Lecture 9

CHROMOSOMES AND GENES

Dominance and Recessivity

Pedigree Chart and DNA Screening
Typical Mating system

In mating: P=G+E (Phenotype = Genotype + Environment)

Standard = Single Cross Breeding Program

Parentals (P) AA X SS (Homozygotes)

↓

F1 Progeny (Dihybrid) AS: AS: SA: SA (All AS Heterozygotes)

F1----- Dihybrid Mating AS X AS

↓

F2 Progenies----------AA: AS: SA: SS
1 Homozygous AA Dominant: 2 Heterozygus AS: 1 Homozygous SS Recessive

Mendel's law of segregation
(1) Parental generation. (2) F_1 generation. (3) F_2 generation. The "red" and "white" allele together make a "pink" phenotype, resulting in a 1:2:1 ratio of red:pink:white in the F_2 generation.

Dominant and recessive phenotypes

(1) Parental generation. (2) F_1 generation. (3) F_2 generation. Dominant (red) and recessive (white) phenotype look alike in the F_1 (first) generation and show a 3:1 ratio in the F_2 (second) generation
F2 could be Upgrades; Backcrosses or Crisscrosses

Two trait Cross

Parental: SSbb X ssBB
Short/White hair X long/Black hair
Genes: Sb : Sb X sB : sB

↓

F1 Progenies: SsbB: SsbB: SsbB: SsbB
All Black/ short hair

F1Interse Mating: SsbB X SsbB
Genes: Sb: SB: sb: sB X Sb: SB: sb: sB (different from the Parentals)

F2 Progenies: SbSb:SbSB:Sbsb:SbsB
SBSb:SBSB:SBsb:SBsB
sbSb:sbSB:sbsb:sbsB
sBSb:sBSB:sBsb:sBsB
SbSB:SbsB:SBSb:SBSB:SBsb:SBsB:sbSB:sBSb:sBSB = 9 Short Black
SbSb: Sbsb:sbSb = 3 Short and white hair
sbsB:sBsb: sBsB = 3 Long and Black hair
sbsb = 1 Long and white hair

Results : 9x short black hair, 3x long black hair, 3x short white hair,
1x long white hair.

Two traits (black/white and short/long hair, with black and short dominant) show a 9:3:3:1 ratio in the F_2 generation. (S=short, s=long, B=black, b=white hair)
(1) Parental generation. (2) F_1 generation. (3) F_2 generation.
Results : 9x short black hair, 3x long black hair, 3x short white hair, 1x long white hair.

SPECIFIC SELECTION REQUIREMENTS
There are Specific Selection requirements on:

- Male lines--------Growth and Feed efficiency, semen quality
- Female lines-----reproductive abilities; mothering ability except in poultry, milk production, ease of calving, kidding, lambing, farrowing, high fertility and hatchability

TYPICAL TRAIT VALUES OF ANIMAL BREEDS

TARGETTED TRAITS FOR ECONOMIC IMPROVEMENT

Major traits of economic importance radiate around:

- Growth
- Reproduction
- Feed efficiency and
- Colour identification for specifically selected breeds by breeders

COMMON TERMINOLOGIES IN ANIMAL BREEDING

- BREED
- STRAIN
- LINE
- SPECIE
- PUREBREEDING
- PUREBRED
- CROSSBREEDING
- CROSSBRED
- INBREEDING
- INBRED
- RANDOM MATING
- OUT CROSING
- TOP CROSSING
- TOP-IN-CROSS
- INCROSSBRED
- TOP-IN-CROSSBRED
- OUTCROSSBRED
- HETEROSIS/ Hybrid vigour
- HYBRID
- DI HYBRID
- TEST CROSS
- DOMINANT
- RECESSIVE
- HAPLOID (n)
- DIPLOID (2n)
- GAMETE
- ZYGOTE
- HOMOZYGOTE
- HETEROZYGOTE
- GENE POOL
- SEX CELL
- SOMATIC CELL
- SEX CHROMOSOME

