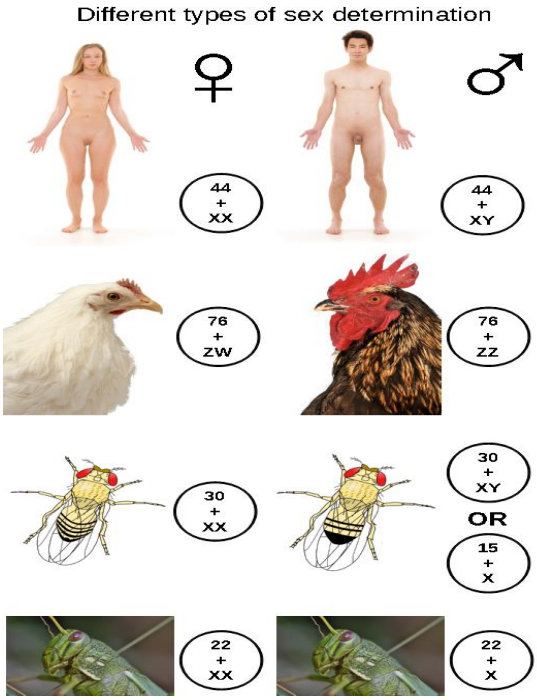
2020-V-75

Mammalian sex is determined genetically by the presence of X and Y chromosomes. Individuals homozygous for X (XX) are female, while heterozygous individuals (XY) are male. The presence of a Y chromosome causes the development of male characteristics, while its absence results in female characteristics. The XY system is also found in some insects and plants.

Avian sex determination is dependent on the presence of Z and W chromosomes. Homozygous for Z (ZZ) results in a male, while heterozygous (ZW) results in a female. The W appears to be essential in determining the sex of the individual, similar to the Y chromosome in mammals. Some fish, crustaceans, insects (such as butterflies and moths), and reptiles use this system.

The sex of some species is not determined by genetics, but by some aspect of the environment. Sex determination in some crocodiles and turtles, for example, is often dependent on the temperature during critical periods of egg development. This is referred to as environmental sex determination or, more specifically, as temperature-dependent sex determination. In many turtles, cooler temperatures during egg incubation produce males, while warm temperatures produce females. In some crocodiles, moderate temperatures produce males, while both warm and cool temperatures produce females. In some species, sex is both genetic- and temperature-dependent.

Individuals of some species change their sex during their lives, alternating between male and female. If the individual is female first, it is termed protogyny or "first female;" if it is male first, it is termed protandry or "first male." Oysters, for example, are born male, grow, become female, and lay eggs; some oyster species change sex multiple times.



LINKAGE AND CROSSING OVER

2020-V-76)

Introduction:-

Linkage and Crossing Over are two related, yet different phenomena occurring in Eukaryotic Organisms. Genetic Linkage or, simply, Linkage is the tendency of genes to stay together in a Chromosome while Crossing Over is a phenomenon through which genetic information is exchanged in the germline. Both of these play an important role in heredity. Both the events are somewhat related to each other. However, Linkage is more about the tendency of genes in a Chromosome to inherit together. Through Crossing Over, the Genes separate and segregate into different gametes.

Genetic Linkage:-

Genetic Linkage means the tendency of the genes or DNA sequences on a chromosome to be inherited together during meiosis of sexual reproduction. Linked genes are the ones located on the same chromosome. For Example, genes on hair colour and eye colour. That is why some individuals inherit hair and eye colours together. Such as black hair with brown eyes or individuals with brown hair and blue eyes inherited from parents.

Crossing Over:-

The exchange of chromosomes between non-sister chromatids to form gametes is Crossing Over. Crossing Over shuffles the alleles on parental chromosomes, so that the gametes carry the combination of genes from mother and father. In simple language, it is the swapping of genetic material in the germline. During meiosis, or the formation of an egg cell and sperm cells, paired chromosomes get aligned so that similar DNA sequences from the paired chromosomes come against one another. This phenomenon accounts for genetic variation in sexually reproducing organisms and it is also essential for the normal segregation of chromosomes.

Difference Between Crossing Over and Linkage

Linkage	Crossing Over
Ensures that the genes stay in a chromosome to inherit together	Crossing over enables the separation of genes in a chromosome and separates it into various gametes
The strength of the genetic linkage between 2 genes is thought to be inversely proportional to the distance between them in the chromosome	The probability of two genes crossing over is directly proportional to the distance between them in the chromosome
The strength of the linkage between 2 genes can increase if the distance between them decreases	The probability of two genes crossing over decreases if the distance between them decreases
Ensures the continuity of the parental trait in the offspring	Causes alternations in the parental traits in the offspring

Reduces the probability of variation through sexual reproduction	Increases the probability of introducing variability in sexual reproduction

Kinds of linkage:

The phenomenon of linkage is of following two kinds:

1. **Complete linkage**: When the linked genes are so closely located in chromosomes that they inherit in same linkage groups for two or more generations in a continuous and regular fashion, then, they are called completely linked genes and the phenomenon of inheritance of completely linked genes is called complete linkage

2**. Incomplete linkage**: The linked genes do not always stay together because homologous non-sister chromatids may exchange segments of varying length with one another during crossing over. The linked genes which are widely located in chromosomes and have chances of separation by crossing over are called incompletely linked genes and the phenomenon of their inheritance is called incomplete linkage.

