Department of APEx

Camel Production Lecture note

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2020

Objectives

- To highlight where they are originated & domesticated and Environmental adaptation mechanisms. Breed,Physiology, anatomy behavioral
- To describe types of camels and distribution
- To identify Ethiopian camels & their purposes
- To high light production advantages of camel.
- To acquaint students with importance of camel raising, feeding, reproduction behavior, house and utilization of camel
- Marketing of camel as well.

Camel-like mammal	Image	Class	Weight
Camelus			
Bactrian camel		True camel	300 to 1,000 kg (660 to 2,200 lb)
Dromedary or Arabian camel		True camel	300 to 600 kg (660 to 1,320 lb)
Lama			
Llama		New World camel	130 to 200 kg (290 to 440 lb)
Guanaco		South American camel	c. 90 kg (200 lb)
Vicugna			
Alpaca		New World camel	48 to 84 kg (106 to 185 lb)
Vicuña		South American camel	35 to 65 kg (77 to 143 lb)

THE TAXONOMY OF CAMEL

Kingdom	Animalia
Subkingdom	Metazoa
Phylum	Chordata
Subphylum	Vertebrata
Super class	Tetrapoda
Class	Mammalia
Order	Artidactyla
Suborder	Thylapoda
Family	Camelidae
Genus	→Camelus(Old world/true camels) →Lama(New world camels)

- Camelidae are classed in two genera. The old world genus of Camelus is generally accepted to comprise two species
- Camelus dromedaries (one-humped camel or Arebian camel)
- Camelus bactrianus, the bacterian ((two-humped camel)
- The habitat of the dromedary is Northern Africa (the Mediterranean littoral, the Sahelian states of west Africa, sudan, Ethiopia, Somalia and northern Kenya).
- The Bacterian camel occupies the colder areas of Southern Russia, Mongolia, east-central Asia & China.

Tylopoda camel like forms with three-chambered stomachs

- **Order-Artiodactyla**
- **Sub-order-Tylopoda**
- **Family-Camelidae**
- **Sub-family- Camelinae**
- **Genus-Camelius**
- **Species- Dromedaries & Bactrianus**

Distribution of world Dromedary camel production

- World total we have 19 million (FAO, 1995) of which
- 73.5 % in Africa, 24.6% in Asia, 1.9% in others.
- From the **Africa part,** Somalia having 43.8%, Sudan 20.5%, Mauritania 7.7% , Kenya 5.7%, Tschad 4.2% & others 18%

Camels in Ethiopia

- In Sudan Bisciari (Bishari) camel provides the greatest number of riding camel, they are very easy to train, females as well as males being used for riding. They are tall and fast and usually white in color.
- The Afar or Danakil of the Danakil low lands and the Afar keep their camel almost entirely for milk production but few females used for the trade in salt from Dalol salt plane.
- The Afar camel is very small and capable of carrying weights up to 120 kg.
- Bisciari camel found in Ethiopia near to Eritrea.
- Anafi, Grain, BeniAmer and Bisciari camel found in between Ethiopia and Eritrea borders.

Some of the camels in Ethiopia

- **1.Bisciari** camel used for riding
- **2. Anaf (Tzedi or white)** camel have been subjected to less intensive selection, as a pure riding breed than in Sudan, and it is bigger, strong, but not so fast as the Basciari.

3. **BeniAmer (Cajah or red)** camel is very strong camel, useful on any kind of terrain with reasonable speed and described as "**true country**" camel little real attention is paid to their breeding.

4. Grain (sandy) camel along the red sea is mainly a pack animal with a few riding types.

5. The Afar or Danakil found North and Somali tribes of the South-East and kept entirely for milk production, but a few males are used for the trade in Salt from the Dalol salt plains some times we call them **Arho.** The Afar camel is very small and capable of carrying weights up to 120 kg.

6. **Ogaden** camels are largest camel almost solely for milk production and occasionally used for transport purposes.

7. Somali camels are not to any extent for pack or riding, a considerable number of males are castrated. These grow very big humps and used to be slaughtered and eaten locally and on ceremonial occasions.

The height of the camel at the shoulder is between 1.75-1.9 m.

8. **Benadir** camel found in middle wabishebelle, pale colored, large head, strong neck, large abdomen & feet.

- **Muduh** found in upper wabishebelle, smaller than Benadir

- **Objective**
- To know differences between ruminants and tylopods in the digestive systems
- **The buccal cavity**
- The upper lip is split, hairy, extensible (covering a large area) and slightly prehensile (be able to hold things). The tongue is small in relation to the overall size of the camel.
- The osophagus is a long tube (1-2m) of large capacity.

Difference between the tylopods and ruminant stomach

1. In tylopods the esophagus discharges directly in to the rumen while in ruminants it joins the stomach between the rumen and the reticulem.
2. A further difference is that the exterior surface of the rumen in tylopods is smooth except for the glandular sac areas, while the rumen of ruminants has strong muscular pillars.

Water cells of the rumen/glandular sac areas/ are not large enough to function as water storage compartment 100 million in No

And also suggested that these glands are for

A. Absorption of the fermentation products of the rumen. Alternatively they may be

B. Areas of secretion to augment the function of the salivary glands and may produce much of the fluid of the rumen

3. The fluid in the stomach of ruminantia consists of salivary secretions but in the camels rumen derives from both the salivary glands and the glandular sacs.

- The rumen contents are equivalent to 11-15% of body weight although levels of up to 20% have been recorded

4. The typical ruminant reticulem has as appearance strongly resembling a honeycomb, covered with horny-papillae.

The tylopod reticulum shows a structure similar to that of the glandular sacs (is further support for the theory of water storage but volumes is only about 2 liters)

5. The omasum of the ruminantia is sharply separated from the abomasums and contains a large number of leaves or blade like or laminae covered with horny papillae. It is a kidney shaped in ruminants.

A. The omasum of tylopods is long and cylindrical and externally can not be distinguished from the abomasums

B. Internally the division is marked by the cessation of the folds of the omasum, which contain the tubular secretion glands.

6. In ruminantia the abomasums is the only secretion of the stomach which contains glands, they are mounted on longitudinal ridges or folds

- A. The abomasums of the tylopods is very small and has no ridges except in the fetus; it contains two different areas of mucosa, the front2/3 having founds glands, the last 1/3 having pyloric glands and gastric pits.

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7. The stomach occupies much of the left side of the abdomen in adult camels, but might be expected, is proportionally smaller in young calves before the ruminating function has developed.
8. Small intestine measures about 40m in length in a fully grown camel
9. Large intestine measures about 20 meters in length. The caecum is blind, and is attached to the mesentery at the blind end.
10. For a length of about 4meter the colon is of large diameter and coiled in to a mass
11. A colon is on the left side of the abdomen in a special mesenteric fold.

- Liver, pancreases & spleen
- The liver is highly lobulated, particularly on the rear lower part

12. As in the horse there is **no gall bladder** (Bill storage organ to be attached to the liver); the bill duct is common with the pancreatic duct before entry to the duodenum. The pancreas has only the single duct. The spleen is attached not to the diaphragm but high on the left side of the rumen by its front lower surface. It is crescent shaped and weight is 1-1.5kg.

Camel Dentition

- **Objectives**
- To differentiate between ruminants and tylopods in dentition

To know the number of teethes present in camels

- Camels have 22 deciduous or temporary or milk teethes, and 34 permanent teethes.
- The camel differs in dentition from the ruminating animals by the possession of incisors in the upper jaw and of canine teeth in both the upper & lower jaws. Tylopoda-camel has 22 = $\frac{1\text{-}1\text{-}3}{3\text{-}1\text{-}2}$ (2)
- TylopodaCamel 34 = $\frac{1\text{-}1\text{-}3\text{-}3}{3\text{-}1\text{-}2\text{-}3}$ (2)

- Camels may live to 40 years or so but their useful working life, at least as transport or pack animals is from 6 to 15 –20 years. Before 6 years of age they are immature and undergo the difficult period of the change from temporal to permanent dentition.
- **The foot and Locomotion**
- The front foot, is about 19cm long by 16 cm broad and covers an average area of about 300 cm^2.
- The bearing surface of the foot is like a large plate. This plate is able to maintain flat contact with the ground.
- The hind foot is smaller and measures about 16 cm long by 14 cm broad, an area of about 220cm^2.

Physiology of camel

- **Objectives**

To To highlight the ways of body heat regulations and water conservation measures.

Adaptations to the desert environment

- The camel losses body heat by sweating more efficiently than smaller mammals. In most mammals fat is spread over the body surface just under the skin. This reduces the rate of evaporation of sweat.
- 1. In camel fat is concentrated in the hump, which enables sweat to be evaporated easily over the rest of the body surface.
- 2. The camels coat is fairly sparse which allows sweat to evaporate at the surface of the skin In mammals with very thick coats evaporation occurs at the ends of the hairs, a less efficient process.

- 3. The camel can lose 25% of its body weight over a period of time, with out losing its appetite for food and can then make up its amount in just 10 mints by drinking. Donkeys are almost as efficient in this respect but the majority of animals die when they lose 12-15% of their bodyweight
- 4. In other animals water loss is drawn from the blood plasma, body tissues &the intestinal tissues. As a result the blood becomes viscous (thick, not flown freely) &the heart can no longer pump it fast enough to transfer the deep body heat to the surface for evaporation. Explosive (easily able to cause) heat death then occurs. In camels very little water is drawn from the blood. Which remains fluid &can thus continue its function of heat transfer.

- Other adaptations to the desert environment in camels are
- 1. The body temperature can vary over a wide range under conditions of dehydration: the large mass of the camel acts as a heat buffer (neutralize)
- 2. The camel is able to concentrate its urine to a considerable extent; urea is reabsorbed from the intestines & transferred back to the stomach for reconvertion to protein

Heat & temperature relations

- In a camel watered daily (hydrated) the diurnal temperature variation is of the order of 2°C,
- In dehydrated camel, however, when energy conservation becomes important, the temperature can fluctuate over a range of more than 6°C.

Under conditions of dehydration the camel adopts behavioral mechanism to conserve energy.

1. Camel sits down in the early morning before the ground has warmed up
2. It tucks its legs underneath its body so that it absorbs little heat from the ground by conduction.
3. The camel orients it self towards the sun presenting the least possible body area for the absorption of radiant heat.
4. Any heat absorbed from the ground or the sun would have to be dissipated later in the day.
5. The camel may gradually change its position during the day to follow the trajectory of the sun.
6. The camel metabolic rate increases in the normal way as the temperature rises.

Hair and skin

- The skin is black and having 30mm thick on the flanks and 15-20mm long coat on the belly and legs. Which helps:-

A. less heat to be dissipated requires to expend less energy

B. Evaporates match less water

C. The coat used as energy conservation mechanism

Evaporative cooling

- Two main sources for evaporative cooling are via the
- Respiratory tract and
- Through the skin by sweating

WATER BALANCE

- The camel does not store water, either in the hump or in the stomach.
- The hump is mainly comprised of fat and thus the metabolic water content is high.
- Complex oxidation of fat in the hump, say about 20kg, would release a total of just over 21 kg of water.
- In a fully hydrated camel in which 70% of the live weight is water,

Water conservation

- Water is lost from the body by evaporative cooling, in the urine and in the faeces.
- Sweating instead of painting is able to achieve considerable savings not only of energy but also of water.
- The structure and function of the kidney are of extreme importance in water conservation.
- The ratio of medulla to cortex thickness is re-absorption ability (4:1)
- **The kidney controls water loss in two ways**

A. By the absolute concentrations achieved and

B. By reduction in flow of urine.

- Camels are not the most efficient animals at concentrating urine. Reduction in urine flow is thus the most important water conservation measure in camel.
- Concentration of urine not only serve to conserve water but allows camels to drink water even more concentrated than sea water and to eat very salty plants that would other wise be poisonous.
- Faecal water loss is also small in camels. Final re-absorption of water occurs in the colon and camels are again more efficient in their conservation mechanisms than other animals. As a result camels have a lower turnover of water than other animals.

