Chapter1.

Introduction

Working animals, mainly equines, camels and bovines are draught animals that perform transport and traction activities. In developed countries technological development has resulted in animal power being minimized, however, in developing countries most agricultural operations are still being conducted by animals, and animal welfare is a major concern. Inadequate knowledge and inappropriate attitudes and practices regarding the management and welfare of working animals are the main contributory factors to welfare problems.

Animal traction: - is the use of animals [cattle (bulls, oxen and cows), donkeys, mules, horses, goats, camels, water buffaloes, etc.] To assist farmers in carrying out the following tasks.

- In **agriculture,** for ploughing, harrowing, planting, ridging, weeding, mowing and harvesting.
- In **transport,** for pulling carts and loads over a surface, logging and carrying loads (pack animals).
- In **irrigation,** for driving water-pumps and pulling water from wells.
- In the **building industry,** for assisting in earth moving for road works, for carrying bricks, etc.
- To **provide power** for the operation of stationary implements such as threshing machines, grain mills and food processing machines.

In many parts of the world, farmers have adapted hoes and cultivating tools so they can be pulled by people, animals or engines. This is called mechanized agriculture; the type of power used is called traction, or pulling power.

Animal traction, animal-powered mechanization, and animal draft are terms which describe the use of animals to pull farm equipment, vehicles, and other loads.

❖ The most common draft animals used for traction in some parts of the world are:-

- cattle
- horses and Mules
- Donkeys
- camels
- Domestic water buffalo
- yaks
- Reindeer and even elephants

The kind of animals used and the kind of work performed depend largely on people's resourcefulness in raising and training animals and devising hitches that allow them to pull.

Definition of Terms

Jack: Adult male donkey.

Jennet: Adult female donkey (sometimes written as jenny, but both pronounced the same).

Donkey geldings: Castrated male donkeys.

Stallion: male horse above the age of four

Mare: female horse above the age of four

Colt: a male horse under the age of four.

Filly: a female horse under the age of four.

Harness: the whole power transmission system attaching the animal to its work load.

Harrow: a wooden frame with 15 to 20 metal spikes to break soil clods and to level the surface.

Packing: placing a load on to the back of an animal for it to transport.

Rein: strap held in hand of rider or driver and attached to a bridle or halter for controlling an animal's head.

Ridger: a plough with two mould boards to make a furrow and two small ridges on either side.

Ripper: a toolbar or plow-frame with a single angled tine used for opening a narrow band of soil for direct seeding; also called chisel-plow.

Tillage: preparation of land for crop-bearing.

Moldboard: a curved piece of metal which turns the furrow slice on its side after it has been cut by the plow blade, or share.

Tines: the soil-contacting descending bars of a cultivator or teeth of a harrow.

Traces: the chains or ropes used to transmit the draft force from the collar or breast-band harness to the work load.

Wagon: an agricultural or freight vehicle with four wheels.

Withers: part of equine just behind where the neck joins its back.

Withers yoke: a yoke positioned on the withers; often called neck yoke.

Yoke: strong bar usually made of wood, which an animal can push against in order to pull an implement.

Role and socio-economic Importance of equines in Ethiopia and other regions.

Agricultural mechanization has become a high priority in developing nations. This is important because farmers using traditional techniques are unable to produce sufficient food for increasing populations. Mechanization can expand the area under cultivation and provide better soil preparation, leading to greater harvests. Government extension services therefore strive to give farmers tools, information and advice to enable them to increase productivity.

Benefits of mechanization to farmers include:-

- Lightened 'workloads,
- Better and more regular yields, or
- Simplification of problems caused by short growing seasons or insufficient labor.

Mechanization also can help to produce income with which farmers can acquire goods and services. Yet mechanization is not practical or economical for every farmer. Acceptance of new techniques increases dependency on outside technical assistance/ thus the farmer who already produces enough food for his family may be reluctant to risk a known harvest (traditional yield) for an uncertain gain in productivity.

The search for agricultural technology that meets the needs and desires of both farmers and governments has led to increased interest in animal traction, sometimes called "light mechanization".

Farmers, agronomists and agricultural extension services often cite the following advantages of using animal traction

1. **It reduces the difficulty of labor and makes farming a more appealing occupation**.
   - ✓ Farmers who might seek employment in other areas are encouraged to develop existing skills and abilities and improve operations.
2. **It increases productivity.**
   - ✓ Replacing hand hoes with draft animals and equipment, farmers can double or triple the area cultivated, thereby increasing crop yields.
3. **It is affordable technology.**
   - ✓ Animals and equipment are low in cost compared to tractors.
   - ✓ Low-interest loans are often available through government or sponsoring agencies.
4. **Animals and equipment can be supplied locally, creating less dependence on external resources than tractors and other machinery**.

- ✓ Tractors need fossil fuels, spare parts, and maintenance know-how which may not be available to farmers.

5. **Used on a small scale, it does not require radical changes in cropping patterns or the role of family or hired labor.**
   - ✓ Although it does reduce manpower needs in some field operations, the reduction is not drastic and labor can shift to other activities like planting, spraying, harvesting and caring for animals and harness.
6. **It creates work opportunities**.

✓ The use of animal traction can stimulate the development of:-

- Artisan resources,
- Increasing jobs for local blacksmiths, carpenters, and Leather makers who produce needed equipment.
- It also creates work in the areas of transport, water-pulling, and tillage on a contract basis (Farmers can hire out their teams and equipment).

Socio economic Importance of Equines

There is a growing recognition and collection of evidence that working animals play a significant role in supporting the livelihoods of the families who own them and in fulfilling socio-economic functions that benefit animal owning households and the wider community. In particular, their contribution to income-generating activities has recently attracted attention and interest. They are often the major or a key source of income for families. It is well acknowledged that working animals contribute to households' livelihoods and benefit the community as a whole, includes the following:-

- ➢ Transporting firewood, water and other daily needs to the homestead, in particular relieving the physical burden of women and freeing their time for other household or income-generating activities
- ➢ Transporting water and fodder for other livestock
- ➢ Providing draught power for agricultural tillage, including ploughing, harrowing and weeding.
- ➢ Taking agricultural and livestock products, such as milk, vegetables and other farm products to the market and bringing market purchases back to the homestead
- ➢ Being used for small-scale commercial activities such as taxi services, carting goods or petty trading

- Being rented out to provide an income for the animal owner and a small business opportunity for the hirer
- Transporting commercial crops, such as coffee, from farm to road-head or transport hub
- Transporting geographically localized goods such as salt over long distances from salt pans or coastal areas to cities
- Strengthening social relationships within extended families and communities through lending working animals at times of need, for example during ploughing and harvesting seasons
- Providing manure for fertilizer and, in some cases, milk, meat and hides for household use or income
- Providing a source of bride wealth
- Forming an important part of weddings or ceremonial occasions

Major Constraints of Draft animal power Utilization

1. Implements

Lack of appropriate implements can be vital constraint to the use of animal traction and farmers have sometimes found it difficult or impossible to obtain suitable equipment. In most West African countries there are factories or workshops capable of producing steel plows, cultivators and other animal-drawn implements. Indeed since most workshops are theoretically capable of producing more implements than the national demand warrants, there is an overall regional overcapacity for the production of animal-drawn implements. This overcapacity is seldom obvious as most workshops are heavily constrained by limited capital availability, unreliable infrastructure (electricity, fuel etc.) or lack of raw materials. Poor marketing channels exacerbate the situation, so that farmers may complain of lack of implement supply at the same time as workshops complain of lack of market demand. In some cases the problem is due to implement quality rather than quantity: farmers are only offered equipment of poor standard or inappropriate design and consequently do not purchase them.

Poor implement adjustment causes unnecessary work for animals and farmers in many countries in West Africa. The lack of knowledge or inadequate training responsible for poor use of implements reduces the overall efficiency of animal traction use. While this is clearly important, it is unlikely to be

a primary constraint to animal traction, although in extreme cases the difficulties experienced can lead to the abandonment of this technology.

2. Harnessing

Several people have suggested that harnessing is a major constraint. Different people have strongly encouraged the use of head/horn yokes, withers/shoulders yokes, collars, breast-bands, single yokes or double yokes,

In West Africa the present adoption position is quite clear, oxen are yoked with double withers yokes or double head yokes and donkeys and horses are harnessed with breast bands. Collars and single yokes are rare or absent. It could be argued that harnessing is not a primary constraint, since the existing yoking systems (when used correctly) do allow animal traction to be used for agricultural development. Nevertheless it could be a secondary constraint and animal traction might be made more efficient, and/or more comfortable for both animals and farmers if harnessing were "improved" either by different designs or by better attachment of existing designs.

3. Human labor

Human labor can be a critical constraint in farming, and animal traction may ease or exacerbate this. The labor bottleneck of cultivation may be lessened if draft animals are used, although the overall effect may be labor-switching rather than labor-saving. For example, draft animals may save adult males valuable time at critical cultivation periods, but this may have to be "paid for" by children supervising the draft animals as they graze throughout the year. Farm households that do not have sufficient labor to manage draft animals throughout the year may be unable to adopt animal traction. Stumping fields to allow the use of animal-drawn plows it requires much labor, and in some areas this may be a critical constraint to adoption. In Ethiopia and most Asian countries it is rare to see more than one person working with a team of animals. If animals are well-trained they are easily stolen, but if they are kept relatively wild, people will be scared to steal them. Thus work oxen are kept wild; and three to four people are needed during the short plowing season. Donkeys on the other hand are well-trained because no one steals donkeys, as their meat has no value.

4. Capital and credit

It is well known that lack of capital or credit can be a critical constraint to agricultural development, and the adoption of animal traction can be highly dependent on the availability of these resources. The market cost of oxen, cultivation implements and carts is high relative to average farm incomes. In areas of low animal traction adoption, few crop farmers have both sufficient savings and also the confidence in animal traction to purchase animals and implements without assistance. In such cases the provision of credit has often led to rapid adoption, as occurred following credit schemes provided by cotton development or marketing.

5. Environment and infrastructure

In forest areas, the presence of trees and stumps constitute a major constraint to animal traction. However this constraint gradually "disappears" as population and land pressures increase and as the time required for land preparation and weeding under forest-fallow cultivations systems increases.

In forest areas, animal disease, notably trypanosomiasis, may act as a constraint to the use of draft animals. In more arid areas, the provision of water can be a constraint, and animals may have to walk long distances to water sources. High temperatures and large quantities of direct solar radiation may exacerbate water shortage, and cause animals to stop work as their body temperatures rise.

6. Animals

The limited availability of animals can be a serious constraint to the employment of draft animal power in some areas. In the humid and sub-humid zones of West and central Africa, there are very few cattle. The problem of animal health is often linked to that of availability. Some very high mortality rates (10-25% in bad seasons) have been recorded for draft animals. Such mortality has often occurred when animals were not readily available locally so that they were brought in from surrounding areas.

The range of horses and donkeys in West Africa is severely limited by disease constraints, and they seldom thrive in the zones infested with tsetse fly. The range of Zebu cattle extends further, but in zones heavily infested with tsetse fly, Zebu cattle succumb to trypanosomiasis and other diseases, and the only the trypanotolerant taurine cattle seem to thrive.

7. Nutrition

Inadequate animal nutrition is often cited as a major constraint to the use of animal traction. Animals are expected to cultivate fields at the beginning of the rainy season. This is the very time of the year when they are in poorest condition, following the inevitable weight losses of the dry season. The seriousness of the constraint is seen most dramatically in drought years, when large numbers of animals may die of starvation. For example, farmers in Ethiopia may sell hay for money, even when their own animals are in poor condition. Similarly farmers in The Gambia and Senegal may sell groundnut hay to commercial transporters, rather than feeding it all to their own animals. These observations suggest that even though nutrition is a constraint, it is not always a limiting factor. It may be that overall farm profitability is limiting, and this discourages farmers from investing in the nutritional status of their working animals. In almost all extension manuals it is recommended that farmers should feed supplements to their animals prior to, and during, working periods.

8. Social constraints

In areas where animal traction is still a highly innovative technology, it is common to hear someone argue that the technology is appropriate to one tribal group, but not another. Social and psychological constraints that may have to be overcome if animal traction is to diffuse into an area. Nevertheless, while social traditions are obviously important, many examples from different parts of Africa show how quickly animal traction can spread, if it is found to be profitable. Apart from social traditions, farmers may simply be unaware of animal traction options. Nevertheless knowledge can spread very quickly, within areas where animal traction technology is technically and economically appropriate.

9. National policies

National development policies can represent either for motivation to animal traction, or they can act as a major constraint, interventions at national level can greatly influence decisions at farm-level. In extreme cases animal traction is actively discouraged by governments. This is the case in present-day Egypt, where the policy is that the forage consumed by working animals could be better used for milk production. More often animal traction has merely been neglected. In several African countries, tractorization policies were actively pursued in the 1960s and 1970s and by providing heavily subsidized tractor-hire services, governments made it economically undesirable to use draft animals. Animal traction has sometimes been neglected in the allocation of resources for the provision of national services such as credit, extension, research and training.

10. Aid policies

Aid donors and international institutions are naturally very sensitive to any suggestion that their policies can sometimes act as constraints for development. Nevertheless donor-funded activities can adversely affect the development of animal traction, and it has even been suggested that one of the biggest constraints to the success of one donor-assisted programme is another donor-assisted programme! For example just as animal traction is developing in an area, with farmers hiring out their animals to their neighbors; another donor may provide tractors to allow a subsidized tractor-hire scheme to start, so reducing the attraction of animal traction.

