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University of Gondar

Working Animal Management (AnPS 3106)

3rd Year DVM Students

By Ayalsew T. (MSc) **Gondar, Ethiopia**

Brain storming

Define the following terminology?

a. Working animal

b. Management

1.1.Definition of Terminologies

- **A working animals**: is an animal usually domesticated that is kept by humans and trained to perform tasks
- **Draught and pack animals**: refers to farm animals that employed for the purpose of on-farm and off-farm activities.
- **Draught animals**: refer mainly to oxen which used for land cultivation.
- **Pack animals**: refer to equines (donkeys, mules and horses) and camels which mainly used for transportation purpose
- **Animal traction:** refers to the use of draught and pack animals to undertake on-farm and off-farm tasks.
- **Harness**-a combination of leather straps, worn by a draft animal, permitting it to pull, or pull brake, and back up a load. Bridle and lines are also part of the harness

Brain storming

What is the difference b/n the following terms

- Working Animal VS Farm Animals?

- **Farm Animal:** mammals or birds commonly kept for agricultural purposes, which include the production of **food, fiber, or fertilizer** and/or the use of animals for **farm work**.

- **A working animals**: is an animal usually domesticated that is kept by humans and trained to perform tasks

Terminology

- **Burro:** Used to define wild, free roaming donkeys
- **Donkey:** Usually referring to domestic stock
- **Flehman:** Flipping up of the upper lip in order to gather scent in the mouth
- **Foal:** Baby donkey
- **Founder**: Deterioration of the bone within the hoof, usually caused by high protein feeds.

Cont…

- **Hinny:** Hybrid cross between a male horse and female donkey
- **Jack:** Male donkey
- **Jennet:** (or jenny) Female donkey
- **John:** Male Mule

Cont…

- **Molly**: Female Mule
- **Mule**: Hybrid cross between a male donkey and a female horse
- **Withers**: Highest part of the shoulder, used to determine height
- **Ass:** Common name of Equus Asinus. Replaced with “Donkey” in the late 18th Century
- **Bray:** Distinctive “Hee-Haw” sound of the donkey

Brain storming

What are the importance of working animals in Ethiopia

and in the world ?

a. Economical

b. Social

c. Cultural

1.2. Role and socio-economic importance of draft animal in Ethiopia

- Recent information to the situation regarding the contribution of draught animal power to the economies of developing countries is scarce,
- Although in 1998 it was estimated that working animals, including horse, produced 75% of traction energy in the developing world
- It has been suggested that more than half of the world's population depends on animal power as its main energy source .

- Today, draught animals and humans provide an estimated 80% of the power input on farms in developing countries
- But traction animals are often neglected in the allocation of resources such as food, shelter and appropriate equipment,
  - Because members of the poorest section of the society, who cannot afford motorized transportation.
- Draught animals play an important role in agricultural production and transport sectors in sub- Saharan Africa in general and Ethiopia in particular

Cont…

- Zebu oxen are the main work animals and in pairs, they are primarily used for seed-bed preparation and threshing.
- Where oxen are in short supply, horses, mules and donkeys are paired with the same species or with others to plough the land.
- All three equine species are used for transport in most parts of the country. In the lower highlands (below 1500 m.a.s.l) and drier regions, camels are used exclusively as pack and transport animals (FAO, 2003).
- Farmers generally require animals that are affordable, well adapted and easily replaced.
- In contrast to cattle, buffalo and camels, which are usually kept for their milk and meats as well as work, whose hides are cured for leather, and even their dung has a number of uses
- equine by-products are not generally used except as source of energy, therefore cheaper to replace them than other large animals.

Role and socio-economic importance of draft animal in Ethiopia and other regions

- ✓ Animal tractions an appropriate, affordable and sustainable technology which is increasingly being used in eastern and Southern Africa.
- ✓ The benefits of animal traction are:

1. Providing smallholder farmers with vital power for cultivation and transport.
2. Empowering rural communities and providing an alternative but complementary power option.

3. Providing employment and transport, and promoting food production and security, thereby leading to a higher standard of living.
4. Making marketing and trading easier.
5. Relieving women of the burden of transporting water by hand, head or wheel borrow.
6. Making transportation of the harvest and shopping easier.
7. Improving fertility by ploughing manure from draught animals back into the soil.

Cont…

- According to Feseha G/ab (1997) donkeys in Ethiopia are used for over fifteen types of tasks, which include the following:

❖ Transportation of grains from fields to farmsteads.

❖ Transportation of grains to local markets or pick-up points.

❖ Transportation of agricultural inputs from distribution centers to farmsteads.

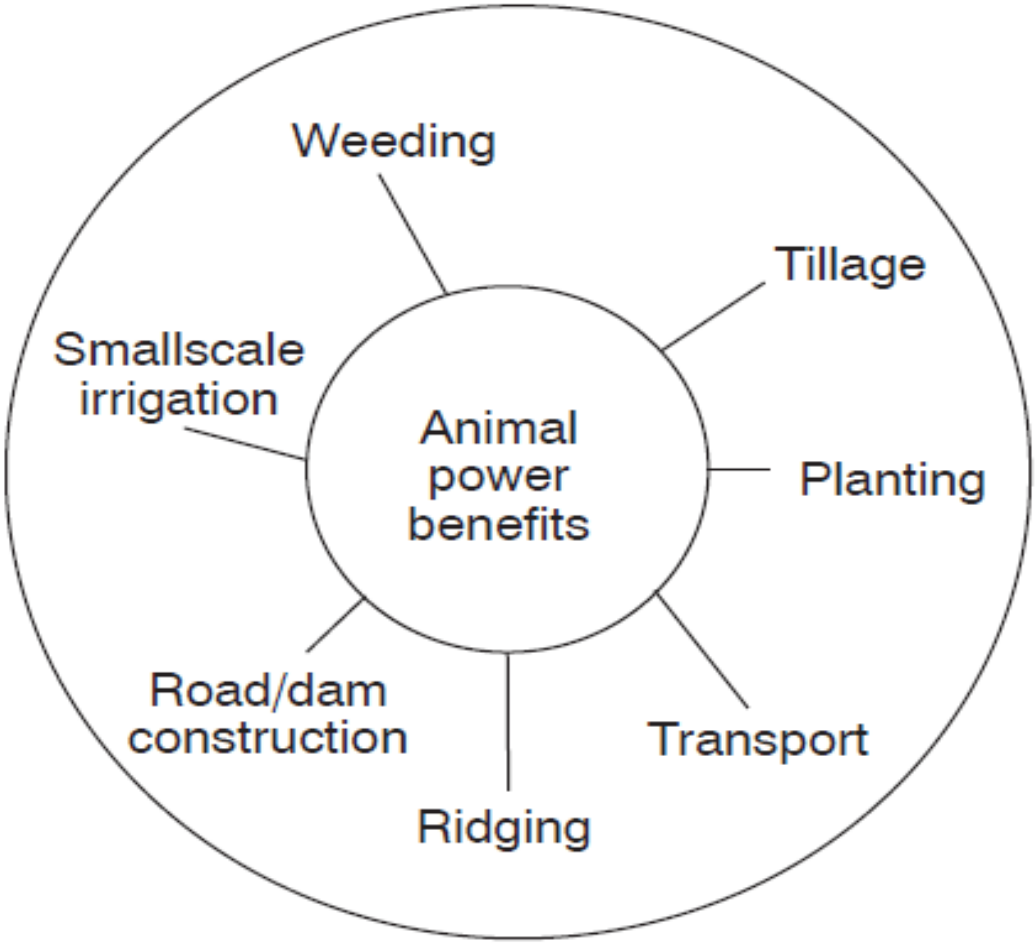
❖ Transportation of fuel wood, animal dung and charcoal for the rural and urban sectors.

- Transportation of water in rural as well as urban centers.
- Transportation of relief supplies from distribution centers to farmsteads.
- Transportation of cash crops such *Khat*, potatoes, onions and other vegetables from fields to local markets or pick up points.
- Transportation of the sick, aged, dead, disabled, persons, etc.

Cont…

- Threshing of cereal corps and beans by trampling.
- Transportation of earthenware such as pots and plates.
- Transportation of animals feed such as hay, teff, wheat, etc.
- Transportation of war hardware and ammunition.
- Biological control of weeds in maize fields (rift valley area).
- Plowing of land in association with oxen (rift valley area).
- Provision of pulled power for the transportation of various commodities

Animal Power benefits



Benefits of animal traction

1.3. Major constraint of draft animal power utilization

- absence of farmer involvement
- little or no literature on how to use and maintain equipment
- inadequate maintenance services at village level
- inadequate research and poor extension

- animal implement disproportionality
- use of inappropriate harnesses
- limited use of animals throughout the year
- poor health care
- lack of information exchange
- absence or little attention by agricultural education curricula and ignorance of gender awareness
- Poor training and extension service for farmers.
- Overloading and inadequate loading technique

Con't

- The average amount of load that should be carried or pulled by draft animals should be as follows
- Pack animal- can carry a load 25% of their body weight
  - $W_{load\ horse}$ = 25**%BW where**
    - ✓ $W_{load\ horse}$ **= Work load of horse**
    - ✓ **BW = body weight of horse**
- For pulling cart- it can pull 5*the load it carry
  - $W_{load\ cart} = 25\%BW_{horse} * 5$

Con't

- Example – calculate the load that a horse with 300kg body weight can pull or carry

  A) Without using pulling cart?

  B) Using pulling cart?

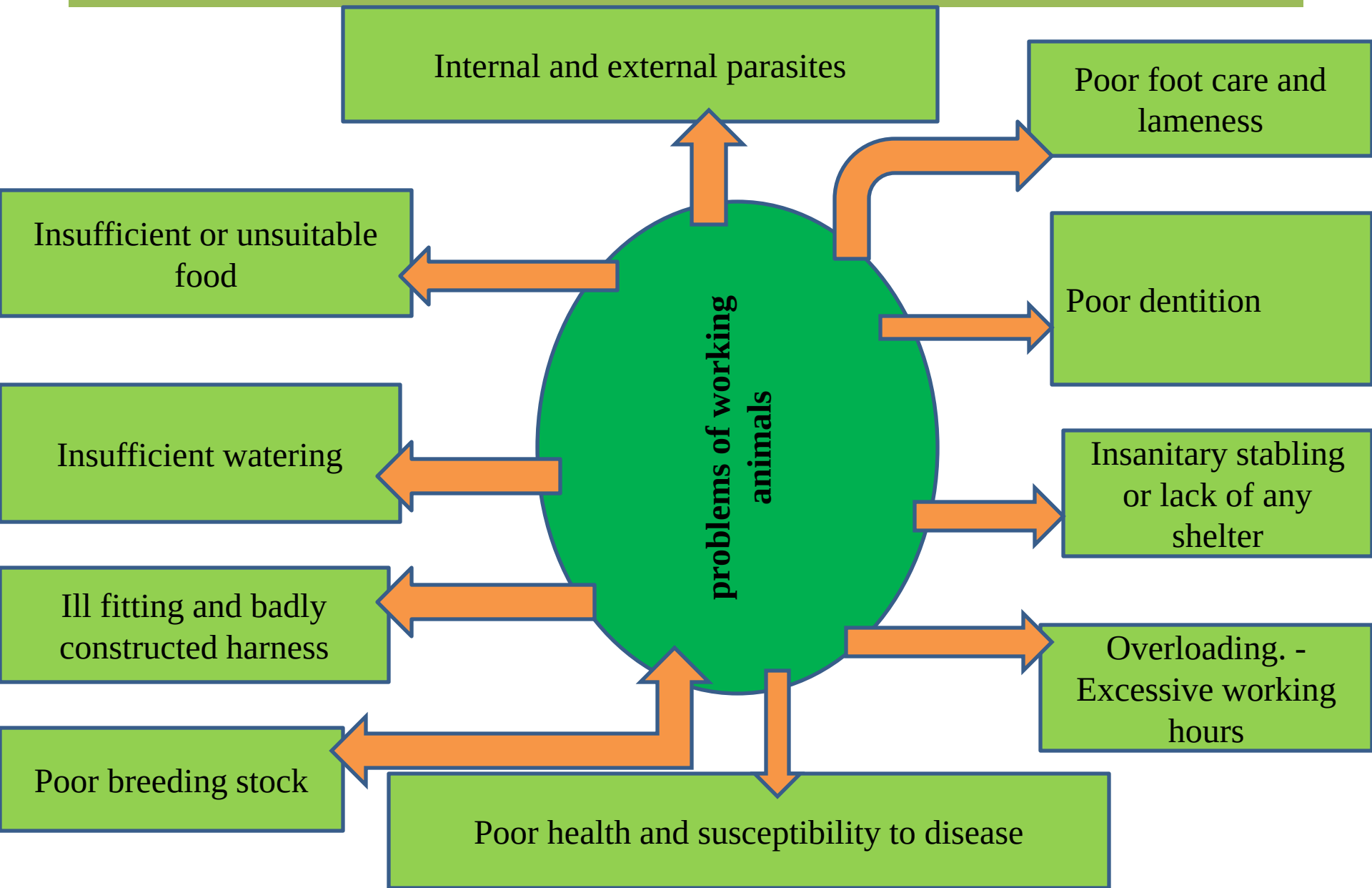
- $W_{load\ horse} = 25\% * Bw_{horse} = 25/100*300$ =75kg
- $W_{load\ cart} = 25\%*BW_{horse}*5 = 25/100*300*5 = 375kg$

  – Overwork/insufficient rest

  – Inadequate equipment

  – Inhumane handling (poor attitude of farmer)

Major Challenges of draft animal



Chapter Two

Working Animal Species and their distribution

Common Species of Draft animal power

- The following species are used as draught animals in various parts of the world:
  - Cattle (mostly oxen and cows)
  - Buffalo (mostly males)
  - Equines (horses, mules and donkeys)
  - Camels and ilamas
  - Elephants (used for logging in forests)
  - Dogs (used for transportation in snow-covered areas)

CSA 2016/2017

Family of Bovidae

- Oxen, Cow and Buffalo

✓ Cattle and buffaloes are the species predominantly used in agriculture operations to pull agricultural implements

✓ (e.g. plough, weeder, paddler, etc.) and devices (e.g. cane crusher, water lifter, etc.)

- Milk Production
- Meat production

- Draught (Oxen are used for ploughing , for harrowing, harvesting potatoes, rowing up and inter row cultivation and for transport and as well as timber haulage in Ethiopia)
- Farmers generally require animals that are affordable, well adapted and easily replaced.
- In contrast to cattle, buffalo and camels, which are usually kept for their milk and meats as well as work, whose hides are cured for leather, and even their dung has a number of uses (Pearson, 2005)

Cont…

- ✓ ***Oxen-cart transporting harvests to local market in Zimbabwe***
- ✓ **Single buffalo drawing traditional plough in Thailand**
- ✓ ***Land preparation using traditional animal-drawn plough in Ethiopia***
- ✓ **In Indonesia Terracing work using oxen**
- ✓ Bangladesh is a good example of this interrelationship, where up to 50% of draught animals are cows.
- ✓ Buffalo is the main draught animals in Asian countries
- ✓ Buffalo is mainly used for **recreational** purpose in European country

Land preparation using traditional animal-drawn plough

Chisel ploughing in Ethiopia

Single buffalo drawing traditional plough in Thailand

Oxen-cart transporting harvests to local market in Zimbabwe

Terracing work using oxen in Indonesia

Family of Equidae

The following is includes equine species

- Horses, donkeys and mules belong to the equine group.
- **Horses** and **mules** are used for in agriculture operations to pull agricultural implements (e.g. plough, weeder, paddler, etc.) in the People's Republic of China, in South America and in Eastern Europe.
- In deserts and arid regions, this role is filled by **camels**.
- Donkeys are used extensively for drawing carts in the People's Republic of China and in Egypt.

- In other countries, donkeys and mules are mainly used as **pack animals**.
- In recent years, more African countries have been using donkeys for ploughing and carting.
- Yaks (long haired oxen of Tibet(China Himaliya)) are used in Tibet and adjoining areas both for haulage and as pack animals.
- Cattle are used in South American countries, and horses in Sweden,

Cont…

- **Donkeys** are usually harnessed in pairs or in larger teams of up to eight for agricultural work.
- Donkeys provide valuable work for the rural dwellers as the animal have great **patience** and are highly dependable
- A donkey can work for up **to four hours**, pulling forces of about 250 N.
- Donkeys are smaller than cattle, at 120 – 130 kg, but can often undertake much of the work that cattle can don:
- Donkeys can be used for **plowing** where soils are light and sandy.
- They may also be used for **riding, weeding** and **threshing**.

Cont…

- **Equine by-products** are not generally used except as source of energy, therefore cheaper to replace them than other large animals.
- Although in many countries including Ethiopia horses, donkeys and mules are kept mostly for **transportation**;
- There are few areas where **equine meat and milk** are consumed.
- In some areas of **North West Kenya** and **Southern Ethiopia**, donkey meat is a delicacy and the milk believed to treat whooping cough (Fred and Pascal, 2006).
- People in most **peri-urban centers** hire horses, mules and donkeys for commercial purposes such as carting goods and people and fetching water by fee.

Cont…

Use of donkeys in Most part of Ethiopia

- Crops from field to threshing ground
- Grain from home to market
- Grain to grinding mills
- Agricultural inputs from market to home
- Grain from market to home
- Vegetable crops to market
- Dairy products to market
- Fuel wood, dung cake and charcoal to market
- Water to home
- Household goods to and from markets
- Livestock feed to and from markets
- Disabled or sick people (in emergency cases)

Donkey transporting grain at Gondar town

Donkey helps people to earn more and remove the drudgery of carrying essential materials

Donkeys are used by farmers to bring their straw back to the home stead

Donkey carts are used in the flat land in the rift valley areas of east shewa zone

Donkey Pack transport can alleviate the burden of carrying loads for women

Family Camelidae

- They belong to the genus Camelus that consists again two species under it.

a. Camelus dromedarius (the dromedary/Arabian/one-humped camel/ the desert camel)

b. Camelus Bactrian's (the Bactrian camel)

- Camels are great interest for the lowland peoples and pastoralists in particular
- They are uniquely adapted to the lowlands of Ethiopia, and contribute significantly to the food security of pastoral households.
- Their most important use is for **milk** and **transport** of household and commercial goods.
- Domestic uses of camel include **carrying grain, commodities from market, large quantities of drinking water from wells** both for people and calves in dry season and ploughing.

Cont…

- Most pastoral campmates have at least one camel.
- Members of different communities exchange **male camels** for transport and female camels for milk
- Camels are also used as **bride-price** and as payment to blood compensation among the Somalis
- Camels are slaughtered for *Moulid* (Birth day of the Prophet Mohammed), wedding, funeral and when payment to blood compensation is effected in contractual agreement.
- A gift of camel is a sign of high honor and is used to **cement relationships** between mutually dependent groups and individuals.
- In Afar, culturally, a woman is **not allowed to drink camel milk** till 40 days after birth giving, believing that the lactating camel would die if the woman drinks milk.

Brain storming

How camel has adapted in harsh environment(take 2minut)

What are the unique characteristics dromedary camel (2minut)

Adaptive Features of Camels

- Camel is well adaptive to desert areas(Desert ship
- The main primary problems of the area are **scarcity of water** and **high ambient temperature.**
- The **availability of water** is the most important limiting constraint of this environment.
- During most of the periods of the year there is no sufficient rainfall.

- Other water sources such as rivers and streams are also very scarce and very seasonal.
- Drying up of these water sources is common due to **high dehydration** as a result of lack of cloud cover. The available ones, if at all, are salty
- Camels do possess **unique anatomical, physiological** and **behavioral adaptive features** which enable them to survive, produce and reproduce under harsh arid and semi-arid environment.

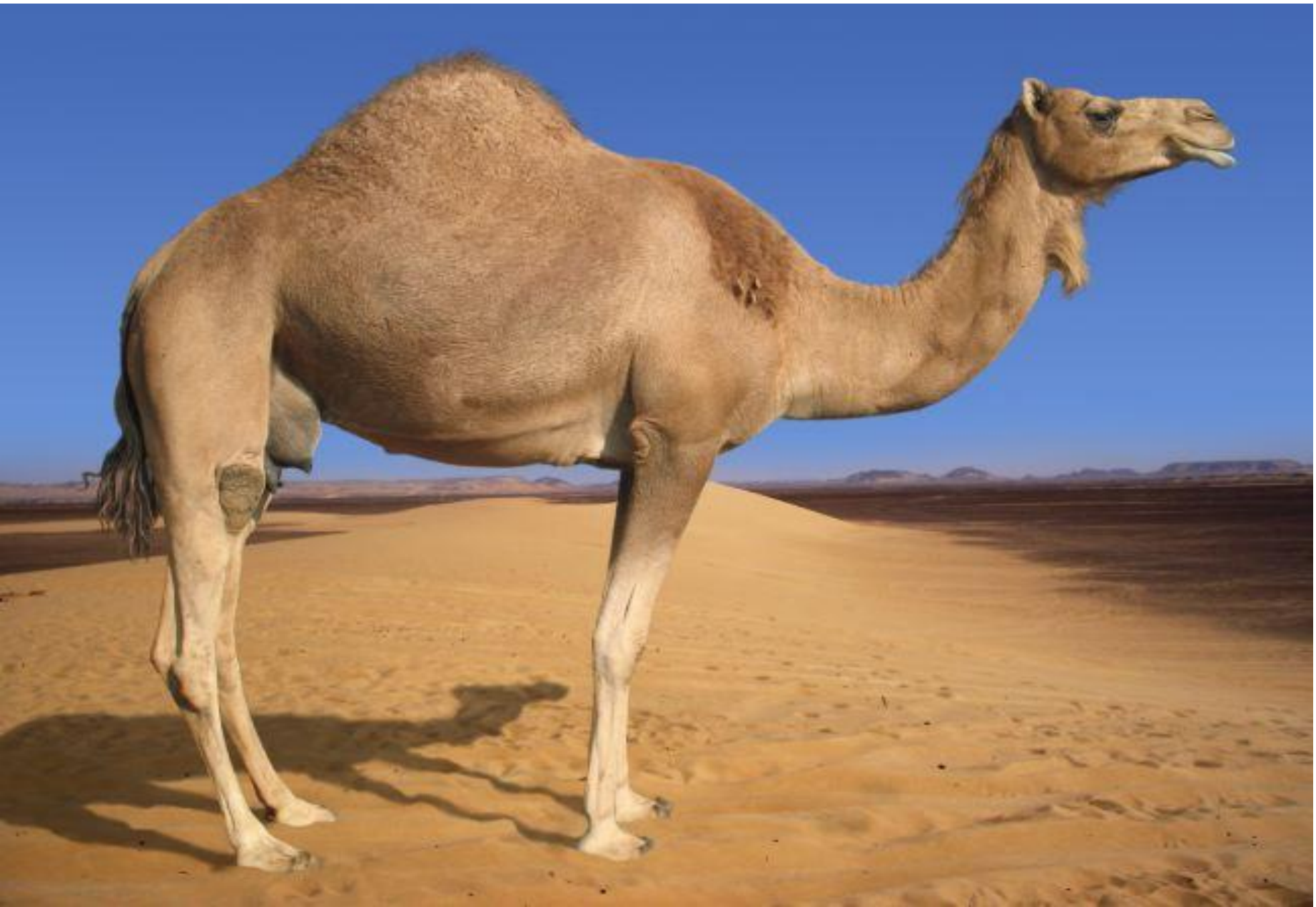
Anatomical Features of Camels

The following **anatomical features** are worth mentioning for their remarkable functions:

i. Long narrow body, Long legs and long neck:

- The long narrow body of the camels minimizes the surface area exposed to the direct solar radiation.
- the long legs and neck together enable the camel to browse from upper storey (3.5 m)
- Possession of long legs enables the camel to move very long distances (50km per day) and browse the sparsely distributed vegetation without difficulty.
- Long legs lift the camels body above ground and away from the **hot reflecting surface** and **cooler air** can pass underneath.