- Some comparative total body weight losses per day are 6.15% in cattle,4-5% in sheep, and about 28-32% camel before death supervenes shows), cattle would die in 4 days with out water, sheep in 7 days and camel in 15 or more.
- Camel drinks at dehydration and has records of camels drinking 104 liters at a single session.
- has a record of 186 liters in two bouts of 94 liters & 92 liters, being taken by a camel in one period of 24 hrs after 5 days of thirst.

Reproduction and breeding of camel

- **Objectives**

  To familiar with camels physiology in reproduction

- To discuss duration of pregnancy
- To highlight the effect of coitus on ovulation
- To know symptoms of rut
- **Female reproduction**
- **Mammary glands**
- The udder has four quarters. The udder is covered by a thin black skin. The teats are small and have three small openings.
- **The follicular wave**

Follecular wave

- In a few mammals including cats, the rabbit and the camel, rupture of the follicle does not occur spontaneously. Coitus being required to induce release of ova.
- In these animals the neuroendocrine reflex involving the initiation of luteinising (used for the initiation of ovulation) hormone release is delayed until coitus occurs. This type of cycle, involving reflex or induced ovulation is more properly known as a follicular wave.
- **The four phases of the follicular wave in camels are**

1. Mature follicular stage, equivalent to estrus or heat. The camel should not be considered to be in continues estrus in spite of fact that ovarian maturity is follicular. female camel will accept the male only during the mature follicular stage. There is no normal luteal phase

- 2. The atritic (withdrawal) follicular stage commences (begin, to start) after a varying period of time if mating does not occur.
- Atresia (withdrawal) is probably due to degeneration and phagocytosis of the granulose of the follicules or to the extravagation of blood and the formation of blood follicules.
- 3. The non-follicular stage
- 4. The growing follicular stage.
- The mean duration of the follicular wave was 24.2 days with estrus lasting 4-6 days

External signs of estrus or heat

- Camels in heat becomes restless, bleat continuously and associate with the males; the tail is lifted and flapped and they urinate little and often.
- The lips of vulva swell and open and close irregularly there is a copious emission of mucus, foul (bad) smelling to humans but presumably (come by car or suppose)
- a powerful and attractive olfactory stimulus for the male camel.
- Pregnancy and parturition
- Ovulation is induced by copulation, the ova being shed about 32-40 hrs afterwards, under the influence of LH hormone. The LH induces corpus luteum formation.
- Left ovary is more active than the right: a very high 99.24% percentage of pregnancy occurs in the left horn of the uterus.

Duration of pregnancy

- The duration of pregnancy simply states 12-13 months or 385 days.
- A pregnant camel will always lift her tail, and perhaps curl it over to the right, when handled by about the neck by a man or when approached by a male camel.
- Parturition
- There is faint uedema of the udder and vulva from between 5 & 10 days before parturition.
- The first post-parturition estrus may occur with in 14-30days of parturition.

The male reproductive organs

- The penis is covered by triangular shaped sheath, which opens to the rear. To the rear of the sheath are four vestigial teats.
- Camel urinates towards the rear,
- The penis has a characteristic S- shaped flexure in front of the scrotum, not behind it as the bull. The approximate length is 600mm.

The rut & the sexual cycle in males

- The period of heightened sexual activity that occurs in the male is known as the rut.
- **Physical signs of rut**
- Males in full rut grind their teeth, suck air, belch (send out gas from the stomach), draw the head back, lash the tail, crouch with (close to) jerky movements of the pelvis & generally make them selves look ridiculous (deserving to be laughed).

- The camel tends to urinate more than normal and will even pass semen. Tying the tail to one side by means of a cord to the hair of the hump, otherwise every thing in the vicinity, including the load and the attendants, is liable to be covered with the urine, dung and semen
- a male camel in full rut drawing his head back & raising his upper lip.
- **Copulation**
- The sexual act in the camel is unusual to the extent that it is affected with the females in the couched position but both male and female face in the same direction.
- The female in heat presents a series of stimuli to the male based on sight, sound and small.
- The male in a highly exited state, courts the already receptive female in various ways-kicking, smelling & biting the vulva, rubbing her along the back with the underside of the his neck & finally forcing her to the couched position.

- The duration of copulation varies from about 7 to 35 mints but averages (11-15mints).
- The ejaculate varies in volume from 5 to 22 ml. The semen is with a PH in the Alkaline renege from 7.2 to 8.8, average 7.8.
- If the male is not allowed to tire himself, he can be expected to serve up to 70 females in rutting season
- **Sexual maturity**
- Males rut first appears in males as early as 3 years. Puberty in females can occurs as early as 8-12 months (Abdonazarov, 1970) & first calving takes place at 3 to 4 years of age. Cow camels will breed without problem up to at least 20 years old & even up to 30 years.

Reproduction, success & fertility rates in camels

The conception rate varies with the time of service, the optimum time being the first or second days, which require an average of 1.87 & 1.75 services respectively per conception.

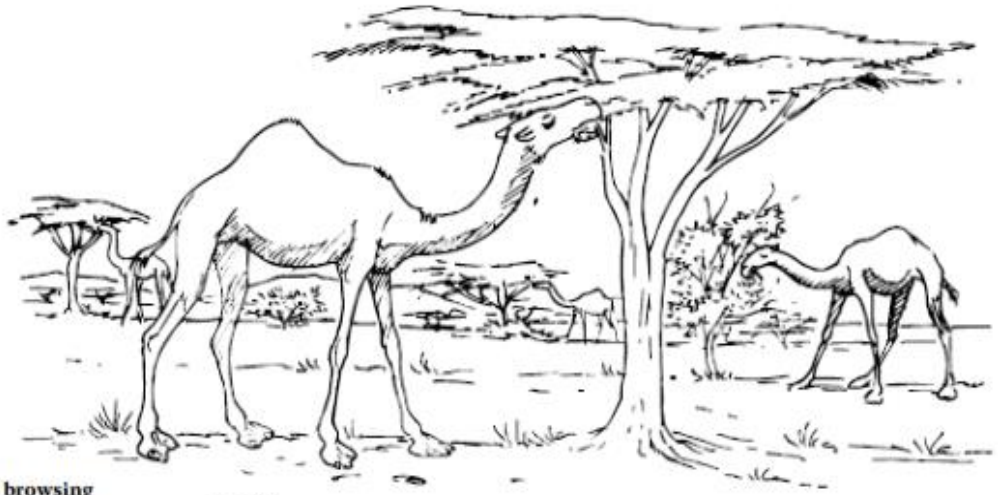
The third to fifth days require 2.75.2.12, &2.71 services respectively for successful conception.

- A female camel may have 20 years productive life. The calving rate could be 66% for the single season area & 75% in two- season area (breeding seasons in Somalia is June & in September)
- Calving, in practice, thus occur every 2 years even in two season areas. From Neo-natal death and losses those in calves up to 1 year old may be as high as 50% of calves born. Levels of loses of 30% would be quite normal.

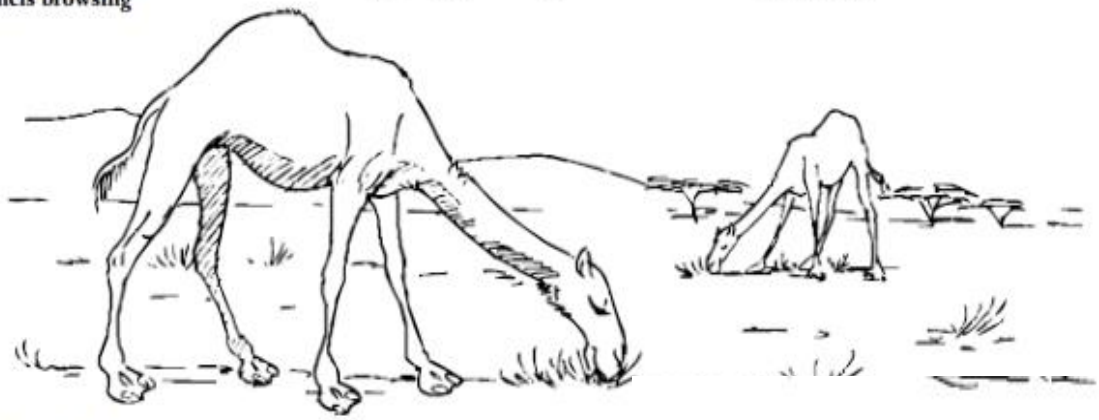
The feeds of camel

- Camels eat or browse, their heads always in the air, their necks stretched, their tongues extended to grasp a thorny twig.
- Anatomical adaptations such as the mobile & prehensile split upper lip, the long tongue & the horny nature of the inside of the mouth is most suitable for browsing rather than a grazing in case of camels.
- Salt for immediate needs give 140gm/day. Camels given free access to salts after being regularly fed 30 gm/day immediately consume huge quantities for few days & then maintain levels of consumption of about 12gm/day.

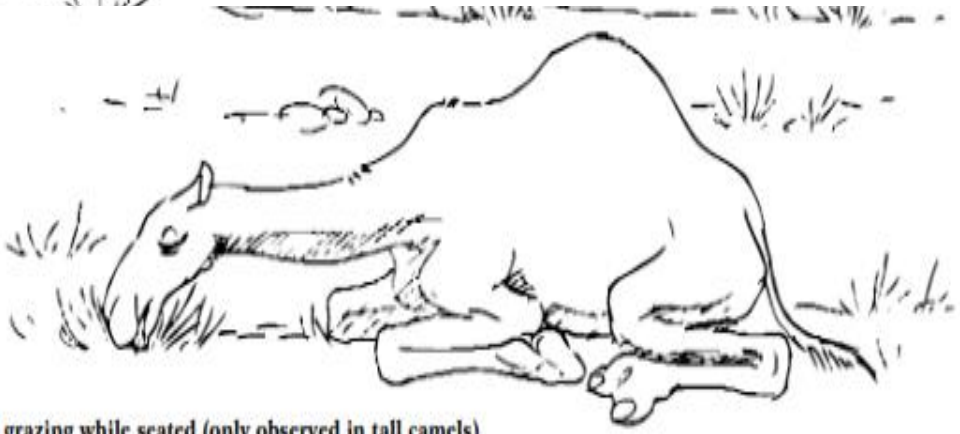
FEEDING HABITS



Camels browsing



Camels grazing



Camel grazing while seated (only observed in tall camels)

- *Based on the preference of camel the most important plant browsed by camels is Acacia brevispica, Opuntia vulgaris and Dichrostachys ciniarea.*
- Species like *Acacia brevispica, Opuntia vulgaris, Dichrostachys cinaria, Gadaba longifolia, Commiphora africina, Grewia bicolor, Rhynchosia velutina, Cordia somalensis and Maurua crassifolia.*
- *Camels are supplied with salt and traditional mineral water.*
- *Ogaden camels are watered every 10-15 days if water source is nearby. But during the rainy season camels may not drink water for 1-2 months.*

Acacia (thorntree)

Opuntia

Dichrostachys ciniarea

- The diet of the camel mostly consists of foliage, dry grasses, and available desert vegetation, mostly thorny plants growing in the camel's natural habitat. These comprise 70% of their diet in summer and 90% in winter.
- In the Sahara, 332 plant species have been recorded for the dromedary. The dromedary will feed on *Acacia*, *Artiplex*, and *Salsola* plants whenever available.
- In case of starvation, they can even eat fish and bones, and drink brackish and salty water.
- Ideally camels should be allowed to feed for 6–8 hours a day, with a further 6 hours being allowed for rumination

- A major requirement for good camel husbandry is availability of suitable browse.
- It is important to remember that proper feeding is more than just sending the camels for browsing.
- They need different types of feed to get their requirements for growth, maintenance, reproduction and protection i.e. proteins (e.g. oil seeds), vitamins, minerals and energy foods.
- Daily food supplements for camels that have no time to graze would be approximately 2kg sorghum, 2kg crushed maize, 10kg of hay and 42 grams of salt. 1kg of oil seedcake should also be added. Rations should be split between morning and evening.
- Camel are feed on Pure alfalfa & over-mature Panicum maximum on irrigated pasture in Ethiopia

Vitamins

- Work influences the vitamin requirement of draft animals particularly of the vitamin **B** complex.
- This is because most of **vitamin B complexes** are used as co-enzymes in energy metabolism.
- Under normal condition no need of **vitamin B complex**es supplementation to draft animals.
- This is because it is synthesized in rumen, **cecum and colon** of herbivorous **monogastrics** and also most forages and stored feed such as **hay** and crop residues have adequate amount of **vitamin B complex**.
- Whenever the diet is poor or incase if **GI** disturbance we should include vitamin in the diet of draft animals.