Feeding, Selection, Housing of equine

Draft animal need several important feed components - energy, protein, vitamins, minerals and water. Different feeds should contain these components in different amounts. Provided natural pasture is abundant and feeding of draft animal should not be a major problem. Besides forage (or roughage) from grazing, the animals may be fed additional forage and concentrates provided by the farmer, depending on age and workload. In general, feeding strategies should be aimed at maintaining adequate body condition during periods of work stress or reproductive stress. Some preserved forage or concentrates should be stored for such periods. This is particularly important if draft animal have to work at the end of the dry season, when natural pasture is scarce.

A properly fed animal will

- live longer,
- work harder and
- Resist diseases better.
- If well fed, females will become pregnant sooner.
- Pregnant and nursing Jennies will produce bigger and healthier foals.
- Foals given extra food at weaning will grow faster, survive disease better and end up larger.

Types of Draft animal feed

I. Forage feeds

In general, forage consists of leaves and stalks of plants (grass, maize Stover, etc.). Draft animal needed to eat forage every day. The quality of forage depends on plant species and age, season and weather conditions.

Example: donkeys are selective feeders; they need to have a wide variety of plants to choose from when grazing. Draft animal can be fenced, staked, herded or left to graze unsupervised.

- If they are herded or range freely, they will be able to seek out a range of plants.
- If donkeys are staked, it is important to move their stake daily, or even twice per day.
- If they are fenced, it is better to have several small paddocks rather than one large one.

The most common forage supplements are crop residues. These include groundnut hay, and maize and sorghum Stover. The leaves of legume fodder trees (e.g., *Leucaena, Sesbania* and some *Acacias)* are rich in protein and can also be fed to donkeys. Other sources of fodder include sugar cane bagasse.

Young plants, as well as those growing in cooler, drier seasons provide more nutrients than older plants. The quality of conserved forages (such as dried grass and groundnut hay) depends both on the quality of the original product and on the way it has been stored. They should be stored in a dry place. Forages that become wet and mouldy or dusty can be very unhealthy. If the available forage is not of sufficient quantity or quality to keep donkeys in suitable body condition, they may need to be given some concentrates as well.

II.Concentrate feeds

Concentrates are generally seed grains and milling by-products such as wheat bran, oilseed cake and molasses. Concentrates contain more energy, and often more protein and minerals than forages. And they are generally more expensive. The choice of concentrate feed will depend on local availability and costs. Concentrated feed includes milled grains such as maize, sorghum and millet. Soiled grains considered unsatisfactory for human consumption can be used, provided if they are not moldy. Cottonseeds, cottonseed cake, groundnuts, and groundnut cake are all concentrates used as supplement. Dried cassava root can be used, as can green bananas. If they are available, brewers' grains or citrus pulp can be fed draft animal like molasses, which provides energy and can be poured on top of bran or forage. Rice bran and wheat bran can also be fed, but should not form the entire diet, particularly not for young animals, as the range of nutrients is very limited. The amount to be fed may be 1 to 2 kg per day. Finely ground bran may need to be mixed with a little water, to prevent choking.

Selection of Individual Draft Animal

- Farmers must be able to select the animal or animals most appropriate for their needs. Selecting a good draft animal is a matter of evaluating both physical and behavioral attributes.
- When the farmers choice draft animals for purchase, the animals must be ;
  - Acceptable by the community
  - Healthy , trainable and sound
  - Maintainable and profitable within the overall farm plan.
  - Available locally to adapt with local feed and climate and to tolerate disease
  - Have considerable work expectancy and resale 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.

Criteria's for judging or selecting a draft animals

- Age
- Sex
- Conformation (shape) and
- Temperament**. (Detail, on ch.6)**

Chapter 2

Scope and Development of Draft & Pack Animals

The employment of domestic animals for tillage or transport is known as animal traction. The term is generally understood to include pack transport as well as the 'pulling' work of animals. In various parts of the world cattle, buffaloes, yaks, horses, donkeys, mules, camels, llamas, elephants, reindeer, goats and dogs are used for transport, crop cultivation, water-raising, milling, logging and land excavation or leveling.

Cattle are the major work animals world-wide. It is most common to use male animals because they are stronger than females and cattle herds always produce a surplus of males. Castrated animals are more docile than intact males. Thus, the most common working cattle are castrated bulls, known as oxen or bullocks. The term bovid encompasses the animals that are closely related to cattle, including water buffaloes and yaks.

After cattle, the main work animals world-wide are horses, donkeys (asses) and mules, known collectively as equids. In current English, a domestic ass is generally called a donkey. Mules are non-breeding hybrid animals formed by crossing a female horse with a male donkey. They are stronger than donkeys and hardier than horses. The other possible cross (female donkey and male horse) is known as a hinny. These are much less common, partly because the cross is biologically much more difficult to produce.

Historical development of the use of draft and pack Animal power

Animal traction is the use of animals to assist human beings in work, especially in agriculture. It has a long history in Eurasia, as well as Egypt, Maghreb (North West Africa) and Ethiopia. In the remainder of Sub-Saharan Africa it is strongly associated with the history of European contact.

- The history and current status of working animals in Africa, beginning with the earliest evidence from the Nile Delta relating with the following operations:-

✓ Ploughing
✓ Carting
✓ Sledges
✓ water-raising and

- ✓ Animal mills.

Origin and expansion of Draft and Pack Animal Power

. The recorded history of animal power in Africa starts about 6-5000 bp in Egypt with the first drawings of oxen and ard plows occurring in the III Dynasty. These, together with the engravings of oxen and plows in early Mesopotamian civilizations, appear to constitute some of the earliest records of animal traction in the world.

. It is possible that the *maresha* animal-drawn plow was spreading in Ethiopia at the same time as animal traction was developing in ancient Egypt, but there are fewer records from this period in Ethiopian history. The plows comprised a long wooden beam that pulled a horizontal wooden plow body fitted with a metal share. The plow was controlled by two handles. The ard plows widely used in Egypt to this day are not dissimilar to the ancient designs. The early drawings and models show animals plowing in yoked pairs. Some early illustrations suggest that the yokes were tied to the horns of animals (head/horn yokes). Other illustrations and models suggest the use of withers yokes similar to those used in present-day Egypt.

. Several ancient Egyptian illustrations clearly show that the animals used for plowing were cows. One possible historical and cultural explanation is that the ox was considered more sacred (blessed) than the cow. However in most parts of the world, oxen are the first bovids to be used for work. Cows only start to be employed when:-

- ❖ Smallholder farming becomes intensive
- ❖ Animal feed resources are limited and
- ❖ The work operations are light or highly seasonal

These conditions have developed early in Egypt, particularly as equids were available for certain transport tasks (year-round work).

Oxen are seen pulling the funeral sledge. Wheeled ox-carts (as opposed to horse-drawn chariots) do not appear to have been common in ancient Egypt. Drawings and models of ox carts in nearby Mesopotamian civilizations date back about 5000 years ago.

Early Development of Common pack Animal power

The employment of horses in Egypt appears to have followed the use of donkeys. They do not appear until the about the 13th Dynasty (about 3800 bp). Many Egyptian illustrations 3000-3500 bp show horses hitched in pairs for pulling two-wheeled chariots. A ceremonial chariot with light-weight spoked wheels was found in the tomb of Tutankhamen (3300 bp). Drawings dating from the same era show animals that appear to be mules or hinnies pulling two-wheel carts or chariots. However, there is no evidence that donkeys were used to pull carts in ancient Egypt.

Animal traction in North Africa

Archaeological evidence suggests that animal traction technology spread from ancient Egypt southwards into Sudan. The technology also spread around the Mediterranean, and it was probably widespread along the coast of North Africa by 500 BC. Animal traction has been an integral part of farming and transportation systems in North Africa for over 2000 years, and a wide range of species and technologies are now used.

- Camels are herded for meat, used for riding and pack transport and may assist with tillage operations or irrigation equipment.
- Horses are owned for riding, recreation and pulling carts, and some transport horses also assist with cultivation.
- Mules are mainly used for pulling carts and wagons in both urban and rural areas. They may also assist with soil tillage.
- Donkeys are mainly used as pack animals, and for riding. Donkey carts are found in urban and rural areas, and donkeys may also be expected to perform some soil cultivation work.

While motorized transport has been increasing rapidly in the twentieth century, the use of animal power for local transport has not shown comparable decline. However, long-distance transport of goods and humans using animals has been largely replaced by cars and Lorries.

Animal traction in Ethiopia and the Horn of Africa

Ox-drawn plows appear to have been used in Ethiopia for at least two millennia, and possibly a much longer, although the origins of the *maresha* ard plow are not known. The single-handled

Ethiopian scratch plow is very different in design from the two-handled plow used in Egypt. The *maresha* is more like a spear, pulled through the soil using a long beam. The ard plow was introduced 2600-3000 years ago by Semitic-speaking peoples invading from South Arabia. Linguistic evidence suggests that the ard was in use 'several millennia' before the South Arabian invasion, which might make the Ethiopian plow the oldest. Although a variety of development programmes has attempted to introduce short-beamed steel plows for the past fifty years, there has been almost no adoption of these. The plowing animals are generally oxen, yoked in pairs with withers yokes, and controlled by a single person. Where oxen are in short supply, horses, donkeys or cows may be used, but oxen are the work animals of choice. Camels are occasionally used for cultivation. Ox-carts do not appear to have been part of Ethiopian traditional systems, and they remain extremely uncommon.

Transport of goods in Ethiopia has long been based on pack donkeys. Little is known about when donkeys started to be used in Ethiopia, and when they became common. Donkeys have long been important in the history of the salt trade in northern Ethiopia and are represented in traditional Ethiopian art.

Pack donkeys are extremely important in both rural and urban economies. The success of military campaigns in Ethiopia and Eritrea in the late twentieth century was owed much by the use of pack donkeys. Despite the large numbers of pack animals employed in Ethiopia, transport of loads by humans (mainly women) is still common.

Horses and mules are mainly used for riding. Simple passenger-carrying two-wheel horse-drawn carts became common in Ethiopian cities around the middle of the twentieth century. They were banned by the authorities from central Addis Ababa around 1963, but remain common in other towns. They are almost invariably used as passenger taxis for hire, and there is negligible use of horse carts for freight purposes.

Donkeys have not been traditionally used for pulling carts. However, an innovative design of low-cost donkey cart started to be seen in the Rift Valley of Ethiopia in the 1970s. The carts made from wooden poles, with steel wheels, appear of recent, indigenous design, and have evolved in a country where donkeys have always been used to carry on their backs rather than

pull from harnesses. At the end of the twentieth century, these carts have been spreading rapidly in the Rift Valley where they are used for the transport of water, straw and other materials.

Stationary applications of Draft animal power

Animals may also be used to pull water from wells. In North Africa, mote systems are employed, where an animal walks down a slope and pulls on the rope attached to a leather water bag. Some motes have self-emptying systems. Descending the slope makes it easier for the animal to raise the water. All types of work animals may be used. Such systems are most common in pastoral areas, where large numbers of animals must be watered at the same time.

Threshing

Threshing is a seasonal operation and the species used are those that are readily available because they are maintained for other work. In this operation, the animals walk round in circles over beans or cereals to separate the husks from the grain. There is a strong geographical distinction between systems using a central tethering post and those which simply make use of random trampling movements. Pigs were used for work in Ancient Egypt, both treading and threshing seed in the eighteenth Dynasty. The first iconographic evidence for animal threshing is in the Old Kingdom (i.e. prior to 2300 BC) and this use of animal power has continued in Egypt up to the present. Iconographic evidence from Egypt suggests that donkeys were used in the Old Kingdom and were supplanted by oxen in the New Kingdom. Exceptionally, camels are used to thresh grain in Tunisia. In the Ethiopian highlands, oxen are used to thresh the cereals. In the Ethiopian Rift Valley, similar technology has more recently been adopted for decorticating maize.

Milling

Animal power is used for milling in a band stretching from Somalia to Chad. Oilseeds such as sesame or groundnuts are placed in a large wooden pestle, carved out of the trunk of a large tree. The animal walks around pulling a counter-balanced frame attached to a large wooden mortar. This grinds the seeds and extracting the oil. The animals employed are often oxen but camels may be used in Sudan and Somalia. This grinding technology is pre-colonial but its exact origin is unknown. The pattern of transfer of this animal-powered grinding technology has not been investigated. Similar mills are found in the Seychelles and on the Indian subcontinent, but they have not spread elsewhere in sub-Saharan Africa.

Animal power for riding and pack transport in sub-Saharan Africa

Horses, donkeys, camels and cattle have been used for riding and pack transport in parts of sub-Saharan Africa for centuries. However, relatively little is known about the history of these applications of animal power. Certain pastoralist groups in the continent, including several in West Africa, ride cattle and use them as pack animals. There are historical observations of fifteenth century European seafarers concerning the Khoi-Khoi (war) of South Africa ride cattle and used them for pack transport. Some cattle were trained for use in battles.

Equid remains have been found in archaeological sites in West Africa date back over 2000 years. But it appears that horses and donkeys were not widespread until about 1500 years ago. This might be because the spread of donkeys was slow and scattered, or it could be because donkeys had low status as compared with horses and camels. Horses became important for riding and prestige in West African civilizations across a wide zone of Muslim influenced cultures from Senegambia (between Senegal and Gambia) to Sudan. Their high social status meant that they were seldom used for transporting goods.