Camelus Dromedaries



Cont…

ii. **Pad-like feet**: It is referred as “tyre field with fat”

- The pad-like feet enables the camel to walk over soft sand without sinking
- It does not cutup soil’s surface unlike the hooves of cattle and small ruminants

iii. Fatty hump

- The fatty hump serves the **camel as energy store** and becomes useful when **browse is very poor.**
- It also serves as **insulator** from incoming solar radiation.
- Accumulation of fat only in a specific area, hump, leaves subcutaneous tissue fat free and this enables more efficient heat **dissipation** from the body.

Cont…

iv. Keratin pads in chest and knees

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

v. Keratinized epithelium on the lips

- enables to browse on the thorny vegetation like acacia

vi. Super orbital arch

- The super orbital arch protects the eye from the sun.

Cont…

vii. Thick eyelashes and translucent eyelids

- allows to walk through sand storms with their eyes are shut, thus protects the eye from the dust.

viii. Thick skin

- It acts as a protection barrier against the spinous plants which cause many wounds on the feet of horses and cattle.
- It is an insulator against incoming solar radiation.

ix. Nostrils

- The nostrils can be voluntarily closed and opened (posses sphincter muscles)
- They protect the camel from inhaling dust.
- They condense moisture leaving from the lungs (in the turbinal bones of nostril.

2. Physiological Adaptation

i. Low water turnover

- In comparison with the camel, sheep and cattle need far more water per day per kg body weight even when drinking water is available
- Camels drink far less frequently and take in relatively smaller volumes of liquid than do sheep, horses or cattle.
- Less water is required by the camel because the rate of water turnover is low.
- Most of physiological changes that occur in the camel during dehydration are water conserving mechanisms which keep the turnover low.

Cont…

These include:

A. Ability to fluctuate body temperature

B. Efficient sweating mechanism

C. Ability to reduce fecal and urine water loss

D. Ability to reduce respiration (O2 consumption)

3. Behavioral Adaptation

- Water and temperature control in the camel are assisted by many aspects of its **individual and group behavior**.
- Principal among these is a **preference for feeding** at night, in the early morning or late evening, or when the sky is clouded over.
- Camels on unrestricted rangeland and not confined in night enclosures will browse and graze at any time of the day or night.
- They tend to forage **more actively** at certain periods,
- As major feeding periods have been noted to occur just **before** and **just after sunset.**
- These and other similar observations led to certain management practices being used by military and transport formations during the colonial period in many countries.

Cont…

- Camels were **ridden** or **trekked** for relatively short periods in two or three stints(times) per day,
- Covering the pre- and post-dawn term, a further period in mid-morning and then perhaps another stage in the **late afternoon**.
- At very hot times camels tend to avoid, of their own volition, feeding around midday.
- At this time it is likely that camels would spend time ruminating or resting, and expend energy on feeding at less stressful times of the day or night.
- Under restricted herding conditions where camels are confined at night, behavior cannot be described as 'natural' as nutritional requirements have to be met in a shortened period .
- Rumination and rest take place for the most part during the hours of darkness.

Cont…

- One study carried out under these conditions in southern Ethiopia has shown that the average time out of the night paddock was 11.6 hours per day and that, of this period,
  - 62 % was occupied in feeding,
  - 23 % in walking,
  - 8 % 'idling (inactive)',
  - 6 % ruminating and
  - 1 % drinking.
- The **total amount of time** spent in daytime activities and the **proportion of time devoted** to each activity varied with the **season**.

Cont…

Elephants

- Elephants are used for logging in India, Myanmar, Sri Lanka and Thailand. For logging operations,

Doges

- Dogs are used for pulling sledges in snow-covered regions

Chapter Three

Selection and Training of Working animal

Objective of the session

- Understand the selection criteria of working animals
- Know the comparative advantage and dis advantage of each working animals
- Knowing the Age determination criteria in working animals
- Under stand the Training principle in working animals

Brain storming

What do you think the factors that need to be considered in selecting/choose of working animals?(3min)

Which animal is the most preferred in the Learners' locality and why? (3min)

3.1. Selection criteria of working **animals**

The primary criteria for the selection of working animals employed are:

- availability,
- Price,
- adaptiveness to the region and conditions existing on the farm (climate, fodder availability, husbandry),
- suitability of the work to be carried out,
- Possibilities of multiple utilization.

Cont…

- The animal species which come into question for animal traction can be distinguished according to possibilities of **multiple utilization**.
- **Equidae,** for example, are almost exclusively used **mono functionally**, as there is normally no demand for their meat and milk in most parts of Ethiopia.
- with the exception of the reproductive capacity of the female animal they are kept solely for the purposes of labour power.

- In contrast, aside from **their mobilization**, cattle, buffalo or camels are often kept for their supply of meat.
- **Female** animals fulfill the function of both **reproduction** and the **supply of milk**.
- With a decrease of labour strain (e.g. due to only seasonal use) the comparative advantage of the **multifunctional utilization** of a draft animal gains in importance.
- For only on the basis of the exploitation of further possibilities of use of the animal can the **year-round quite high investment** for keeping and feeding be justified.

Cont…

- Very few studies are available on the **annual number of work days/hours** of different draft animal breeds.
- For **annual working time** of draft oxen on smallholdings in Ethiopia gives an approximate figure of 65 days,

❖ whereby the work is poorly distributed throughout the year (about 50 days of seedbed preparation with an average **5.5 hours daily**, as well as 15 days for threshing).

- In comparison, studies on the use of mules on smallholdings in Morocco (grain, sugar beet, cotton and vegetables) shows up a double amount of 720 hours annually,
- which are evenly distributed throughout the year.
- The types of **feedstuff resources** available locally also play a decisive role in the selection of draft animals.

❖ In Bangladesh for example the **limited fodder resources** on the farms must be used at an optimum due to the high population density and large number of animals

- This has led to an increased use of draft cows.

Cont…

- In Burma, where sufficient fodder energy is available because of the widespread cropping of oil seed, a differentiation of utilization was observed insofar as only **male animals** are used for labour (Lindsay, 1986).
- In addition, the demand for animal products (meat, milk) as well as the **prestige value** of the animals (e.g. horses) plays a significant role in the question of multiple use of draft animals.
- An **absolute lack of draft animals** can lead to an increased labour mobilization of female animals under harness.
- **Indigenous breeds** tend to be well adapted to the local climate, feed availability, diseases and to traditional management systems.

Brain storming

- List down the possible advantage of **Cattle as draft animal as compared to other draft animals?(2min)**
- **List down the possible disadvantage of cattle as compared to other draft animals?(3min)**
- **What are the comparative advantage of equine vs Camel ?**

Comparative Advantage of working Animals

A. Cattle

- Employed as draft animals in **all climatic regions** where rainfed cropping is carried out in the tropics and subtropics.
- Oxen are some of the **most powerful draught animals** currently used in south and , Eastern Africa but they are **slow and labour intensive**.
- They are generally used for **heavy work** where speed is not essential (ploughing and pulling heavy carts and wagons).
- **Ripping and planting using oxen**
- Cows can be used where the **work is light** and **infrequent** (planting and cultivating).
- Bulls can also be used as part of a span(distance).

Advantages

- high endurance
- use of simple harness
- low fodder demands
- multiple use possible (meat, milk)
- trypanosome tolerant breeds
- draft cows: simpler training
- own reproduction

Disadvantages:

- slow pace
- Draft cows: low draft power, working time loss during tile of calving

B.Horses and ponies

- Horses and ponies are mostly used for **riding in highland** areas.
- They provide **strong, fast transport** but do not generally have the **hardiness** of other draught animals.
- They may be used for **ploughing, harrowing, planting, weeding** and **transport**.

- These animals have not been used as widely as oxen as a result of **horse sickness** which occurs in low-altitude areas.
- Horses are used to **pull carts** in the rural areas.
- Sometimes “thoroughbreds” are bought cheaply from the racing industry.
- As they have not been bred as draught animals, they do not do well and generally do not live long.

Advantages

- more rapid pace
- intelligent
- high prestige value
- Recreational purpose
- Own reproduction
- Adapted in mid and high altitude

Dis advantage

- higher price
- demand of high quality fodder
- high husbandry demands
- complex harnessing required
- Not appropriate for lowland area
- not trypanosomatolerant
- no slaughtering value

C. Donkeys

- Donkeys provide power for agriculture and transport at the low cost.
- Donkeys **adapt well** in dry areas.
- They **eat less than cattle** and for this reason do better than cattle under **drought conditions** and in heavily stocked areas.
- They are also **lighter** and **smaller** than cattle.

- Donkeys can live a **long life** and can be worked up to 25 years of age.
- They can carry goods and people on their **backs in hilly** as well as flat areas, pull carts, turn mills and waterwheels, cultivate fields.
- Carts can be pulled **faster** than in the case of oxen, but donkeys are better suited to **lighter field work** and cannot work for long periods.
- Women and children can also handle donkeys.
- The animals are very patient, hard working and dependable.

Advantages:

- low purchasing price
- low fodder and husbandry
- high endurance and draft power in relation to body weight
- docile spirit
- well adapted to semiarid locations
- easy guiding under harness (often by children)
- sure-footed

Disadvantages:

- low status value
- low absolute draft power
- susceptible to harness sores
- not trypanosoma tolerant
- no slaughtering value

D. Mules

- Mules are **strong, intelligent, hardy** and **hard-working** animals.
- Because they are **large animals**, they are more easily used by men than by women or children.
- They **cost the same as oxen**, but are considerably more **expensive** than donkeys.
- Mules can be used for **ploughing, harrowing, planting** and logging.
- They can also be used for packing and to pull carts and wagons.
- The animals can work on **poor quality feed**, under hard conditions up to an age of 35 years

Advantages:

- low fodder and husbandry demands
- resistant constitution
- high draft power
- sure-footed
- rapid pace

Disadvantages

- higher price
- not fecundity
- not trypanosoma tolerant
- no slaughtering value

E. Camels

Advantages:

- well-adapted to arid and semi-arid locations
- low water requirements
- rapid working pace
- multiple use possibilities (milk; meat)
- High prestige value
- Own reproductive

Disadvantages:

- slow reproduction
- inappropriate draft angle due to height of animal
- poor guiding and maneuverability due to long harness span
- Labor intensive during training and plowing

Brain storming

- What are the helpful criteria for judging a draft animal's value.(selecting a good draft animal).(2min)

- Q2.In your local area what criteria used farmers to select the best /good draft animals ?(1min)

Selection of individual working animals

- Once farmers decide what kind of draft animal will be used, they must be able to choose individual animals which are
  - sound ?
  - trainable
  - have a considerable work expectancy and
  - re-sale value.

- **Selecting a good draft** animal is a matter of evaluating both **physical** and **behavioral** attributes.
- **Age, sex, conformation** (BCS), and **temperament** are helpful criteria for judging a draft animal's value.
- The farmer's total animal needs must be noted when judging an individual animal.
- If it is to be used as a pair, it should be roughly the **same age** and **size** as its work mate, and should be the same sex.

Brain storming

- How farmers know/determine the age of animals(bovine and equine) during purchasing working animals(2min)
- Do you have an experience to identify the age of cattle with out record information?(2min)

Age determination of working animals

- Ideally, farmers should raise their own draft cattle or purchase them when they are **very young**.
- This allows the farmers to provide **proper nutrition** during the critical **growth stage** as well as to **observe and shape** the animal's **behavior** long before it is put to work.
- Oxen are normally put to work between **the ages of three** and **four years.**
- They may be trained at **two to three years of age** and given light work for a season.

- However, before the age of three, oxen have little power, and hard work can **stunt their growth** or cause **abnormal** development of bone and muscle.
- After the age of four, animals may be **difficult to handle** and train; they must be broken of old habits before their power can be used.
- Although oxen can work until they are 12 or older, many farmers prefer to sell them as soon as their work capacity tapers off.
- A common practice is to work oxen hard until age **seven or eight,** use them as a reserve or alternate animal (or pair) for a season or two, and then sell them for butchering.

Determining Age of bovine by Their Teeth

- When buying an ox, the purchaser can determine the animal's age by **counting its teeth**.
- Because the approach of an unfamiliar person may cause the animal to shy or to struggle, it is best to have the owner open the animal's mouth.
- Otherwise restrain the animal and pry open the mouth by pulling up on the nostrils and down on the lower jaw.
- Cattle have **front teeth** only in the **lower jaw**.

- Temporary teeth appear at **one month**.
- The **first permanent teeth** appear at age two.
- By **age five**, the animal has a full set of permanent teeth.
- The age of older animals can be determined by observing the wear patterns of the teeth.
- An alternate method is to **count the number of rings** on the animal's horns;
- Each ring corresponds to one year of growth, the first ring appearing at age two.

Age of Calf

The calf have eight milky teeth. Therefore its age is below 1 year.

The ox have four permanent teeth and four milk teeth . Therefore its age is 3-4 years.

The ox has eight permanent teeth. Therefore its age is more than six years

Age determination by help of horn

- Determination of bovine by counting the no circle in the horn
- Formula calculation
- Age = N+2

Where N is number of circle on horn

e.g. number of circle on horn is 8, what is the age of the animal

Age = 8+2=10

Therefore the age of animal is 10

2. Determination age of animal with help of horns

For ex.cow

Number of circle of horn is 5

Formula and calculation

Age=N+2 N=number of circle on horn. N=5

=5+2

=7 years

Therefore age of Cow is 7 years.

Number of circle of horn is 7

Fromula and calculation

Age=N+2 N=number of circle on horn. N=7

=7+2

=9 years

Therefore age of Cow is 9 years.

Selection task-

1. Video Clip of Horn of Cow.

Sex of Bovine Animals

- Sex has a bearing on the power and temperament of draft animals.
- As a rule males tend to be bigger, more powerful, and more difficult to train than females.
- **Females** have less endurance and, of course, cannot be used when they are carrying or nursing young.
- Studies of African cattle have shown that within the same breed and age bracket, **males** tend to be 50-100 kg heaver than females and can work twice as long during a given day(bulls, five to six hours; cows, two to three hours).
- Studies from temperate zones show more pronounced differences in **size** and **powe**r.

Cont…

- Such evidence makes it clear that there is an **advantage to using male animals**.
- However, the males of some breeds of cattle and buffalo have proven particularly **difficult to train**.
- In these circumstances, the animals are castrated at the age of one and a half years in order to make them more docile.
- There is disagreement about the value of castration, however. Some farmers feel that this makes the animals **lazy or interferes** with their physical development.
- Tests have substantiated that castrating eight-month-old calves **retards their growth.**
- Other tests, comparing two-year-old castrated and entire male buffaloes, showed that the animals **performed equally well**.
- **Castration** also limits a small farmer's ability to raise his own stock, especially if he owns only a few animals.

Summary

Animals should be chosen according to:

- the type of work to be performed,
- the local environment,
- socio-economic conditions and
- the availability of local animals.
- Age of Animal
- Sex of Animal
- Indigenous breeds tend to be well adapted to the local climate, feed availability, and diseases and to traditional management systems.

Comparative advantage of working animals

- The criteria that are choice individual animals are:

✓ **Environment-**adaptation

✓ **Endurance** ,,,,,,, based on the type of work

✓ **Speed** …… based on the work required

✓ **Behavior** ….. Docile and temperament

- Donkey :- low social value
- Cattle : wide adaptation
- Horse : high social value
- Mule : odd B/hr
- Camel: better in hot climate and scarce feed& higher price

Age determination of equine

- **Age of Equine** Animals Recommended ages for training and working equine animals are very similar to those outlined for cattle.
- However, in practice, these animals are worked until they are older because their meat is less valuable.
- As the animal grows older, the enamed wears off the tooth, giving it a smooth, white grinding surface (the dark center disappears).
- The **teeth grow longer** and begin to slant; the entire mouth elongates.
- Compare the side views of the four-and thirty year-old horse and note the increased pointing of the jaw.
- The correct method for opening the animal's mouth is as follows:
- Place the palm of one hand under the animal's jaw;
- Insert the thumb and middle finger into the animal's mouth on either side of the lower jaw, at a point behind the teeth;

Determining Age of Horse by Their Teeth

- The art of determining the age of horses by **inspection of the teeth** is an old one.
- It can be developed to a considerable degree of accuracy in determining the age of young horses.
- The probability of error increases as age advances and becomes a guess after the horse reaches 10 to 14 years of age.
- **Stabled animals** tend to appear younger than they are, whereas those **grazing sandy areas**, such as range horses, appear relatively old because of **wear on the teeth**.
- Horses, like people, vary considerably in vigor and longevity.
- In general, they have passed their physical peak when they reach 9 to 10 years of age.
- At this age, the chance of an unsoundness being present has increased.

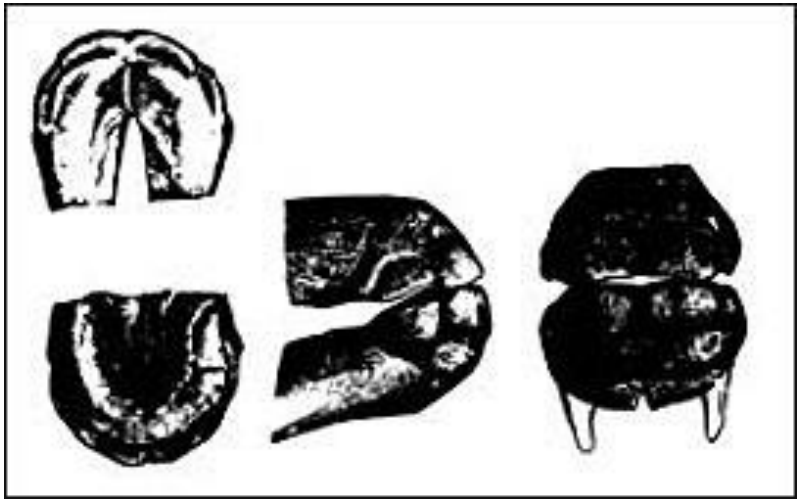
Cont…

- Age determination is made by a study of the 12 front teeth, called incisors.
- The two central pairs both above and below are called centers, pincers, or nippers.
- The four teeth adjacent to these two pairs are called intermediates, and the outer four teeth are designated as corners.
- Canine teeth or "tusks" may appear midway between the incisors and molars at 4 or 5 years of age in the case of geldings or stallions, but seldom appear in mares.
- Adult horses have 24 molar teeth.

Cont…

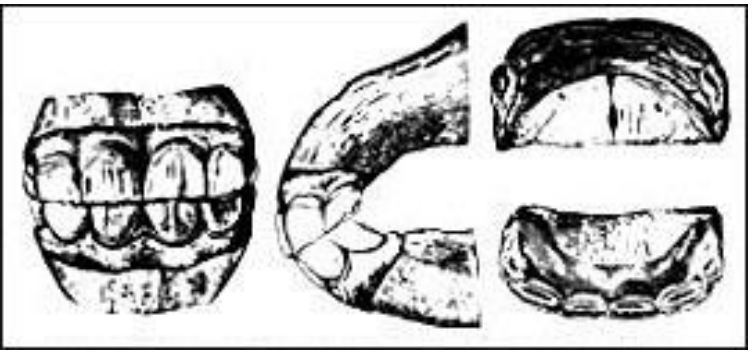
There are four major ways to estimate age of horses by appearance of their teeth:

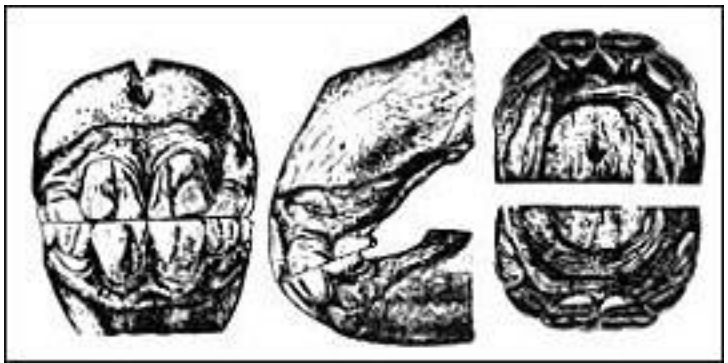
- Occurrence of permanent teeth
- Disappearance of cups
- Angle of incidence
- Shape of the surface of the teeth



F.g 1. The mouth of a colt at birth. None of the teeth have penetrated the gums.

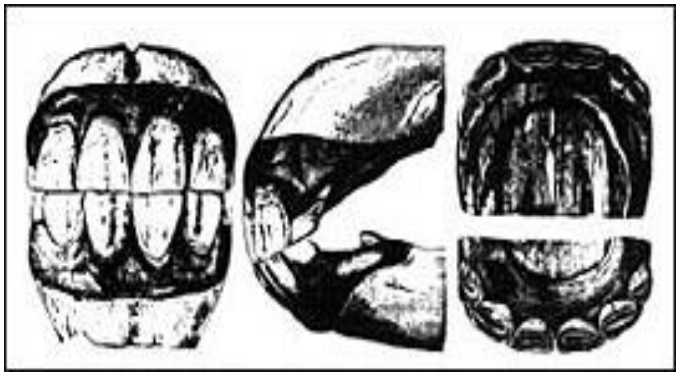
1. Occurrence of permanent teeth





- **One year of age**. All temporary teeth are present. The corners are not yet in wear.
- **Two-year-old** mouth showing corners in wear. Temporary teeth may be identified by the well-defined neck joining root and gum, a lighter color and smaller size than permanent teeth.
- A typical **3-year-old** mouth showing the large permanent center teeth, both upper and lower. Contrast these with the small, light-colored temporary teeth shown in the previous figures.

Cont…



- Note the well-developed permanent centers, immature intermediates and milk teeth at the corners in this 4-year-old mouth.
- Tusks or canines have appeared.
- At 5 years, all of the temporary teeth have been replaced by permanent teeth.
- This is called a "**full mouth**." Although the corner teeth are well-matched from a profile view, they show very little wear in the view of the upper jaw.
- The upper centers are beginning to appear round on the inside back surface. Cups are very plain, both above and below, with little wear appearing on them.

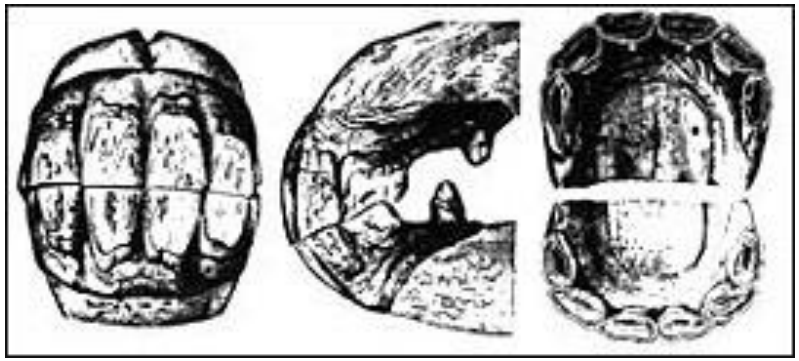
Cont…

- Horses have **two sets of teeth**, one temporary and one permanent.
- Temporary teeth may also be called "baby" or "milk teeth.
- " **Temporary incisors** tend to erupt in pairs at **8 days, 8 weeks, and 8 months of age**.