- SEX-LINKED GENE
- AUTOSOMELOCUS
- PHENOTYPE
- EPISTASIS
- TELOMERE
- CENTROMERE

MAJOR CLIMATIC ZONES

Equatorial

- constant heat, rainfall and relative humidity (RH)
- mean annual temp. = $27^{o}C$
- total annual rainfall. =2000 to 3000mm
- bimodal rainfall , 2 peaks
- lies between 5 and 7^{o} latitudes north and south
- vegetation=tropical rain forest
- climatic stress, considerable

Humid

- high temp, relative humidity and rainfall
- temp between 15 and 30^{o} C
- 3 seasons-cool/dry,hot/dry,hot/wet
- rain forest, plants less vigorous
- radiation less 120kcal/cm^{2}/yr
- adjacent to equatorial zone

Sub humid

- rainy season is short , dry season longer
- wider temp range;10 to $32^{0}C$
- savanna/ open grassland
- nomadic livestock husbandry, common
- less climatic stress
- f0rage prod seasonal, nutritional ,yes
- epizootic diseases, common
- parasites, easier to control

Semi arid

- low rain, very long dry season
- daily and seasonal temp ,varied widely
- high solar radiation, dry atmosphere, clear sky
- 250 to 500mm/yr. livestock production only
- lack of feed, water, nutritional and climatic stress affect productivity
- parasites easy to control
- not suitable for cattle

Arid

- desert common in sub tropics
- temp. 0 to 52^{o}C
- rainfall insignificant
- support limited no of livestock
- total radiation,= 140kcal/cm^{2}/yr

Montane

- altitudes 300 to 1500m above sea level
- mean annual temp decreases by 5.6^{0}C for every 1000m ascent
- the higher the altitude, lower ambient temp
- the higher the altitude, lower atmospheric pressure
- pressure decreases by half at 5,500m above sea level
- potential for dairy not exploited

DIRECT AND INDIRECT EFFECTS OF CLIMATE ON LIVESTOCK

Direct Effect

1. heat balance: homeotherms?
   mammals, 37 -39 ^{o}c. birds, 40 – 44^{o}c

- a thermal balance must be preserved by livestock in order to maintain temp.
- balance between heat production and / or gain from the environment and heat lost to the environment.
- m= e ± f ±cd ± cv ± r or
- m – e ± f ± cd ± cv ± r = 0

m =metabolic heat production
e = heat lost from skin and respiratory passage by evaporation,
f = heat lost or gain in bringing food and water to body temperature,
cd = heat ± by direct contact between body and surrounding surfaces
cv = heat ± by convection
r = heat ± by radiation

- m is affected by basal, digestive and muscular heat production and increased metabolism due to growth, milk production & reproduction.
- out of these avenues only basal hp cannot be reduced else no maintenance of body temperature.

Heat lost in domestic animals

- e, most important & includes losses from skin thro sweating and respiration (panting).
- non evaporative heat losses : r, cd and cv.
- heat lost thro respiration depends on ambient air temp, difference in water vapour pressure between inhaled air and area of soft mucosa.
- cv and e heat losses are increased when cool breeze blows on the animals.
- maximum air movement to be consider in housing of animals.
- at high temp wind & water sprays prevented significant reduction in milk yield.

- solar radiation increases the heat load on the animal.
- pigmented skin of tropical breeds helps them to adapt better than temperate ones in the tropics.
- white surface may absorb 20 % while black surface may absorb 100 % of the visible radiation.
- the length, density & condition of hair affect the influence of solar radiation on the heat load of the animal.
- standing animals receives less solar radiation /unit body area than lying down,
- daylight length affects metabolic rhythms reproduction & hair growth.