Animal power for cultivation and wheeled transport in sub-Saharan Africa

Ethiopia, together with a few neighboring parts of the Horn of Africa, is exceptional in sub-Saharan Africa, since farmers have been using animal power for tillage for thousands of years. However, in most sub-Saharan African countries, animal traction for tillage and wheeled transport was introduced during the colonial period. The process of introduction and adaptation is still continuing.

There are various factors that may be responsible for the late adoption of plows in sub-Saharan Africa from which

- Traditional farming systems have been based on bush-fallow rotations: (The bush is cut down and burned, and seeds planted in the cleared area).
- The farming was relatively productive: in terms of yield per unit of human labor. It is only when human population pressures necessitate.
- Short fallow periods: that it becomes justified to clear the land of roots and stumps.
- Social, environmental and unfavorable agricultural conditions.

Another important constraint on the spread of the plow in precolonial times was the presence of trypanosomiasis in virtually all lowland areas.

CHAPTER 3:

Role of Draft Animal Power in Developing Countries

Draught animals play an important role in agricultural production and transport sectors in sub-Saharan Africa in general and Ethiopia in particular. Although draught animal power has been superseded by tractors on many of the large commercial farms in Africa, it remains a relevant farm technology in a small-scale agriculture, mainly for economic and agro-ecological reasons. Purchase and maintenance costs of tractors are high in many of the sub-Saharan African countries, whereas animal power is cheaper, locally available and easy to maintain when compared with motorized forms of power. Some cultivatable areas, particularly on hillsides and in steep valleys are inaccessible to tractors and can only be worked by animal or manual power.

The majority of farmers in sub-Saharan Africa including Ethiopia practice small-scale mixed farming on areas of less than four hectares. For these people draught animal power offers a feasible alternative power source to manual power in the cultivation of food crops and cash crops. Animal power was introduced in the sub-Saharan Africa over the last century and its use has been increasing in recent years. However, manual labor still predominates. People provide 89% of the power used inland cultivation, while draught animals supplied only 10% of the farm power input. Therefore, for sub-Sahara Africa and many developing countries, draught animals, technology has been qualified as an ecologically sustainable means of increasing agricultural production, reducing human drudgery and improving the quality of rural life. There is a need to promote the use of draught animals in sub-Saharan Africa to fill the gap between the deteriorating levels of food production and the increasing Demand for food

In Ethiopia, draft animal power particularly those of oxen is the main source of power for agricultural operations. Unlike most countries of Sub-Saharan Africa the use of oxen for agriculture dates back to several millennia. However, the use and management of draft animals in Ethiopia is merely of traditional and probably is the least exploited. Although the country has huge draft animal power resource (Table 1), did make use of this resource towards ensuring food self-sufficiency to the steadily growing population. The prevailing poor management, nutrition,

health care and harnessing systems of draft animals are some of the factors responsible for the poor performance and inefficient utilization of draft animal power [9].

The supply of satisfactory levels of draught animal power at the right time for crop production requires sound management of draught animals throughout the year. Relevant features of draught animal management include -adequate feeding, health care and appropriate use of animals to ensure their sustained use on-farm. Adequate feeding to meet the nutrient requirements of draught animals' is a major constraint facing farmers using animals' power in semi-arid areas. Reasonable level of animal productivity can be expected from natural pastures during the rainy season. However, during the long dry season feed resources become increasingly scarce and their nutrient content is low. The resulting feed shortage causes dramatic losses of live weight in draught oxen.

To be successful in crop production, farmers using draught animal power need to understand the animals' requirements. Also, efficient use of working animals depends on the capabilities of the animals for work, knowledge of their husbandry requirements and all other factors, which influence their performance

3.1. Strategies for Improvement of Draught Animal Power Supply:

The main species of draught animals used for cultivation in Ethiopia are oxen. The use of oxen for crop production in this country dates back to several millennia. Despite the huge draught animal resources of the country (Tables 1 and 5), the use of other species such as horses, donkeys, camels and mules for cultivation are quite limited. In addition to their popularity in the transport sector. Donkeys are being preferred to cattle for tillage in parts of sub-Sahara Africa owing to their better comparative advantages to survive and perform during draught under poor feed recourses. Horses and mules usually used for cart puling rather than ploughing. Camels are used for mining, cart puling and even for draught power supply in Ethiopia. Previous works indicate that donkeys could be cheap alternative draft power sources for tillage if managed and used proper conditions. The use of the huge equine resource of Ethiopia as draft power sources for cultivation will therefore improves the availability of draft power and thus alleviates the problem of draft power scarcity for timely cultivation.

Proper Working Strategies

The way draught animals are used the time, level and duration of work greatly determine their health and productivity

Time and Duration of Work

The time of the day determines the work capability of draught animals. If the day is too hot it causes heat stress that will result in less performance. In hot climates, heat loss by convection becomes less effective than in a cool climate and hence the animal has to rely mainly on evaporative losses through sweating and/or panting and/or drooling. Failure to dissipate the heat associated with work limits the amount of work done in a hot climate. The heat accumulated leads to increase body temperature. An increase in RT to 42°C is usually associated with muscular temperature of 44-45°C. Such muscular temperature enhance rapid onset of fatigue due to neuron-muscular disorders leading to decreased performance. To avoid heat stress, oxen should be made to work during the coolest times of the day i.e. early morning (from 6-10:00 AM) and late afternoon (4:00-6:00 PM). The duration of work done by the animals generally depends on; food input or the body condition score (nutritional status), physiological status particularly in females (non-pregnant cow can work for longer time without being stressed and time as indicated above. Average working duration for oxen on ploughing that are on good nutrition and body condition is about 5-6 hours per day

Avoid Seasonal Use of Working Animals

In most areas the use of oxen is seasonal associated with the cropping season which is the peak period of work. Thus oxen are almost left idle for the rest of the year. Due to this they will be stressed whenever they are called for work during the next cropping season. Stress effects may lead to increased susceptibility to various infectious agents. This seasonality can be avoided by using draught animals such as oxen for other operation throughout the year for example for cart pulling to keep them exercised and/or trained throughout the year

Care and Management

Working Horses: It is absolutely essential that horses have complete confidence in being handled by human beings before any attempt is made to train them, for either riding or harness work. With the exception of thoroughbred race horses, which commence training at two years old or earlier, most horses undergo a gradual training up to 3 years of age. This includes teaching them

to be led and familiarizing them to bits, rollers and harness. In the fourth year, if sufficiently mature, breaking and schooling for riding or draught purposes can be done.

Grooming, which is a general care, is carried out not only for ensuring cleanliness and improves the appearance of the animal but also prevents disease and promotes health. Some important points of considerations during grooming of draft horses include:

- Thorough removal of dirt and dried sweat sticking to the coat using a dandy brush or a wisp of hay or straw. Then a body brush that penetrate through coat and contact with the skin can be used
- Attention must be given specially to those areas of skin, which are in contact with the saddle or harness fittings where sweat may accumulate
- Horses should be lightly groomed before going to work but should be given vigorous grooming on their return

Horses need to be shod to protect the feet from excessive wear when working on hard surfaces, to prevent the wall from splitting and to prevent slipping. Only people who have had proper and sufficient training horse should attempt shoeing. But all people working with horses should recognize whether or not shoeing has been correctly carried out.

The essentials of well-shod hoof are the following

- The bearing surface of both shoe and foot should be level. The shoe rests on the barring surface of the foot which consists of the lower edge of the wall andincludes a small part of each of the bars, a white line and small part of the margin of sole.
- The angle of the hoof should be maintained and each side of the foot should be level when viewed from rear and front
- The outer edge of the shoe should follow the wall.
- Consistent with its ability to withstand wear and tear with its ability to withstand wear and tear for a month, the shoe should be as light as possible
- The minimum numbers of nails should be used and their points should emerge at the correct distance up the wall of the hoof.
- The outer surface of the wall should be untouched except for removing horn for the reception of clips and to make beds for clenches (small hooks). The frog, sole and bars should not be pared away, but loose fragments of cartilage can be removed

Some of the recommended management measures for working oxen include the following.

- They should not be made to work or plough on hard surfaces since predisposes to hoof injury. If they must work they should be shod.
- Bullocks should be trained for work at early ages and should not be brought to full work until they are 3 years of age.
- Check and remove pack clay between the claws regularly. Sometimes stones also enter between the inter-digital skins that predisposes to inter-digital colibacillosis. Stabling area thus should be clean and dry. If wet, the animal will easily be susceptible to physical damages and infections such as mud fever and dermatophillosis.
- Weight estimation should be done correctly for proper dosing, feeding and for determination of draft capability of animals to enable match with the proper implement.
- Castration of working bulls is important because it avoids undesired behavior. In most tropical countries castration is done late about four years of age. This is important for a bull to attain its secondary sexual characters such as heavy short neck, powerful shoulder, stronger musculature, well developed hump so that the bull easily fit with the harness [2].
- Oxen should get appropriate feeding regimen according to the amount of work performed

The advantages of animal power over human power are twofold. First; draft animals are five to ten times more powerful than humans, so they can pump more water in a shorter time which tends to make the irrigation operation more efficient and productive. Second; by freeing the operator from having to work the water-lifting device, he can often manage the water distribution system more effectively. In effect, the use of an animal provides the equivalent power of several people, generally at a fraction of the cost.

Animal tractions are an appropriate, affordable and sustainable technology which is increasingly being used in eastern and Southern Africa.

The benefits of animal traction are:

- Providing smallholder farmers with vital power for cultivation and transport.
- Empowering rural communities and providing an alternative but complementary power option.
- Providing employment and transport, and promoting food production and security, thereby leading to a higher standard of living.

- Relieving women of the burden of transporting water by hand, head or wheelborrow. Animals are easy to use and donkeys, specifically, can be handled by children and women.
- Making transportation of the harvest and shopping easier.
- Improving fertility by ploughing manure from draught animals back into the soil.
- It is an affordable and sustainable technology. In comparison with mechanical systems, animal power has the advantage to rural families of of being available, timely and affordable.

Tractors vs. animal power

Tractors provide the power to push and pull farm machinery and are designed with one thing in mind: utility. The best type of tractor to use should be determined by the farm's acreage, physical layout, and soils, as well as the tasks the tractor is needed for and the implements that will be mounted to it. Small-scale farms do not need large quantities of horsepower for mechanical tillage or weed cultivation. For intensive crop production, farmers generally can achieve their goals with tractors in the 5- to 30-horsepower range, but may need up to 30 additional horsepower for deep tillage.

Advantages and disadvantages

Tractors

- Tractors are more expensive to buy and to hire.
- They are much faster and timelier for those who own them, but those who hire tractors often have to wait a long time before they arrive to do the job.
- They are generally used for cultivating large areas and when the soil is hard.
- Tractors are generally only economical on large-scale commercial farms.
- Owing or hiring a second-hand tractor for a small farm will usually disempower the farmer.

Animals

- Animals can be bought for much less and are readily available, ensuring that the farmer does not have to wait to carry out his various activities and is in full control of his farming operations.

- They are less of a risk. Owning draught animals on a small farm will usually empower the farmer.
- Animals are easy to work with and can, in the case of donkeys, be used by women and children.

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 4

Draft and Pack Animal Species, Distribution and their Attribute

What are the Common Draft and pack Animal Species?

The most common draft animal species are: Horses, Donkeys, mules, Camels, Cattle and buffaloes.

1. **HORSE (*Equus ferus caballus*)**

Origin and Domestication of horse

- Humans began to domesticate horses around 4000 BC in **central Asia.** Horses in the subspecies *caballus* are domesticated, although some live in the wild as feral horses. There were working farm horses of more phlegmatic temperaments used for pulling military wagons or performing ordinary farm work, and provided bloodlines of the modern draft horse. In many countries, transport horses also assist intermittently with small-scale crop cultivation. They do not thrive in humid, tropical conditions. However, in temperate regions and in arid or high altitude areas in the tropics horses can be very usefully employed for plowing and other farm operations. However the limited market for horse meat makes that, old horses have lower resale value than oxen.

Characteristics

- Horses are fast with good acceleration, making them excellent transport animals.
- Horses are not as robust as cattle and need better care and feeding.
- Draft horses are recognizable by their tall size and extremely muscular build body.
- They have a more upright shoulder, producing more upright movement and conformation that is well-suited for pulling.
- They have broad, short backs with powerful hindquarters, again best suited for the purpose of pulling.
- The draft breeds usually have heavy bone & a good deal of feathering on their lower legs.
- Draft breeds range from approximately 16-19 hands high and from 640- 910 kg.
- Draft horses crossbred on light riding horses, adds height and weight to the ensuing offspring, and may increase the power.

Breeds of Exotic Horses

1. **American Saddle bred**

Originally known as the ***Kentucky Saddler***, it was developed by Kentucky plantation owners. The foundation sire was a Thoroughbred called **Denmark,** foaled in 1839 by selective breeding. It has a small, elegant head set on a long muscular neck and strong shoulders, back and quarters. Predominant colors are bay, brown, chestnut and black. Average height is 15 to 16.1 hands.

2. **American Standard breed/American Trotter**

Descends from an English thoroughbred named **Messinger**. Today, it is one of the world's finest harness race horses, with courage, speed, endurance and refinement. It has length of stride and action for great speed. Its' height is approximately 15.2 to 16 hands and predominant colors are bay, brown, black and chestnut.