- A well-grown 2-year-old may be mistaken for an older horse unless permanent teeth can be accurately identified.
- **Permanent teeth** are larger, longer, darker in color, and do not have the well-defined neck joining root and gum that temporary teeth do.
- The four center permanent teeth appear (two above and two below) as the animal approaches 3 years of age, the intermediates at 4, and the corners at 5.
- This constitutes a **"full mouth**."

2.Disappearance of cups

- This 6-year-old mouth shows some wear on the corner teeth as viewed from the side.
- Cups in the lower jaw in the centers should be worn reasonably smooth at this age.
- They show relatively less wear than is customary in the normal 6-year-old mouth.
- The dovetail or notch is apparent, but the angle of incidence shows little change.



Con’t

3.2. Training of Working Animal

- Training animals for traction involves an understanding between the trainer (yourself) and the animals.
- Reasons for Training Animals

  - Trained animals can do more work in a shorter time.
  - Trained animals hear and accept commands (voice commands).
  - Trained animals pull better, like a team with well-coordinated movements.
  - They are easier to control.
  - They are able to pull heavy loads for longer periods.

Con’t

3.2.1. Training Principles and Handling techniques

- To train animals properly the following principles should be considered

1. The approach must be simple, calm, patient, persistent, and the trainer needs to be firm (not to show fear to the animal).
2. There should always be a routine and a repetition of the training steps, so that the animal adopts the new behaviour.
3. Spoken commands and names should be few and simple such as: “Go”, “Turn left”, “Turn right”, “Reverse” or “Stop”. Remember to always use the same language during and after the training.

Con’t

4. Train either early in the morning or late in the evening so as to avoid the heat of the day.
5. Reward the animal for any positive behavior, then correct bad behavior immediately and don't reward. Rewarding the animal includes;
   - ✓patting on back,
   - ✓calling the animal's name,
   - ✓grooming him
   - ✓giving some feed.

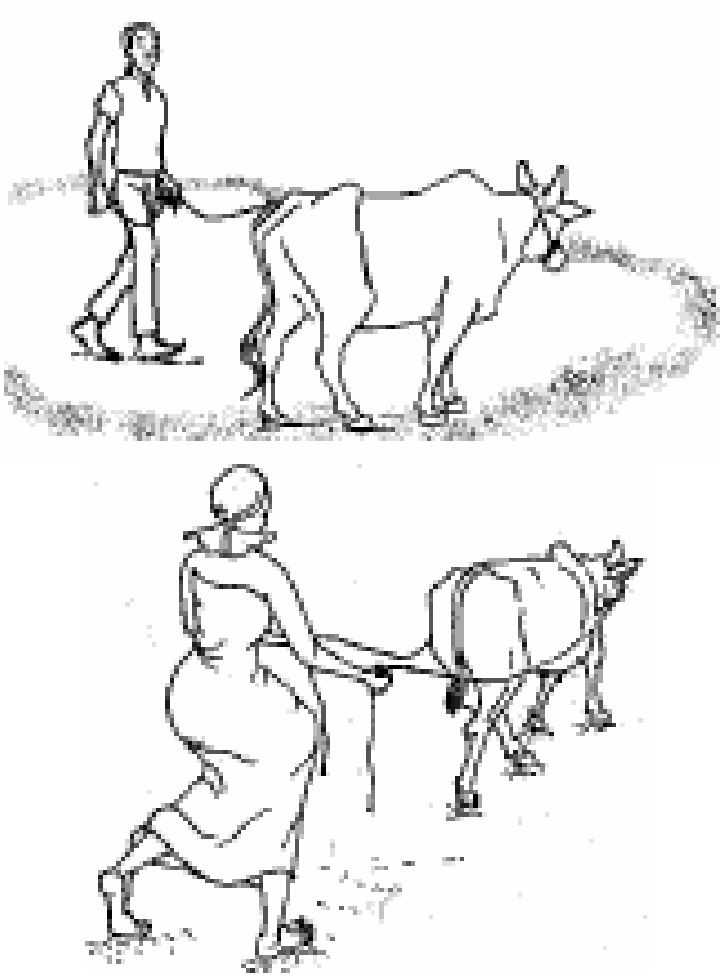
Con’t

6. Complete every step in the training programme before moving to the next one.
7. To carry out the training you need the following items:
   - ✓Animal,
   - ✓Proper kraal, a
   - ✓Good pegged training field and tools (ropes, different types of yokes, ploughs, weeders, loads and sledge)

Con’t

Steps of training

Step 1 Roping and Walking



- In this step the trainer works to create friendly conditions and to remove fears/suspicions from the animals.
- You should tie the oxen with ropes and make them walk in circles without yokes.
- To tie you can use halters or nose punched animals (as explained below).

Con’t

- Each time you train, you should reduce the rope that separates you from the animal, so that you come closer to it and this one keeps on gaining trust in you.

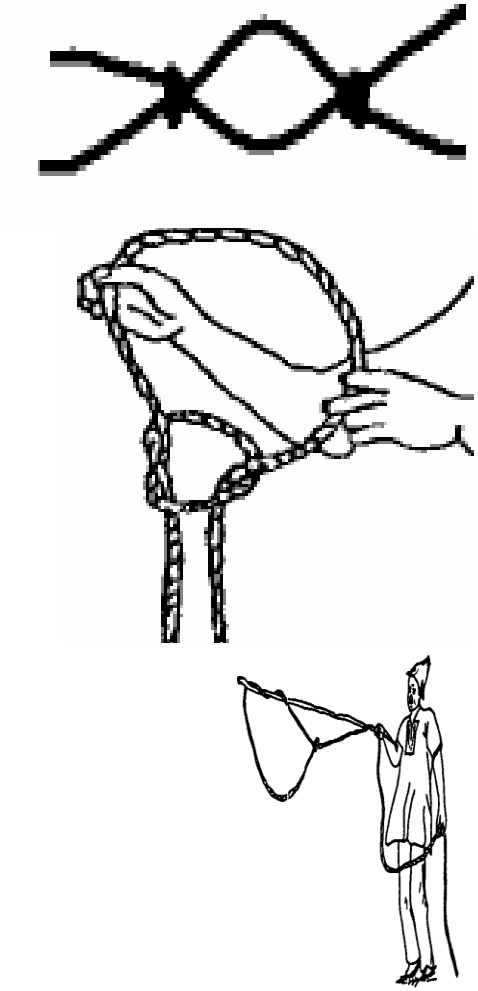


Fig. 2 The rope loop can often be placed more easily by holding it on a stick about 3 metres long

Source: Barwell & Ayre 1982

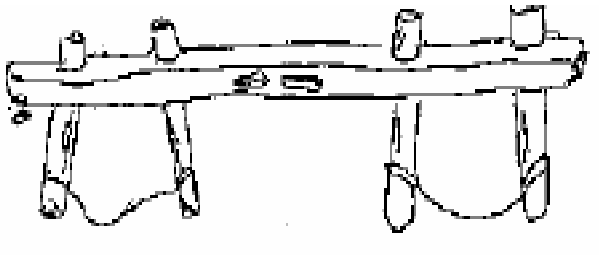
Con’t

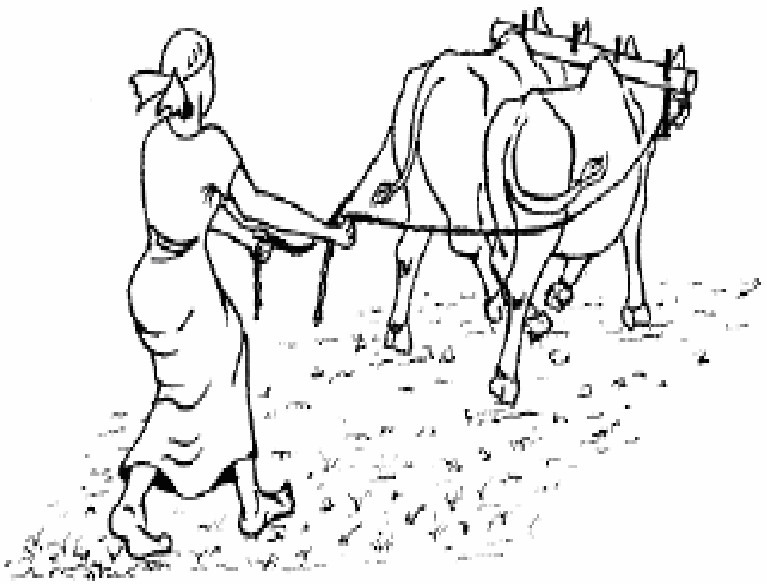
- These exercises take 2-4 hours per day for 2-3 days
- The animal should learn to accept commands and animal should be able to go left or right, to stop or start and even to go backwards following the voice commands.
- This step ends when a trainer is able
  - ✓ To move closer to the animal,
  - ✓ To put a rope around the neck,
  - ✓ Name the animals,
  - ✓ Make them walk or move and stop using simple commands.

Con’t

Step 2 Harnessing and Walking the Animals

- The trainer in this step works to train animals to be able to accept harnessing and removal of the harness while they are outside the kraal.
- In this step, harnessing or yoking is done in the kraal. After that, the animals are moved to the field





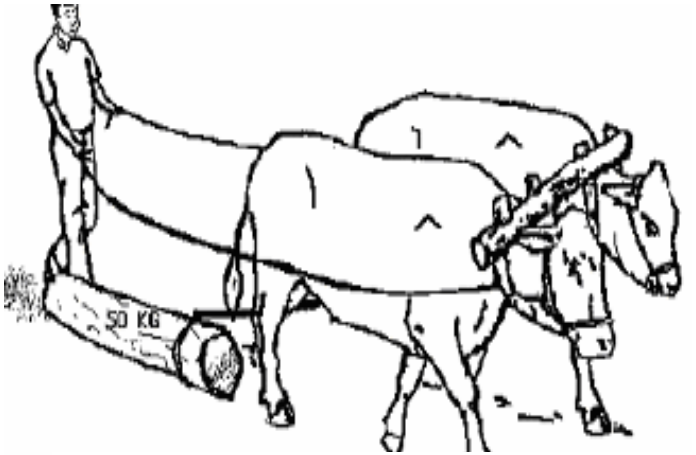
Con’t

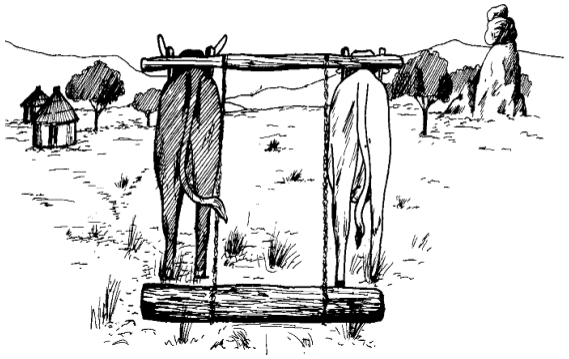
- These exercises should take 3-4hours per day for 7-10 days
- By the end of this step, the pair of animals should be able to move forward, stop, turn left, turn right and eventually turn and walk back using voice commands e.g. go, stop, turn-left, turn-right, about-turn, etc.
- The items used here include a yoke, ropes, a kraal, a training field and animal for training.

Con’t

Step 3 Pulling Loads

- The purpose is to train the muscles of the animals and for them to gain strength to pull heavy loads.
- During this step, varying loads are introduced from 20, 30, 40, 50 kg /log.
- **These exercises are done in the field, 2 hours per day, for 7-14 days.**
- Frequent rest should be allowed for the animals on training





Con’t

Step 4 Pulling Implements

- Implements such as ploughs, weeders, harrows, planters, etc, are introduced in this step.
- This can be done for 3-4 hours per day for 21-30 days

Chapter 4 Animal drawn implements

Tillage

It is a mechanical manipulation of soil to provide favorable condition for crop production. Soil tillage consists of breaking the compact surface of earth to a certain depth and to loosen the soil mass, so as to enable the roots of the crops to penetrate and spread into the soil.

4.1. Tillage Implements

Primary tillage

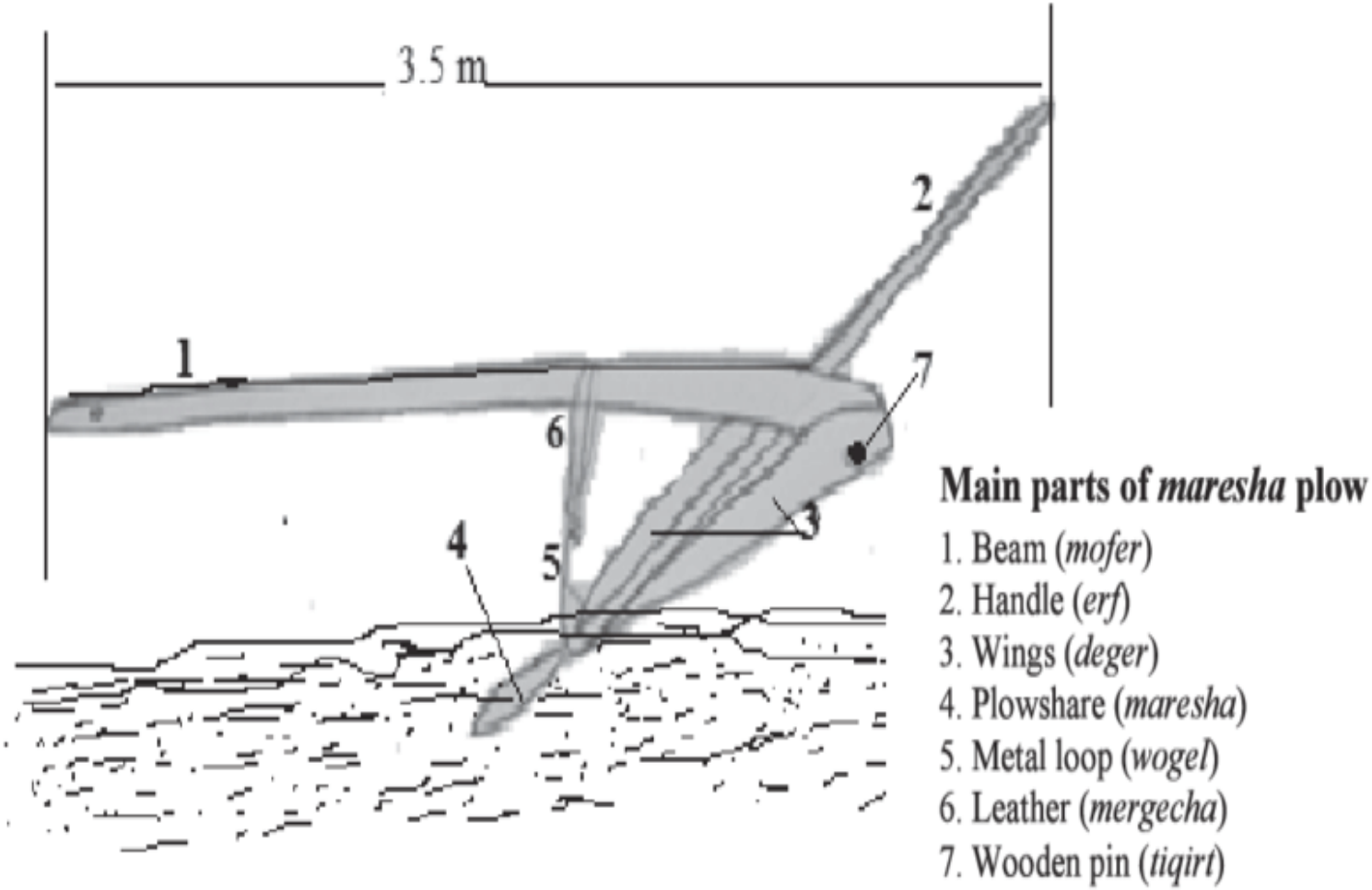
- It constitutes the initial major soil working operation.
- Designed to reduce soil strength, cover plant materials and rearrange aggregates.
- Animal drawn implements mostly include indigenous plough and mould-board plough.
- Tractor drawn implements include mould-board plough, disc plough, subsoil plough, chisel plough and other similar implements.

Primary tillage implements

- The most common traditional primary tillage implement is the Ard, a wooden plough with a steel share or tip, which operates like a chisel plough or ripper tine and does not invert the soil.
- Another common primary tillage implement is the steel moldboard plough pulled by a chain, which inverts the soil and buries surface trash and weeds

- A less common primary tillage implement in Sub-Saharan Africa is the ripper tine, used to break up plough plans.
- It is best used at the end of the cropping season when the draft animals are in peak condition and before the soil hardness increases during the dry season.
- Ripper used in reduced tillage systems for preparing land for planting through a cover crop or mulch.
- Ripper tine can be fitted to the standard plough beam.

- 4.1.1. single furrow mould plough



- 4.1.2. ridging plough (ridger)

Secondary tillage equipments

Secondary tillage

- Tillage operations following primary tillage to create proper soil tilth for seeding and planting
- Lighter and finer operations, performed on the soil after primary tillage operations.
- Consists of conditioning the soil to meet the different tillage objectives of the farm.
- Implements include different types of harrow, cultivators, levellers, clod crushers etc.

Secondary tillage implements

- Secondary cultivation is aimed at both reducing the **clod size** and **leveling the soil surface** or forming it into the required shape by **ridging**.
- Implements include leveling planks or leveling blades, both used to improve the evenness of the soil to facilitate equitable **moisture distribution** and to **improve tilth**

- Leveling blades are also used to level land for **irrigation systems**, together with **dam-scoops** for transferring soil over slightly longer distances.
- Dam-scoops are also used to construct soil conservation works, such as conservation **contours** and **storm drains**.

- **4.2. Planting Equipment's**

4.2.1. Furrow Openers or Row Markers

- The design of furrow openers of seed drills varies to suit the soil conditions of particular region.
- Most of the seed cum fertilizer drills are provided with pointed tool to form a narrow slit in the soil for seed deposition.

4.2.2. Planters

- A simple animal drawn semi automatic row planter developed at AIRIC.
- The metering of the row planter was made independent of ground wheels because ground wheel driven animal drawn row planters failed to work effectively in the rather rough and cloddy fields of the small-scale farmers.
- The new planter worked effectively wherever the *Maresha* worked.

- Farmers conducted trials on both open and closed furrow planters and reported that if they do not expect any rain seven days after planting, the closed furrow planting is advantageous.
- In contrast, when it rains in the first few days after planting crust formation can hinder seedling emergence for closed furrow planting.

- Farmers were also able to practice tie-ridging on the open furrow planted fields.
- Some farmers did this by cross ploughing while others lifted the row planter at 4-6m intervals along the furrow.
- Farmers who tested the row planter by comparing it with manual row planting and broadcasting of seeds and fertilizer came up with results.

4.3. Weeding Implements

- The animal-drawn inter row weeder is the same as the winged plough but with a reduced width of cut (20-40 cm depending on the type of crop and row spacing).
- The winged plough with 55 cm cutting width can also be used on widely spaced crops (75-80cm). It can be pulled by a single ox or a pair of donkeys.

- According to field tests by farmers the weeder reduced the time and labour required for manual weeding, up to 18 fold.
- It also earthened up row planted crops with the open furrow system and killed weeds between rows and buried those in the row.
- An exceptional advantage is that it cuts shallow and moves little soil, such that the young seedlings are not buried unlike the Maresha.

4.4. Transport Equipment

4.4.1 Carts

- Carts are two-wheeled vehicles.
- They can be small and light, pulled by one equine, or may be hitched to a team of equines.
- Carts are becoming very popular, especially in Africa, as they can be used on rough roads and throughout the year

- Where the use of specially fabricated animal-drawn carts is common in Africa, the preferred designs have been based on straight steel axles with sealed roller bearings.
- A simple steel cart frame is bolted onto the axle and a wooden or steel platform is fitted. While such designs are not particularly cheap, they are usually long lasting.

4.4.2. Pack Transport

- Donkeys, horse and mules are the main pack animals in most regions of the world.
- Mules are larger and stronger than donkeys, but donkeys are cheaper to buy and to maintain.
- The reliability of donkeys is legendary.
- Once trained, donkeys can follow particular routes with minimal supervision; they will wait patiently for several hours and they can often be trusted to return "home" unattended.

- Horses can be fast and efficient pack animals, although they are not as hardy as donkeys.
- Being more expensive to purchase and maintain than donkeys, horses are used mainly for high-value or strategic operations.
- Camels are excellent pack animals, unrivalled in their ability to cope with severe desert conditions, but they also are more costly than donkeys.
- It is rare for cattle to be used as pack animals.

Mouldboard plough

Ripper tine

subsoil plough

Disc plough

Dam scoop

Row planter

Row weeder

Chapter 5. Harnesses Systems of Draft Animal Power

5.1. Mechanical principles

- **A harness -** is a system or a device that is fitted on the body of the working animal.
- harness has several functions:
  - To control the working animal
  - To transfer/transmit power from the animal to the attached implement
  - To hold in place any load carried
  - To act as a braking system when pulling a cart.

Con’t

- A good harness has the following characteristics:
  - Transmits efficiently the pulling energy from the working animal directly to the attached equipment
  - Is smoothly-shaped, broad or padded so that the loads/forces on the animal’s body are spread over a large area
  - Does not have sharp edges which could injure the animal

Con’t

- Has joints on the outside, away from the animal’s skin
- Fits well so it does not cause rubbing, chaffing or wounds on the skin caused by excessive movement or friction
- Does not impede the animal’s movement or natural functions such as breathing or restrict the blood supply to the tissues
- Is affordable, durable, and easy to maintain and clean.