Water requirement

- Water requirement of draft animals is affected by several factors.
  - Physiological condition of the animal
  - Stage of growth of the animal
  - Duration and intensity of work
  - Moisture content of the feed
  - Weather condition
- In general draft animals on a higher level of work in hot environmental conditions need significantly higher amount of water beyond the maintenance requirement.

- The camel's ability to survive long periods without drinking water is legendary, and is fundamental for its survival in arid areas.
- Somali camel can survive with only one drink in 4 days.
- Somali camels have a ability to abstain from water for 30 days provided the grazing was good.
- Camel can consume 200 litres over two to three drinking sessions(consume 30% of its body weight)

Housing

- Camels should be protected from both natural and artificial factors that could harm them. These include excessive rain and wind, pests, predators and thieves.

- The basic housing unit for camels is a boma. This should be sited in a place that is dry and well drained, and protected against strong winds.

- Many camels have never seen barbed wire or fences, thus caution must be observed if penning desert camels in wire pens.

Feeding camel

- Camelodae are more efficient in the digestion of dry matter, fiber cellulose and crude protein than sheep.
- The greater efficiency may be achieved because of the
- The more rapid frequency of contraction in the fore-stomach& of the ruminating cycle as a whole.
- A more rapid turn over of rumen contents in the camel.
- **Nutrition of calf**
- New-born camel require milk because of the rumen, rumen function & rumen founa are not developed until some time of birth & can not digest plant material.

The feeds of camel

- Camels eat or browse, their heads always in the air, their necks stretched, their tongues extended to grasp a thorny twig.
- Anatomical adaptations such as the mobile & prehensile split upper lip, the long tongue & the horny nature of the inside of the mouth mean that a browsing rather than a grazing diet is most suitable for camels.
- Estimates of daily intakes vary from 4-55kg of wet material.

- Salt for immediate needs give 140gm/day. Camels given free access to salts after being regularly fed 30 gm/day immediately consume huge quantities for few days & then maintain levels of consumption of about 12gm/day.
- Feed calcium: phosphorus at a ratio of 11.2:1 in leguminous plants browse Ca: P ratio could be 5:1. & Ca:Mg ratio of 2.8:1.
- Metabolic disorder due to calcium/phosphorus imbalance including the disease known as **Krafft**..

Camel feed intake

- Camels to have a maximum intake of 2.5 kg per 100 kg live weight (12.5 kg for a 500 kg) in a feeding period occupying 10hrs.
- Under Saharan summer conditions a rise of 6.2°C in
- the rectal temperature from 34.5°C – 40.7°C.
- Have a respiratory rate 8 – 18 respirations / mint.
- Pulse rate 36 – 45 per mint during hottest parts of the day.

Camels production systems

- **Objectives**

To highlight the functions of camel rearing

Production systems involving camels have traditionally been very extensive & highly mobile.

Nomadism (& to a lesser extent, transhumance which is move & returned to the settled environment). **Pastoralism** (no fixed base and are mobile) strategies are in fact designed to minimize the risk of destitution (time of poverty) and not to maximize production.

Traditional systems

- Traditional systems are principally subsistence oriented. Camel products are mainly consumed in the family or used to bring in small amounts of cash that is then used for further subsistence.
- Where milk is the main product, males may be sold for slaughter, and there is thus a preponderance (influence) of females in the herd.
- Where the transport role is still important more males are kept and there will be as many males as females in the herd.
- **Peri urban system**
- Peri urban systems camels provide milk for the city and there are peri urban camel dairies in Djibouti, Somalia & Sudan. In Mogadishu women sell a combined total of as much as 5000 liters/ day in a flexible, reliable & efficient system

Ranching

- Kenya ranches to transport water for younger stock and the herdsmen, and to provide milk for the herds men.
- The ranches camels are now an integral part of the commercial operations.
- Superior bulls have been imported from Pakistan to improve milk production.
- **Present day uses for the pack & draught capacity of the dromedary**
- **1**. Traditional pastoral production system
- 2. Agricultural production system dromedary
- **3.** Commercial transport and services of dromedary
- **4.** Individual transport, sport and leisure
- 5. Military and paramilitary uses

- **Husbandry and management**
- In the overall nomadic economy camels fulfill three roles
  - 1.Transport of effects
  - 2.Transport of personnels
  - 3.Provision of subsistence mainly
  - 4.Additional products such as meat, skin, hair & blood

Relative importance of different animal products

				Agricultural role			
Species	Milk	Meat	By products	Drought	Pack	Riding	Blood
Cattle	+++	+++	++	+++	+	+	+
Goat	+	+++	++				
Sheep	+	+++	++				
Camels	+++	++	++	++	+++	++	+
Donkey				++	+++	++	
Horse				++	++	+++	
Pigs		+	+				
Mules				++	+++	+++	

IMPORTANCE OF CAMELS

1. Milk production

Camels are capable of:

- Lactating in adverse desert conditions.
- Lactating throughout the year
- Producing larger volumes of daily & lactational milk yield (e.g. 1 equivalent to 4 to 10 in producing milk)
- Camels milk has high vitamin C content and longer shelf life.
- Camel's milk has lower fat content as compared to fat content of milk of zebu cattle.
- The size of fat globules is also very small (more digestible than cows milk).

Composition of camel milk

Constituents	%
Moisture	86
Dry matter	12-15
Protein	2.7-4.5
fat	2.9-5.2
lactose	4.4-5.5
Total solid	11.7
Solid not fat	7-10.7
Ash	0.7
Vitamin C	2.9mg/100g
pH	6.5

- The quantities of sodium, potassium, zinc, iron, copper, manganese, niacin and vitamin C were relatively higher than the amounts in cow's milk. At the same time levels, of thiamin, riboflavin, folacin, Vitamin B_{12} , pantothenic acid, vitamin A, lysine, and tryptophan were lower than those in cow's milk.

- The molar percentages of the fatty acids in milk fat were 26.7% for palmitic acid, 25.5% oleic acid, 11.4% myristic acid, and 11% palmitoleic acid.

- Camel milk has higher heat stability compared to cow's milk.

- Thus, education of camel owners about the importance of sanitary milking practices would help solve the problem in the future.
- According to the pastoralists report, presence of the calf is crucial to initiate milk-ejection by camels.
- *Milking procedure*
  - Wash udder/teats before milking
  - Wash hands before milking
  - Wash/smoke milking utensils before milking
  - Let the calf to suckle before milking
  - Hand milking
- *Milking frequency:* Twice, thrice, four time or even six times a day.
- Generally Milking in morning and evening.

2. Meat production

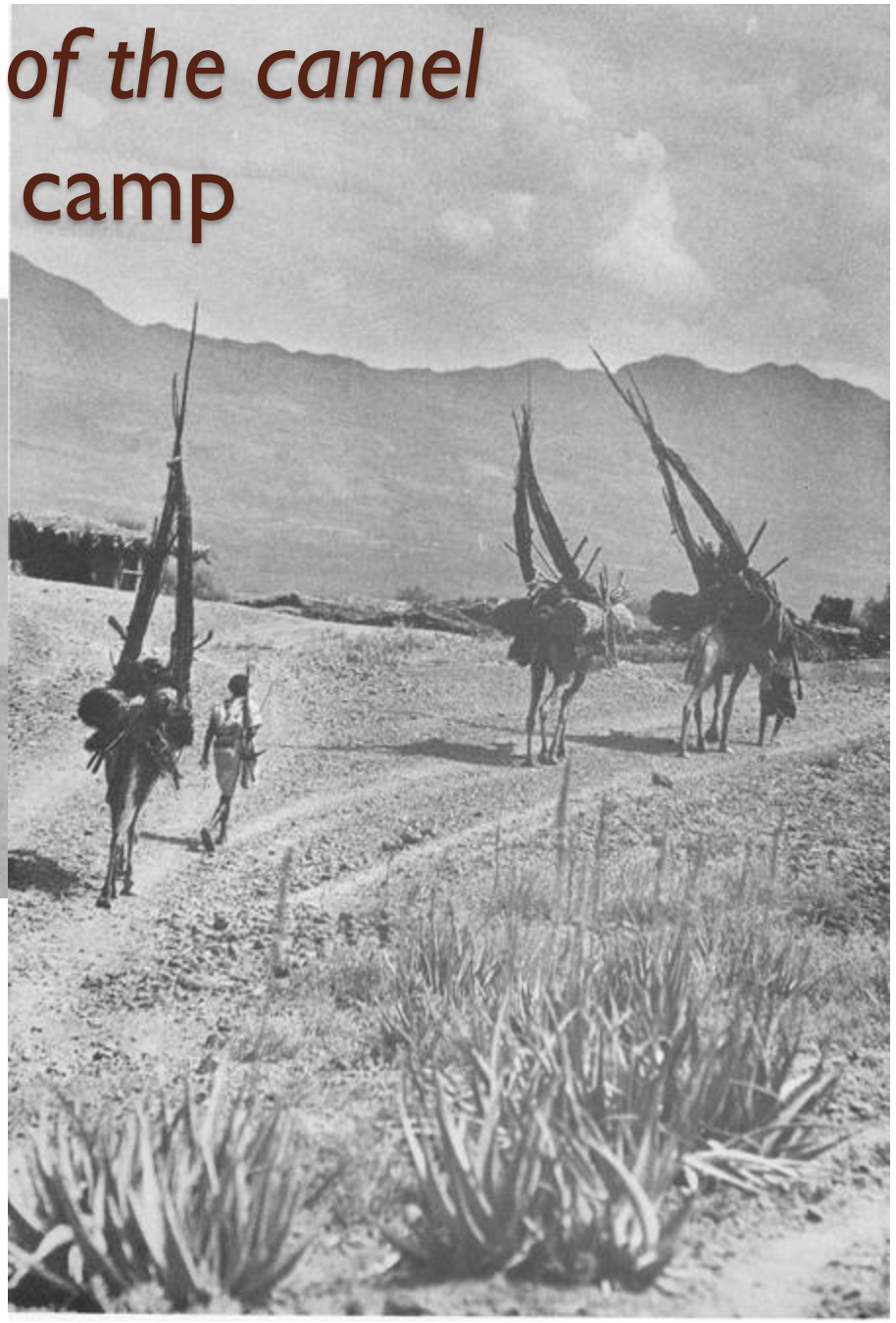
- Limited **information** available in the market
- In traditional pastoral society camel meat is considered as a by-product.
- Dromedary meat is a good source of food, composed of 78% water, 19% protein, 3% fat, and 1.2% ash.
- The carcass is composed of 57% muscle, 26% bone, and 17% fat with an average carcass weight of 300kg, average 18 kg hump weight carcass, 12 kg liver weight.
- The meat is a raspberry red to a dark brown or maroon in colour, while the fat is white in colour. It tastes like beef and has the same texture.