3. **American Quarter Horse**

Originated during the Colonial era in the Carolinas and Virginia. The foundation was **the Arab, Barb and Turk.** The average height is 15.2 hands and any solid color is permissible, although chestnut is predominant.

4. **Appaloosa Horse**

Is a great breed of spotted horse with intelligence, speed and endurance. It was the Indian horse of the Nezperce tribe in the Northwest and was used for hunting, traveling, racing and war. Today, the Appaloosa is one of the most popular horses in America, and finds much favor as an all-around saddle horse.

The deciding characteristic is the **color patterns of the coat**, usually solid-colored foreparts, fading to white on the rump and broken with dark spots. Due to its coloring, it is often used as a ***circus and parade horse***. Height is approximately 15.2 hands.

5. Arabian Horse

The Arabian horse was breed to withstand long treks across the desert and the tribal wars. The Arabian's head has a characteristic of dished profile with a prominent eye, large nostrils and small teacup muzzle. Arabians horse color come in grey, chestnut, bay, roan and black. Although some individuals will vary, most are between 14.2 and 15.2 hands in height and weigh between 800 and 1,000 pounds.

6. Belgian Horse

This breed was came to America in 1886 and now ranks as one of the foremost draft breeds. Belgian draft horses are compact, but with exceptional style and action. The leg are free from feather characteristics but has limited feathering around the hooves. It has good placement of the legs with a long stride and great power. Mature stallions weigh from 1,900 to 2,300 or more pounds and stand 15.3 to 16.3 hands.

7. Morgan

Originated in the United States and is principally of Thoroughbred and Arabian blood, tracing its ancestry to the great stallion, "**Justin Morgan**." It is a smaller type of trotting horse and is known for speed and endurance. The Morgan has also been of value in building up the American saddle horse and Standard-bred. Height is 14 to 15 hands and the weight from 800 to 1,000 pounds. Usual colors are bay, chestnut, brown and black.

Equine Colors and Markings

I. Common Equine colors

There are five basic colors of horses.

- **Brown** – A brown horse has a mixture of black and brown in his coat.
- **Bay** – A bay horse can be any shade of brown (which is a mixture of red and yellow).
- **Black** – A black horse is completely black, including muzzle and flanks.
- **Chestnut** – A chestnut horse has brown skin and the hairs are actually red.
- **White** – A truly white horse is born white and remains white.

Major Color Breeds of horses

A. Palomino – Palominos are golden horses with light colored or "flaxen"(Golden) manes and tails.

B. Pinto – Pintos have a mixture of white and colored areas on their bodies. Pinto is a Spanish word meaning painted. Painted horses are divided into two categories:

- **Tobianos**, the most common white splotches extended downward across their backs.
- **Overos**, the white extends from the belly (stomach) and legs upward towards the back.

C. Appaloosa — this is a color breed. It is divided into three color patterns:

- ***Leopard*** is a white horse with dark spots all over the body.
- ***Snowflake*** is a dark horse with tiny white spots.
- *The "**Blanket**"*, the most well-known Appaloosas pattern which usually consists of a white blanket with dark spots on the rump.

II. Common markings of Horses

Many horses have markings on their faces and legs. The following are the most common ones.

- **Blaze** -A white mark spread over the forehead and the length of the face. If the blaze is cover the entire front of the face, the term "**bald face**" might be used.
- **Stripe** - A white mark down the face, similar to a blaze but narrower.
- **Strip** - A white mark running partway down the face.
- **Star** - A patch of white on the forehead.
- **Snip** - A white or pink patch on the nose or lip.
- **Whorl** - A patch of hair **swirling** opposite to the surrounding hair, usually found on the forehead.
- **Sock** - White hair on a leg, looking like human ankle socks.
- **Stocking** - White hair on a leg, extending from hoof to hock or knee.

Blaze

Snip

Star

Stripe

Figure 1: Some common horse markings

2. Donkeys (*Equus africanus asinus*)

Origin and Domestication

The **donkey** or **ass** is domesticated from the wild ancestor of the donkey (African wild ass, *E. africanus)*.The donkey has been used as a working animal for at least 5000 years and first domesticated around 3000 BC, probably in **Egypt or Mesopotamia.** The scientific name for the donkey is *Equus asinus asinus* based on the principle of priority used for scientific names of animals. However, the International Commission on Zoological Nomenclature ruled in 2003 that if the domestic species and the wild species are considered subspecies of each other, the

scientific name of the wild species has priority. Thus scientific name for the donkey is *Equus africanus asinus*. From the 18th century, the name donkey gradually replaced ***ass*.**

Characteristics

- The major unique characteristics of donkeys is the black cross found on all donkeys.
- It consists from the main to the tail and a cross stripe between the withers.
- Donkeys are mainly smaller than cattle and horses but they are very robust and resistant to drought and Farmers joke that, ***they seem to survive on air and sand***.
- Donkeys vary greatly in size, depending on breed and management.
- The height at the withers ranges from 79 cm-160 cm, and the weight from 80-480 kg.
- Have a life expectancy of 12-15 years in the poorest countries and 30-50 years in prosperous countries.
- Donkeys are adapted to marginal desert lands.
- Each adult donkey establishes a home range; breeding over a large area may be dominated by 1 jack.
- The loud call (**bray**) of donkey can be heard for over three kilometers, may help keep in contact with other donkeys over the wide spaces of the desert.
- Donkeys have large ears; which may pick up more distant sounds.
- Donkeys can defend themselves by biting, striking with the front hooves and kicking with the hind legs.

Description of some Donkey types found in Ethiopia

Types of donkey	Height at wither	Physical description
Jimma donkey	95-100 cm	Head is large, short ear, grey in color
Abyssinian donkey	86-102 cm	Dominant color (grey) abundantly found in Ethiopia
Ogaden donkey	103 cm	Tall with heavy bones
Sennar donkey	100-114 cm	Large with better conformation

Exotic Donkey breeds

Breeds registered by the American Donkey and Mule society include the following.

1. The Mammoth or American Standard Jack
2. The Large Standard or Spanish Donkey
3. The Standard Donkey or Burro
4. The Miniature Mediterranean Donkey
5. The American Spotted Ass.

1. Mammoth Donkey

- Are blends of several breeds imported to the U.S. in the 1800's from Southern Europe.
- They are the largest of the asses with the jacks being 56 inches or more high.
- The foundation sire was a jack named Mammoth.

2. The Spanish donkeys

- The Spanish donkeys stand between 48 and 56 inches tall.

3. Standard donkey/Burro

- Burro's or the Standard donkey stands between 36 and 48 inches tall.

4. Miniature/ Mediterranean Donkey

- The miniature Mediterranean donkey imported from Sicily and Sardinia must stand under 36 inches to qualify for registry

Uses of Donkey

- Used principally as pack animals or for draught work in transport or agriculture, cheapest after human labor.
- Used to be ridden, or used for threshing, raising water, milling and other work subsistence levels.
- Both sexes of donkey working with oxen in agriculture
- The donkey is harder than the horse, survives with poor quality food and can tolerate considerable heat and dehydration suitable animal for harsh environments.

- Donkey-hide gelatin is produced by soaking and stewing to make a traditional Chinese medicine product and restaurants specializing in such dishes.
- Transporting grain from agricultural areas to the various markets, Fuel-wood and animal dung, Water, Crop residues, building materials such as sand, gravel, wood and stones at the low cost.
- Donkeys adapt well in dry areas and are also lighter and smaller than cattle, eat less than cattle.
- They are better suited to lighter field work than oxen; can carry goods and people, pull carts, turn mills and waterwheels, cultivate fields and are.
- used to guard sheep against predators such as jackal & lynx

Advantages of donkey than other animals

- Friendly towards humans
- Willing to work
- Can turn in a small space
- Easy to train
- Need little supervision in work
- Can utilize poor feed well
- Not affected much by external parasites
- Can survive well in tsetse-infested areas
- Can survive droughts better than cattle
- Comparatively cheap to buy
- Strong relative to size
- Live and work many years in good care
- Fast walking speed

Disadvantages

- Noisy when frustrated or lonely
- Friends not easily separated
- Un castrated males aggressive towards other donkeys

- Skin easily wounded
- Need shelter from cold and damp
- Meat not generally eaten
- Mature slowly
- Breed slowly

3. MULE

Mules are sterile animals that are created by crossing a male donkey (jack) with a female horse (mare), and this tends to make them relatively rare and/or expensive. The opposite cross, male horse (Stallion) and a female donkey (jennet) is called a **hinny**. Both are sterile due to an uneven number of chromosomes (n= 63). Mules and hinnies have 63 chromosomes, a mixture of the horse's 64 and the donkey's 62. The size and work of a mule depend largely on the breeding of the mule's female parent (dam). A male mule is properly called a **john mule**, which is the correct term for a gelded mule. A young male mule is called a **mule colt**, and a young female is called a **mule filly**.

Zoological classification of mule

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Perissodactyla
Family: Equidae
Tribe: Equini
Genus: Equus
Species: E. asinus♂ × E. caballus♀

Characteristics

- Mules are believed to be more hardy and long-lived than horses and are described as less obstinate and more intelligent than donkeys.
- They are large, strong and robust and excellent for transport purposes in mountains.
- Because of their cost and their behavior characteristics (they are best kept in regular work).
- They tend to be the animals of choice of transport contractors rather than smallholder farmers.

- The size of a mule and work is depends largely on the breeding of the mule's dam.
- Mules can be lightweight, medium weight, or moderately heavy weight.
- Thus, a mule has a short thick head (if the jack has a short thick head), long ears, a short mane, thin legs, narrow hooves, a narrower body than a horse.
- mules are "more tolerant, sure-footed, hardy and long-lived than horses,
- They are considered less obstinate, faster, and more intelligent than donkeys.

Color and size variety

Mules come in a variety of shapes, sizes and colors, the coats of mules come in the same varieties as those of horses. Common colors are sorrel, bay, black, and grey. Less common are white, roans (both blue and red), palomino, dun, and buckskin. Least common are paint mules or Tobias's.

Fertility

Mules and hinnies have 63 chromosomes; a mixture of the horse's 64 and the donkey's 62.The different structure and number usually prevents the chromosomes from pairing up properly and creating successful embryos, rendering most mules infertile. There are no recorded cases of fertile mule stallions. A few mare mules have produced offspring when mated with a purebred horse or donkeys.

4. CAMEL

Origin and Domestication of Camel

The dromedary camel was probably domesticated on the south coast of Arabian Peninsula in the region of the present Yemen and Oman around 3000 to 4000 years ago and then introduced with spice trade into North Africa and the horn of Africa. The bacterian camel was probably domesticated **at the same time** in the present day Turkey and in Northern Persia, spreading from there westward to Anatolia and east to Northern China.

1. The old world camels (true camels)

They belong to the genus Camelus which consists again two species.

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

b. Camelus bacterianus (the bacterian camel)

- Dromedary (Greek word "dromedos" =running);
- Bacterian (name of the place 'Bacterian' found in Afghanistan). The dromedary camel is believed to be evolved from bacterian camel. The justifications for this belief are:

1. The species have embryological similarity, i.e. both dromedary and bacterian camels have two humps during embryological development
2. These two species of camels can hybridize giving fertile cross bred animal.

- The cross breeds possess one hump and are larger than either of the parents.

The dromedary and Bacterian camels differ in their habitat and by some other characteristics.

Descriptions of Dromedary and Bactrian camel

	Dromedary	**Bactrian**
Habitat	-hot arid and semi-arid of Africa and Arabian countries	- Cold desert of Asian continent
Population	-numerous	-few
Morphological characteristics	-Single hump	-two humps
	-larger	-Smaller
	-woolly but shorter coat cover	-woolly but thick coat cover
	-Long legs	-Short legs
	-Carries its head high	-carries its head low
	-spiting is not common	-spiting habit is common
Voice	-grunt	-shrew

2. The new world camels

They belong to the genus Lama which has again four species.

-*Lama glama* (the llama)

-*Lama pacos* (the alpaca)

-*Lama guanicoe* (the guanaco)

-*Lama vicugna* (the vicugna)

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

Characteristics

- Camels are tall, strong and walk fast.
- They have large feet and are well-adapted to long distance transport in arid conditions.

- Their large size makes them expensive to own, and like mules they tend to be the animals of choice for transport contractors rather than small-scale farmers

Types and Breeds of Dromedary Camel

Breeds of camels are not as such differentiated as breeds of other domestic species. Systematic selection for productive traits has never been done in camels probably for the following reason(s):

(1) Recent domestication

(2) Negligence of these animals

Nevertheless, there are a large number of different types of dromedaries, many of which are spoken of as 'breeds'. These breeds may be classified in to two general types, the ridding and the baggage, but breeds within these types are not marked by so many pronounced functional or conformational characteristics as distinguish many cattle breeds.

- Wilson (1984) classified dromedary camels into two based on:-

A. Primarily on function and secondarily on habitat

1. riding/racing type
2. baggage/pack type
   - Hill
   - Plains

B. Primarily on habitat and secondarily on function

1. Lowland
   - riverine-pack
   - desert-pack and riding

- There are physical differences between riverine and desert camels

Importance of Draft Camels

A. Power source: camels are used for riding, as pack animals, for wheeled transport, as draught animals in agriculture, for drawing water and as a power source for small industries.