5.1.1. Approach to Mechanical principles

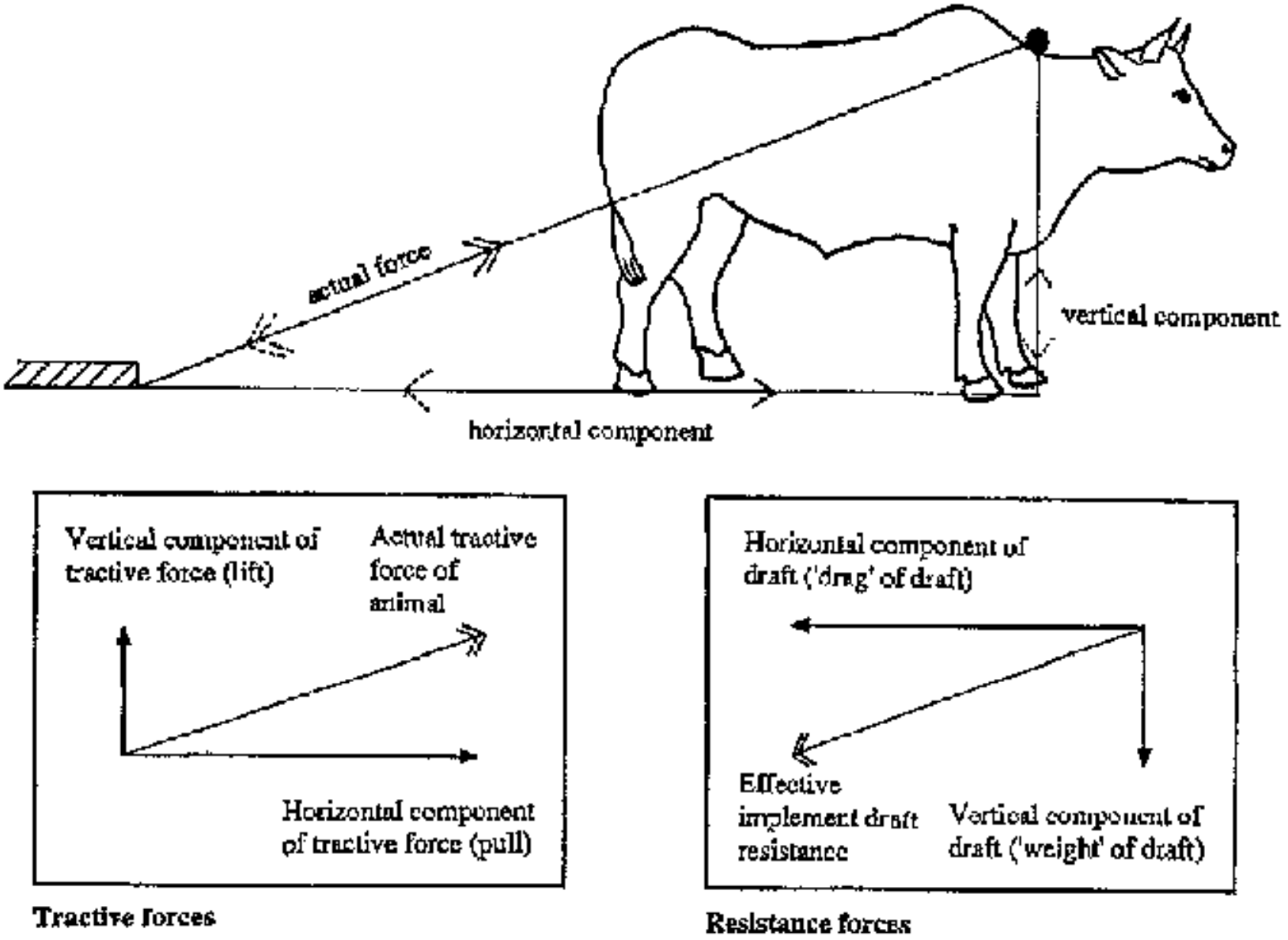
- An understanding of the physical principle involved when using animal power is essential for comparing the working ability and efficiency of draft animals between and among species.

Many agriculturalists regard mathematics and physics different units that have been used when assessing animal drawn implements

- horsepower
- kilowatts
- kilogram force
- pound force
- Newton’s
- joules
- miles per hour
- kilometers per hour
- meters per second
- square meters per hour
- hours per hectare
- acres per day

5.1.1.Force and vectors

- Force is the names given to the amount of pull that an animal /has to exert to move an implement or cart.
- Force used to pull load can be analyzed in terms of three axis at right angle to each other



Fig; 5.1. Illustration of the vertical and horizontal components of draft forces.

- The first mechanical principles that might be recalled are those relating to forces.
- Newton's first law was that a body will remain at rest or in straight-line motion unless acted upon by a force.
- Second related to changes in momentum and direction of movement as a result of forces,
- Third was that actions and reactions are equal in magnitude and opposite in direction).

- The standard unit of force is a Newton (symbol N).
- 1 Newton = 1 kg • m/s2
- The definition of a Newton is based on the force resulting from acceleration acting on a mass of one kilogram.
- Since the acceleration due to the Earth's gravity is about 9.8 meters per sec, the weight of one kilogram mass (on most of the earth's surface) is about 9.8 Newton’s, i.e. one kilogram of mass weighs about 10 Newton.

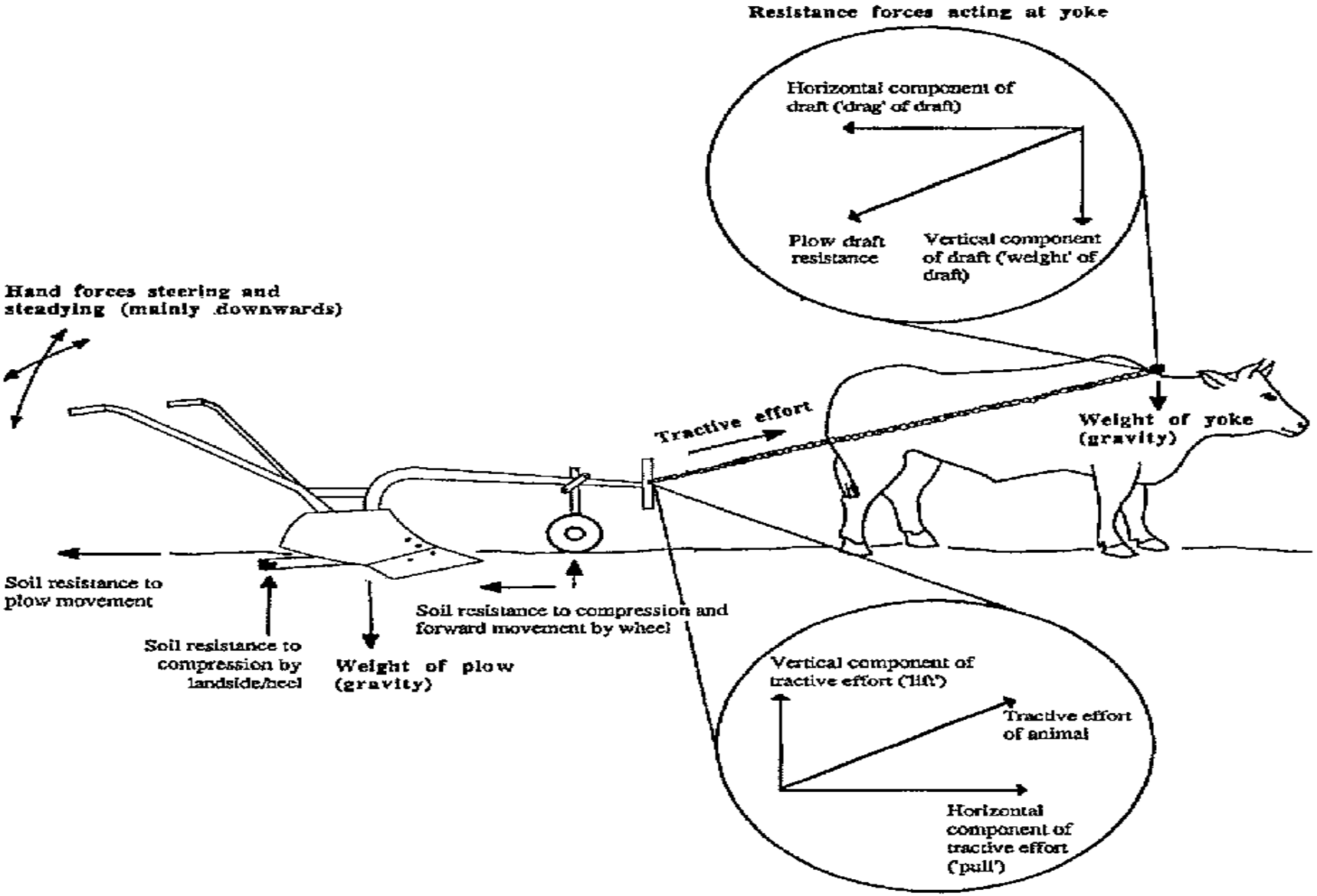
- Forces have direction as well as magnitude, and the concept of vectors is useful in studying them.
- Forces can be analyzed in terms of three axes at right angles to each other
- In such cases a "diagonal" force (such as the pull on a traction chain), can be thought of in terms of vertical and horizontal components

- (Fig. 5-1). Such a pull has an upward component and a forward component. If the pull were at an angle of 45°, these horizontal and vertical forces would be equal, so that as much of the applied force is being used in "lifting" as in "pulling".
- If it were possible to change the 45° pull into one that was almost parallel to the ground, the same force would have a much greater horizontal (forward) effect.

- **One means of achieving a more effective horizontal force**
  - use of a very long traction chain, and another would be to lower the point from which it were pulled.
  - In terms of horizontal pull, short-legged oxen with a low-hitched harness and a very long traction chain would be more efficient than long-legged camels with a high hump harness and short chain.
  - Over-long chains make turning very difficult and short legged mini-beasts may not have sufficient power, speed or endurance.

- Fig. 5-2 gives a highly simplified diagram of some major forces acting on a plow.
- This can be explained with reference to Newton's third law, since all the forces cited will have opposing forces
  - the pull of the animals is opposed by the draft of the implement;
  - the downward force of the yoke due to gravity and
  - the vertical component of the draft is opposed by the body of the animal as it stands and pulls
- In a mathematical vector diagram, or triangle of forces, the lengths of the sides are directly proportional to the forces.
- In practice vectors are seldom included in diagrams of harnesses and plows since the actual forces are highly variable

Fig. 5-2: Illustrative diagram of some of the forces acting on a plow



- Although emphasis in this discussion has been placed on the forces associated with plows, similar forces are involved with other animal-drawn implements.
- For tillage implements, the soil resistance to forward movement is generally the most crucial.
- For wheeled implements or animal-powered gears, internal frictional resistance to the rotation of wheels, bearings or gears may be at least as important as the draft forces between the implement and the environment.

Summary of the units cited in this book and some equivalents

Quantity	Units	Symbol	Comparisons and approximate conversions
Mass	kilogram	kg	1 kg = 2.2 lb; 1 lb = 0.45 kg
	gram	g	1000 g = 1 kg
	tonne	t	1 t = 1000kg ≈ 1 imp ton
Length	kilometre	km	1 km = 0.621 miles; 1 mile = 1.61 km
	metre	m	1 m = 100 cm = 1000 mm = 1.09 yard = 3.28 ft
	centimetre	cm	1 cm = 0.394 inch; 1 inch = 2.54 cm
	millimetre	mm	1 mm = 0.04 inch
Time	second, hour, day	s, h, d	1 h = 60 mins = 3600 s
Area	square metre	m^2	1 m^2 = 1.20 sq yd; 1 sq yd = 0.84 m^2
	hectare	ha	1 ha = 10,000 m^2 = 2.47acre; 1 acre = 0.405 ha
Volume	cubic metre	m^3	1 m^3 = 1000 litres = 220 gallons = 35.3 cu. f.
	litre	l	1 l = 0.22 imp gallons
Speed	metres per second	m/s, m s^{-1}	1 m/s = 1 m s^{-1} = 3.6 kmh^{-1} = 2.24 mph = 3.28 ft s^{-1}
	kilometres per hour	km/h or km h^{-1}	1 km/h = 1 km h^{-1} = 0.278 m s^{-1} = 0.62 mph; 1 mph = 1.6 km h^{-1}
Force	newton	N	1 N = 9.8 (≈10) kg force (kgf) = 0.225 lb force (lbf)
	decanewton	dN	1 dN = 10 N = 1 kgf = 2.25 lbf
	kilonewton	kN	1 kN = 1000 N = 100 kgf = 225 lbf = 0.10 tonf
Work or energy	joule	J	1 J = 1 newton metre (Nm)
	kilojoule	kJ	1 kJ = 1000 J = 737 ft.lb
	megajoule	MJ	1 MJ = 1000 kJ = 1,000,000 J
Power	watt	W	1 W = 1 joule per second = 1 Nm s^{-1}
	kilowatt	kW	1 kW = 1000 W = 1.34 hp = 1.32 cv; 1 hp = 0.75 kw

5.1.3. Work and power

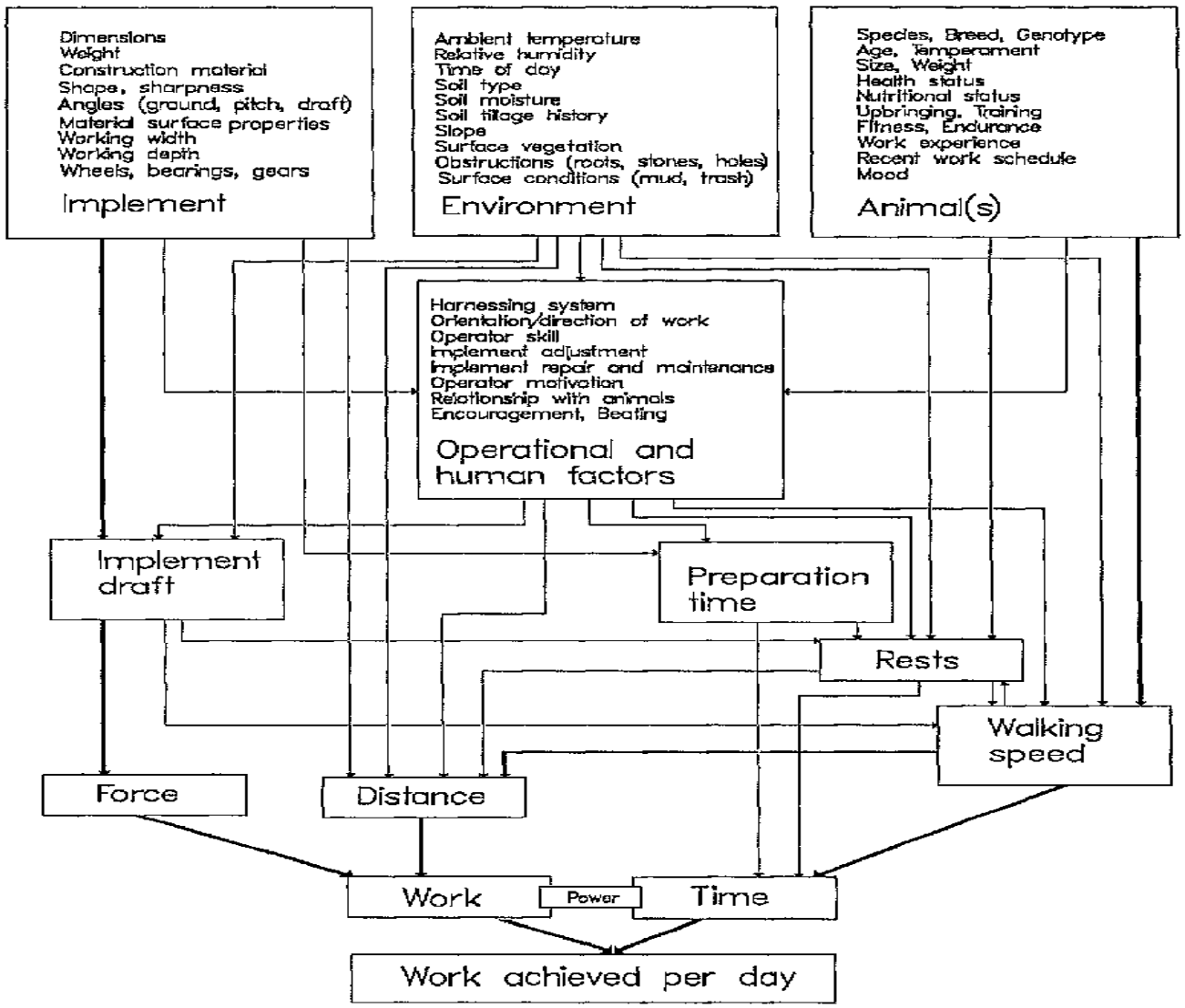
- Work involves moving a force through a distance.
- As an implement is pulled through the soil, the animal or team exerts a tractive force and as it moves across a field, it performs work.
- Work done is not a function of time, so that however long an operation takes, the actual work done is the same..

- Plowing a field to a particular standard and depth entails the same amount of work (in principle)
- whether it is completed in one morning, in one day or in many days,
- whether the work is done by a single animal, a pair, or by a large team, and
- whether the animals pull a narrow plow through a long distance or a wide plow through a shorter distance

- (In practice there may be some small differences since some frictional forces vary with speed and surface to volume ratio).
- Although the actual work achieved in terms of plowing will be the same in all the cases cited, the number of animals and the rate of work may well have significant implications for total energy expenditure.

- (Animals are constantly using metabolic energy for maintenance, in a way comparable to the non-stop idling of a vehicle engine, so that a slow job or one involving more than one animal may involve higher metabolic energy expenditure;
- animals also perform work moving themselves, so that the shorter the distance they travel, the less work they do moving themselves; in such cases pulling a wide implement though a short distance will involve less energy for walking than pulling a narrow implement through a long distance).

Fig. 5-3: Some of the factors influencing the work achieved per day by draft animals.



- On the left side of the diagram: the shape, weight, width and working depth of the implement largely determine in draft in the prevailing environment, and thus the force the animal(s) have to apply to pull the implement.
- On the right side of the diagram: the breed, size, weight, training, fitness, temperament and work schedule of the animal(s), together with the implement draft, will largely determine the walking speed and thus the power output and, depending on the distance covered in the day, the resulting work achievement.
- Centre: implement draft, walking speed and non-working time are greatly influenced by a wide variety of interacting environmental, operational and human factors,

- In any given situation, a very large number of different, interacting parameters relating to the animal(s), the implement, the harnessing, the environment and the human operators will determine the amount of work that can be achieved.
- It is the implement (its size, weight, width, depth, etc.) and the environment (soil conditions, obstructions, etc.) that together determine the draft force

- These can be effected by the operator (settings for depth and width of work, working condition of implement, etc.). Since the draft is determined by the implement and the environment, this will be broadly the same whether it is pulled by one animal or many animals, and whether it is pulled quickly or slowly. What is determined by the animal(s), is the speed at which the implement is moved.

- The units used to measure work are joules (J), kilojoules (kJ) or mega joules (MJ). A joule is the work of moving one Newton through one meter.
- Since 1 kg weighs about 10 Newton, lifting one kilogram through one meter is equivalent to about 10 joules of work.
- Similarly pulling a 1000 N force through 1000 m (1 km) is equivalent to about one mega joule of work

- By way of illustration, during a relatively light work schedule, a pair of 250 kg oxen might achieve 2.5 MJ of work in a day by pulling a 500 N force through a distance of 5000 m;
- in a more rigorous schedule, a pair of 350 kg oxen might achieve 12 MJ of work in a day by pulling a 800 N force through a distance of 15,000 m.
- Seeding a hectare of land with a low-draft (200 N) implement at 60 cm spacing (requiring travelling 17,000 m) might represent 3.3 MJ of work.

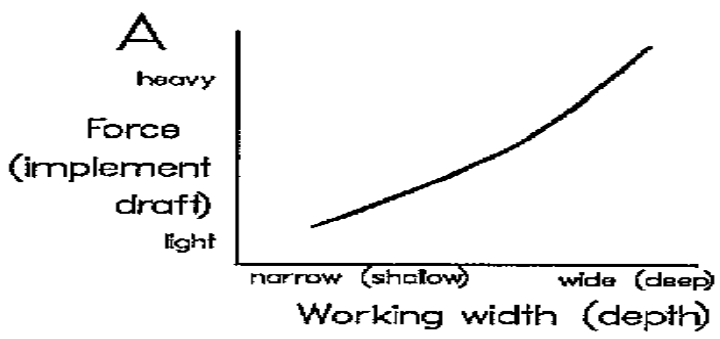
- **Power** is the rate of doing work, and therefore unlike work, power is a function of time.
- The "imperial" horsepower unit was suggested by James Watt who timed a horse and also his new steam engine as they pulled weights up a well shaft:
- he concluded that a horse could work at a rate equivalent to lifting a 550 pound weight through one foot in one second

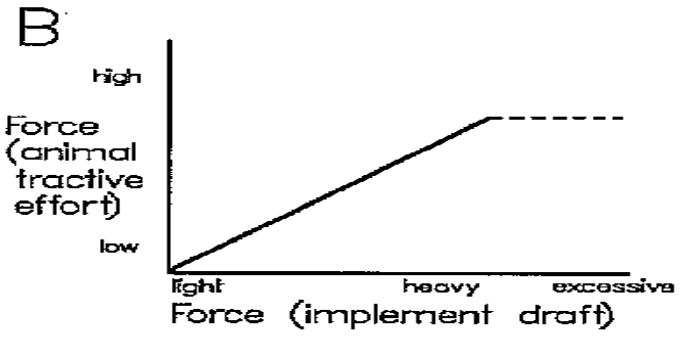
- Horsepower units have been replaced by the international standard unit of power, the watt and its multiple, the kilowatt.
- A watt is a unit of power is equivalent to one joule of work per second. Lifting one Newton by one meter in one second requires a power of 1 watt (W).
- Similarly lifting one kilogram (i.e. 10 N) one metre (i.e. 10 joules of work) in one second requires a power of 10 watts. A kilowatt (kW) is 1000 W and 1 kW = 1.34 hp = 1.32 cv.
- For illustrative purposes, a pair of oxen walking quickly at one metre per second (1 m/s or 1 m s-1) and pulling a load of 1000N, produce a joint work output of 1000 W or 1 kW. A single donkey pulling a 200 N draft seeder at a rate of 1 m s l works at the rate of 200 W.

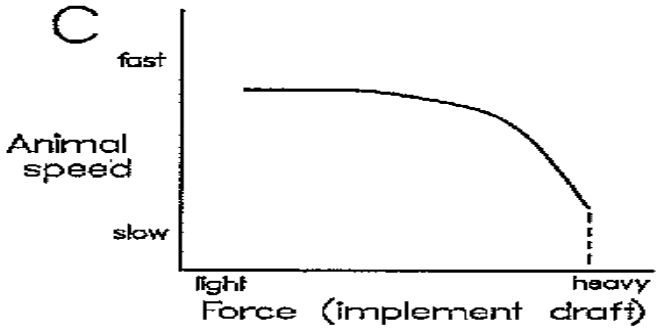
- For any particular force or amount of work, it is speed that determines power output.
- Pulling an implement that has a draft of 800 N at a speed of 0.8 m s-1 requires a power of 640 W, while to pull the same implement at 0.3 m s -1requires only 240 W.
- Animals therefore tend to adjust their speed in reaction to the draft load and the reduction in speed is particularly noticeable with cattle.

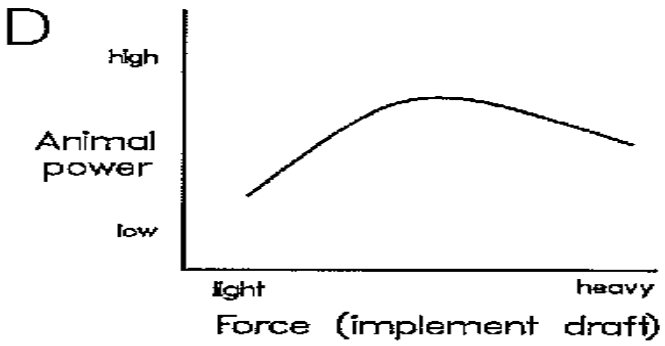
- It should be noted that while many of the terms such as force, draft, work and power have specific scientific definitions, they are also used in a more general and loose sense by agriculturalists and farmers. Subjectivity and context can bring to these words a wide variety of meanings. For example, oxen are often said to be more "powerful" than horses.