- The proportion of edible meat in camel's body is comparable to cattle**.**
- *Olobe* (cooked meat) can be consumed safely for more than one year
- Export opportunities to **Egypt, Libya, Saudi Arabia** and the Gulf sates do exist.
- The contribution of camel meat to the total meat production: **Ethiopia**: 20,000 MT per year, **Somalia:** 12.6% of the countries total meat production **Sudan:** 2.9% from 1983 to 1988.

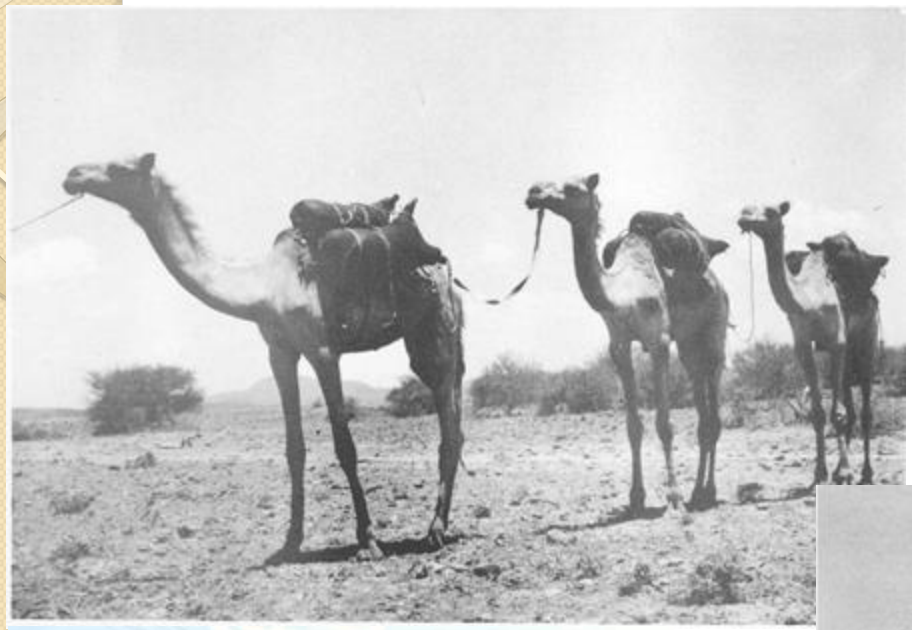
Problems or limitation of meat production

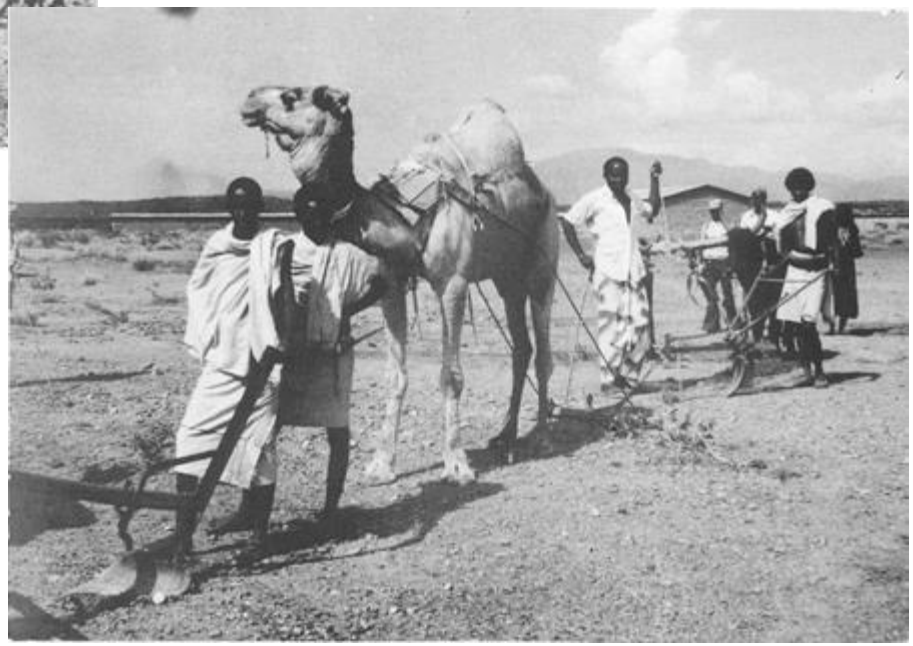
1. Low reproductive efficiency
   - Camels have intrinsically low reproductive rate
2. Off take rates of **3 to 5 %** may constitute a stress on the population which is low
3. There is religious and cultural taboos limitation on meat consumption. e. g. declining in camel population a**frica and Arabia** and stagnation in **Sudanese** camel herds is due to pronounced consumer preference and strong purchasing power of the society.
4. Slow growth rate
5. Under developed meat market in east Africa except in Sudan.

A traditional function of the camel
Afar region shifting camp



Fetching water in dry Afar region





Ploughing trials in the irrigated Awash Valley of Ethiopia.

Hide

- Camel hides are extensively used to make ropes to fetch water from deep wells, and to make ropes (xarig) to construct the traditional hut.
- The hides of camels are also used as covers over baggage during migration (Gebil).
- After migration hides were used to decorate the constructed hut. It was also used as bedding material for sleeping and praying.

Camel Milk products

1. **Fermented Milk (*Dhanaan*)**
2. **Cheese.**
3. **Butter**
4. **Camel milk ice cream**
5. **Camel Milk Powder**
6. **Camel milk-**based **beauty product**

Camel Meat products

1. ‘Olobe’
2. ‘Darreein’
3. **Butter**

Camel fresh cheese

Camel feta cheese immersed in vegetable oil and added herbs

Dried and sweetend camel cheese

Castration

- to avoid less development of bone & muscle castration should not be done until mature body size and weight have been achieved at 8 years
- Milk production from camel
- Lactation length varies from 9 to 18 months, with a total lactation yield of 800 liters to 3600 liters, with daily yield vary from 2.8 and 11 liters.

- Camels milk has 86%moisture, 7-10.7% solid not fat, 2.9 – 5.4%fat, 3.3 – 5.8% lactose, 3- 3.9% protein & 0.7% ash. Cheese was difficult to make under natural conditions but success was achieved by using 50 times the natural amount of rennet (that used for ripening).
- The cheese was ripened for two months at 5 - 10°C Butter or ghee (clarified butter) yield was only 2%. The ghee melted at 43.5 – 44.7°C & solidified at 34-35°C (compared with that of the cow, which melts at 28 - 38°C and solidified at 19- 30°C.

Meat of camel

- Dressing percentage of camel meat is 54-57% with an average carcass weight of 300kg, average 18 kg hump weight carcass, 12 kg liver weight.
- Camels meat contains about 22% protein, and only 1%fat, almost all the fat is stored in the hump.
- It considers camels fat a delicacy, and it can be stored for 3 years as suet.
- Bones on average weighs 20%of the carcass weight with a possible off-take of 6%.

- Hides weighed between 22.5 – 47 kg, which is equivalent between 8.5 – 11.8% of energy live weight.
- Riding camel
- Camels can travel 7 to 8 km/hr with a total load of 180kg, which can travel 650km, up to 65km per night for five nights.
- Camels specifies the walk, 4 km/hr; the jog, 9.5 - 13km/hr this is being the usual pale for a riding camel); the fast run, 14.5 – 19km/hr.
- A fast run of 16- 32 km/hr also recorded

Generally Camels comparative advantages over other domestic animals

- 1. Its water economy (reduce water losses)

2. Ability to support a high degree of water loss (loss up to 30% of body weight)
3. Making up water loss in a short time (drinking up to 180 liters in 24 hrs)
4. Can go with out water for up to 10 days
5. Do not loss its appetite for feed at times of dehydration
6. Ability to fluctuate its temperature by 6.2°C
7. Factors stay with out water for 10 days, not loss appetite in dehydration and can fluctuate temperature by 6.2°C increases the ranging area of camel

8. Camels have greater speed
9. Camels are primarily browsing animal able to use fodder not relied by other domestic animal
10. Because browse at a higher elevation reduces computation between other domestic animals
11. Browsing at higher elevation reduces possible erosion
12. The huge plate like feets, are less damaging the soil structure

ORIGIN OF CAMEL

- Came are originated from **North America** when the land masses were still joined.
- Ancient camels **were not** larger than Hares (larger rabbits) (about 50 cm high).
- They remained in North America from the upper Eocene period throughout the territory period into Pleistocene epoch (a period of about **40** million years).

The two types of camel

- The domestication were started in Southern Arabian before 1500 BC predominantly for **pack animal only**.
- Camelus dromedary : found in most African country which has one hump.
- Camelus bacterian : found in most Asian country which has two hump.

Cn't

From North America the animals migrated to other parts of the world in the late tertiary period.

♦ Finally, camels disappeared from their origin of habitat entirely.

♦ By adapting to various environmental areas to which they migrated, the camels evolved into different species of the family as they are known today.

DOMESTICATION, DISTRIBUTION AND POPULATION OF CAMELS

Domestication

- The dromedary was probably domesticated on the South coast of Arabian Peninsula in the region of the present **Yemen and Oman** around **3000 to 4000** years ago.

Then, introduced into North and the horn of Africa with spice trade.

- The **bacterian** camel was probably domesticated at the same time in the present day Turkey and in Northern Persia, spreading from there westward to Anatolia and east to Northern China.

Differences b/n the two species

	Camelus dromedary	Camelus bacterian
Habitat	-hot arid and semi-arid of Africa + Arabian countries	-Cold desert of Asian continent
Population	-numerous	-Few in number
Morphological characteristics	-Single hump	-Two humps
	-larger body size	-Smaller body size
	-woolly but shorter coat cover	-Woolly but thick coat cover
	-Broad feet, long eyelashes, trap door nostrils and extremely thick lips	opposite
	-Long legs	-Short legs
	-Carries its head high	-Carries its head low
	-Spiting is not common	-Spiting habit is common
Voice	-grunt	-shrew

The new world camels

- The new world camel belong to the genus Lama which comprises 4 species

1. **Lama glama (the llama)**
2. **Lama pacos (the alpaca)**
3. **Lama guanicoe (the guanaco)**
4. **Lama vicugna (the vicugna)**

- The llama and alpaca are domestic species whereas the guanaco and the vicugna are wild forms.

Cn't

- The world stock of **bacterian** camels is estimated around 2 million.
- The areas of distribution of the **two** camels overlap only slightly.
- In this area of overlap the hybrids of these two types are found, though nothing is known about their numbers.
- The wild forms of both types are now a days become extinct.

Distribution

- In general terms the camel is considered as an animal of the tropics but much of its present-day normal range is extra-tropical.

- About **20%** spread rather thinly over a vast area found outside tropics.

Factors governing the distribution of camels include:

a. Environmental factors
b. Social factors
c. Economic factors

I. Environmental factors

- Camel is tropical in general climatic terms with very few exceptions.
- The padded feet are in some cases disadvantageous; they are not suitable to walk on **stony, swampy and /or permanently wet areas.**
- Increased humidity, weather from high rainfall or from more or less permanent bodies of surface water are unfavorable to the habitat of camel.

Cn't

- Presence of **tsetse or other biting flies** are detrimental for the survival of camels since camels do not have **paniculus** muscles in the skin.

2. Social factors

- Mode of living of people:
- Camel is essentially nomadic animal, and permanent cultivation areas are **uncommon** for camel production

2.1 cultural and Religious Taboos

- The recent distribution of camels came after the advent of Islam.

- As the **Arabs** poured from their heartland to conduct their Holly wars they took their camels with them.

3. Economic factors

- After the advent of motorized transport & monetarization of certain nomadic economies, camel remained only as **beast of burden** for the personal transport in the areas to which it was adopted.