B. Transport: Camels consist about 4% of the estimated total animals used for transport of goods such as firewood, food and feed, building materials household items etc.

- In Ethiopia, camels transport salt from Danakil to the Tigray average 90 kg load, 160 km distance within 4 days.
- In Ogaden adult camels carry 300 kg and cover up to 40 km per day.

C. Ploughing: Camels are known to have good potential for ploughing in Ethiopia (Afar & Ogaden regions).

Why camels commonly used for traction in arid areas?

In arid and semi-arid areas camel used for traction for the following reasons:-

- Camels are well adapted in the area
- The indigenous people know how to take care of them
- in most cases the camel is an existing property of most pastoralists
- Camels are easy to feed bushes, which are green even during the dry season.
- Camels have adaptable characteristics to desert areas.

5. CATTLE

Cattles are domesticated bovine farm animals that are raised for their meat, milk, or hides or for draft purposes

Origins and Domestication

Domesticated cattle belong to the family Bovidae, which includes ruminants with hollow horns, and members of this family such as true buffalo, cattle etc. Domestication possibly occurred 8,000 – 9,000 years ago.

Species - B*os taurus* and *Bos indicus*

- B*os taurus* includes the ancestors of the European cattle of USA
- *Bos indicus* (the humped cattle (Zebu) of India and Africa and the Brahman breed of America.

Breeds of draft cattle

Breeds of chattels fall into two main types

1. *Bos indicus* (or *Bos taurus indicus*) cattle, also called zebu, are adapted to hot climates and

2. *Bos taurus* (or *Bos taurus taurus*) are the typical cattle of Europe, north-eastern Asia, and parts of Africa adapted to cooler climates (such as the Sanga cattle of Africa).

Characteristics

Characters	*Bos Taurus*	*Bos Indicus*
Hump	Hump Absent	Hump present in the thoracic region.
Head	Short and wide.	Long and comparatively narrow.
Skin Thickness	thick, average thickness 7-8 mm.	thin, average thickness 5-6 mm.
Dewlap	Small.	Extensively developed.
Back line	Straight or relatively straight.	High at shoulder, low behind hump.
Hip bone	Wide and outstanding.	Narrow and angular.
Udder	Suspended between behind the hind limbs.	Suspended and carried between the hind limbs.
Leg	Short, slow moving.	Longer, faster moving.
Maturity	Fast maturity.	Slow maturity.
Milk yield	Good	Poor

6. Water buffalo (*Bubalus bubalis)*

It is domestic type buffalo and currently it is also found in Europe, Australia, North America, South America and some African countries.

Origin and domestication

The water buffalo or domestic water buffalo is a large bovid originating in the Indian subcontinent, Southeast Asia, and China. Its domestication was approximately 5000 years ago from their home in India. They were carried for meat, milk and draft to Egypt by Arabic invaders in the 9th century and subsequently to Europe by travellers. They have now spread to 38 countries in Asia, Europe, Africa, South America and Australia and in several countries, up to 30% of the draft power for agricultural operations. Unfortunately, the species did not receive the attention of the policy makers and the researchers in accordance with its merits, which resulted in

buffalo population decline in several eastern Asian countries. In case of Ethiopia using buffalos for draft power is not adopted.

- Two extant types of domestic water buffalo are recognized based on morphological and behavioral criteria

1. The river buffalo: Found in Indian subcontinent, Balkans, Egypt and Italy.

2. The swamp buffalo: Found in Assam, Southeast Asia and Yangtze valley of China.

The origins of the domestic water buffalo types are debated, although results of a phylogenetic study indicate that, the swamp type may have originated in **China** and was domesticated about 4,000 years ago, while the river type may have originated in **India** and was domesticated about 5,000 years ago. At least 130 million domestic water buffalo exist in India, and more people depend on them than on any other domestic animals .They are especially suitable for tilling rice fields, and their milk is richer in fat and protein than that of dairy cattle.

Characteristics

- The skin of river buffalo is black; However Swamp buffalo have a grey skin at birth, but become slate blue later.
- River buffalo have comparatively longer faces, smaller girths, and bigger limbs than swamp buffalo.
- Their dorsal ridges extend further back and taper off more gradually.
- Their horns grow downward and backward, then curve upward in a spiral.
- Their tail is short, reaching only to the hocks.
- The swamp buffalo has 48 chromosomes but the river buffalo has 50 chromosomes.
- The two types do not readily interbreed.
- River buffalo prefer deep water. But Swamp buffalo prefer to wallow in mud holes.
- Both are well adapted to a hot and humid climate with temperatures ranging from 0 °C in the winter to 30 °C and greater in the summer.

Chapter 5.

Selection and Training of Draft animal power

1. Selection of Draft animal power

Selection is a process of matching ideal qualities against those seen or latent in a given animal selecting a good draft animal is a matter of evaluating both physical and behavioral attributes. Age, sex, conformation (shape), 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.

Animals should be selected according to

- The type of work to be performed,
- the local environment the animal adapted,
- Socio-economic conditions and
- The availability of local animals. .

Farmers must be able to select the animals most appropriate for their needs. Once farmers decide what kind of draft animal will be used, they must be able to choose individual animals, the animals they choose must be:-

- Culturally acceptable, have considerable work expectancy and Resale value.
- Trainable, maintainable and Profitable within the overall farm plan.
- It is also important that the animal be available locally, since these animals are already adapted to local feeds and climate and are likely to be resistant to diseases in the region.
- Farmers should choose healthy animals from strong stock.
- In some areas, farmers must consider social or religious traditions which restrict the ownership or use of animals.

Qualities or criterias to be considered during selection of animals

A. Conformation

Conformation refers to the form or shape of an animal, which shows the normal characteristics of its species and breed.

- An animal used for draft must have a build well suited for pulling.
- Have powerful shoulders and legs, and
- Have a broad frontal dimension that will accommodate the placement of a harness.
- It must be big enough to deliver, alone ‘or in a pair, the power needed to pull equipment for an extended period of time.
- It must also be able to exert the concentrated or "instantaneous" effort needed to overcome temporary increases in the draft requirement caused by roots, rocks, hard soil, or inclines.

While some animals are bred to produce good draft abilities, within any breed individual animals vary greatly in these qualities, and care must be taken to choose those with the most potential.
A thin but well-balanced animal can be strengthened with a good diet, health care, and work.

Good draft animals will have the following qualities:-

- Head should be well proportioned and squarish.
- Balanced vision and hearing; head carriage high and straight, normal mouth; good teeth and jaw structure.
- Body should have depth and width; short, full neck, full shoulders, broad chest, and straight, broad back
- A wide, thick hindquarters
- Short legs, straight and square to the body; ample bone.
- Clean, well-developed joints; no swelling or un usual thinness; no turning in or out of knees or hoofs; free movement of limbs.
- Feet straight, hard; normal angulations of hoof.

B. Temperament

Temperament refers to the nature or disposition of an animal. Part of its temperament is determined genetically, both by breed and parentage; some of it is learned a response to the treatment it receives from other animals or the people who raise and handle it.

Temperament is reflected in an animal's behavior from:-

- The way it moves and acts, and
- The way it reacts to the things around it.

It is difficult to know much about temperament from the quick evaluation that usually precedes the purchase of a draft animal. The buyer must guess, from what is observable, whether or not an animal will accept new habits and training, behave well in a pair, and prove to be a spirited and manageable worker. A basically lethargic bull, for example, may become very alert or nervous at the approach of a stranger, showing aggressiveness that could be misinterpreted as a strong yet controllable spirit. A donkey that is mishandled and mismanaged might kick or butt at its owner, or at any adult, but be led away quite easily by a child. The buyer must be aware of such possibilities and at the same time draw some basic conclusions about the animal's temperament.

The following are signs of good temperament:

- Good overall conformation and health.
- Good vision or hearing,
- Comprehensive leg or joint
- Free from chronic respiratory or strong muscle.
- Pulling forward
- Volunteer to be harnessed or not lying down during work.

The animal's temperament is affected or shaped by its physical condition. The animal must accept the handling of the owner. The owner can pick up the animal's foot, open its mouth; lead it with a rope without having to use force or harsh measures. If an animal is usually aggressive it may not work well in a pair. Aggressive animals force their work-mates to shy or lean out of the yoke or harness, while weak animals may refuse to step evenly with their mates, lagging behind.

1.1. Cattle Selection

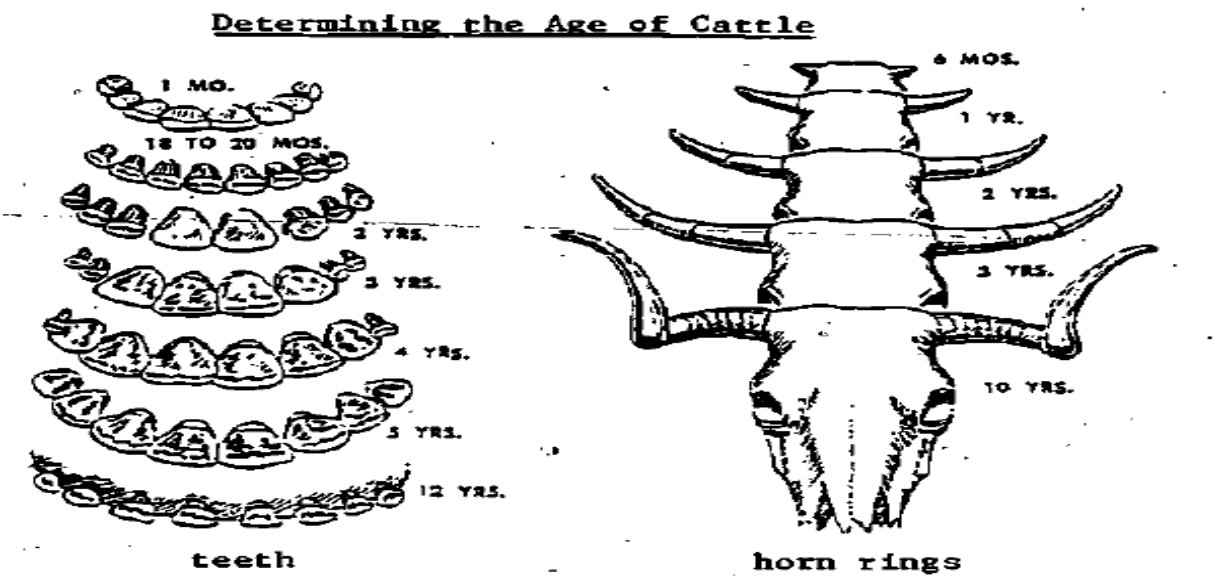
The most commonly-used draft animals are cattle. Among cattle oxen are often preferred, because they are well-muscled and have good temperaments. Oxen are some of the most powerful draught animals, but they are slow and labor intensive. They are generally used for heavy work where speed is not essential (ploughing and pulling Heavy carts and wagons).Cows can be used where work is light and infrequent (planting and cultivating).

C. Age

Age of Bovine 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 for a season or two, and then sell them for butchering. When buying an ox, the purchaser-can determine the animal's age by counting its teeth. 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 and matching them to the patterns shown in the illustration on the next page. The other alternate method is to count the number of rings of the animal's horns; each ring corresponds to one year of growth, the first ring appearing at age two.



D. Sex

Sex of Bovine Animals

Sex has a manner 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 cannot be used when they are carrying or nursing young. Studies of African cattle have shown that within the same breed and age, males tend to be 50-100 kg heavier than females and can work twice as long during a given day (bulls, five to six hours; cows, two to three hours). 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.

1.2. Selection of donkey, horses and mule

Selection characteristics

When selecting an animal for work certain physical characteristics should be observed. These include: a large frame with wide shoulders and a deep chest, a straight back and well-muscled straight legs which have a 90° angle to the ground (figure 2). In young animals large knees are an indication of future thickness. The donkey should have good eyesight and agility and an attractive hair coat, without skin diseases or an abundance of ticks. It is important to observe an animal while it is working, to detect whether it has a physical disability, such as coughing, poor breathing, lameness, sores or wounds.

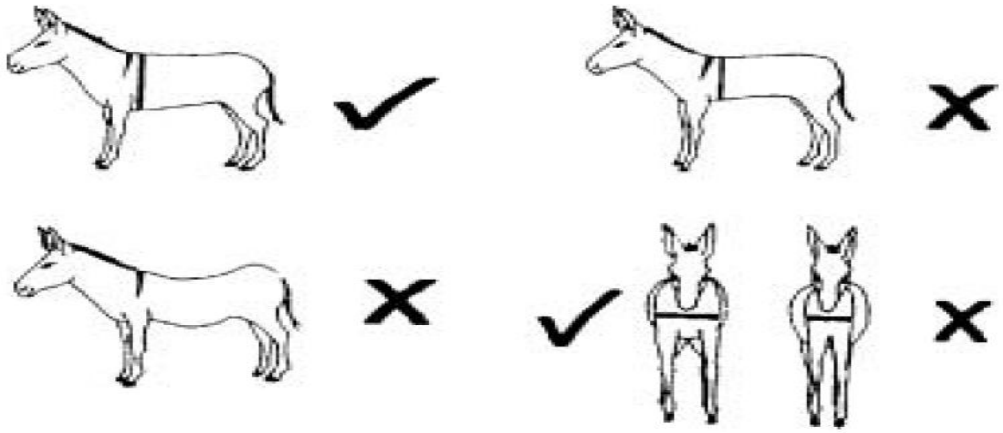


Figure 2: Desirable and undesirable conformation features in donkeys.