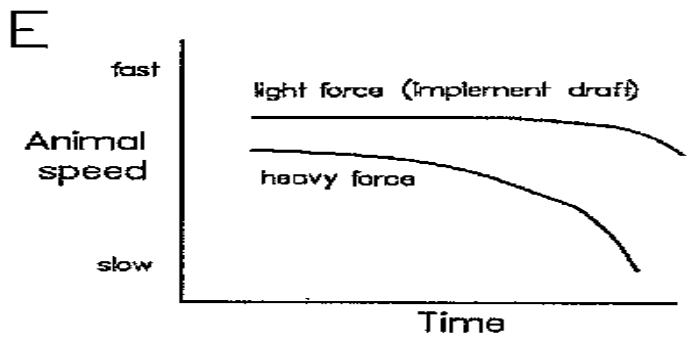
Fig 5-4a: Some highly simplified, illustrative relationships between force, speed, power and time

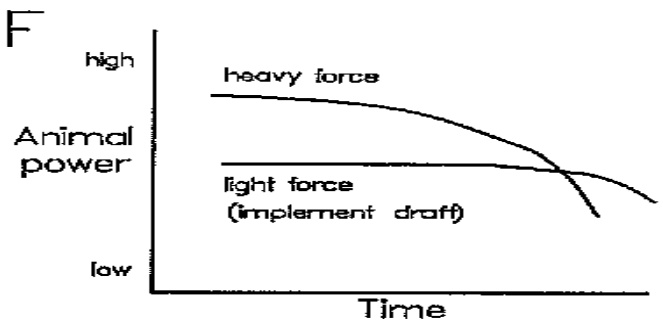












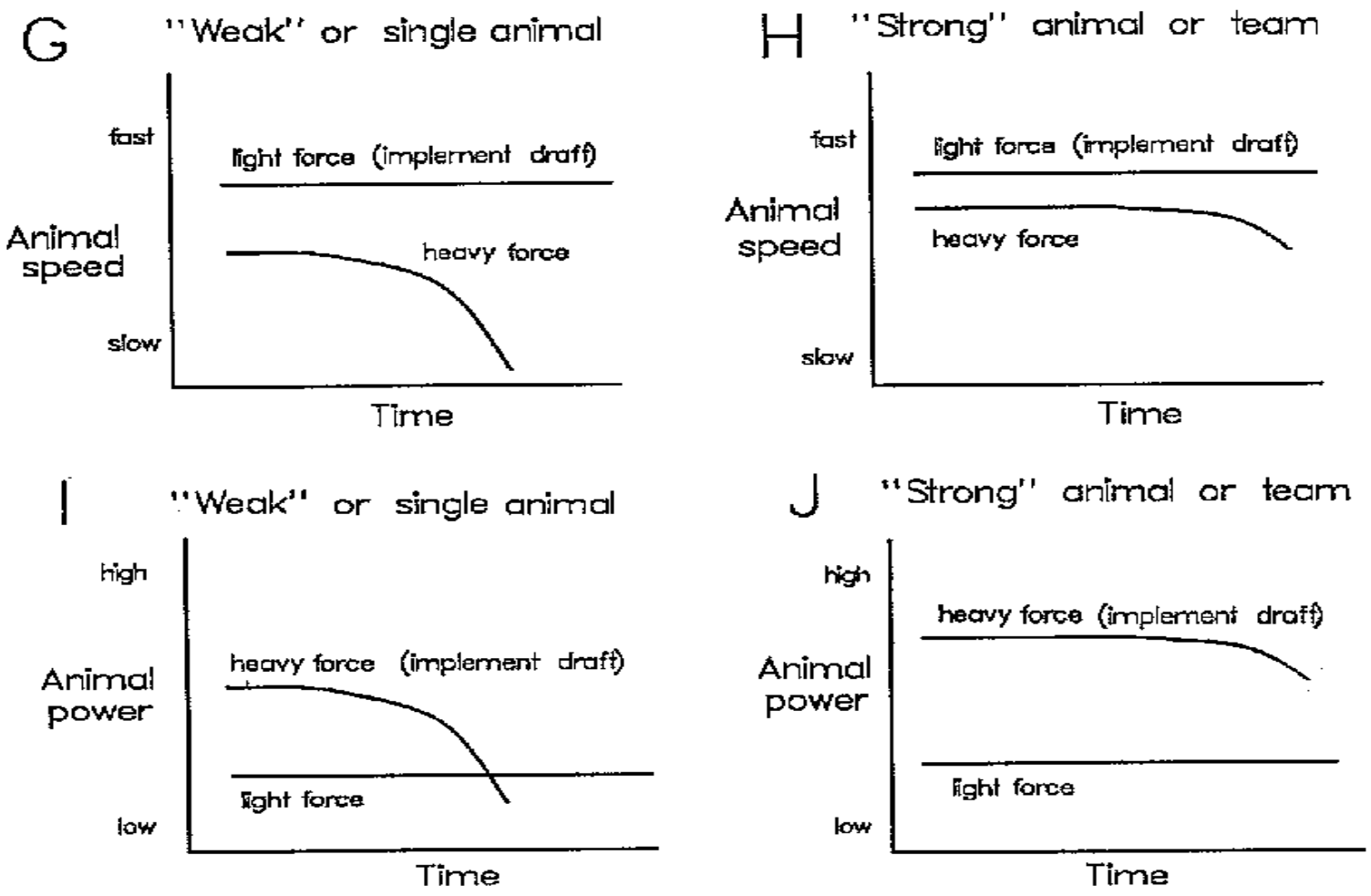
Important note: these graphs are included only for the purpose of illustrating some general points, as described in the captions and discussed in the text. Their exact shape is not significant. These graphs should not be interpreted as demonstrating exact relationships between the variables involved.

- A: The draft of an implement increases with working width or working depth.
- B: As Implement draft "resistance force) increases, an animal has to exert an equal force in order to pull the implement at a steady speed. When the resistance is greater than the maximum pull of the animal, the animal may exert a force by straining at the implement, but it win not be able to move it.
- C: As the draft of an implement increases beyond a certain point, an animal slows down and eventually stops.

- D: As the draft of an Implement increases, an animal increases its power output (power = force x speed), until a point when the increase in the force it exerts is more than offset by its decline in speed.
- E: An animal with a light load maintains its normal walking speed for some time, although speed may eventually decline. An animal pulling a heavy load starts at a slower speed, and noticeably slows with thee.
- F: With a light load an animal maintains its (low) power output for some time, but with a heavy load its (higher) power falls off rapidly when it tires and slows. The cross-over of the graphs illustrates that the power output of an animal may be greater when a light load is pulled fast, than when a heavy load is pulled slowly.

Fig 5-4b: Some highly simplified, illustrative relationships between force, speed, power and time, showing some differences between "weak" and "strong" animals, or b/n single animal and teams

Important note: these graphs are included only for the purpose of illustrating some general points, as described in the captions and discussed in the text. Their exact shape is not significant. These graphs should not be interpreted as demonstrating exact relationships between the variables involved.



- G: With a light draft force (low-draft implement), the "weak" or single animal is able to walk fast and maintain its walking speed, but with the heavier load it staffs at a slower speed and soon slows down significantly.
- H: With a light load, the "strong" animal or team consistently walks at a fast speed (but no faster than the "weak" or single animal). With the heavier load the animal or team starts off at a slightly slower speed than when pulling only a light load, and maintains the speed well although it does declines after some time. The "stronger" animal or team invariably walks faster than the "weaker" or single when pulling the heavy draft.

- I: The "weak" or single animal maintains its low power output with a light load, and since walking speed and implement draft are the same as those of the "strong" animal or team, its power output is equal to that of the "strong" animal or team (graph J). With the heavier load the animal initially provides power at a much greater level than with the light draft, but this rapidly falls off as the animal tires and slows down.
- J: Although the animal or team is "strong', it cannot. apply any more power than the "weak" animal or single when it pulls the same light-draft implement at the same speed (graph 1). However with the heavier draft, the "strong" animal or team can maintain a high power output, which only drops off as the animal(s) tire and slow.

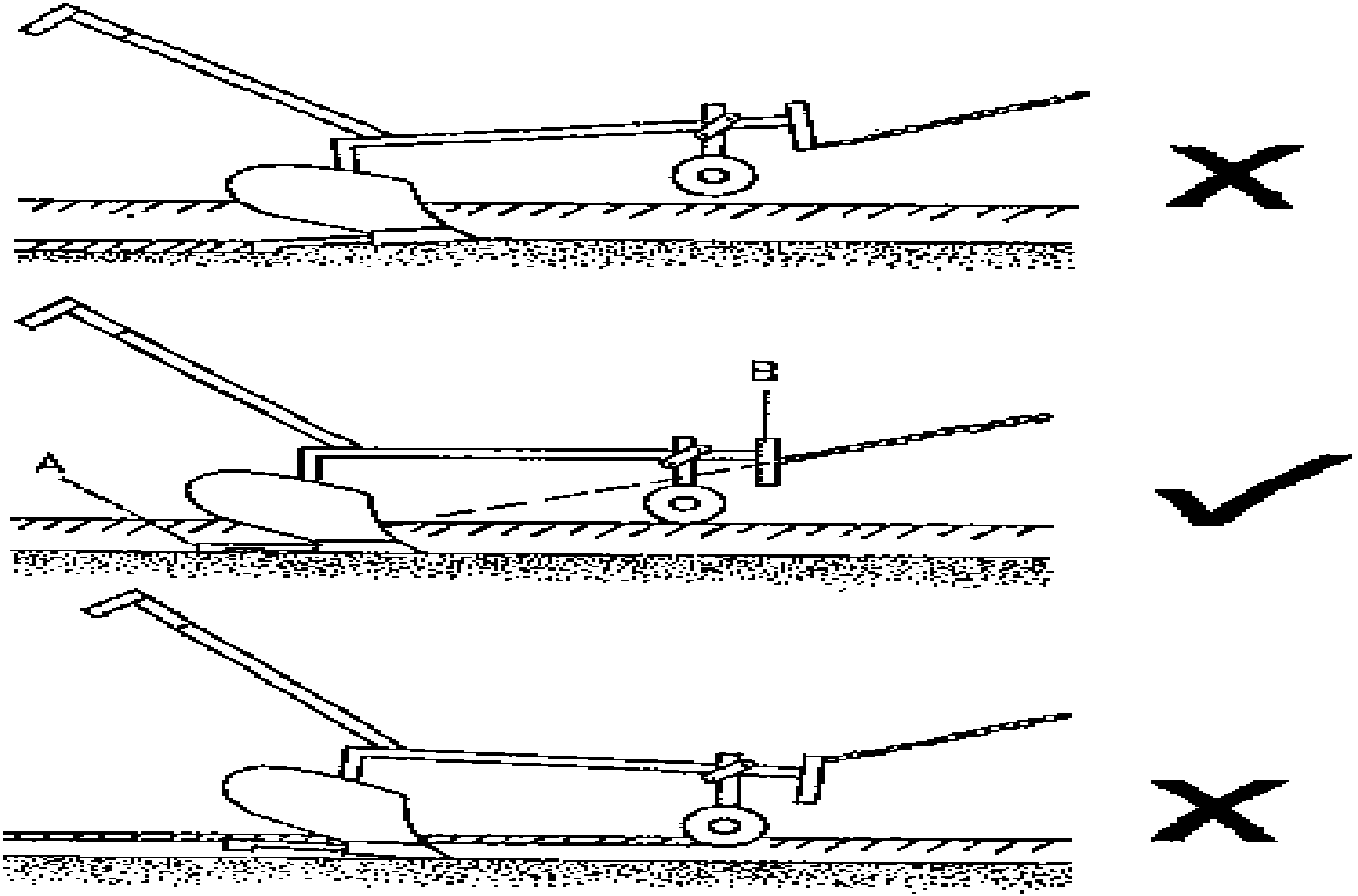
- What is usually meant by this is that oxen may be better at sustaining a heavy draft force for a longer period than a horse.
- However because of their higher speed, horses can generally develop more actual "power" than oxen.

5.1,3 Levers

- Much to do with equipment design and adjustment can be explained by reference to principles of levers.
- The "eveners" used in the harnessing of multiple teams are simple levers, as are yokes.
- In either case if the position of attachment of the hitching is moved from a central position, levers of unequal length are created.
- The weaker animal requires a longer lever to help it, while the stronger can make do with the shorter one.

- Pressing down on the handle(s) of a plow can be thought of as a lever action. The rear of the plow-body acts as a fulcrum (pivoting point) so that downward leverage on the handle(s) causes the share to move upwards to a shallower depth. (Such a movement is one of the many reflex responses associated with plowing; it is most obvious when plowing at a reasonable speed in light soils; in heavier soils and at low speeds the plow is unlikely to be sufficiently in equilibrium to allow the operator to distinguish between the different leverage effects).

Fig 5-5: Pitch adjustment of a plow (exaggerated).

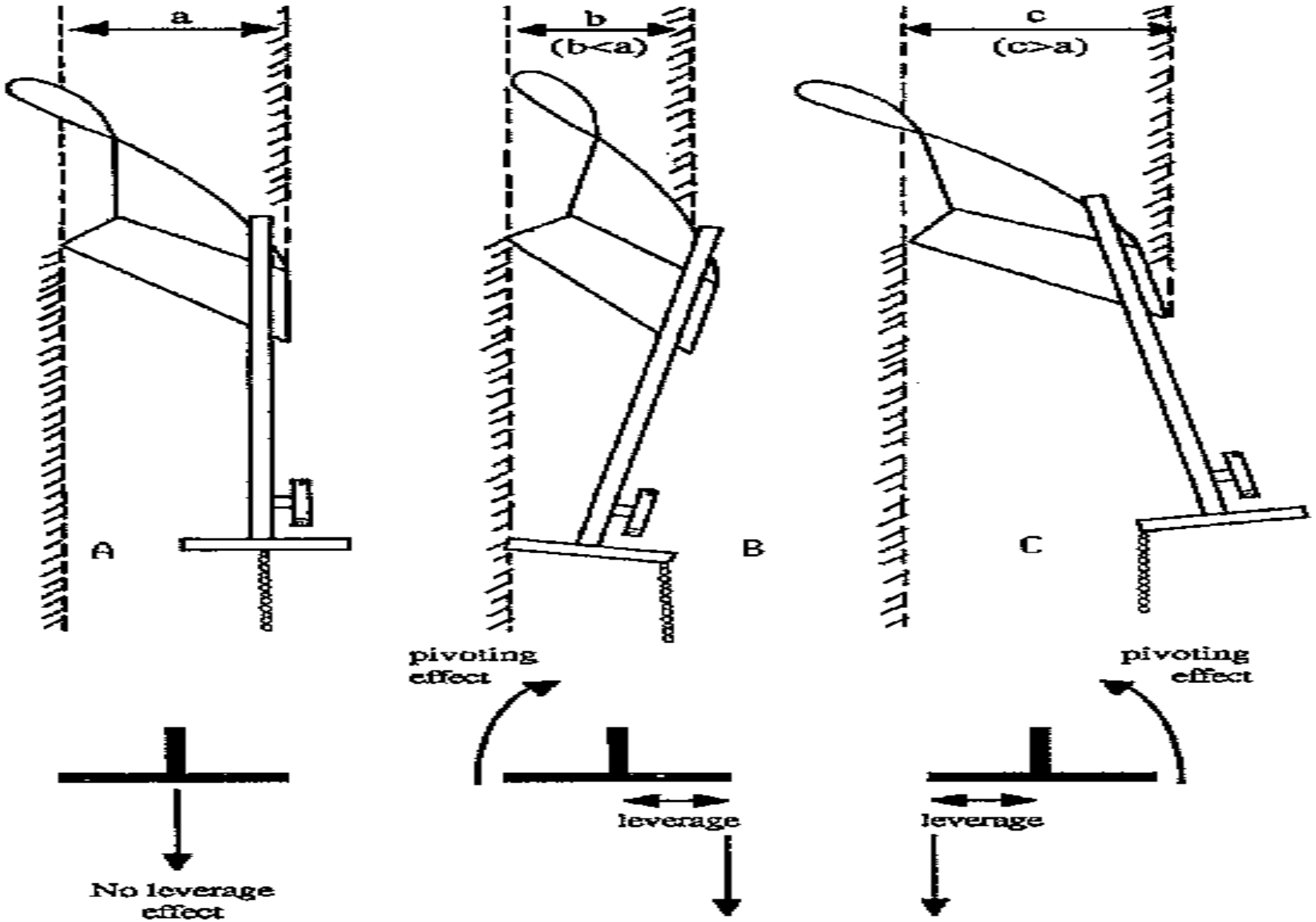


- A. Heel or end of the landside.
- B. Hake or vertical regulator.
- Top: Incorrect adjustment: wheel lifts off the ground and heel digs in too deeply. (Problem: too much leverage low down on regulator; solution raises the chain attachment A similar problem is caused if the chain is too short).
- Middle: Correct adjustment.
- Bottom: Incorrect adjustment: wheel digs into sod and heel lifts out of furrow. (Problem: too much leverage high on regulator; solution lower the chain attachment. A similar problem is caused if the chain is too long).

- The width and pitch adjustments of a plow can also be understood in terms of levers.
- Moving the chain attachment or adjustment from a central position will cause a slight leverage effect, pivoting around that central attachment point.
- Moving the chain in either horizontal direction will cause the plow beam to pivot round a little, and the plow body will move through the soil slightly crabwise, as shown (exaggerated)

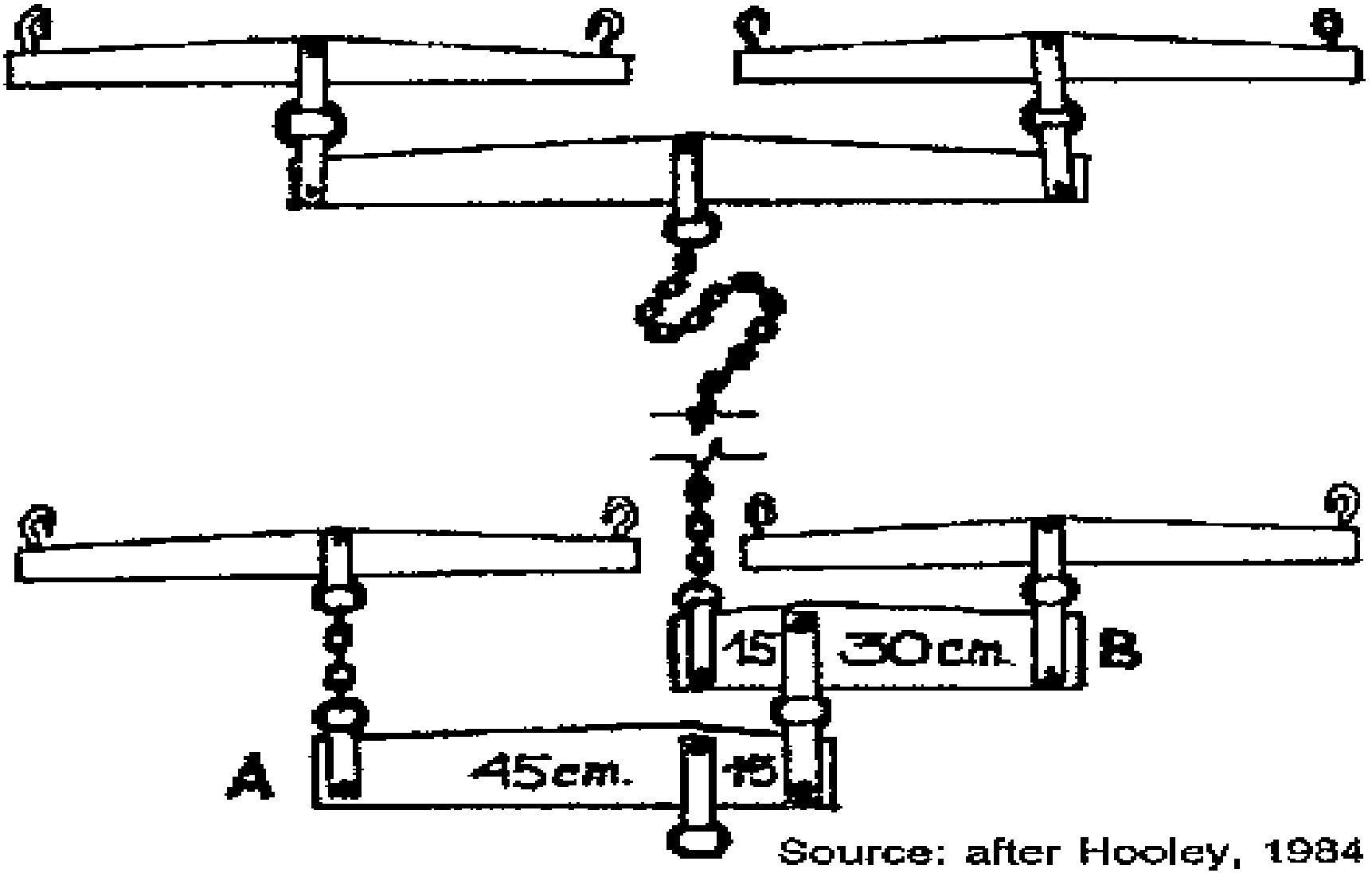
- If the movement is towards the unplowed land, the share will be skewed so that it is even more angled to the direction of movement, and thus it will cut a smaller slice of soil.
- If the traction chain movement is in the direction of the plowed land, the share will be pulled round so that it cuts a wider furrow.
- The pitch adjustment on the hake can be viewed in a similar way
- Moving the chain upward causes the plow to pivot so that the heel rises and the share points downwards. Moving the chain down causes the heel to press down and the share to point upwards.

Fig 5-6: Horizontal adjustment of a plow (exaggerated J.



- A). Chain attached to central position. Plow cuts furrow equal in width to share size.
- B). Chain attached towards unplowed land. Lever effect of the regulator causes slight pivoting around central position which causes share to cut a narrower furrow.
- C). Chain attached towards furrow. Lever effect of the regulator causes slight pivoting around central position which makes the plow body move through the soil slightly "crabwise" so that the share cuts a wider furrow.

Fig. 5-7 (right): Eveners for a four-horse team.