Cn't

- So far, there has been little reduction of the camels range due to economic factors although current numerical trends in the areas affected would lead one to expect such a reduction in the future.

- The increased cost of motorized transport and the increased world demand for milk and meat will have the opposite effect.

CAMEL POPULATION

- During the last **two** decades, the world camel population has increased approximately by **40** percent.
- The major part of increase in tropical Africa (number of dromedaries).
- The dromedary population declined in the **oil** rich states of western Asia.
- The reason for the increase of dromedaries in Sahel and north east Africa:

1. Increase in aridity and land degradation.

- The continent Africa contains about **75%** of the Worlds camel population.
- The major concentration of camels in African tropics is in the north east of the continent.
- One-third of the total world camel population is found in Somalia and almost **60%** within the boarders of Ethiopia, Kenya, Somalia and Sudan.

Cn't

- Ethiopia has an estimated camel population of **1.05 - 1.7 million** which is found mainly in the lowlands of Afar, Somalia and Southern Oromia regions.

- This figure of camel population is believed to be very sketchy (unclear) and underestimated although it has placed Ethiopia in the third position in Africa and fourth in the World.

Camel Population in the World in million
(Source: FAO, 1989)

No.	List of Country	Population
1	Somali	6.7
2	Sudan	2.9
3	Ethiopia	1.1
4	Mauritania	o.8
5	Kenya	0.9
6	Chad	0.5
7	Niger	0.4
8	India	1.4
9	Pakistan	0.9
10	Saudi A.	0.9
11	Pakistan	0.3

Camels production systems

- **Objectives;** **Students will be able to understand**
- The functions of camel rearing
- Production systems involving camels have traditionally been very extensive & highly mobile.
- **Nomadism** (& to a lesser extent, transhumance which is move & returned to the settled environment).
- **Pastoralism** (no fixed base and are mobile) strategies are in fact designed to minimize the risk of destitution (time of poverty).

CO;T

- Pastoralist group in Northern Kenya, are known to have a sophisticated land-use system that uses mobility, Social cooperation and intensive labour inputs as part of its overall system.
- Traditional systems are principally subsistence oriented.
- Where milk is the main product, males may be sold for slaughter, and there is thus a preponderance (influence) of females in the herd.
- Camels are also used in many societies for lifting water from deep wells to supply other stocks & households, and also used to grinding by making use of as a source of power for mills.

Peri urban system

- Peri urban systems camels provide milk for the city and there are peri urban camel dairies in Djibouti, Somalia & Sudan.
- In Mogadishu women sell a combined total of as much as 5000 liters/ day in a flexible, reliable & efficient system and are effective way to supplying increasing urban demands for livestock products using local resources. Milk is sold door to door
- Ranching; Ranching of camels in the commercial sense is still relatively rare.
- It is practiced in Northern-central Kenya camels were first used in a limited way on Kenya ranches to transport water for younger stock and the herdsmen, and to provide milk for the herds men.
- The ranches camels are now an integral part of the commercial operations. Superior bulls have been imported from Pakistan to improve milk production.

Present day uses for the pack & draught capacity of the dromedary

. 1. Traditional pastoral production system

- The transport capacity of dromedary ensures mobility with in the system and secures grazing management options.
- 2. Agricultural production system dromedary
- Used for various cultivation work. Carrying of produce, wheeled transport and drawing water for irrigation from traditional deep wells. (up to 40m deep)

- **3.** Commercial transport and services of dromedary
- Used for transport both a pack & draught animal and for other services like powering driving oil mills, pumps and water wheels.
- **4.** Individual transport, sport and leisure
- Used for riding as a manse of individual transport and it is use for sport and leisure activities like racing and trekking is slowly but steadily increasing in connection with tourism.

Husbandry and management

- In the overall nomadic economy camels fulfill three roles
  - Transport of effects
  - Transport of personnels
  - Provision of subsistence mainly
  - Additional products such as meat, skin, hair & blood

TYPES AND BREEDS OF DROMEDARY CAMEL

- Breeds of camels are not as such differentiated.
- Systematic selection for productive traits has not been done.

Reason(s)

- Recent domestication
- Neglect of these animals (harsh env't, political prbm.)

Cn't

- Nevertheless, there are a large number of different types of dromedaries, many of which are considered as breeds.
- These breeds may be classified in to **two** general types
- The **ridding & the baggage**
- Breeds within these types are not marked by so many pronounced functional or conformational characteristics.

Cn't

- **Wilson** (1984) classified dromedary camels into **two** based on:
- a. Primarily on function and secondarily on habitat

1. Riding/racing type
2. baggage/pack type

1. Hill
2. Plains

Cn't

- There are physical differences b/n reverine or wet & desert camels.

Other classifications

a, Based on morphological characteristics

1. Brachymorphic -short
2. Mesomorphic -intermediate
3. Dolichomorphic -long

Based on ethnic groups owning / coat color

- Afar camels (denakil)
- Anafi (biniamir camel)
- Somali camels (Ogaden camel)
- Boran camels (Gujie camel)
- Sudan (bishari camel) their coat color varies in
- Red, white, gray, etc. in color

Camel in Ethiopia

- In the central highlands of Ethiopia, the domestication of camel is unsuitable, due to
- High altitude (RF, humid)
- Continue rain fall
- Topographical features of the land
- Vegetation condition (feed leaf)

Cn't

- Anatomical, physiological and behavioral disadvantage but in the periphery of the land the above condition could be favorable.

IMPORTANCE OF CAMELS

1. Milk production

- Camels are capable of:
- Lactating in adverse desert conditions.
- Lactating throughout the year
- Producing larger volumes of daily & lactational milk yield (e.g. 1 equivalent to 4 to 10 in producing milk)

Cn't

- Camels milk has high vitamin C content and longer shelf life.
- Camel's milk has lower fat content as compared to fat content of milk of zebu cattle.
- The size of fat globules is also very small (more digestible than cows milk).

Cn't

- Water content of camel's milk is known to increase when water becomes scarce to the animal.
- Believed to have medicinal value for many diseases.
- The draw back of camels milk unfavorable to processing into other milk products.
- Milk is the most important camel product in Eastern Africa.
- (Valuable food source)

Composition of camel milk

Constituents	%
Dry matter	12-15
Protein	2.7-4.5
fat	2.9-5.2
lactose	5.5
Vitamin C	2.9mg/100g

Factors affecting milk yields include

→ Nutrient supply

→ Health status

→ Milking techniques

→ Genetic potential for milk production

→ Number of previous lactations

→ Age of the animal

Cn't

- The first **3** are possible but require good **husbandry, feeding and health care**.

- Improving genetic potential for milk production in East African camels is only possible in the long term.

Reasons:

- Low reproductive rate (inefficient selection)

2. Meat production

- Limited **information** available in the market
- In traditional pastoral society camel meat is considered as a by-product, (**1^0 objective for milk).**
- The proportion of edible meat in camel's body is comparable to cattle (Dressing percentage **45 - 55%).**

Cn't

- Have larger body size (320 to 750 kg) a good meat production potential.

- Camels meat is believed to have a medicinal value for **bone damage, back pain** problems, impotence.

Cn't

- Export opportunities to **Egypt, Libya, Saudi Arabia** and the Gulf sates do exist.
- The contribution of camel meat to the total meat production:
- **Ethiopia**: 20,000 MT per year
- **Somalia:** 12.6% of the countries total meat production
- **Sudan:** 2.9% from 1983 to 1988

Problems or limitation of meat production

1. Low reproductive efficiency

- Camels have intrinsically low reproductive rate and cannot be efficient for meat productions.

2. Off take rates of **3 to 5 %** may constitute a stress on the population which is low

3. There is religious and cultural taboos limitation on meat consumption.

- e. g. declining in camel population

Cn't

- **Africa and Arabia** and stagnation in **Sudanese** camel herds is due to pronounced consumer preference and strong purchasing power of the society.

4. Slow individual growth rate

5. Under developed meat market in east Africa **except in Sudan.**

3. Power source

Camels are used

1. **Riding and pack** animals
2. Wheeled transport
3. Draught animals in agriculture, for drawing water
4. Power source for small industries (oil extraction).

Cn't

- Within eastern Africa, camels are more frequently used as **pack animals** (it is only in Sudan that camels are used for **riding**).

- The following criteria should be considered for the **choice** of camel for work

Cn't

1. The camel should be **trained** and well accustomed to be guided
2. **Male camel** is preferable to female camel since male is more powerful.
3. Age should be considered; an appropriate age seems to be about **5** years old or more (**400kg** body weight or more)

Cn't

4. The camel must be in good condition and calm
5. (E.g. during the **rutting period**, the male camel may become aggressive, weak and tends to run away).

4. Transportation:

- Consist about **4%** of the estimated total camels used for transport.

Cn't

- E.g. In Ethiopia, camels transport salt from **Danakil depression to** the highlands of **Tigray** with average load of **90 kg** and travel a distance of 160 **km within 4 days.**

- In Ogaden an adult camel is reported to carry **300kg** and cover up to **40km** per day.

Cn't

- **Cultivation:**
- Camels are known to have good potential for **plowing in Ethiopia**.
- Use of camels as **draught** animals is traditionally practiced in some parts of Ethiopia (**Afar and Ogaden regions).**
- According to estimate of MOA (1984), there are about 130,000 camels used for draught purpose (**2/3 are females).**

Cn't

- In these regions of the country (semi-arid areas), using camel for **traction** is found to be better alternative for the following

Reasons:

1. Well adapted in the area
2. The indigenous people know how to take care of camel.
3. Require **low investment** (in most cases the camel is an already existing property of most pastoralists

Cn't

4. Easier to feed unlike oxen
5. Easier to train compared to local oxen
6. Easier to work with (provided they are guided)
7. Won't forget its training
8. Has a considerable working power.

- (e.g. a single camel was reported to outperform a pair of oxen and could plough **one hectare in 2 hours**

5. OTHER USES OF CAMELS

1. Source of cash from sale
2. Social solidarity (used for payment of bride price, blood compensation and simple gift)
3. Cultural and social roles- sacrificial animal
4. Social prestige
5. Skins, wool, blood and manure

ARID AND SEMIARID ENVIRONMENT

1. Primary problems of the area are scarcity of water and high ambient temperature
2. Quality of water:
3. Scarcity of feed is the most important limiting factor

THE NATURAL HABITAT OF CAMELUS

- High ambient temperature:
- The radiant energy falling on the ground is very high (1000 kcal/m^2/hour
- The heating of the ground results in updraft of the hot air which forms a twisted air

➥ This twisted air contains dust and fine sand which affects respiration.

Cn't

- Feed scarcity and unpalatability:
- Plants are salty and their availability is seasonal
- Salt water for drinking
- They have also undergone various **xerophytic** adaptations to withstand the harsh environment

These adaptive features xerophytic include:

1. Reduction in leaf size
2. Replacement of leaves by thrones-to reduce evaporative surface
3. Increment of **phenolytic** substances on the surface of leaves
4. **Steams-insulating substance to minimize evaporation of**
5. Sparse distribution -minimizes completion for ground water

ADAPTIVE FEATURES OF CAMELUS DROMEDARIUS

Camels do possess unique features in adaptation with

1. Anatomical
2. Physiological and
3. Behavioral adaptive features

ANATOMICAL

1. Long narrow body

- Minimizes the surface area exposed to the direct solar radiation.

2. **Long legs and long neck**

- Enables to browse from upper storey (3.5 m).

Cn't

3. Long legs

- Enable the camel to move very long distances (50kg per day) and browse the sparsely distributed vegetation without difficulty.

4. Lifts the camels body above ground and away from the hot reflecting surface and cooler air can pass underneath.

- Enables walking over soft sand without sinking

Cn't

- Do not cutup soils surface unlike the hooves of cattle and small ruminants, hence contribute less to erosion

5. Fatty hump

- Serves as energy store and becomes useful when **browse** is very poor.
- Serves as **insulator** from incoming solar radiation

Cn't

- Leaves subcutaneous **tissue fat free** and this enables more efficient heat dissipation from the body.