Significance of linkage: The phenomenon of linkage has one of the great significance for the living organisms that it reduces the possibility of variability in gametes unless crossing over occurs.

Kinds of crossing over:

According to its occurrence in the germinal or somatic cells following two types of crossing over have been recognized:

Germinal or meiotic crossing over: Commonly crossing over occurs in the germinal cells of reproductive organs during the process of gametogenesis which includes meiosis. This type of crossing over is called germinal or meiotic crossing over. It is universal in its occurrence and has great genetic significance.

Somatic or mitotic crossing over: Sometimes crossing over may occur during mitosis or somatic cells. this type of crossing over in rare cases, has no genetic significance and is called somatic or mitotic crossing over. It has been observed in body cells of Drosophila.

Significance of crossing over:

- The crossing over provides origin of new characters due to the exchange of a segment from one chromosome to another and thus it is a source of genetic variation
- The crossing over provide the direct evidence that the genes are linearly arranged on the chromosome
- The frequency of crossing over is helpful in chromosomes mapping
- Crossing over gives an operational definition of a gene
- Crossing over has a great importance in the field of breeding to improve the varieties of plants and animals.

MUTATIONS

2020-V-77

Review

1) A huge molecule made up of amino acids (adenine, cytosine, guanine, thymine) DNA

2) A process that produces the sex cells with half the chromosomes of a body cell Meiosis

3) Strands of genetic material Chromosome

4) Factors that control traits Gene

Mutations

- a **CHANGE** in a gene or chromosome
- Mutations result in a ***different phenotype*** than normal à lead to genetic variation
- Mutations may lead to **genetic disorders**

Types of Mutations

Point Mutations

Transfer Mutations
In these mutations, extra chromosomes (or parts of chromosomes) transfer into the sperm or egg. Some of these do not survive far beyond fertilization while others may survive and live after birth.

There are two ways in which mutations occur:

- Mutations can be **inherited**.

This means that if a parent has a mutation in his or her DNA, then the mutation is passed on to his or her children.

- Mutations can be **acquired**.

This happens when environmental agents damage DNA, or when mistakes occur when a cell copies its DNA prior to cell division.

Mutations can be…

1) helpful
2) harmful
3) neutral (no effect)

Harmful Mutations

- They reduce the organism's chance for survival and reproduction
    - Any mutation leading to a disease
        - Cancer- overexposure to UV light
        - Cystic fibrosis
        - Sickle-Cell Disease
        - Hemophilia
        - Down Syndrome

Examples of Harmful Mutations

This is an albino tree frog. It has a harmful mutation because it can be easily seen among the green trees. Therefore, it has a decreased chance of surviving because predators can see it easily.

Helpful Mutations

- Improve the organisms chance for survival and reproduction

Scorpion with an extra stinger

This extra stinger gives the scorpion an advantage over its prey (and predators. It has an increased chance of survival.

Neutral Mutations

- These mutations do not show any advantages or disadvantages to an organism.
    - In fact, many organisms may have mutated genes and not know it because it does not show through on its phenotype and does not affect the structure or function of the gene in the cell at all

HARDY WEINBERG LAW AND ITS APPLICATION

2020-V-79

HARDY WEINBERG PRINCIPLE

In population genetics, the Hardy–Weinberg principle, also known as the **Hardy–Weinberg equilibrium, model, theorem**, or **law**, states that allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences. These influences include *genetic drift*, *mate choice*, *assortative mating*, *natural selection*, *sexual selection*, *mutation*, *gene flow*, *meiotic drive*, *genetic hitchhiking*, *population bottleneck*, *founder effect* and *inbreeding*.

In the simplest case of a single locus with two alleles denoted *A* and *a* with frequencies $f(\mathrm{A}) = p$ and $f(\mathrm{a}) = q$, respectively, the expected genotype frequencies under random mating are $f(\mathrm{AA}) = p^2$ for the AA homozygotes, $f(\mathrm{aa}) = q^2$ for the aa homozygotes, and $f(\mathrm{Aa}) = 2pq$ for the heterozygotes. In the absence of selection, mutation, genetic drift, or other forces, allele frequencies p and q are constant between generations, so equilibrium is reached.

The Hardy Weinberg equation is represented by the following equation: p2 + q2 + 2pq = 1

Applications of Hardy Weinberg Law

Below mentioned are the applications of Hardy Weinberg law:-

The confusion over selection and dominance just isn't very exceptional in today's times. The Hardy-Weinberg genotype frequency tests are currently used to determine population stratification and other forms of non-random mating.

- Genetic variations that change from mutation, genetic drift, migration, sexual selection and natural selection are persistently reflected by natural populations. A statistical criterion for a non-evolving population that can be contrasted with evolving populations is given by the Hardy-Weinberg rule.
- Through this period, if the allele frequencies are recorded and calculated on the basis of the Hardy-Weinberg law values for the predicted frequencies, then it is possible to hypothesize operations that drive population evolution.
- The law provides a template that is usually used to research the population genetics of diploid organisms as a point of origin that fulfills the common argument of a large population, random mating, no mutation, selection or migration.
- However, for haploid pathogens, the Hardy-Weinberg model is not valid. Each of the principles in this law is thus broken in the case that a population is not discovered in the Hardy Weinberg equilibrium equation.
- This suggests that the population has been affected by selection, migration or non-random mating, where studies are taken out and theories are pursued in order to understand the mechanism behind its population's non-equilibrium.