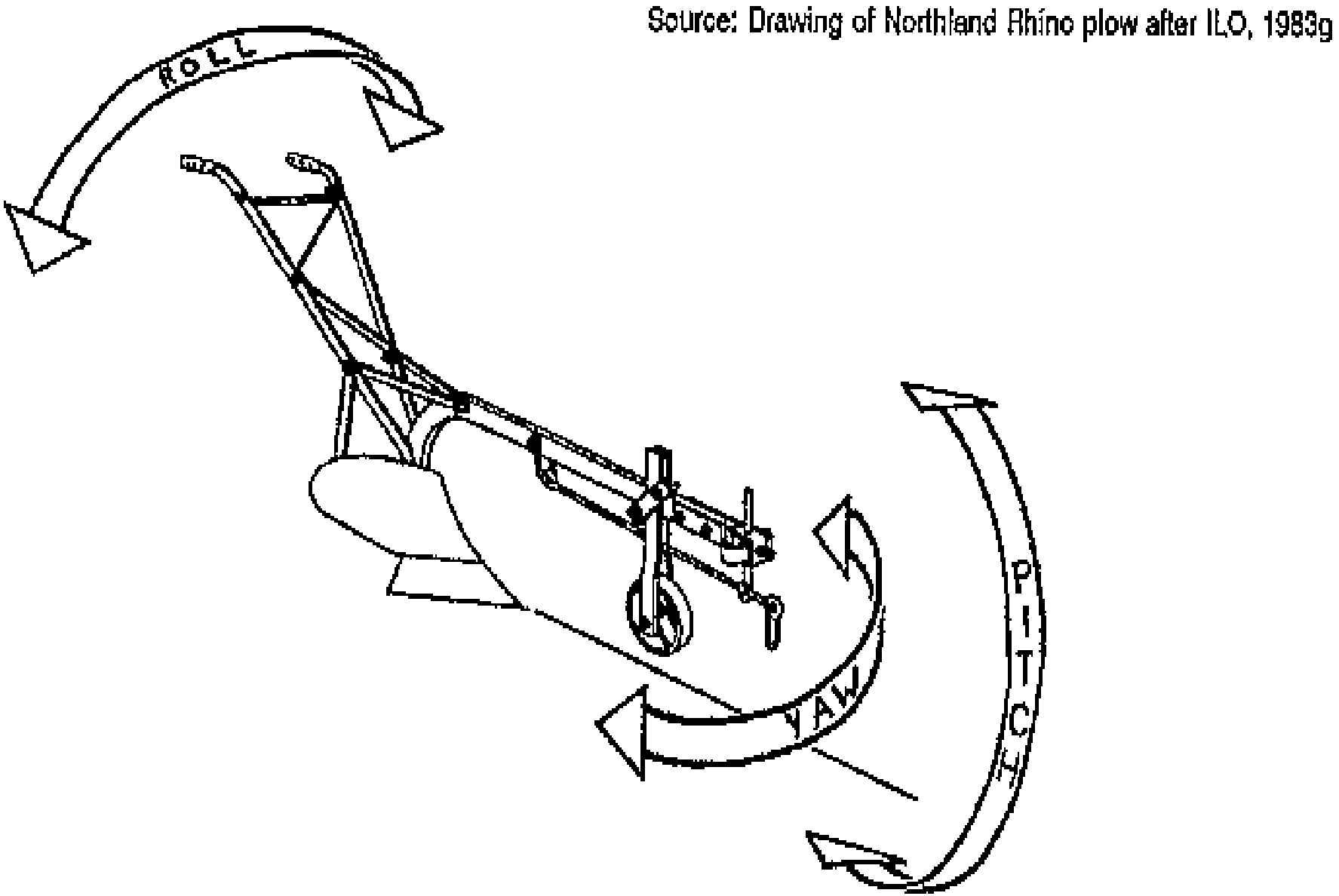


Source: after Hooley, 1984

- The front (top) evener is symmetrical as the two front animals are assumed to be of equal strength.
- Evener B has a short lever of 15 cm to take the force of the front two animals, and a longer lever (2 x 15 = 30 cm) to allow rear right-hand animal to match this.
- Evener A provides a short lever for the three animals attached to it and a long lever (3 x 15 = 45 cm) to allow the rear left-hand animal to provide equivalent and balancing leverage.

- Finally, in practical situations it is rare for all the forces acting on a body to be even and constant, so that any object in motion (be it a boat, aeroplane or plow) has a tendency to move in orientation in one or more planes.
- For convenience these are described in terms of three major planes at right angles to each other.
- The complex movements of an implement in use can be systematically analyzed with reference to these three planes, and instability can be described in terms of pitching, rolling and yawing

Fig. 5-8: Three possible rotations: rolling, yawing and pitching.



- A simple swing plow is relatively unstable and thus requires considerable human effort to counteract all the tendencies to move out of equilibrium.
- Pitching (that is when the front moves up or down relative to the back, consequently changing working depth) can be minimized by using a land wheel (or skid) and a long landside with heel.
- Rolling (tipping over sideways) can be reduced with the use of a second wheel parallel to the depth wheel.
- Yawing (moving out of line, moving out of parallel with the direction of movement) can be reduced if the unbalanced side forces causing these "crablike" movements are absorbed by a landside and a furrow wheel or courter.

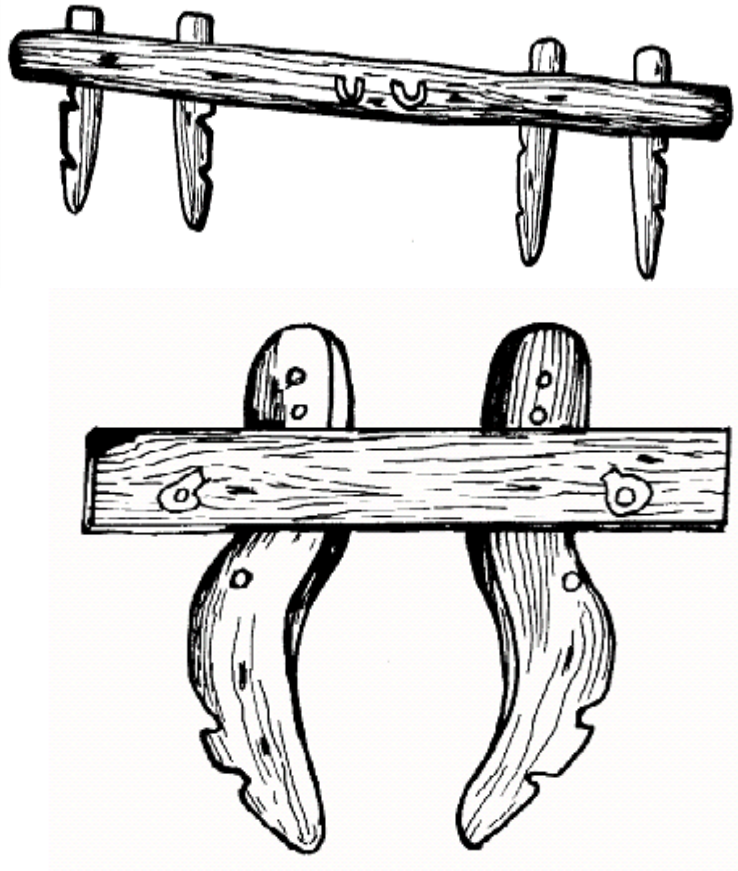
5.2. harness
5.2.1 Types of harness

- The are four common types of harness

1. Yoke harness
2. collar and breast band harness
3. load carrying and Pack saddle harness
4. Harness for camel

5.2.1.1. Yokes

- There are two main types of neck yoke that can be used with draught cattle; these are
  - Double neck yoke,
  - Single neck yoke.
- The double clamp yoke is commonly used because most jobs require the combined power of at least two animals.



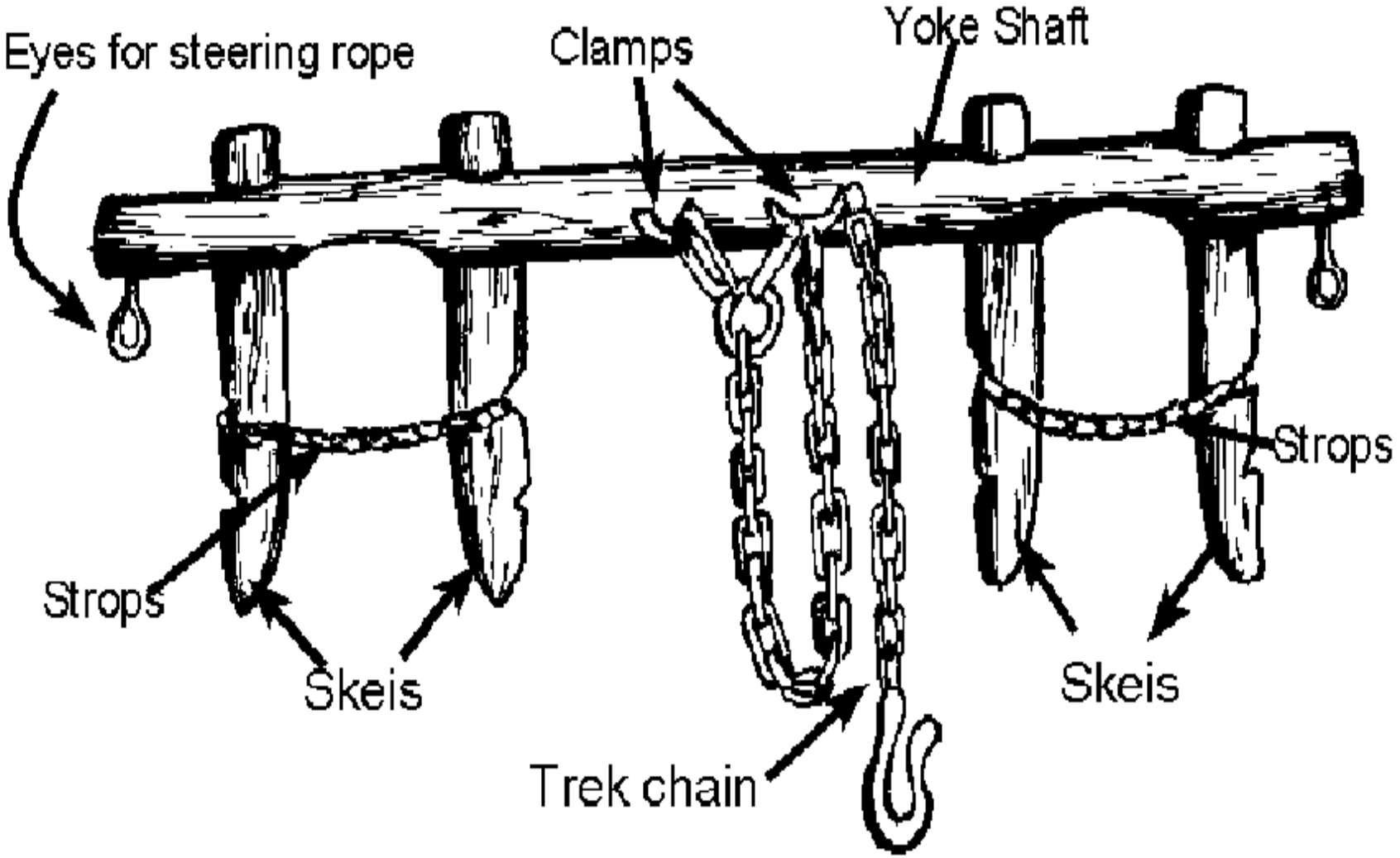


Fig complete double clamp yoke with all of the parts:

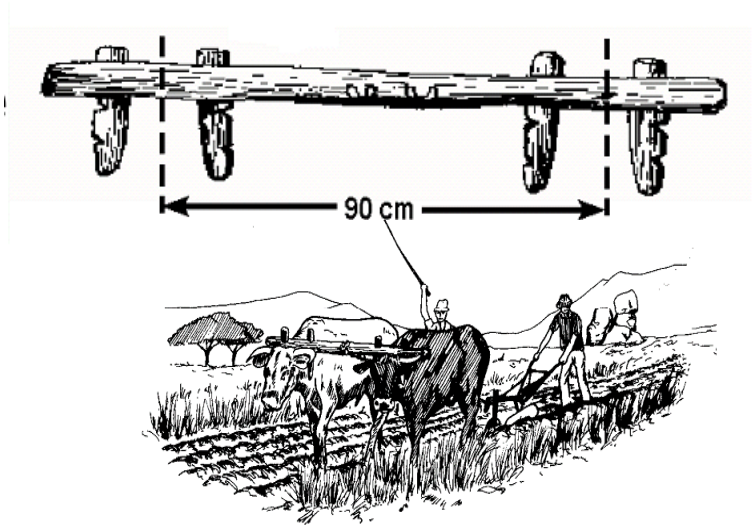
Con’t

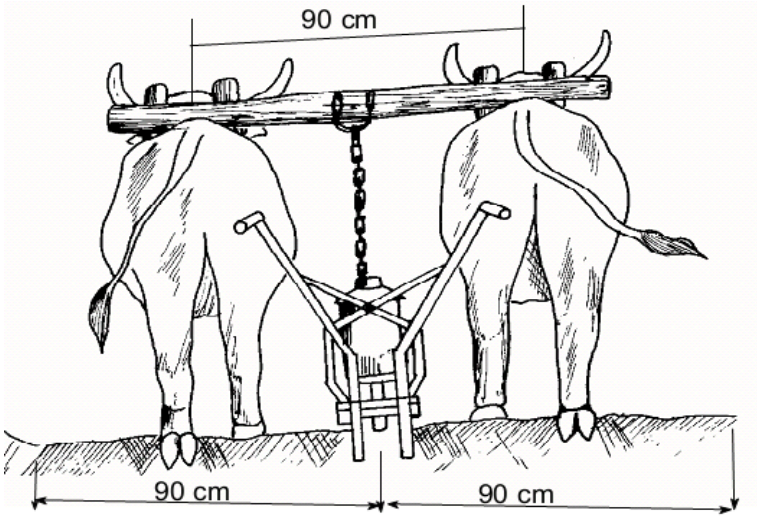
- There are three types of commonly used double neck yokes:

A. The Plough Yoke

  - ✓ Used with the plough, the ripper and the planter.

- If the wrong size yoke is used the oxen can walk along the planting lines and compact the soil surface





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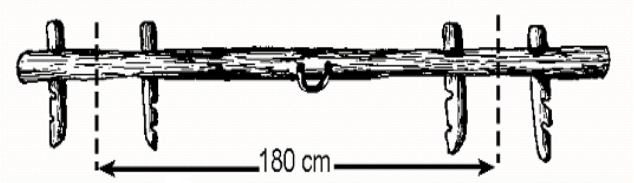
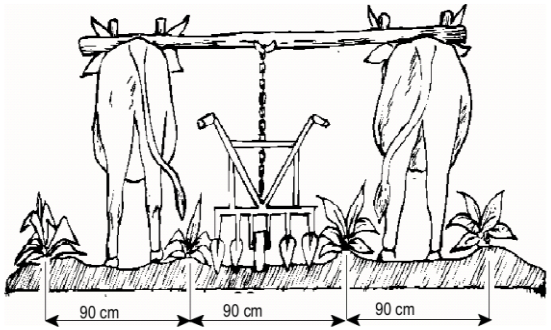
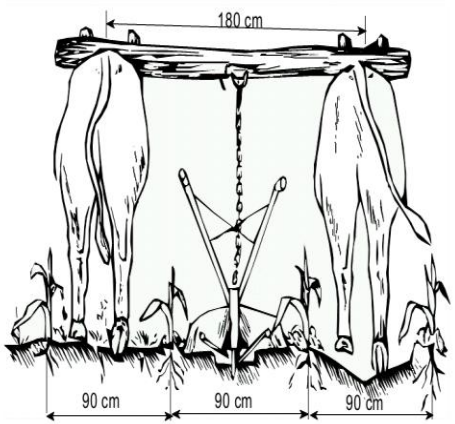
B. The Cultivator Yoke

- ✓ Used with the cultivator and the ridge
- ✓ The yoke length should be twice the crop row spacing





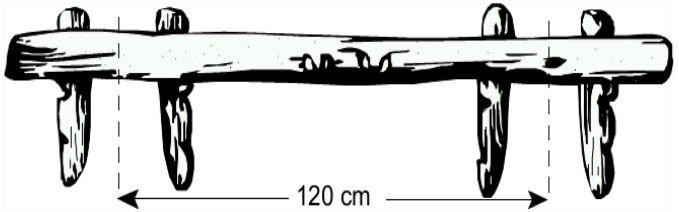
Ridger

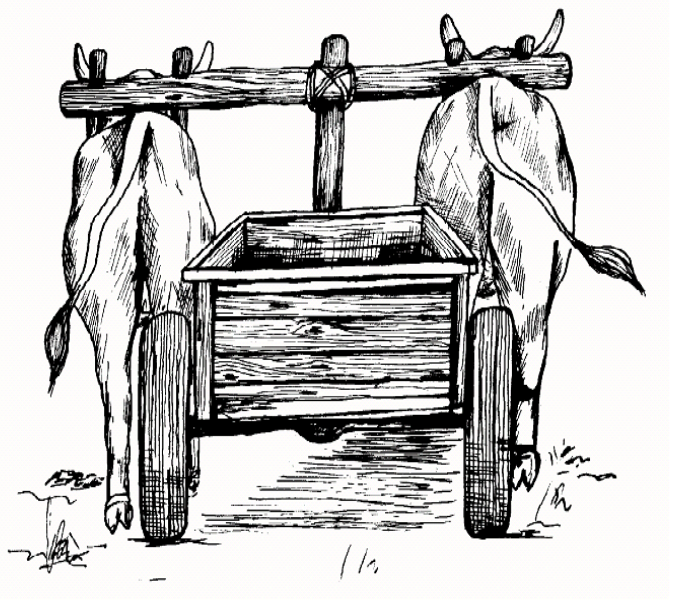


Con’t

C. The Cart Yoke

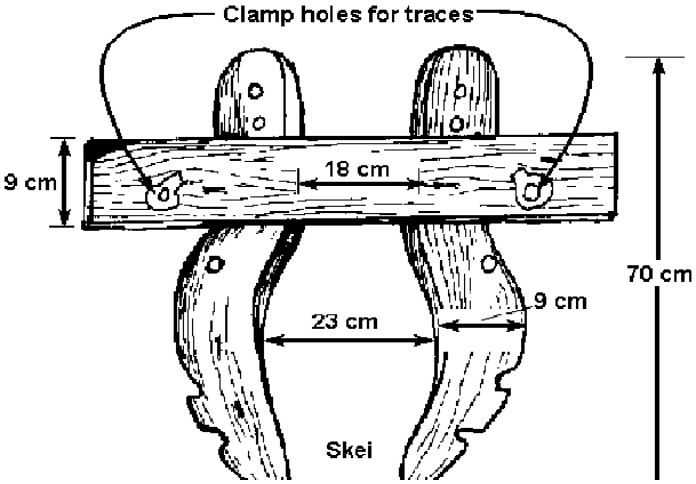
- ✓ Yoke used for pulling carts



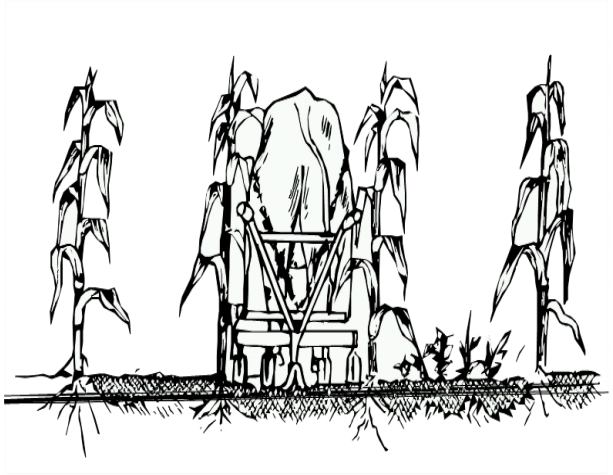


Con’t

- The single neck yoke is used on a single ox or Cow when light cultivation equipment is to be used or a small cart.



#Cultivating between rows of tall maize

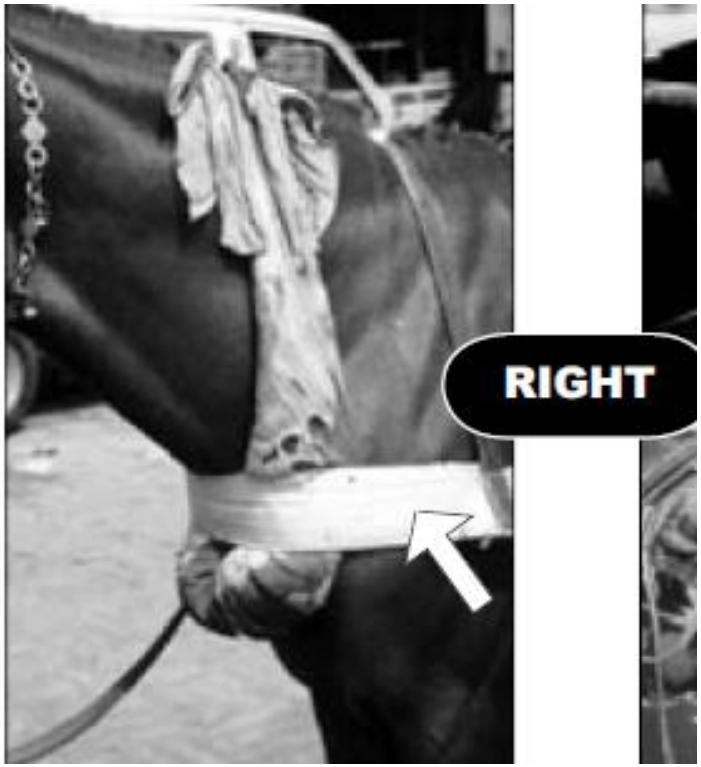


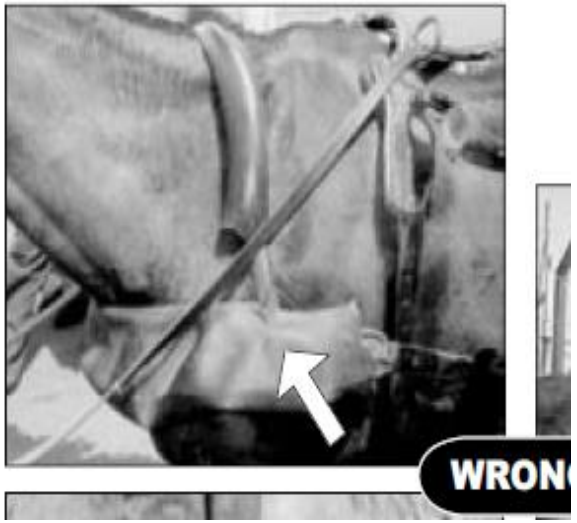
5.2.1.2.Collar and Breast Band Harnesses.

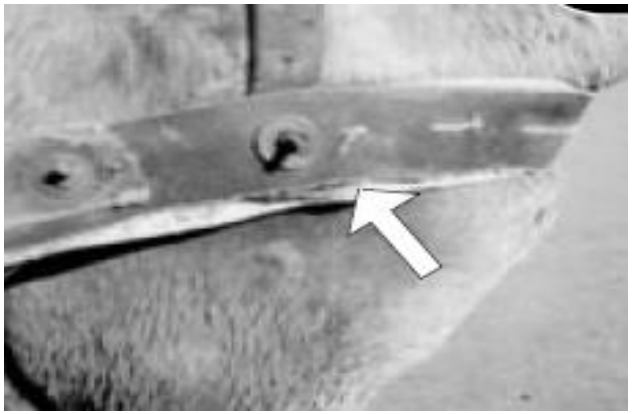
A. Breast Band Harnesses

- The breast band harness is a simple design and can be made from cheap and locally available materials.
  - ✓ belting materials
  - ✓ Thick cotton
  - ✓ Leather
- It can be used for various work activities such as pulling a cart or cultivation implement.