The sole of a donkeys hoof should be concave underneath; only the front part and the edges touch the ground. The shape of the hoof should be as round as possible. The angle between the pastern and the ground should be about 50-60 degrees, being slightly steeper in the front legs. The hoof angle and the pastern angle should be similar. Animals with feet abnormalities should not be selected (figure 3).

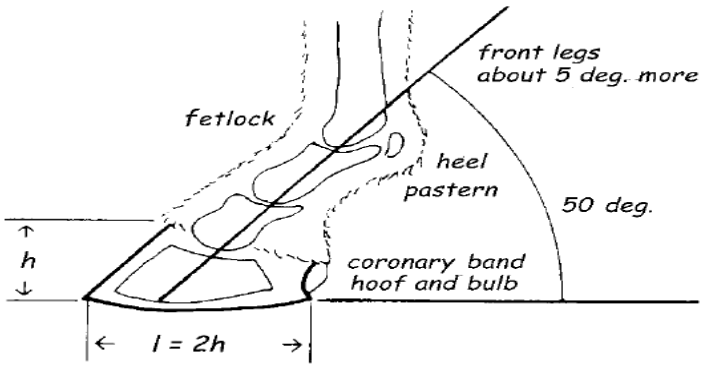


Figure 3: Hoof and bones showing correct angles and dimensions.

In addition to complete physical characteristics, an animal should have a suitable temperament. It should be responsive, but not excitable or aggressive. However, the extent to which an animal develops into a good working animal will also depend on its relationship with its handler. No animal will perform well if its handler is hard or inconsistent.

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 until their meat is less valuable. The age of a horse, donkey or mule can be determined by comparing the animal's mouth to the diagrams on the following page. As the animal grows older, the **enamel** wears off the tooth, giving it a smooth, white grinding surface (the dark center disappears).The teeth grow longer and begin to incline; the entire mouth elongates. 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;
- Rub or press the gums with these fingers; this will cause the animal to open its mouth;
- Grasp- the tongue with the other hand, pull the tongue out, and hold it to one side
- so that teeth can be seen

Sex of Equine Animals

Castrated horses or donkeys (geldings) are preferred over stallions because they are even-tempered and manageable in the presence of females. Female horses, mules and donkeys are nearly as powerful as males and geldings, but are known for their stubbornness and' unpredictable moods.

2. Training Working Animals

General Explanations on Training Procedure

Training draft animal is the process of teaching them to obey commands, accept harnesses and yokes, and pull animals loads**.** The person who gives the commands and controls their speed and direction is called the driver. The goal of training is to teach animals to obey the driver's signals so he/she can steer the load (plow, wagon, etc.) and regulate the power of the animal(s) at the same time

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.

Before an animal is trained, it is "broke" or "broken" and made to recognize the authority of the Trainer. Breaking an animal is a matter of introducing it to new schedules, and teaching it to obey. The word also describes the process of getting an animal used to new behavior or equipment. An animal is considered trained when it responds consistently to commands. This may take as little as two weeks, or as long as two months.

Training Principles

Before formal training sessions begin, an animal should have time to adjust to its new owner and surroundings. Separated from its familiar environment and handled by someone whose touch, voice, and movements may be new, it may refuse to eat or drink, appear abnormally quiet or nervous, or try to run away.

Seven Principles to Consider when Training:-

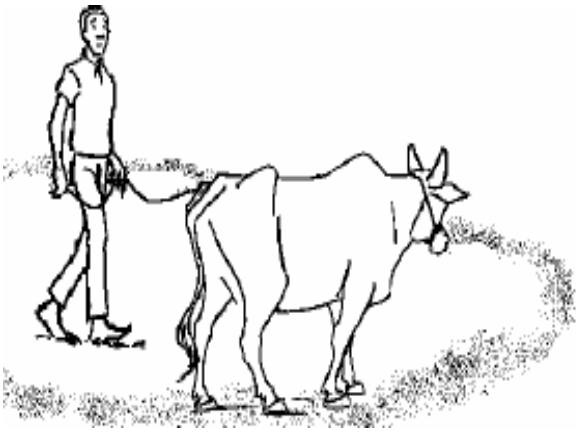
1. The approach must be simple, calm, patient, persistent, and the trainer needs to be firm (not to show fear to the animal).
2. There should always be a routine and a repetition of the training steps, so that the animal adopts the new behavior.
3. Spoken commands and names should be few and simple such as: “Go”, “Turn left”, “Turn right”, “Reverse” or “Stop”. Remember to always use the same language during and after the training.
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 or giving some food.
6. Complete every step in the training programme before moving to the next one. Do not move to the next step, unless the animals have understood the one before.
7. Organize the training items. To carry out the training we need the following items including

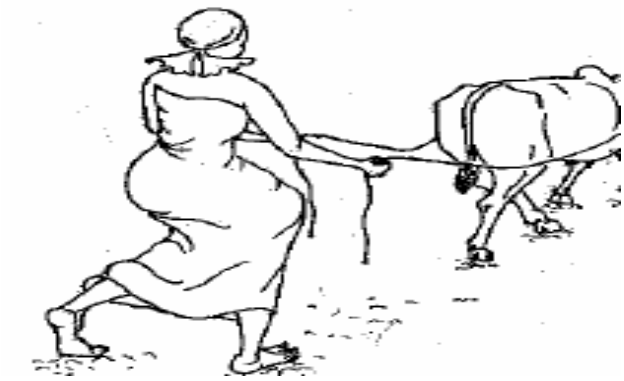
a trained animal, a proper kraal, a good training field and tools (ropes, different types of yokes, ploughs, weeders, loads and Sledges).

Training stages and Duration of training

Step 1: Roping and Walking

The purpose of this step is to create friendly conditions and to remove fears/suspicions from the animals. The trainer should tie the oxen with ropes and make them walk in circles without yokes. To tie the trainer can use halters or nose punch. These exercises take 2-4 hours per day for 2-3 days

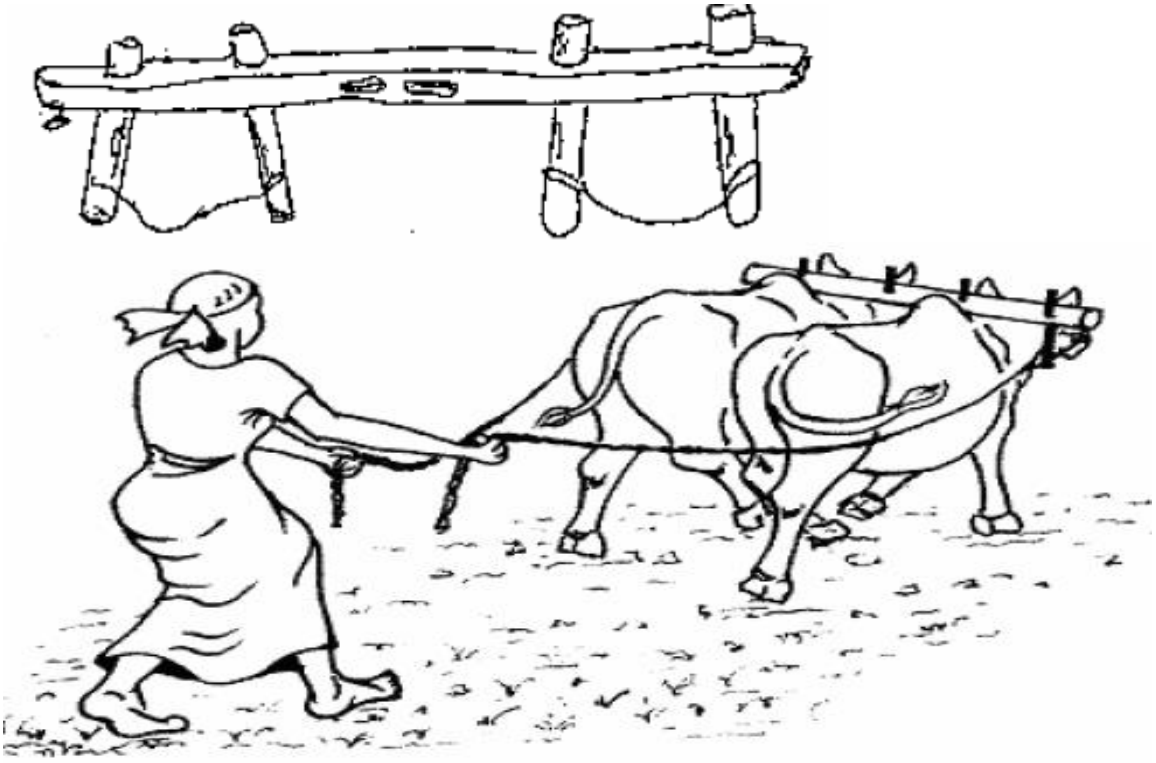




The animal should learn to accept commands, so by the end of this step the animal should be able to go left or right, to stop or start and even to go backwards following the voice commands. This step ends when a trainer is able to move closer to the animal, to put a rope around the neck, name the animals, make them walk or move and stop using simple commands.

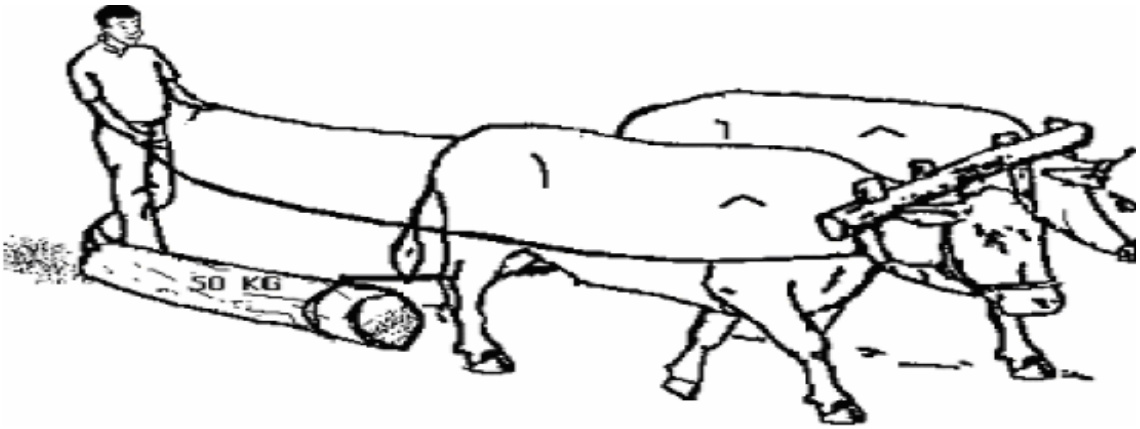
Step 2: Harnessing and Walking

In this step, harnessing or yoking is done in the kraal. After that, the animals are moved to the field. The objective here is for the animals being trained are able to accept harnessing and removal of the harness while they are outside the kraal. If a trained animal is there, use it to train the new one, so that they learn to move in pairs. 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 trained animal, these exercises should take 3-4hours per day for 7-10 days



Step 3: Pulling Loads

The purpose this step 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 starting from light loads eg; 20, 30, 40, 50 kg. These exercises are done in the field, 2 hours per day, for 7-14 days.



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 3 days

Factors influence the rate of training

- species and breed,
- individual temperament,
- health and condition,
- type of harness equipment used, and
- Skill, patience, and persistence of the trainer.

Animals learn faster, and new owners acquire training skills, when training advances in small, clear steps. Generally speaking, one-and-a-half-hour sessions are used. Two of these sessions are given per animal per day. Training is done in the same location and during the same hours each day. Early morning and late afternoon are good times, as this gives animal's time to rest and graze between sessions. Before any draft animal is harnessed as part of a team, it must individually recognize and obey the voice commands stand, walk, and stop, left, right, and back. Commands are the language given to the animals in which the driver will use. Drivers who must rely on an assistant to control their animals with pulls of a rope or constant whipping get limited performance and results. Sometimes it is possible to train an animal by putting it in a yoke or harness with a veteran animal. This is a good technique, but it does not eliminate the need for

individual training. The driver must be able to control each animal within the team if the team is to pull evenly. This is especially important during turns, or when one animal lags or acts up. Finally, it should be understood that handling and training methods for cattle differ from those used for equines. This is because these classes of animals have different strengths and temperaments. With horses, donkeys and mules, the overall approach is to use the least severe methods possible to greater force if needed. With cattle, and particularly bulls, it is important to break the animal of its independence quickly and with carefully applied force. Forceful handling is rarely needed once a bull recognizes your strength and your ability to make it obey. Animals kept for draught purposes can be easily trained if the correct procedures are followed. Animals to be trained should be properly selected and should not be younger than two years. If animals are treated with calmness and patience and are firmly disciplined they are easy to train and use.

A person who gives training for animals should really like animals. They should never be afraid of them, as their fear will be sensed immediately by the animal and satisfactory training might then be impossible. Each animal should be given a simple, clear-sounding name and should be fed by hand so that it gets used to people, in particular its handler, they should be trained for short periods at a time but on a regular daily basis. In the first week of training the animal should get used to the harness by walking around with it for about one hour in the morning and one hour in the afternoon. When used to the harness it can be given commands. As ploughing is the most difficult task, so once the animals can plough it is easy to train them for other tasks. Start with shallow ploughing and gradually go deeper. Teach the animals to walk in furrows so that the whole land is ploughed evenly. Always try to end each session on a good note and reward and also with good performance and small quantity of food.