6. Keratin pads in chest and knees

- The only parts of the body that come in contact with the sand when the animal squats down

Cn't

- It prevents abrasions when the animal kneels down.
- It allows the animal to squat on the hot sand by **slightly elevating** the body above the surface

7. Keratinized epithelium on the lips

- Enable to browse on the thorny vegetation like acacia

8. Super orbital arch

- Protects the eye from the sun

Cn't

- Thick eyelashes and translucent eyelids
- Allow walking through sand storms with their eyes shut, thus protects the eye from the dust

9. Thick skin

- Acts as a protective barrier against the spinous grasses which cause many wounds on the feet of horses and cattle.

Cn't

- Insulator against incoming solar radiation

10. Hair

- Shiny and reflects incoming radiation
- Stands erect allowing air to pass from the surface of the **skin, cooling** it more effectively
- It is grouped in clusters

Cn;t

- (Clipping of hair was found to increase water loss by 50%)

11. Nostrils

- Can be voluntarily closed and opened (posses sphincter muscles)
- Protect from inhaling dust
- Condenses moisture leaving from the lungs (in the turbines bones of nostril)

PHYSIOLOGICAL Low water turnover

Animal	BW (Kg)	Evaporation (% BW h^{-1})
Camel	500	0.77
Man	70	1.47
Donkey	95	1.33
Rabbit	2.00	4.77
Rat	0.10	12.80
Mouse	0.021	21.50
Wood louse	0.0002	105.00

Camels

- Drink far less frequently than do sheep, horses or cattle
- Less water is required by the camel b/c the rate of H_2o turnover is low
- Most of physiological changes that occur in the camel during dehydration are water conserving mechanisms which keep the turnover low

These include:

- Ability to fluctuate body temperature
- Efficient sweating mechanism
- Ability to reduce fecal and urine water loss
- Ability to reduce respiration (o_2 consumption)
- The camel is a homoeothermic animal.
- Homeothermia meaning a strict adherence to a set of body temperature that is controlled internally

Cn't

- Each warm blooded animal has its own preferred air temperature (the critical temperature)
- At this temperature the animal does not have to expend energy for cooling or warming the body
- In a desert environment critical temperatures of animals are below the day temperature in the summer, therefore, they are under heat stress

Cn't

- The dehydrated camel is not a strict homoeothermic animal but reacts to changes in ambient temperatures by great changes in body temperature.
- Early morning Late after noon
- **34^0c** **41^0c**
- Both these extremes in temperature would be lethal to most mammals

Cn't

- The body temperature of homeotherms functions within limited range (37-39^0 in mammals; 40-44^{0}c in birds).
- Importance of fluctuating body temperature:
- No water is expended for cooling processes
- As body heats up during the day the difference b/n air & body temperatures remains virtually unchanged
- Therefore, the net uptake of heat from the environment is almost the same throughout the day

Cn't

- The daily rise in body temperature of 6^0c is 600 Kcal which means a saving of 5 liters of water
- Excess heat stored in the body during the day is dissipated during night (conserve energy)
- Efficient sweating mechanism
- The camel does not need to sweat until its body temperature surpasses **42^0c**
- Sweating only begins when the upper limit of heat storage is reached.
- Then the sweating is not continual.

Cn't

- The sweat evaporates directly from the skin rather than from the tip of the hair as in other animals
- Ability to reduce fecal and urine water loss
- Normally camel produces hard dry pellets containing 1-2 liters of water a day
- The cow losses 20-40 liters of water a day through feces
- Fecal water loss in camels is likewise comparatively low due to the efficient re-absorption of water in the colon

Cn't

- Similarly, water losses through camels urine are minimized by concentrating urine, by reducing renal urine flow and by retaining metabolites in the body fluids
- The camel's kidneys have very long loop of Henle where water is reabsorbed
- The process is efficient and camel excretes very concentrated urine
- Much of urea itself is recycled

Cn't

- Because of this camel is able to consume very salty drinking water and halophytic Shrubs which are inedible by other livestock.
- Ability to reduce respiration (o_2 consumption)
- Respiration rates of camels remain low even at high temperatures
- They lose less water through respiration than a cow which may breathe twice as fast

cn;'t

- Since heavy breathing generates heat they also get less hot
- They have water conservation mechanism whereby moisture from the lungs condenses on the turbinal bones in the nostrils and is not lost to the atmosphere.
- Some traits related to water turnover and drinking water requirements of domestic herbivores under east African ranching conditions

Source: Schwartz, 1992

Species	Camel	Goat	Sheep	Cattle
1. Daily water loss under complete water deprivation	1-2	5-7	4-6	7-8
2. Adjusted water turnover (ml/kg body wt/day)	38-76	62-166	50-140	51-150
3. Maximal urinary osmolar conc.(mosm/kg H_2o)	3100	3000	2900	1400
4. Minimal fecal water content (%)	35	50	45	60
5. Estimated water content in the selected diet of grazing stock (%)	34	29	26	15

Rehydration capacity

- Camel posses an enormous drinking capacity (capable of drinking at any one time a volume of water equivalent to as much as 30% of its **BW**).
- After periods of water restriction replenishing water losses is important.
- In some mammals rehydration is rapid while in others it is much slower.
- **The 600** kg camel replenished its entire deficit of 200 liters of **water in 3** minutes which has occurred after 14 days without water.

Cn't

- Sheep after losing **25-31%** of their body water replenish (refill) only after **2 days**).
- The cessation of drinking in most animals is not determined by the entry of water into the blood stream.
- Except for the **camel,** no animal has a rapid entry of water into the blood.
- Rapid absorption of water into the blood stream is **not** safe physiologically for many animals.
- Camel's **erythrocytes** are extremely resistant to hypotonic and hemolytic.

Cn't

- Camels **red blood** cells are very elastic (can expand up to **200 times**) and oval in shape contrary to disk (round) shaped **of human** and cattle red blood cells.
- Ability to maintain its blood volume constant.
- Water loss from the body is drawn from the body **cells, interstitial fluids** and from the **blood in other domestic animals.**
- But in case of the camel, unless **sever** condition is occurred water could **not** be drawn from **blood**

Cn't

- This helps to maintain the viscosity of the blood at minimum (If the blood becomes viscous, heat will not be removed from deep body surface and this causes heatstroke)
- **Dehydration tolerance**

- The degree to which mammals can still remain functional when **no** drinking water is available is the dehydration tolerance.
- Man and many mammals reach their **physiological limit** when **10%** of their body weight water reserves are lost

Cn't

- Over a period of **2-3 weeks** without drinking water camels lose over 1/3 of their body weight with water without suffering from any **ill-effect.**
- The fore stomach of camel contains about **25%** of the water of the whole body.
- It serves as a substantial and dynamic reservoir releasing water during dehydration and accommodating it when a **thirsty** animal takes a large drink to allow gradual dehydration of tissue.

BEHAVIORAL ADAPTATION

1. The dehydrated camels:

- Face towards the sun
- To minimize surface area exposed to solar radiation
- Prefer squatting on the ground before the ground gets warmed
- To enable loss of heat from the body to the ground through conduction.

Huddle together

- To minimize surface area exposed to the sun.

REPRODUCTION

- **SEXUAL MATURITY IN MALES AND FEMALES**
- **Sexual maturity:**

☞ The ability to conceive or cause conception

- Attained before full physical maturity

SM may be correlated with

- Absolute age
- Body condition
- Nutrition
- Climate

Male

- Onset of **puberty** may appear at 3 year of age
- A reasonable level of activity attained at 6 years
- Full overt sexual activity may be delayed until 8 years.

- Physiological capacity may increase up to 10 year and remain more or less constant until 15-20 years of age.

Female

- Onset of puberty **8-12** months
- Age at sexual maturity 3 to 4 years
- Age at first calving 4 to 5 years
- Remain in breeding up to **20-30** years

SEXUAL BEHAVIOUR IN MALE CAMEL

- The period of heightened sexual activity which occurs in the male camel is generally known as the **rut**.

- In bachelor herds all bulls appear to go through a quiescent rutting period which develops into a full rut when one male joins a female herd.

- During rut the testicles are quite increased in size.
- A bull in his prime (7-13 years old) can serve up to 50 females during one breeding season.

Cn't

- ➢During the rutting period the incidence of fights among males in mixed herd is very high.
- ➢After having established dominance, only the dominant bull, which is usually the heaviest, will display a fully developed rutting behavior throughout the breeding period.
- Other males only show subdued version.

Cn't

- ➢During rut, the dominant bull loses condition quite dramatically due to loss of appetite and consequent reduction in feed intake combined with high muscular activity.

- In the view of other bulls and humans the bull adopts a typical stance with hind legs a part to signal its dominance.

The Xts. behavioral patterns of rut

→ Frequent urine spraying

→ Tail flapping

→ Frequent expulsion of dula

→ Repeated loud vocalization

→ Teeth grinding

→ Frequent diarrhea

→ Aggressive behavior towards other males and human beings.

Cn't

- Increased poll gland secretion (has strong smell, high androgen levels, black reddish color and thick consistency) and gland hump rubbing

COURTSHIP AND MATING BEHAVIOUR

- The camel bull tends to herd its females and constantly investigates their perennial regions.
- After having picked up their smell he displays 'flehmen.
- He forces the receptive female to sit and mounts her from the rear and coitus takes place in sitting position.
- If the female has conceived, she will refuse to lie down and curl tail up when approached by the male.

Cn't

- The earliest time tail curling up can be observed in 20 days after copulation.
- It will be reliable if it persists curling the tail for about 2 months.
- During copulation the bull:
- Gurgles (sound)
- Froths
- Extrudes the dulaa
- Copulation time may take between minutes up to half an hour.
- The same female may be served several times during a day by the male.

FEMALE SEXUAL CYCLE AND BEHAVIOUR

- Camel is an induced (non-spontaneous) ovulation
- Ovulation occurs after **coitus.**
- The neuroeincocrine reflex involving initiation of LH release is delayed until **coitus** occurs.
- Ovulation occurs 32 to 40 hours after copulation under the influence of LH.
- Deposition of seminal plasma in the vagina or uterus induces ovulation in Bacteria camels.
- IM administration of LH or hCG and LH-RH produced ovulation in similar manner

FOLLICULAR WAVE ('OESTROUS CYCLE')

☞ It is more appropriate to refer as follicular wave instead of estrous cycle.

This could be divided into 4 phases:

1. The growing follicular stage (Prooestrus) (6 days)
2. Mature follicular stage (estrus/heat) (4 to 6 days)
3. Atretic follicular stage (if mating did not occur) (7 to 10 days)
4. The non-follicular stage or lag phase

Cn't

- The duration of the follicular wave ('oestrous cycle') varies slightly in relation to geographical location
  - India = 23.4 days
  - Egypt = 24.2 days
  - Sudan = 28 days
- The camel is polyestrous breeder.
- However, there are certain months in the year of the season where the ovarian activity is very low.