Con’t





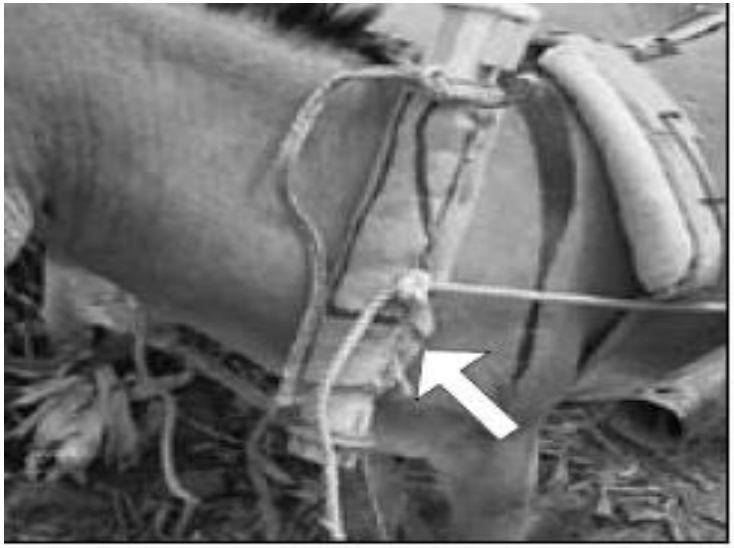


Con’t

- Make sure that bolt ends are always kept away from the animal’s body and any stitching is on the outside of the breast strap, not in contact with the animal.
- Always remember to make sure that a harness is fitted properly on the animal, not too loose or too tight.

B. Collar harness

- Collar harnesses may be classified as either full-collar or split-collar.
- The full collar harness is commonly used with horses and tends to be expensive
- The split collar harness with two vertical hames joined at the top and bottom, is more versatile and is widely used for donkeys and mules

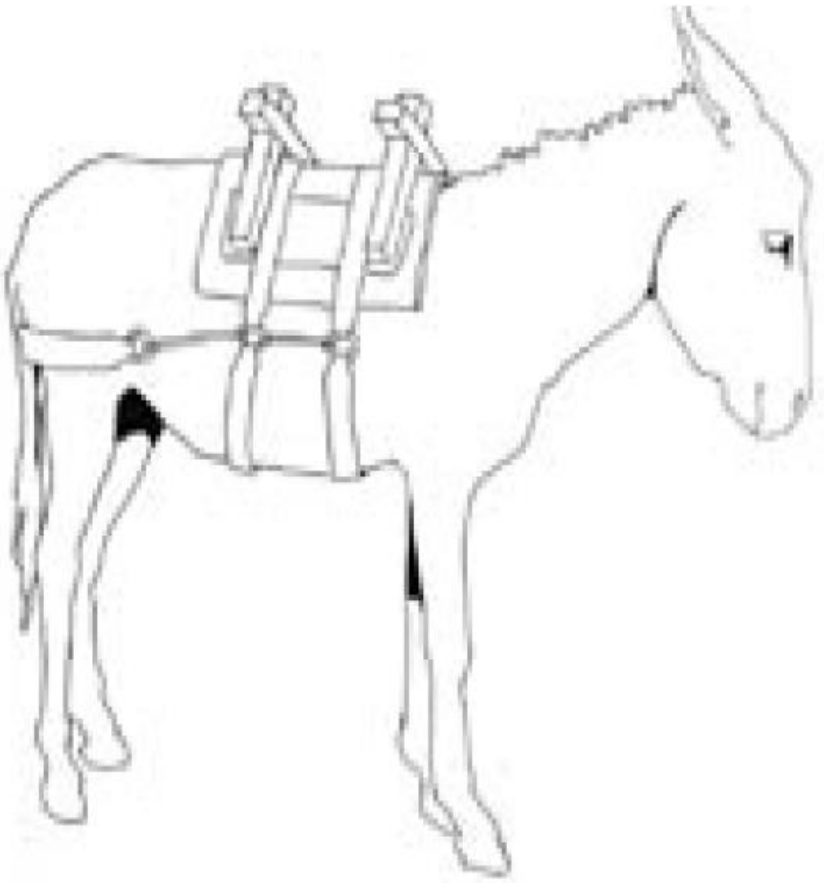


Con’t

- The collar harness should not be too big or too small for the animal, but should sit comfortably in front of the shoulders. Padding must be used between the harness and the animal
- The collar harness has the disadvantage of being more complex in design than the breast band.
- The advantage of a collar harness is that it is good for work at high draught forces, it spreads the force of pulling over a wider surface of contact with the animal than a breast band harness.

5.2.1.3. Load carrying and Pack saddle harness

- The saddle harness enables donkeys, horses, and mules to carry substantial loads on their backs. The saddle is usually made out of wood.
- Padding should be used between the pack saddle and the animal's back

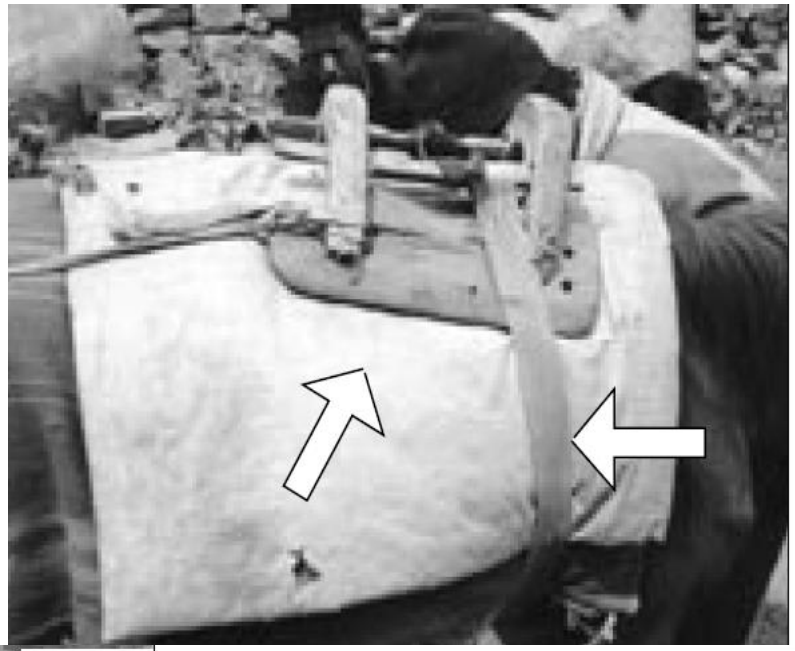


Con’t

- The harness may have three or four straps for belly, breast and hind quarters to keep it in place
- The straps should be of leather, webbing or canvas.
- Thin ropes can cut and rub the animals and these, and synthetic or plastic materials must not be used.
- The straps should be properly adjusted so that they fit well without restraining the animal’s breathing or causing skin sores

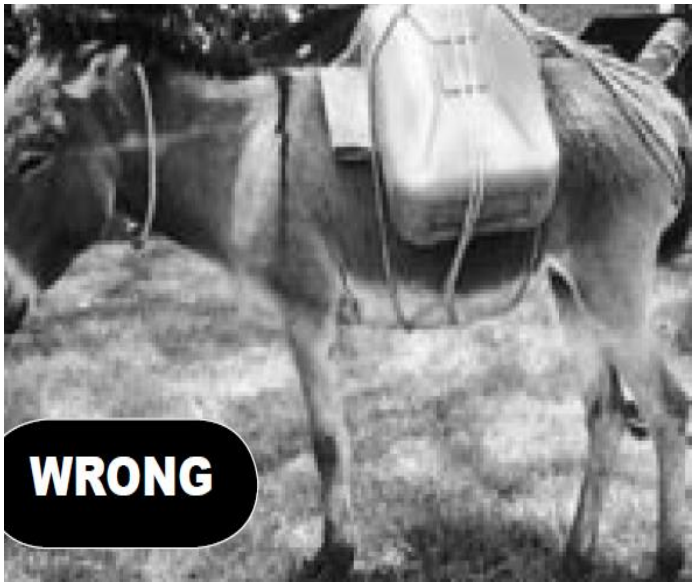
Con’t

- Padding should be used between the pack saddle and the animal’s back
- This is important especially when carrying hard loads such as bricks.
- The materials in direct contact with the back of the animal should be soft.



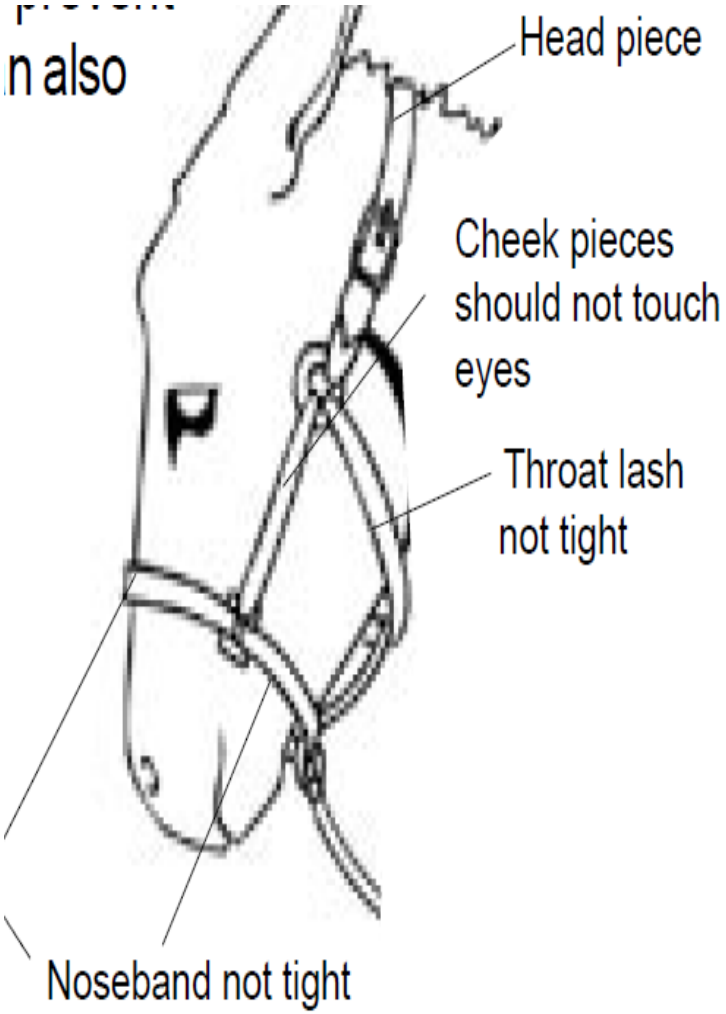
Con’t

- Hard or abrasive materials should not press directly on the back of the animal otherwise sores occur quickly



Placement of Halters and bridles

- These are used to control the donkey, mule or horse during work.
- Controlling an animal's head is the best way to control it
- A halter consists of a simple head piece and noseband with a single rope (or two reins) attached.



Con’t

- The parts of the halter or bridle in contact with the animal should feel smooth to the touch, especially at joints
- The joints should be on the outside away from the animal.
- Make sure bit is put in the mouth the right way round, with the inside curve of the bit to the back of the mouth so the bit ring is flat against the side of the animal’s head.
- Do not make a bit out of a wire. This will cut the animal’s mouth, tongue and lips

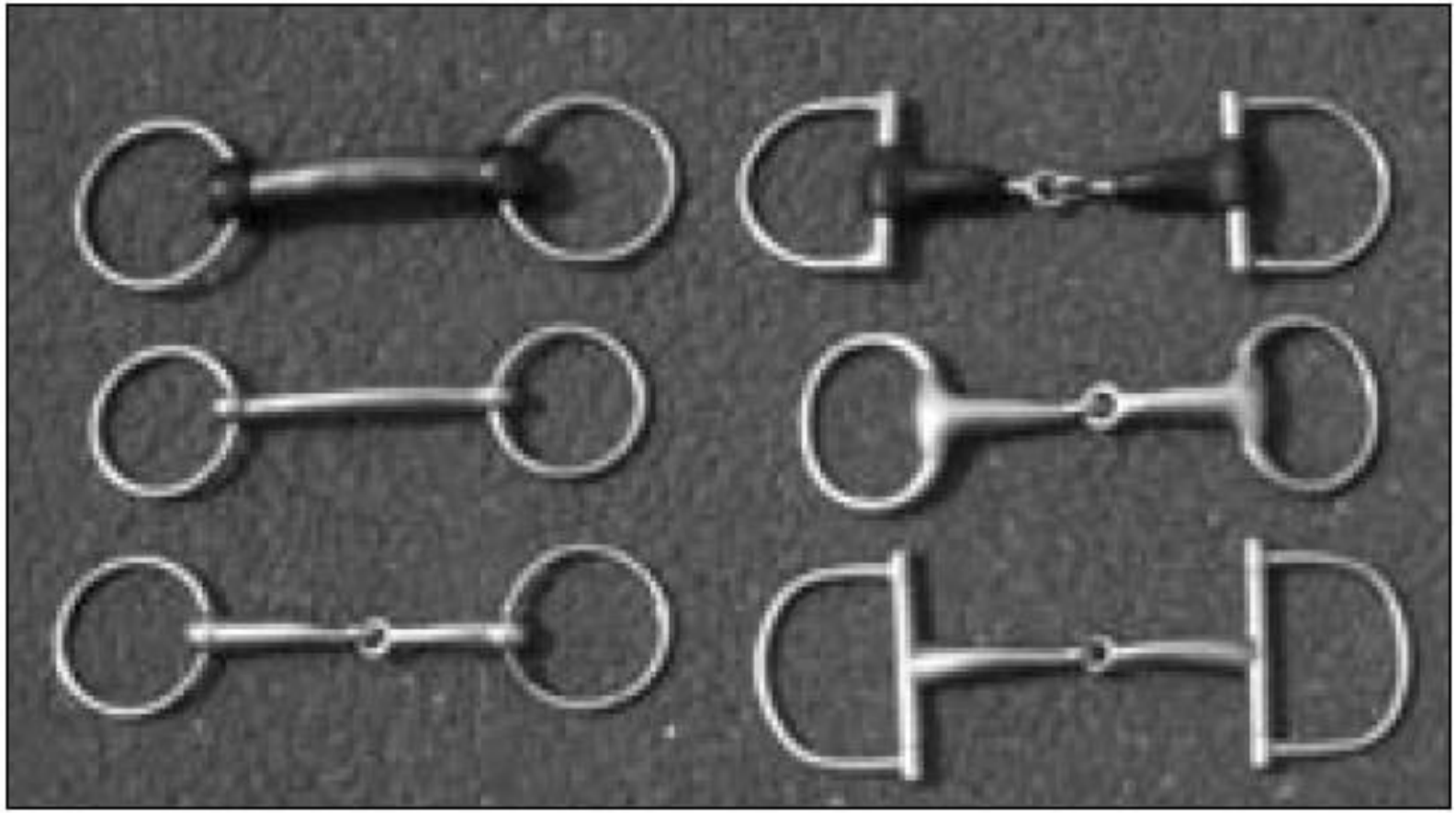
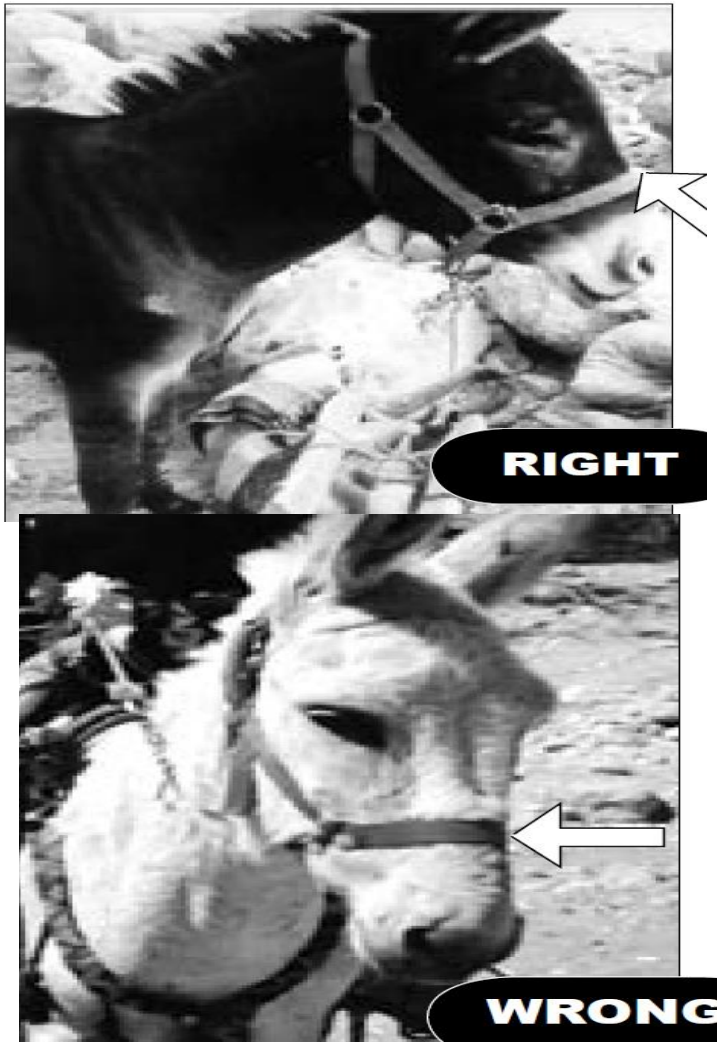


Fig: Some snaffle bits

Con’t



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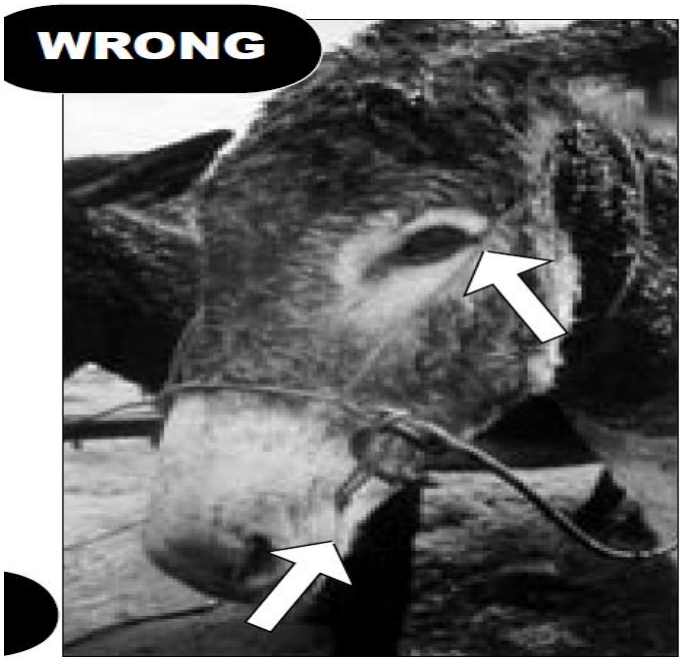


5.2.1.4. Harness for camel

- When harnessing working camels, the following considerations are important about a good harness:
  - It should efficiently transmit pulling energy directly from the camel to the equipment or implement.
  - It should not cause chafe or wounds on the skin of the camel.
  - It should not impede the camel's movement or natural functions like breathing.
  - It should not have sharp edges, which could be injurious to the camel.

Saddling

- Saddles are mainly used for carrying loads or people and normally sit over the hump.
- However, the weight of the saddle should rest on the ribs not on the hump itself.
- Some saddles have been adapted for use in pulling carts, ploughing etc

In selecting or using a saddle, it is important to ensure that:

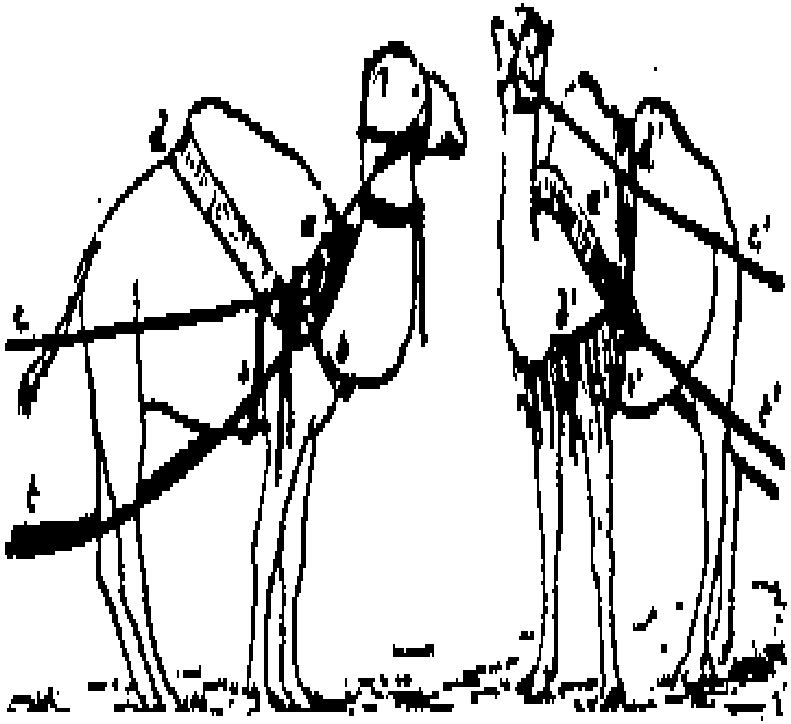
- there is sufficient padding between any hard frames or parts of the load and the camel body;
- there is no movement of the saddle that can chafe or cause sores through friction;
- the girths are firmly tied and the load does not slip or slide;
- padding is soft and absorbent i.e. made of materials that do not prevent sweat evaporation;

- the camel is comfortable and the load well balanced;
- it is easy to place on and remove from the camel;
- it is not twisted but lies flat along the body contours;
- it is wide enough and padded to distribute pulling or weight bearing force rather than concentrate it in one area;
- it is designed so that it rests on muscles rather than bones.

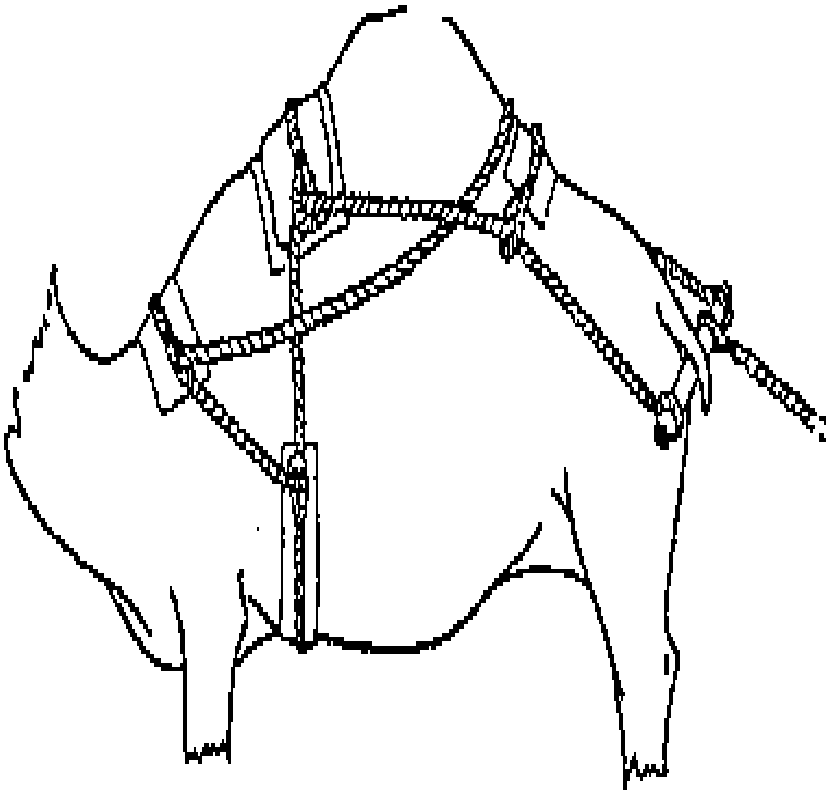
- Saddles can be very simple to make. A common saddle consists of two inverted forks of a tree connected by two wooden crossbars on each side of the hump.
- Sometimes a third diagonal crossbar is added for stability. The inside of the inverted V is then pared down and padded with cloth, wool or sacking.
- use cotton waste, sponge mattresses or grass and hay.