The Qualities of Good Trainer

Training of animals requires patience, firmness, perseverance and above all, Consistency. Due to this reason the trainer must qualify the above requirements to train the animals within appropriate time. Continuity of the training programme is of prime importance as the animal can soon forget previous lessons when breaks occur. Animals undergoing training will be in close contact with unknown people, disturbing noises and animal restraints such as harnesses, halters and equipment. They must become accustomed to all of these and also learn to follow clear instructions.

The following points may therefore be useful to the trainer or the farmer:

- Keep a calm, patient and consistent approach to the animals.
- Follow the training steps as described and repeat until full control of the animal is obtained.
- Do not try to train the animal too quickly, but follow the animal's acceptance of the training.
- Reward correct behavior of the animal with a short rest, some choice food, given always with a word like .good so that in the end the word alone will function as reward.

Voice commands

Commands are languages given to the animals in which the driver will use during training. The number of voice commands should be kept to a minimum and as short as possible. The following list of words and sounds can easily be taught to a donkey. It is useful to make use of one standardized set of short words that are also used by other farmers in the region, so that if a donkey changes owners, the confusion will be limited.

No	Stop the donkey's action
Good	Verbal reward for donkey
Come	Move donkey towards speaker
Home	Send donkey home
Shed	Send donkey into shed
Harness	Donkey to stand still for harnessing
Move	Start donkey moving
Faster	Speed up donkey
Stop	Stop forward movement of donkey
Reverse	Donkey to go backwards
Straight	Donkey to move in a straight line
Right	Donkey to turn right
Left	Donkey to turn left

Chapter Six.

Animal Drawn Implements

Animal drawn implements are equipments used to break up the soil and prepare seed bed including the removing of weeds. The use of appropriate agricultural Implements and tools for small-scale intensive crop production contributes to the viability of the farm by enhancing production efficiency. Equipment and tools are necessary for plant propagation, soil preparation, planting, pest and weed control, irrigation, harvesting, postharvest handling, storage, and distribution.

Tillage

The mechanical manipulation of soil to provide favorable condition for proper crop growth is called **tillage**. 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.

Objectives of Tillage

- To prepare a desirable soil structure for a deep seed bed
- To control weeds or to remove unwanted crop plants (thinning)
- To minimize soil erosion
- To incorporate and mix fertilizers, pesticides, soil amendments in to the soil

Classification of Tillage

Tillage operations for seed bed preparations are classified as: Primary tillage and Secondary tillage.

1. Primary tillage

Primary tillage is the initial major soil working operation designed to plough the soil deeply to reduce soil strength, cover plant materials and rearrange aggregates. Primary tillage is the first soil tillage after the last harvest. It is normally conducted when the soil is wet enough to allow plowing and strong enough to give reasonable levels of traction.

Objectives of primary tillage are

- To reduce soil strength
- To cover plant materials and burry weeds
- To kill insects and pests

The implements used for primary tillage are called as primary tillage implements. They include many animal drawn and tractor drawn implements. Animal drawn implements mostly include indigenous ploughs and mould-board ploughs. Tractor drawn implements include mould-board ploughs, disc ploughs, heavy duty disk harrows, subsoil ploughs, chisel ploughs and other similar implements.

2. Secondary tillage

It is the lighter and finer tillage operations performed in the soil after primary tillage to create proper soil tilth and surface configuration for seeding and planting are called secondary tillage operations. Secondary tillage operations are generally done on the surface soil. They do not cause much soil inversion and shifting of soil from one place to other. They consume less power per unit area compared to primary tillage operations.

The main objectives of secondary tillage are

- To break the big clods and make the soil surface uniform and leveled for a seed bed
- To destroy grasses and weeds in the field.
- To cut crop residues and mix them with top soil

There are **two types** of agricultural tillage implements, primary and secondary tillage implement The implements used primary tillage operations are called primary tillage implements they includes different types of mould board plough, ard, scarifier, ripper and ridger. The implements used for secondary tillage operations are called secondary tillage implements. They include different types of harrow, cultivators, planters, sweeps, clod crushers, levellers,e.t.c.

Primary Tillage Implements

Primary tilling is performed by different types of plows, discs, rot tillers, and spading machines. Primary cultivation equipment has a high draft requirement and is usually more suited to larger animals than the donkey except where the soils are especially light and sandy. The choice of various animal-drawn implements are depends on Climatic conditions, Soil type and Farming system.

1. Single Furrow Moldboard Plough

Ploughing is the primary tillage operations, which are performed to cut, break and invert the soil partially or completely. Ploughing essentially means opening the upper crust of the soil, breaking

the clods and making the soil suitable for sowing seeds. **Moldboard plough is** a curved piece of metal which turns the furrow slice on its side after it has been cut by the plow blade, or share. The weeds can be buried by inverting the soil with a mouldboard plough. The degree of inversion depends on the cohesion of the soil and the shape of the mouldboard. As it moves soil to one side, the mouldboard plough clears a distinct furrow. By continually turning soil into each previous furrow a farmer can systematically cultivate a field in one operation, covering both weeds and surface trash. It is important to mix organic or chemical fertilizers in to the soil.

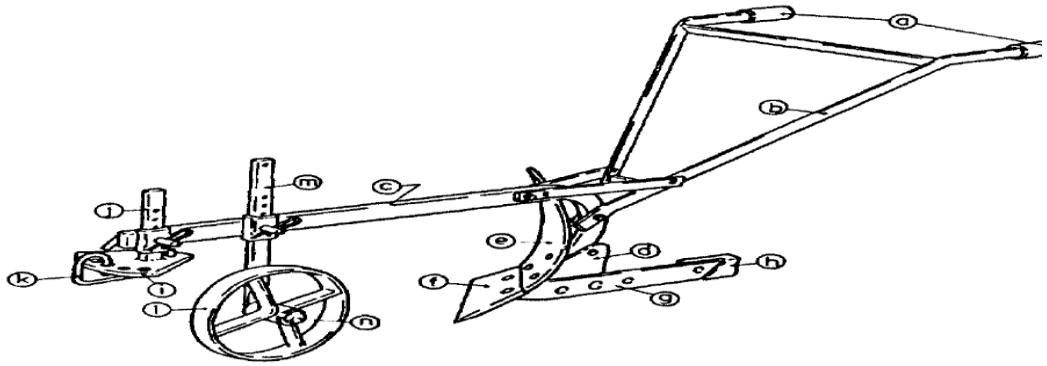


Figure 31: Parts of the Rumptstad Sandy III plough.

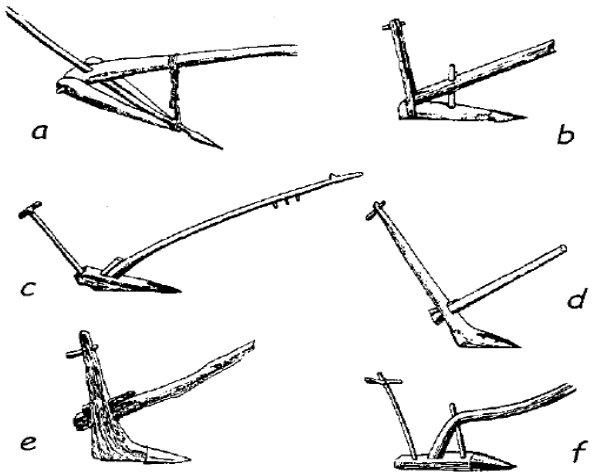
2. Ard plough

The ard, ard plough, or scratch plough is a simple light plough without a mouldboard. It is symmetrical on either side of its line of draft and is fitted with a symmetrical share that traces a shallow furrow but does not invert the soil. Ards are the most important animal-drawn implements in the world. It began to be replaced in most of Europe by the carruca turn plough from the 7th century. An ard plough is symmetrical on either side of its line of draft. The practice of removing organic matter and residues is common, for example by burning or by the grazing of animals. Under semi-arid conditions a fine tilts may be dangerously susceptible to erosion. A coarse seedbed preparation, with the ard for example, reduces these erosion risks. Though ards have been in use for thousands of years, they still are clearly well adapted to many contemporary-farming systems.

The design features of common ards are:-

- the use of a single, symmetrical share set at a fixed angle to the ground;
- use of a long beam between the body of the implement and the yoke;
- provision of a single handle for control;
- Use of materials and construction techniques that allow fabrication by village artisans.

As the share and the body of the plough pass through the ground, the soil is fractured and disturbed equally on either side, due to the symmetrical construction.



a: Ethiopian maresha

b: Egyptian balady plough

c: Nepal sole ard

d: Indian body ard

e: Afghanistan body ard

f: Cyprus sole ard

Figure 35: Some ard designs.

3. Scarifier

Sometimes referred to as a dethatcher, is a garden tool that is designed to cut through the soil, helping to remove dead moss and other debris, the scarifier is normally equipped with light tines made from spring steel. This implement rapidly opens the land after the first or second rain of the season to improve infiltration of the next rains. When using a pair of donkeys, only three tines should be attached. One is placed at the front and the other two at the rear of the implement. The appropriate choice must be made according to local field conditions, and it also depends upon the type of point fitted. Under normal conditions, a team of four donkeys can pull a scarifier with five tines. Lateral spacing between each tine must be equal and varies normally between 15 and 20 cm. It is particularly important on an expanding frame such as the **Houemanga** that each tine be aligned in the direction of advance.

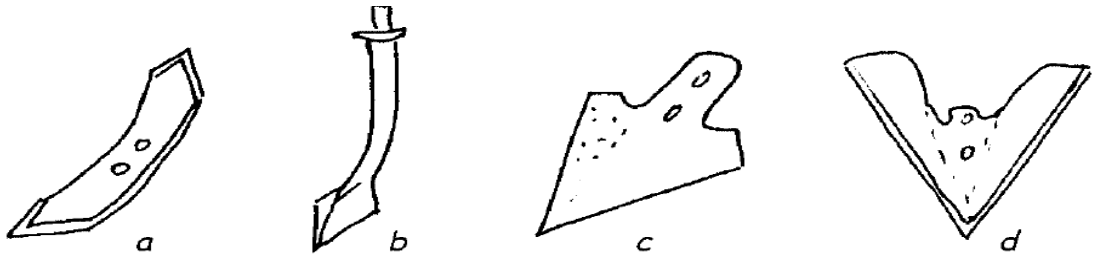


Figure 36: Several examples of a scarifier tine: (a) The reversible point for scarifying harder soils. (b) The rigid point. (c) The duck-foot point for scarifying lighter soils and general weeding operations. (d) The sweep used for weeding.

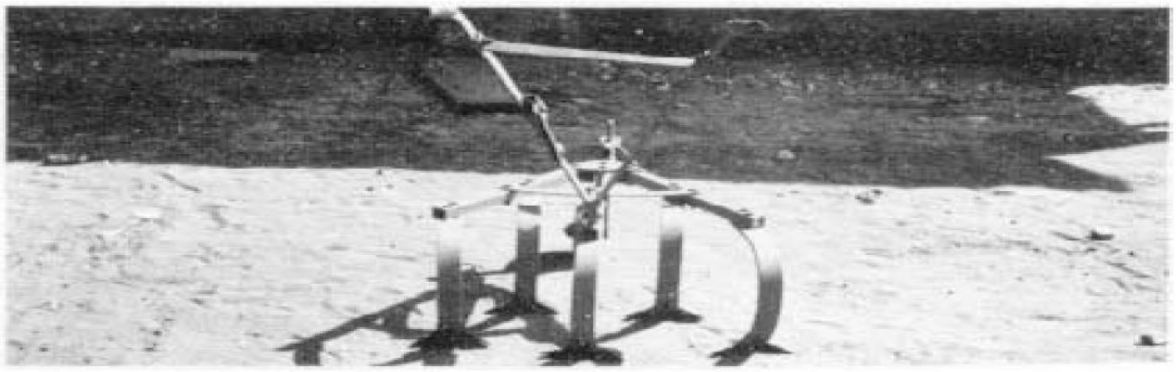


Figure 37: The Houe Manga in this illustration has the four left-hand tines correctly alligned. The right-hand tine, however, needs adjusting.

4. Ripper

Where the soil is practically free of weeds a ripper can be used to open a narrow band of soil ready for seeding. The rest of the soil is left undisturbed, if possible under a mulch cover to keep that soil cool and moist. The ripping system is not widely used but highly promoted in the interest of soil conservation. Single**,** symmetrical, angled tines may be used for tillage in semi-arid conditions.

These are mounted onto steel beams or toolbars, as commonly used in sub-Saharan Africa. In Zambia the Magoye ripper was developed as an attachment to a local plough or ridger frame.

It is recommended for a breaking Operation to make planting furrows for maize instead of a ploughing operation. On heavy soils this operation should take place right after the onset of rains but on light soils it can even be done before the rains start. The ripper tine can perform this

operation after ploughing, but more often a special subsoiler is used or a subsoil attachment to the common plough. A subsoiler tine is built heavier than a ripper tine and consequently takes more draft force.