Grazing behaviour

- Grazing time of cattle during the day is affected by; degree of climatic stress, breed & type of cattle and quantity & quality of pasture available.
- *bos taurus* (exotic type of cattle) and their crossbreeds seek shade in the hot afternoon thus confining their grazing to early morning and late afternoon.
- *bos indicus* (indigenous cattle)only con- fined at night ; protect from predators during the dry season in semi arid tropics cattle under nomadic and semi nomadic systems experience inadequate feed and water. Distance covered in search of water and feed + stress of ambient temp have significantly reduced livestock productivity in the semi arid tropics.

Intake and utilization of feed and water

- feed intake: depressed by high ambient temp
- feed intake in *B*. taurus is depressed at lower temp than of *B. indicus*
- at temp above 40^{o}C, feed intake and rumination ceases in *B. taurus*
- feed intake is depressed with increase relative humidity at temp >23.9^{o}C
- increased radiation depress feed intake in *B.taurus*
- water is a nutrient, assist in heat loss – cd
- in *B taurus* milking cows, water intake increased with temp up to 29.4^{o}C, before declining
- increasing radiation intensity leads to increased water intake in cattle

Growth

- birth weight are low, growth rate, slow in *B indicus*
- piglets require temp >32^{o}C in first two days so they do not get chilled
- chick s more tolerant of high temp than adult birds
- above 35^{o}C, chicks may die in boxes on transit from hatcheries

Milk production

- milk, butter fat and solid non fat (SNF) are depressed by high ambient temp
- milk production in *B.taurus* is optimal at 10^{o}C
- production declines at 21 to 27^{0}C in jersey *B. taurus* but > than 32^{o}C in *B. indicus* (critical temp)

Reproduction

- temp, RH and length of daylight affect reproduction in domestic livestock

- female cattle: climate affect age at puberty, oestrus duration, incidence of ova abnormality and embryonic death, foetal death, gestation length and foetal size
- bulls: age at puberty, sexual libido & spermatogenesis/semen characteristics

Indirect effects:

1. **feed and water supply:**
   Temp, effective rainfall photoperiod and intensity of radiation limits plant growth and quantity available. Feed quality depends more on effective rainfall & intensity of solar radiation

a. <u>equatorial/ humid tropics</u>
   -forage has low DM (%), graze from mid morning. more nutritious in wet than in dry season
- positive correlation between rainfall and crude protein, nitrogen free extract, silica free ash
- inverse relationship between rainfall and crude fibre

b. <u>semi arid/ arid tropics</u>
   DM contents are high most part of year. Cattle require regular and frequent access to water. *B. taurus* require more water than *B. indicus*
- water demand of small ruminants and camel not as high as for cattle
- restrict feed intake when water is deprived,
- cattle exist on low quality feed
- crude fibre of standing hay is high & onset of lignification is earlier than in the humid zones

2. parasites and diseases
3. storage of products

FORAGES

Panicum maximum (Guinea grass)

- A perennial, bunch tall grass, spreading by short rhizomes or rootstocks from which tillers emerge freely. The grass is suitable for silage, green silage, hay and pasture.
- Guinea grass is one of the most productive forage grasses in tropical countries. It grows up to 3.5m tall. The plants seed readily but the heads ripen very unevenly and shatter readily.

Pennisetum pupurpureum (Elephant grass)

- A robust stoloniferous grass with a vigorous root system. Though native to subtropical Africa (Zimbabwe), it is common in most tropical and subtropical countries. It occurs either as green or purple variety but the green predominates.
- Elephant grass spreads slowly but the growth is very rigorous. The forage is grazed or made into silage or used in a cut and carry system. Elephant grass could be grazed and cut at heights of 90 and 50cm, respectively.

***Stylosanthes guianensis* cv. Verano**

- An annual/short term perennial legume suitable for the Guinea and Sudan Savanna zones of Nigeria. *Verano stylo* is adapted to various soil types and areas with annual rainfall from 700-1700mm. It is the most common stylo species found all over the country. *It* is preferred by

ruminant from the late growing season into the dry season. Suppression of *stylo* by the associated grass species can be prevented through early grazing of the pasture.