Harness for camel

Source: Duchenne, 1984
(after Ringlemann, 1905)



Source:
Pathak, 1984



Cart

Chapter 6. Performance Assessment of draft animal power

6.1. Dietary Energy Requirements of Working Animal

6.1.1. Energy Requirement in Cattle

- Under normal level of working, cattle utilize 150-175% of their maintenance energy, i.e., they utilize energy for work 1.5-1.75 times of their maintenance, i.e., almost two times.
- Requirement is high whenever there is other type of work/production.
- For example, a 400 kg adult bullock requires 76 MJME/day for normal work while a 400 kg draft cow, 3 months pregnancy and producing 3 l of milk per day requires 95 MJME/ day.

6.1.2. Energy Requirement for Equines

- **Horses:** Amount of energy should be adjusted according to level of work other wise feeding extra energy may lead to health problem, i.e., Monday morning disease (paralytic myoglobinuria).
- **Mule:** In average size or medium size mule on medium work requires an estimated amount of concentrate from 2.7-5.4 kg/day, roughage 4.5-5.7 kg/day.
- Estimated daily base concentrate and roughage should be divided into 2 or 3 meals per day.

- **Donkeys:** Working a regular work estimated feed requirement is concentrate about 1.8 kg/day and roughage 3.6 kg/day is the recommended ration and should be divided in 3 meals per day.
- **Camels:** Have high maintenance requirement because they walk a long distance for searching water and feed.
- Amount of maintenance energy required for 500 kg male camel is 54 MJME/day for draft or pack transport.
- One hour work 500 kg camel requires 8.2 MJME/day.

Protein Requirement of Draft Animals

- Very little extra protein is required for physical work, i.e., requirement of protein for physical work is insignificant.
- Protein is required when there is injury/wound as a result of work because protein is responsible for building.
- In general, in light or medium work, there is no immediate need of increase protein.
- Certain conditions require increase of protein in ration:
- Presence of injury/wound and Heavy work.

- **Minerals**: With exception of some minerals (salt, Mg, P), work has insignificant effect on mineral requirement of draft animals.
- Work increases salt requirement because during working considerable amount of salt is excreted through sweating.
- Work reduces blood level of Mg and P.
- Most mature and dry and green forage in highland part of Ethiopia are found to be deficient in P and Ca.
- Salt lick/ mineral lick should be supplemented for working/draft animals.

- **Vitamins**: Work can increase total requirement of many vitamins particularly B-complex vitamins because they are important in energy metabolism because they serve as co-enzyme and they are component of CoA, NAD, FAD.
- Amount of extra vitamins required for extra work for increased energy metabolism can be made by extra feed consumed to supply extra energy needed for the work.

- Moreover, these vitamins are synthesized in body of animal (rumen and colon) of ruminants and herbivorous monogastric animals respectively.
- Deficiencies of these vitamins are unlikely to occur.
- In general, there is no need of extra supplementation of vitamins for work production.
- Regarding fat soluble vitamins, there is no evidence of work increase the vitamins requirement.

- **Water:** requirement for draft animals is affected by several factors:
  - Physiological condition of the animal,
  - Stage of growth,
  - Level of work/ working condition,
  - Dry matter intake,
  - Feed composition and Weather condition

6.2. Energy Available For Work

- Energy is important for muscular work.
- Extra nutrient is required for physical work because of energy expenditure.
- For this carbohydrate and fat are the primary source and most efficient source of energy for work under normal condition

Glycogen and glucose:

- At rest glycogen comprises 0.5-0.9% of a well nourished muscle in weight proportion.
- Working animals require feed that are rich in TDN or rich in net energy.
- Chemical energy stored either in fats or carbohydrates are not totally utilized for energy production but smaller part only utilized

6.3. Basic Units to Measure Performance

6.3.1. Force

Tests have shown that

- light horses, bulls, buffalo, mules and camels all provide about three quarters horsepower,
- cows about one half horsepower, and
- donkeys one third horsepower.

- But it must be remembered that these are the rates at which the animals normally deliver force, not the maximum force they can produce in a given instant.
- In pulling tests, horses have, for several seconds, exerted pulls up to twice their weight and bulls have pulled up to their actual weight.
- But the intensity of such efforts uses up the animal's strength and reduces the total time it is able to work.

6.3.2. Work

- Animals vary not only in their ability to pull loads, but also in the number of hours they will work.
- In the tropics, breeds of oxen will pull between one-seventh and one tenth of their weight for four to five hours per day.
- Donkeys will pull about one-fifth of their weight for three to four hours.

- In tests performed in Africa, bulls worked longer when the load was decreased slightly and the work done in two sessions, two to three hours in the morning and two to three hours in late afternoon.
- Donkeys refused to work beyond three or four hours regardless of how the work was distributed and in spite of a reduction in the size of the load

6.3.3. Power

- What is Power?
- **Power** is the rate of doing work, and therefore unlike work, power is a function of time.
- Historically power was assessed in terms of what a draft animal might perform, and was measured in units called horsepower (hp), units that are still quoted today in some countries.
- The draft of an implement increases with working width or working depth

6.4. Assessment of work performance of draft animal power

- Before attempting to determine the kind and number of animals required for any particular farm, animal owners should be familiar with the concepts of pulling (draft) capacity and power.
- They should also consider the work characteristics of draft animals.

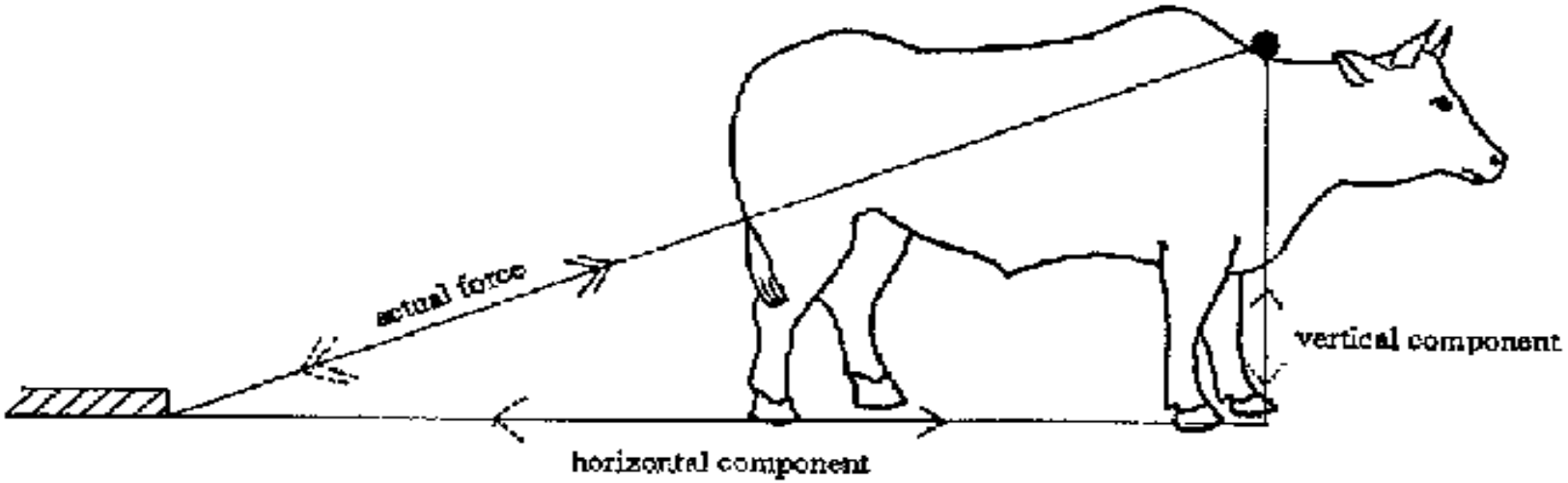
- **Draft** in order to move any object, an animal must exert a force equal to the weight or resistance of that object.
- For example, it takes 50 kilograms (kg) of force to move a 50kg log.
- If the movement is accomplished by pulling, rather than by lifting, or carrying, the force is called draft.

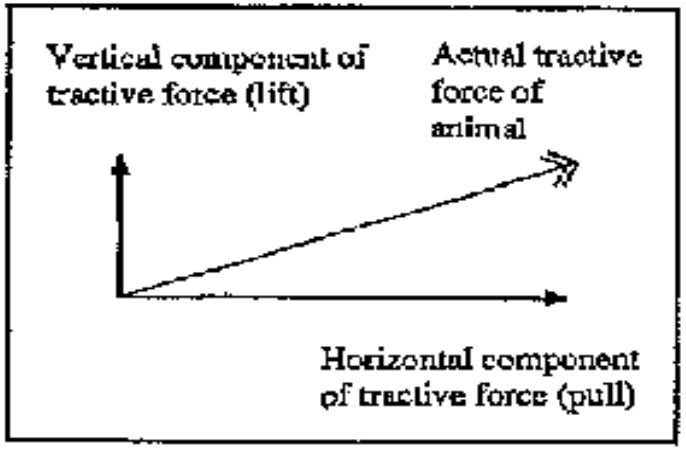
Table 2: Sustainable power of individual animals in good condition

Animal	Typical weight kN (kgf)	Pull-weigh t ratio	Typical pull N (kgf)	Typical working speed m/s	Power output W	Working hours per day	Energy output per day MJ
Ox	4.5(450)	0.11	500(50)	0.9	450	6	**10**
Buffalo	5.5 (500)	0.12	650 (65)	0.8	520	5	**9.5**
Horse	4.0 (400)	0.13	500 (50)	1.0	500	10	**18**
Donkey	1.5 (150)	0.13	200 (20)	1.0	200	4	**3**
Mule	3.0 (300)	0.13	400 (40)	1.0	400	6	**8.5**
Camel	5.0 (500)	0.13	650 (65)	1.0	650	6	**14**

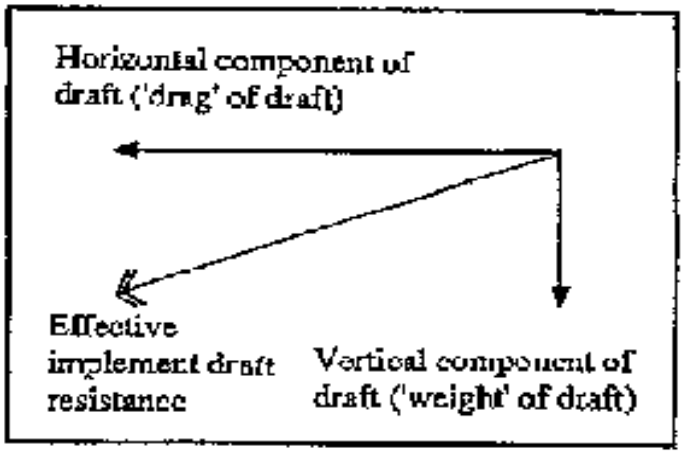
Note: For animals of different weight the power output and energy output per day may be adjusted proportionately. Source: Tools for Agriculture, 1992

Fig 11: Illustration of the vertical and horizontal components of draft forces





Tractive forces



Resistance forces

6.4.1. Units Associated With Work

- Newtons, meters per second, watts and square-metres per hour.
- Such units are important for permitting the exchange of information between scientists and professional agriculturalists but they mean nothing to the majority of farmers) yet farmer "assessment" is crucial.

- work will influence (directly or indirectly, in the long term or short-term)
  - the design,
  - selection,
  - production,
  - provision or utilization of harnessing and
  - implements must know that actual progress depends ultimately on the farmers and farmers' perceptions

6.4.2. Techniques to Assess Draft Animal Power Performance

- draft of an implement determined by many factors related to its specific design, including:
- overall weight;
- overall shape;
- shape of its components- harpness
- angle(s) at components meet soil or working surface;
- position and angle (s) of attachment of traction chain or draw pole;

Cont…

- material of which the implement and its components are made;
- adhesion properties of working surfaces;
- working width;
- working depth;
- friction within any rotating or articulating parts;
- elasticity/rigidity of different members

6.4.2.1. Measurements at Field Condition

- Implement draft force depends on many things (briefly discussed in the previous section) including
- implement size,
- shape,
- weight,
- width of work,
- depth of setting;
- soil type,
- moisture content,
- tillage history;

- vegetation quantity and quality;
- environmental obstacles,
- stones,
- stumps and roots;
- land slope.
- The distance and speed moved depends greatly on the characteristics of the animals used: their species (different species have characteristic walking rates), their weight, size, strength, condition and their standard of training

- The power output of an animal may be influenced by its past history (nutrition, disease, body condition, training, recent work experience) and
- its immediate environment (temperature, relative humidity, sunshine, ground surface).
- Different species and individuals may react to the environment in diverse ways.
- Some animals are better able (or willing) to withstand disease challenges or environmental extremes such as high air temperatures, bright sunshine or deep mud than others.

- Humped cattle (Bos indicus), with very effective temperature regulation systems, are often able to work longer in hot conditions than humpless cattle (Bos taurus).
- Water buffaloes have relatively inefficient temperature regulation systems so that "over-heating" during prolonged heavy work is a problem

- **Hand hoe, Animal power and tractor**
- Manual, animal and engine power sources are all important in agricultural development.
- Animals and engine powered machines help to reduce human drudgery and allow people to achieve more with their time.
- Engine power, where available and affordable, can achieve the highest savings in **time** and **labour**.
- Many smallholder farmers would like to benefit from tractor power, but such aspirations are often unrealistic.
- Engine power tends to be appropriate for **large-scale farming** and **long-distance** transport.
- Animals are often more affordable and appropriate for **small-scale farming** and **local transport**

- **Choosing between tractors and animals**
- The farmer must decide which of the two options is:
  - The most affordable and economically viable
  - The most timely and manageable to his or her best advantage
  - The farmer may even decide to use both, and on marginal commercial farms this can be highly effective.

Chapter 7- MANAGEMENT OF DIFFERENT DRAFT ANIMAL POWER

7.1. Housing of Draft Animal Power

- It is important to give work animals a place where they can eat and **rest unbothered** by weather, insects, other animals, and uncomfortable restraints such as hobbles, short ties, and narrow stalls.
- In the tropics, animals do not need elaborate shelters, but stabling them in dry, comfortable surroundings contributes to their overall soundness and work value.
- A lean-to with a straw roof provides shelter from **heat**, **rain,** and **wind**.

- A simple lean-to is a wall four or five meters long and two and a half meters high, with a canopy on one side.
- It is built on high ground so water drains away.
- The wall is situated so it blocks prevailing winds, and the roof made on the side opposite the wind.
- An earthen floor is adequate, but straw or sand should be kept in the area where the animal sleeps, or "beds down."
- Horses often prefer standing to lying on a hard, cold, or wet surface, so owners should make special efforts to ensure that bedding is ample.

7.1.1. Quality of Animal Shelter

- afford protection against cold winds and driving rain.
- provide shade and protection from the sun.
- provided by any of the following: shelter belts, trees, hedges, walls, purpose-built shelters (open fronted shelters and windbreaks) and rugs (water proof turnout rugs).
- The lack of adequate shelter and feeding can result in cold stress, discomfort, weight loss (loss of body condition) and increased susceptibility to diseases.
- Very young and very old animals will be more susceptible to climatic extremes and require extra consideration.

7.1.3. Housing for Equines

- Housing facilities should be designed and constructed to provide for the equine welfare.
- Equine should be provided with a clean, dry area for lying down.
- In all types of housing systems equine should be free to stand up or lie down comfortably at all times.
- Housing facilities should provide for enough height to permit equine to have a full range of head and neck motion without touching the ceiling when standing with four feet on the floor.

- Flooring should be properly designed, constructed and maintained to provide good traction, proper drainage, comfort and prevent injury.
- The design of housing facilities and the materials used in their construction should permit thorough cleaning and disinfection from time to time.
- Loose boxes (or traditional stables) are the most common form of stabling individual horses.

7.2. Feeding and Nutritional Requirement of Draft Animal Power

7.2.1 General Management of Feeds

- A good feeding program is essential in maintaining the **strength** and **health** of draft animals.
- Food is the fuel which an animal converts to **energy** and **pulling power**.
- Animals that are not fed enough of the right foods can show chronic fatigue, will **lose** the ability to **work,** and are more **susceptible to disease**.
- Excess calories are stored as fat, causing animals to become inefficient workers, lazy, stubborn, and ill-tempered.

10.2.2 Nutritional Requirements of Draft Animal Power

Energy needs: bovine animals

- Oxen are ruminant- swallow large amounts of unchewed food as they graze and eat and regurgitate this feed in small portions (boluses) and chews it thoroughly.
- The micro-organisms (bacteria and protozoa) in the animal's fore stomach (rumen) break down fibrous feeds (including the cellulose) and use them as a substance for growth.
- These micro-organisms and their products then become digestible nutrients for the animal.
- For this reason, ruminants can derive many nutrients from roughage whereas other animals cannot.

Energy needs: equine animals

- Horses, donkeys, and mules are non-ruminant animals.
- They do not store food and later chew it, as oxen do.
- In addition to their molars, they have a set of upper and lower front teeth suitable for grinding roughages. (Bovines have no upper front teeth: they pull the grass loose, swallow it, and later bring it up and chew it with their rear molars.)
- With equines, digestion begins in the mouth, continues in the stomach, and is completed by various intestinal organs.

Daily Protein and Mineral Requirements for Draft Animals

- Requirements may be adjusted depending on the elements available in the pasture where the animal grazes.
- A mineral-starved animal should not be given free access to a lick or loose mixture. Instead, mix the correct does in with its concentrate.
- A ration is a combination of feeds which provides the daily requirements for energy, protein, vitamins and minerals.
- Since the chemical composition or nutritional value of grain or pasture is determined by soil, weather, and other environmental factors, rations should be formulated using data obtained from regional testing centers.
- When this is not possible, other tables may be used, but with attention to the system of measuring as well as basic principles of feeding

- **Water Requirement**
- During the rainy season, grazing animals get considerable amounts of water from the grasses and other succulent forages they consume.
- Under these circumstances, drinking water consumption is not an accurate indication of water requirements.
- Actual water needs are determined by
  - **size,** **- environment**, and
  - **species**, **- intensity of work**
  -

7.2.3. Supplementary Feeding of Draft Animal Power

- Why Draft Animals Need Special Diets?
- Grazing draft animals need supplemental feeding for two reasons:
  - To increase energy intake and prevent protein, vitamin and mineral deficiencies
  - Because of limited grazing time or limited forages availability. Pulling loads is hard work.

7.3. Health Care and Welfare of Draft Animal Power

- Good animal health is a prerequisite for the success of animal traction.
- Animal **sickness** and **mortality** can be particularly serious where animal traction technology, or a new type of animal, is being introduced.
- Many health problems can be avoided by a combination of indigenous knowledge and modern prevention systems (vaccination/prophylactics), deworming, spraying and treating for other infectious diseases.
- Disease limits the working capacity of draft animals, and work can exacerbate disease.
- The relationships between disease, work and nutrition are complex and not yet well understood

Fig: Drenching a donkey using stomach tube

Caring for draft animals

- Animal welfare is widely recognized as one of the information gaps, increasingly needing intervention in order to reach out to the poor communities, and improve their livelihoods.
- Animal welfare studies and interventions are generally pursued because of the concern for the quality of life of animal.
- Historically, and naturally, we all agree that animals need to be treated in a certain way.

- Even the bible tells us in Exodus 23:12 that we shall rest on the 7day and so will our ox and ass (donkey). **ኦሪት ዘፀአት 23፡12 ስድስት ቀን ስራህን ስራ ፡በሬህ እና አህያህ ያርፉ ዘንድ ለባርያህም ልጅ ለለመፃተኛውም እረፍት ይሆን ዘንድ በሰባተኛውም ቀን እረፍ።።**
- Deuteronomy 25:4 says you shall not muzzle an ox when it treads out the grain. **ኦሪት ዘዳግም 25፡4 እህል የሚያበራየውን በሬ አፉን አትሰር**
- So we all agree that animals should be treated well, but what many have not agreed on is what constitutes a good quality of life for animals

Fig 13: Donkey with back bruises due to in humane utilization

Different ways of defining animal welfare

- There are a number of approaches in trying to define animal welfare.
- There is **"Feeling-based" approach**, which maintains that animals are sentient they have feelings, and so if we treat them well, they are likely to be more productive.
- This approach describes animal welfare in terms of their subjective experiences (feelings, emotions); and so emphasizes the reduction of negative feelings/ emotions (pain, injury, hunger, thirst); and promotion of positive ones (normal behavior).
- There has been argument whether this sentimental mentality has any scientific basis.

- The other approach is "**Functioning-based" approach**, which defines animal welfare in terms of normal or satisfactory biological functioning of the animals their health, longevity and reproduction.
- A less developed approach is one that calls for animals to be raised in a manner that suit the nature of that particular species to be able to perform its full repertoire of behavior i.e. allowing animals to be just that animals.

- All these approaches have nevertheless agreed that welfare has both a physical and a mental component.
- Whatever the approach, we have a moral and ethical obligation to ensure that all animals enjoy good quality life.
- The famous quote by **Mahatma Gandhi** is that “the moral integrity of a nation is seen in the way people treat their animals.”
- The truth is that people who treat their animals better are more likely to treat themselves well, and vice versa.

- **Five frameworks for assessing animal welfare**
- Our BIG question is what constitutes good quality life for animals, be they for work or consumption?
- Do we have standards or guidelines, at the very minimum for welfare?
- What is unfortunate, is that we humans being at the end of the cognitive scale always feel that we know best what and how the animals feel and want.
- So, do we really know what is best for animals?
- Have we asked, or heard from them?

- To judge the quality of life for work, companion, food and/ or wild animals, we must be able to assess their welfare objectively.
- Different frameworks have therefore been used for welfare assessment, and the most common is the five freedoms.
- These include:
    1. Freedom from hunger and thirst;
    2. Freedom from fear and distress;
    3. Freedom from injury and disease;
    4. Freedoms from discomfort and
    5. Freedom to express normal behavior.

Chapter 8. Record Keeping

- Record keeping is an essential part of good livestock and farm business management.
- Recording can be done most easily if animals have some form of identification.
- There are two main objectives of animal identification and recording:
    1. To identify animals belonging to a particular owner; proof of ownership.

2. To use as a management tool to:

- undertake performance evaluation,
- perform genetic selection,
- keep proper health records,
- accurately measure of draft power and
- Perform other important management functions required to run an effective and efficient farm enterprise.

8.1. The importance of record keeping

- provides basis for evaluation of animals from past records hence helps in selection and culling animals
- Helps in progeny testing of draft animals.
- Helps in analyzing feeding cost and benefits from animal product outputs.
- Helps in detection of abnormal conditions or disease status that leads to loss in body weight, loss in draft power etc.
- Helps in finding the commonly occurring diseases to formulate in time precautionary measures like vaccination, deworming etc.

Essential aspects of good record keeping systems

- ✓Accuracy,
- ✓completeness,
- ✓arrangement,
- ✓permanency,
- ✓neatness,
- ✓legibility,
- ✓simplicity, and
- ✓consistency

8.2. Types of record

- Production record
- Breeding record
- Health record
- Financial record