External signs of heat:

- Seeks the bull and may even sit in front of him
- Becomes restlessness
- Flicks her tail rapidly and urinate frequently
- The vulva is relaxed and slightly edematous
- Slight discharge from vulva may be present

GESTATION LENGTH

- The literature concerning the gestation length in camel is very conflicting compared to variations reported in other species.
- 390±2 days (Yagil, 1985)
- 375 days (Arthur *et al*., 1985)

NB:- Commonly stated as 12 to 13 months

REPRODUCTIVE SUCCESS AND FERTILITY RATES

Affected by:

- Long gestation period
- High rate of egg and early embryonic mortality
- Recurrent drought and diseases
- High neo-natal mortality
- Closed breeding
- Poor culling practices

Cn't

- Calving interval: 18.6 - 28.6 months
- Total lifetime calf production: 2.7/breeding female (Niger)
- 3.5/breeding female (Kenya; commercial farm)
- 2-8/breeding female (India; National camel farm)
- Neonatal mortality rate: 30-50%

NUTRITION

- Camels➔Pseudo-ruminants (3 compartments)
- ➔Compartments 1 & 2 (rumen & reticulum)
- ➔ Compartment 3 (Omasum & Abomasum)
- ➔ Large oesophagus-secrete gastric juice
- ➤ Much more efficient in digesting roughage feeds
- ➤ Can make better use of many poor feeds

Reasons efficient to roughage:

- ➤ Longer retention of fibrous feed in the stomach
- → Small particles for 41 hrs
- → Large particles for 57hrs
- → Fluid for 14hrs
- → High motility of stomach and its contents
- ➤ Well adapted to diets low in protein
- ➤ Recycle urea effectively (recycling ↑as stress↑)
- Example: (13.6% dietary protein →urea recycling =47%); (6.1% dietary protein →urea recycling = 86%)

Cn't

- Camels overcome the effect low protein content in the diet by selection

Feed preference:

- Browse (1st choice)
- Not obligate browsers

Intake:

- Little is known under free ranging conditions
- Example: Growing camels of 1 year of age /Voluntary intake= 1.6kg/DM/100kg LW
- Live weight gain =326-525g/day
- Conversion ratio=74kg DM/kg of gain

Vitamins

- Work influences the vitamin requirement of draft animals particularly of the vitamin **B** complex.

- This is because most of **vitamin B complexes** are used as co-enzymes in energy metabolism.

Cn't

- Under normal condition no need of **vitamin B complex**es supplementation to draft animals.

- This is because it is synthesized in rumen, **cecum and colon** of herbivorous **monogastrics** and also most forages and stored feed such as **hay** and crop residues have adequate amount of **vitamin B complex**.

Cn't

- Whenever the diet is poor or incase if **GI** disturbance we should include vitamin in the diet of draft animals.

Water requirement.

- Water requirement of draft animals is affected by several factors.
  - **Physiological condition of the animal**
  - **Stage of growth of the animal**
  - **Duration and intensity of work**
  - **Moisture content of the feed**
  - **Weather condition**

Cn't

- In general draft animals on a higher level of work in hot environmental conditions need significantly higher amount of water beyond the maintenance requirement.

Feeding and feeding management of draft animals

Working cattle.

- In the tropics animal feeds are scarce, low in quality and show seasonal variation in its availability.
- During dry season though animals are not working, they lose their body weight.
- This is because the feed available **cannot** support the requirement for work output and sometimes even it may not support the maintenance requirement of the animal.

Cn't

- Therefore during the working period (cropping season) oxen should be supplemented with **high energy** diets to maintain their body weight and to support certain level of work production.

Factors that determine the feeding of draft oxen with high energy diet include:

- **State of body reserve (body condition)**
- **Duration and intensity of work**
- **Timing of off take of the animal**

Body condition

- Oxen in poor body condition or those with dramatic weight loss during the dry season should be supplemented with high energy diets approximately **1-2 months** before the start of working season.

- Such feeding practice of draft oxen is referred to as **strategic work flush.**

Cn't

- **Strategic work flushing** helps draft oxen to have good body condition at the time of **working season.**
- High energy diet supplement to oxen should be **gradual** otherwise they suffer **GIT** disturbances like **CHO** engorgement/rumen **overload/lactic acidosis. (little and frequet feding).**

Duration and intensity of work

- Working oxen should be supplemented during working period regardless of their body condition if the working duration is greater than **6 weeks**.
- If the working period is short (**less than 6 weeks),** supplement feeding is recommended for animals scheduled to be sold after work (**beef purpose).**

Cn't

- Supplement with expensive **energy** concentrates is **not** usually practiced.

Because farmers could **not afford** it and it may **not** be profitable as it does not lead to significant increase in **work and crop out puts**.

- Therefore supplementation during the **dry season** using low opportunity **cost feed resources** is reasonable strategy because such strategy can be **afforded** by the farmers.
- Such strategies include improving the **quality and quantity** of existing feed.

Methods of improving

1. Through harvesting and conservation of surplus forage before it **loose its quality.**
2. Storing adequate amount of **crop residues** and other non conventional animal feeds such as **brans of cereals, molasses.**
3. Production of **quality forage** during the wet season.
4. Improving the feed intake of **oxen** and can be achieved through:

Cn't

1. Increasing the frequency of feeding.
2. Improving the digestibility of roughages through **urea treatment**,

- Supplementation of **block licks** containing **NPN** compounds and by giving legume hays or tree fodders.
- All serve as source of **N** for the micro flora to **synthesize** protein and thereby increase its activity.

Cn't

- Finally leading to an increase in digestibility.

Feeding management of working equidae

- Feeding with energy supplements should be arranged with the **level of work**.
- Donkeys can live under **poor level** of nutrition due to their higher efficiency of feed utilization.

Recommended feeding management practices

1. Avoiding over feeding
2. Avoiding sudden change in diet
3. Maintaining proper **frequency and regularity** of feeding
4. Regulating the **roughage to concentrate** ratio according to the level of work
5. Improving the digestibility of **grain concentrate**
6. Avoid dusty or mouldy feed.

Cn't

7. Improving the efficiency of feed utilization of equines. it can be improved by:
   - Regular deworming
   - Regular dental check of equidae (once in a year)
8. Equines should be given free access to water and salt

Care and Management of draft animals

Health management

- Major (economically important) health problems and their control/prevention

1. Vector borne diseases

i) **Protozoal diseases**

a) Trypanosomoses:- affects cattle, equidae and camels = (Vectors:- **tsetse flies**, haematophagus flies, vampire bats

Cn't

b) Babesiosis:- affects cattle and equine = Vector:- tick (boophilus)

ii) Rickettsial diseases.

a) Cowdriosis (heart water):- mainly affects cattle

Vector:- **tick (amblyoma)**

b) Anaplasmosis:- mainly affects cattle

- vector:- **ticks of several species**, insects, vampire bats

Control and prevention of protozoa and rickettsial diseases

1. Control of the vectors
2. Chemoprophylaxis

iii) Viral diseases

a) African horse sickness:- mainly affects equines

- Vector:- flies of cullicoides species
  - **Control:- vaccination**
  - **vector control**

Cn't

b) Rift valley fever:- mainly affects ruminants

Vector:- flies of many genera

Anopheles spp., culex spp)

- Control:- **vaccination**

Cn't

c) **Rabies:-** affects all vertebrate animals

- Vectors:- wild and domestic carnivores, **vampire bats.**
- **Control:-**
  1. **vaccination of domestic carnivores(dogs and cats**
  2. **Destruction/killing of stray dogs.**

B. Soil borne diseases

- They include aerobic and anaerobic bacteria.
- Their most important feature is the vegetative form of the bacteria will be changed to the more resistant **spore form** when they are exposed to **unfavorable** condition.
- The spore can survive for **long period** of time and can be a source of **infection** for other draft animals.

Cn't

i) Anthrax:- affects all species of draft animals

- Control:-
  1. **vaccination**
  2. Appropriate disposal of animals dying from anthrax
  3. Proper feed management of animals because it is associated with **P** deficiency

Cn't

- ii) Clostridial diseases

a) **Black leg:-** mainly affects cattle

- Control:-

    1. **vaccination**

b) Bacillary haemoglobinuria:- mainly affects cattle

- control:-

    1. **vaccination**

c) **Enterotoxaemia complex:-** occurs at times of sudden feed change from **low quality diet to high quality diet.**

control

1. Proper feeding management of animals (gradual feed change)
2. Use of antibiotic feed additives
3. Use of probiotics

d) Botulism

- Affects cattle, equidae and camels
- Animals acquire the **toxin** when they **lick dead carcass**

Control:-

1. Appropriate disposal of animal carcass
2. Appropriate feeding management
3. Vaccination using toxoids

e) Tetanus

- Mainly affects cattle and equines
- **Control:-**
  1. Active immunization of animals by toxoid
  2. Prevention of **injury** in draft animal

C. Contact (contagious) diseases

- It includes diseases transmitted by **direct or indirect** contact between animals.

i) Fungal diseases)

a) Dermatophytosis (ring worm):- affects **cattle, equine and camels**

- Control:-
  1. Sanitation of stables
  2. Treatment of affected animals
  3. Avoid common use of harness

b) Epizootic lymphangitis

- Affects mainly equidae and commonly horses
- **Control:-**
  1. **Detection and elimination of affected animals.**
  2. **Avoid use of common harnessing materials.**

ii) Bacterial and mycoplasmal diseases

a) CBPP:- mainly affects cattle

- Control:-
  1. Eradication of affected animals
  2. Vaccination

b) **Bovine TB:-** affects cattle and humans

- Control:-
  1. Test and slaughter of the animal

c) TB of dromedaries

- Affects camels
- Control:-

1. **test and slaughter**

d) dermatophilosis:- affects cattle, equidae and camels

- It is highly associated with **injury** in draft animals

Control:-

1. Isolation and treatment of affected animals.
2. Avoid common use of **harnesses** for draft animals
3. Reduce the **predisposing** factors such as wetting of skin injuries.

e) Colibacillosis

It is a disease of young animals particularly **calves**

Control:-

1. Treatment of affected animals with **antimicrobial agent.**
2. Sanitation of stables orconstant.
3. Proper feeding management.
4. Provision of colostrum.

f) Pasteurolosis

- Mainly affects **cattle**
- Stress is one of the important **predisposing** factor to the disease.

Control:-

1. Prophylactic treatment of animals with antibiotics
2. Vaccination

iii) Viral diseases

a) Pox infections:-

- affects cattle and camels

Control:-

1. **vaccination**

b) lumpy skin disease:- mainly affects cattle

Control:-

1. **vaccination**

c) Rinderpest:-

- it is eradicated from the country

control:- vaccination

d) FMD

- Mainly affects cattle and camels

control:- **vaccination**

D. Endo and ecto parasites

control:-

1. regular or strategic deworming of endoparasites
2. Regular application of **acaricides and insecticides**

Specific health problems associated with work

1. Yoke galls (hump sores)
2. Back sores
3. Horn injuries
4. Luxation of patella
5. Hoof injuries
6. Cancer
7. Several skin diseases

Predisposing factors

a) Whenever draft animals are made to work for the first time in their life for **long period.**

b) Use of too **young** animals for work.

c) When there is excessive pressure exerted by the **load** for prolonged period on the **hump or back** of animals.

Cn't

d) Inadequate padding.

e) Excessive and unbalanced load on the back of pack animals

Cn't

f) Use of harnesses having rough surfaces.

- When draft animals are made to work on hard or rough surface.

h) When draft animals are bite by inexperienced operator during training.

I) Using a single harness for different draft animals.

Practices to prevent health problems

1. The initial work period should be **short** and draft animals should be used for work at the proper age.
2. The skin of the animal that makes contact with harness should be kept clean.
3. Harnesses should have **broad and smooth** bearing surface.
4. The skin should be greased when animals used for traction are made to work in the rain.

Cn't

5. Draft animals need to be shoed if they are working in **hard or rough** surfaces.

6. Proper wound management.

7. Avoiding use of the same harness for different animals.

Management of working oxen

1. In indigenous breed **four** years of age is recommended age for work.

2. The age of the animal will be **physically fully matured.**

3. In exotic and crosses, they could be ready for work even in less than **four years** of age

Cn't

4. They are strong enough to work well and have several work of life
5. It reduces the risk of yolk injury as well as growth retardation
6. Too old animals are difficult to train.

Selection of bullocks for work

- **It is based on certain criteria's including**:

1. Thickset animals with short legs
2. Animals with broad chest and strong feet
3. Animals with strong muscles under a fine **short-haired coat.**
4. Bullocks with powerful short neck
5. Strong healthy bulls with good spirit

Training of work oxen

- It could be started at about **2-4 years of age**.
- The training period normally lasts **3-4 weeks** and it depends on some factors like experience of oxen **handler, age of the animal and behavior of the animal**.

Time and duration of work

- Time:- refers to the time of work with in a day

Cn't

- Working should be at the **coolest** parts of the day (early morning and late afternoon).
- If oxen are made to work during **hot** period, they will be **heat stressed**.
- This is because it can **not dissipate** the excess heat produced during work.
- so the animal suffer **hyperthermia**.

Cn't

- Oxen increase in rectal temperature during work up to **42-43^{0}c** is recorded when they work **3-4 hours** in hot temperature.
- Usually this rectal temperature is associated with muscle temperature of **44-45^{0}c**.
- Whenever the muscle temperature exceeds **40^{0}c**, there will be rapid onset of **fatigue**.

Duration of work:-

- Oxen should not be overworked.
- The amount of work expected from an animal depends on **body condition of the animal, state of nutrition and physiological state of the animal.**
- In general, oxen that are in good state of nutrition and good body condition are expected to **plough 5-6 hrs/day**

Avoiding seasonality of work

- Oxen are intensively used to work during cultivation period and **left** almost idle during the **rest period.**
- Work pattern is seasonal which is associated with cultivation period. i.e. **4-5 months**
- After a long period of **rest** when they are subjected to intensive work, they suffer **stress**.

Cn't

- To avoid this stress, use of oxen for different purposes is recommended because it keeps them trained and exercised and avoids work stress.

Care of the foot

The foot of oxen is very important organ, so the following cares should be taken

1. Oxen should not be made to plough on dry ground, if must shoeing is preferred
2. Check and remove packed clay/soil between the claws.
3. Stabling areas/floors should be clean and dry.

Weight estimation in cattle

- It is useful for:-
  1. proper dosing of drugs during treatment.
  2. Proper feeding.
  3. Knowing the draft capability of oxen
- Usually oxen provide draft power of **10-12%** of their body weight.

Cn't

- There are other easy weight estimating methods rather than using **weigh bridge.**

1. **$LW = L \times G^2/300$**
   - where = LW- is live weight in pound(lb)

     L- is the length from the point of the shoulder to the pin bone in inch.

     G- is chest girth in inches.

Cn't

For adult donkeys:

- **$Wt = 0.000252 \times height^{0.24} \times heart\ girth^{2.575}$**

For donkeys under 2 yrs of age:

- **$Wt = 0.000283 \times heart\ girth^{2.778}$**

Cn't

- Using this formula **live weights** are more often under estimated.
- This variation could be due to error in measurements.
- So the following preconditions should be taken before taking measurements.

1. In taking measurements, the animal should not drink or eat for the last **12 hrs**.

Cn't

1. The animal should stand with all **four legs** and the head held in the normal position.

2. Chest girth measurement should be taken immediately behind the **forelimb.**

Castration

- Bulls used for work should be **castrated** because castrated animals are more docile.

- It avoids aggressive behavior of bulls associated with **sex hormones**.
- In most tropical countries castration of bulls is carried out at late ages (after **4yrs**).
- Late castration is advantageous because bulls for work should be **castrated** after the animal has fully developed.

Cn't

- this include:-
  - development of heavy short neck
  - Powerful shoulders
  - Strong musculature
  - Well developed hump

Cn't

- Improving the genetic potential for power output.

- The strategies in cattle to improve their genetic potential for work capacity include:

i) selection and breeding of of better performing cattle

ii) Cross breeding with exotic breeds

Cn't

- work capacity is directly related with **size/body weight** of the animal.
- F_1 crosses have larger size than indigenous **zebu cattle** but they have a lower heat tolerance capacity.
- Moreover they are found to be less susceptible to **yoke injuries**.

Cn't

- So if F_1 are used at the coolest period of the day and managed properly, so they can perform better work than zebu cattle.

Management of working equidae

During **selecting** equines for work we should consider the following points:

1. The animal should be **healthy** and in **good body condition**
2. Good confirmation with strong and straight front leg.
3. Males are preferred than females for work.
4. The animal should have good behavior.

Care of feet

1. The ability of working equine lies on the health state of the feet.

Excessive hoof growth occurs:

1. when they are kept on **soft ground surfaces.**
2. When equine is housed for most of the time
3. When equine is not used shoed.
4. The hoof of horses should be trimmed every **6 weeks and** in mules and donkeys every **4-6** weeks.

Shoeing

- It is the practice of making **shoes** for animals
- Unbalanced shoeing results in walking difficulty

Shoeing is conducted for the following reasons:

i) To prevent excessive wear and splitting of hoofs.

ii) To prevent animals from **sliding** while working on slippery surfaces.

Maintenance of proper hoof moisture

- It is important in maintenance of good hoofs because moist hoof is **liable** to **cracking** and splitting.

Factors that increase hoof moisture content include:

- Stabling in deep manure (mud and urine)
- Daily packing of saturated clay(mud) in the bottom of the hoof

Preventive measures

- Stabling area should be clean and dry
- Daily checking of equine hoof for any clay (mud)

Grooming

- It is the process of cleaning the skin and coat of an animal by means of friction and massage.

Advantages of grooming include:

- It removes the internal waste of the body that have been radiate through the holes of the skin.

Cn't

- **Rubbing and brushing** massages the skin and improves **blood flow** to the skin.
- Horses on fast/heavy work and that are on good state of nutrition require more grooming because **respiratory** rate is high.

Use of proper saddle or harnesses

- The major cause of **back sore** is improper saddles.
- Harnessing materials should be individually made. **this is because**:
  - It causes injury if it is **not** properly fit
  - It transmits certain skin diseases
  - Care of the body surface that makes contact with the harness.

Cn't

- Particular care must be given to areas of the body that makes contact with the harness.
- Sweat or worry is liable to accumulate in such areas and creates suitable media for multiplication of **microorganisms.**

Preventing stable associate

- Vice or associate occur when horses are housed for **long period** or nourished well.
- Examples of vices include wood chewing, stall kicking, stall weaving or pace or speed.

Preventive measures include

- The animal should get regular and sufficient exercise.
- Good friendship with the animal.

Draft work has two forms

i) **Haulage work:-** it involves the pulling of farm equipments such as ploughs and

- The pulling of loaded carts in a walking manner.
- Endurance is required rather than speed.
  - eg. bovine and camels

ii) Driving of carts

- It involves the pulling of light carts and passenger carrying vehicles

- Speed is required rather than endurance

- It is restricted to horses

Performance evaluation of draft animals

- Advantages:-

1. To know how much sustainable **force draft** animals can provide with out being stressed.

2. To match draft animals with the appropriate **implements** that can operate with in the draft capability of the animal.

Cn't

3. To measure the draft force of animals, energy absorption system is required.
4. It is a system that **absorbs and measures mechanical energy**.
5. The portable load cell is attached between harness and implement and gives the instantaneous work **force out put**.

Work efficiency of draft animals

- The efficiency of **work out put** of draft animals can be given by the formula:

Efficiency = work performed by the animal / (energy expended for that particular work + energy expended for maintenance for that working period)

Cn't

- As compared to farm machines, draft animals have lower work efficiency.
- This is because unlike machines they consume **energy for maintenance**.
- equines have work efficiency of **10-12%** and bovines **9-10%** where as farm machines has up to **28%** work efficiency.

Draft capability of work animals

- **Draft capability:-** it is the sustainable force that an animal can exert to pull an implement

Factors affecting draft capability

1. **Biomechanical factors:-**

- Refers to physical characteristics of animals associated with its movement like coordination in mov't, gait or walk, muscular strength

2. Physiological factors

- Rate of metabolism increases several folds during work.

Physiological adjustments made by the animal to increase **0_2** uptake and transport include:-

- **increase in cardiac out put**

- increase in pulmonary ventilation

- increase plasma and red cell volume

- increase in peripheral circulation

3. Environmental factors

1. Refers to weather condition such as ambient **T^0 and humidity.**

2. Animals working in extreme weather condition expend their energy uneconomically. so the draft capability will be **lower.**

Other factors affecting draft capability

i) Factors associated with certain features of particular animal

a) **Animal species**:-

- There is great variation in draft capability among different species of draft animals.

- This may be due to **size, conformation and physiological** capability peculiar to the species.

Cn't

- eg. horses have the greatest capacity for physical work compared to other domestic draft animals.

- This is because they have more physiological advantages. such physiological advantages of horses include:

1. Unique ability to increase 0_2 carrying capacity

Cn't

2. They can store **1/3- ½ of their RBC** in spleen. so during work spleenic contraction will increase releasing stored RBC.

3. Horses muscle has greatest capacity for **glycogen** storage which provides considerable energy for anaerobic metabolism.

b) breeds

- European breeds have higher draft capacity because of larger size.

c) sex:- males have higher draft capacity than females of equal body weight

d) age:- usually middle aged **adult** animals have higher draft capability than either of extreme ages.

e) health and nutritional status:- animals in good state of health and nutrition have higher draft capability

Cn't

- f) body condition of the animal.

ii) Factors associated with the operators ability to use and manage their animals

- **working speed:**
- If animals are made to work **faster** they easily get tired and **fatigue** and their draft capability will decrease.

Cn't

- Motivation and experience of operator during work:

- Some animals are **dull** and require motivation by the operator.

Duration of effort

If animals are used for longer period, they get **fatigue** and their overall draft capability will decrease.

- As a general rule provided all other factors are favourable, an estimated value of draft capability of draft animals is given as follows:

Cn't

- **Cattle and buffaloes** provide sustainable draft force of **10-12%** of their weight

- Equines and camels provide sustainable draft force of **12-14**% of their weight

Harnesses and harnessing system for draft animals

- **Harness:-** it is any material or device that is fitted to draft animals in such a way that it transmit power from the animal to the implement. eg. **yoke, saddle**

- Efficiency of application of animal power partly depends on harness.

Cn't

- The existing harnesses are inefficient for power transmission means they demand the animal to exert a greater traction force than is actually required.

Criteria for selecting and use of harnesses for draft animals

- harnesses should **suit /fit** to the physical characteristics of the animal
- harnesses should be **designed** to ensure that the animals strong muscles are effectively utilized.
- harnesses should be designed to bring line of pull as close to the horizontal as possible to increase the useful draft force.

Cn't

- harnesses should be adjustable to fit the animal to compensate for body size changes resulting from growth or change in state of nutrition.
- harnesses should have a large surface area which makes contact with the animal
- harnesses should have adequate padding

Implements

- It refers to any device drawn by animals.
- eg. **ploughs, carts farm cart or wagon.**

- Animal drawn implements should fulfill the following criteria for an efficient utilization of draft animals with out any harmful effect on the animal:

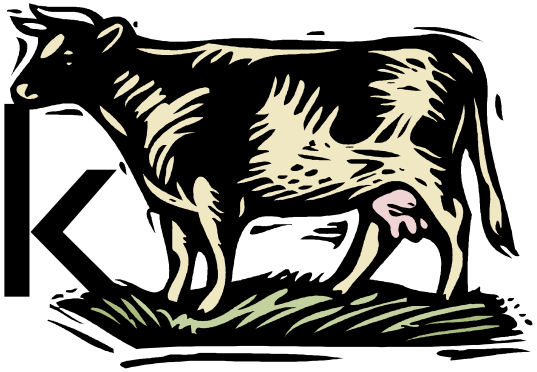
1. Implements should not be too heavy.

Cn't

2. Implements should be easily manageable

3. Implements should have easy attachment to the harness.

4. From the weight of tillage implements, it is possible to estimate its draft force requirement.

Thank  U