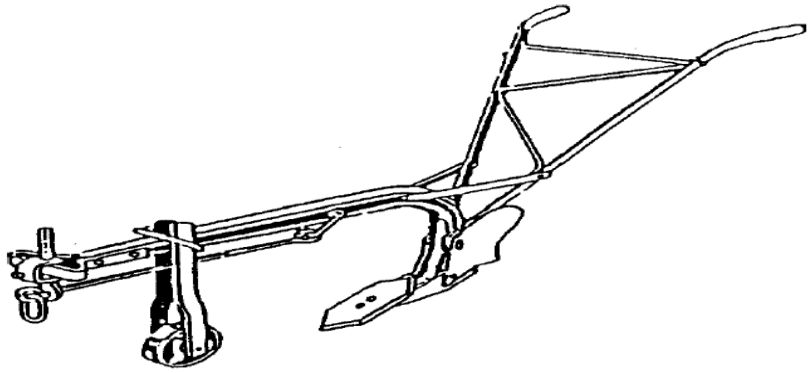


Figure 38: Magoye ripper attachment on plough beam.

4. Ridging plough (Ridger)

Ridger is a primary soil tillage machine, the usage aim of the machine is to open furrows between rows and ridging for row-planted seeds such as; corn, sunflower, cotton, potato, vegetable etc. Ridging ploughs are symmetrical around their line of draft and the two mould boards turn soil to both sides. In each pass through the soil a ridger makes one furrow and two small ridges. In normal use the furrows are so spaced that two small ridges are combined to make one larger one. Alternatively a ridger attachment is added to a common plough. Not all the land is tilled or the soil under the ridges is not disturbed. When using a properly designed ridger for direct ridging on soils where also ploughing can be done effectively, the draft requirements for these two operations will be comparable. In heavy soils however, direct ridging could lead to the formation of large aggregates that could hamper seed germination. In those conditions soil may have to be broken first with tines or a mouldboard plough and ridging becomes a secondary tillage operation.

Permanent ridges may lead to the development of hard layers of soil that are difficult for roots to penetrate. Even on light soils this can lead to yield reductions and increased competition by weeds. The best application of direct ridging seems to be in rotation with normal ploughing: a field that is directly ridged one year should be ploughed the following year and could be directly ridged again the third year. Consequently, direct ridging cannot replace ploughing altogether

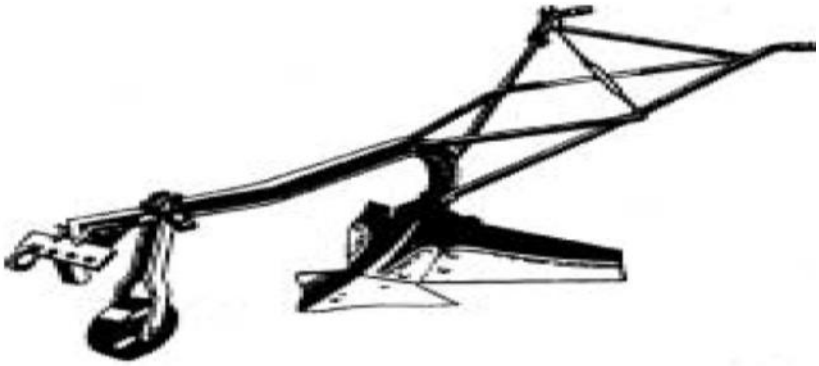


Figure 39: "Inkunki" high wing ridger, manufactured in Zimbabwe.

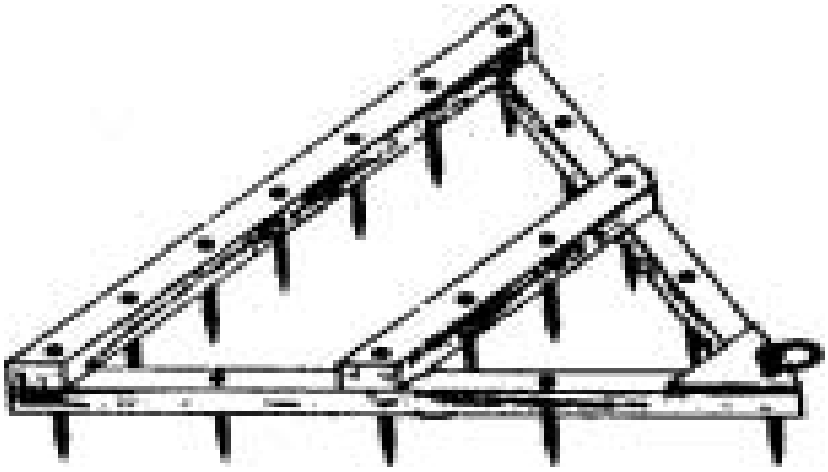
Secondary tillage implements

Secondary cultivation is aimed at both reducing the clod size and leveling the soil surface or forming it into the required shape.

Planting Equipments

1. Harrow

Harrows are used for shallow cultivation in operations such as preparation of seedbed, covering seeds and destroying weed seedlings. Harrows a~ of two types: disc harrow and blade harrow. A harrow may be as simple as a few tree branches or a wooden board or a log, weighted down with stones or the weight of the operator and pulled across the field by the animals. Harrowing is the process of smoothing and leveling a plowed field. A common harrow consists of a wooden frame with 15 to 20 metal spikes, which breaks the clods, mixes the soil and helps to level the surface. Excessive grinding of the soil should be avoided as the surface will then become susceptible to wind erosion and some soil types will later form hard crusts after rain. The correct hitching is very important to achieve best results. The size of the animals and length of the pull chain affect the way in which the harrow floats across the surface. The implement should be one meter behind the animals' hooves and remain level during the work. The harrow breaks clods and works the tops of furrow slices into a fine, moisture-retaining bed where seeds germinate easily.



Harrower

2. Planters or seeders

The objective of sowing is to place seeds at an appropriate depth in the soil with an optimal spacing between seeds. It has repeatedly been shown by comparative trials that accurate planting produces higher and more reliable average yields than random seed placement.

The object of a seeder is to obtain such accurate and reliable seed placement conveniently and at an acceptable cost.

The main manual techniques for sowing are broadcasting, dibbling and drilling

- **Broadcasting** involves the scattering of seeds over the soil surface followed by some mixing of the topsoil.
- **Dibbling** necessitates the making of a small hole into which are dropped one or more seeds.
- **Drilling** is the process of making a narrow furrow into which seeds are placed at regular intervals after which the furrow is covered with top soil and loosely compressed.

The various manual processes may be either combined with, or replaced by, animal traction techniques.

Broadcasting has historically been the major method of seeding grasses and small cereals such as wheat' teff and rice. When broadcasting is combined with animal traction, soil is generally plowed several times to obtain a satisfactory seedbed, or plowed once and then harrowed. The seed is spread by hand and then a light seed harrowing (or seed plowing with an arc) ensures that seed is combined into the topsoil. The broadcasting of wheat and rice may be replaced by animal-drawn single-row seeders or multi-row seed drills.

Animal drawn large seeder

4. Weeding Implements

Weed control is an important issue in the agriculture field. Automatic weed removing is achieved by the help of the machine system which typically uses sharp blades jointed at the bottom of the machine. In most cases, the farmer who uses animal power will plow and plant more ground than can be weeded by hand. The weeding operation can be accompanied with a' weeding sweep or with a cultivator. Sweeps work at shallow depths; move on rig weeds and loosening soil between row crops.

The sweep has several functions

- It scrapes a shallow furrow" between rows, cutting or uprooting weeds in its path.
- In addition, it pushes some soil to the sides, covering weed seedlings growing between plants on the row.
- The soil helps shade and support roots of the plants, and also covers fertilizer distributed at the base of the plants.
- It loosens soil, improving aeration and moisture retention.

Weeds must be killed before they compete with crops for soil nutrients and water reserves. The first weeding is performed as soon as weed seedlings appear between the crops.

Transport Equipments

Transport equipment are equipments used to move material from one location to another e.g., between workplaces, between a loading dock and a storage area, etc. Pulling is generally a more efficient way of moving things than packing, because most of the load is not borne by the animal. Moreover, the load does not have to be prepared in a special way to fit the animal.

Sledges, Carts and Wagons

1. Sledges

A sledge is the most simple load vehicle made out of a Y shaped tree branch. The sledge is attached to the animal by a trek chain.

The advantages of sledges are:-

- They are cheap and simple to make and maintain.
- They have a low centre of gravity and they are narrow, enabling them to be used on tracks too narrow or steep for carts.
- They can often be used in sandy, muddy or rutted conditions where a cart might become stuck.

Disadvantages of sledges are:-

- In most conditions they require more effort to pull than a cart.
- They have limited clearance and can be stopped by stumps.
- Most importantly they tend to accelerate erosion by leaving rutted tracks, often only passable by other sledges, which become watercourses during heavy rains.

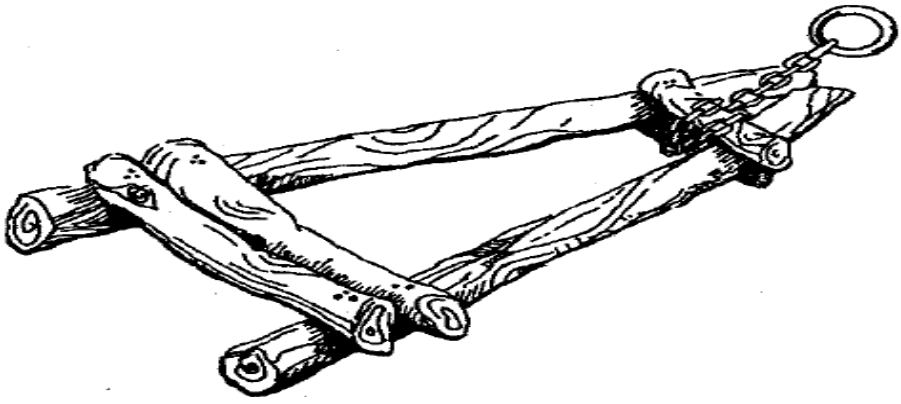


Figure 27: Simple wooden sledge as used in eastern and southern Africa.

2. Carts

Carts are two-wheeled vehicles, they can be small and light, pulled by one donkey, or may carry over one ton and be hitched to a team of donkeys. Carts are becoming very popular, especially in Africa, as they can be used on rough roads and throughout the year, while other implements can only be used for a small number of days each year.

Figure 30: Two-wheel donkey cart in Mali. Provided the load is well balanced, donkeys can pull impressive loads along flat roads.

3. Wagons

Wagons are four-wheeled vehicles with a higher weight capacity than carts. They also have the advantage that the wheels support the whole load, so that the animal power is only needed for forward movement. Wagons can be left with loads in place even when the animals are not present. However, wagons have a more complicated design to ensure operation and stability, which makes them heavier and more costly. They are best suited to tarred and level roads and to areas where the increased load capacity is cost-effective.

Pack Transport

The most common use of donkeys is as pack animals for transport of goods and people. They do not need very intensive training to be able to be used as a pack animal. Often, young animals already walk along with the older animals and learn by observation. If donkeys transport goods in a group there is normally a natural order. The strongest animal will lead the group while the others follow. If the farmer keeps a good eye on the leader, managing the rest of the group is not a problem.

Loads and comfort

Because donkeys are so docile and willing, it is easy to overload them. Some farmers make donkeys carry goods equal to the weight of the donkey. A pack donkey should be comfortably loaded. A smooth load of reasonable weight on its well-padded back will allow a donkey to walk long distances with little or no attention. Loads should be kept as close to the animal as possible. Tall loads are unstable, particularly if they are not well balanced. They are more likely to be uncomfortable and to shift during motion. In extreme cases they may cause a donkey to fall. At the end of the working day, pack saddles and pads should be removed to allow grooming.

Packing rules

A. Load balancing

All loads should be balanced evenly, with similar weight and bulk on either side of the animal so that it is comfortable.

B. Back padding

Two-layer padding material between the pack load and the donkey's back is required for protection of its skin. The layer that rests on the skin should be both soft (to provide protection) and absorbent (to take up sweat). It has to be washed or replaced regularly, to avoid growth of harmful bacteria. Several layers of cotton material or sheepskin are ideal for this purpose.

The second layer should provide a moderating effect. Well-suited are a folded blanket or a straw-filled sack.

C. Protection of the backbone

The back padding should be shaped in such a way that it prevents any direct pressure on the backbone. Therefore, a pack saddle or pack frame is recommended.

Chapter 7.

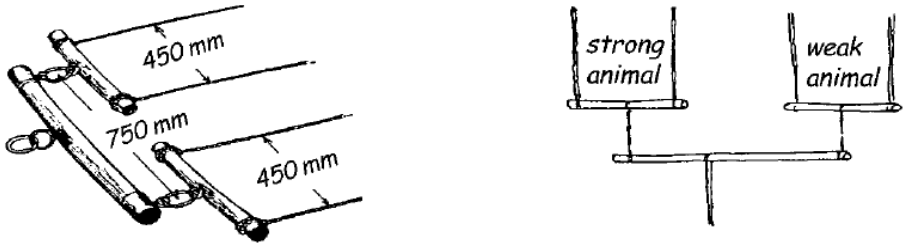
Harnesses systems of Draft animal power

Harness is the whole power transmission system attaching the animal to its work load. It is the combination of straps, bands, and other parts forming the working equipment of a draft animal. Yokes and harnesses are kinds of gear worn by draft animals when they work. Most of the gear is designed for pulling; it fits around or over the animal's front, providing a broad,' comfortable surface to push against. The "push" is turned into pull through use of rope, chain or leather lines which connect the yoke or harness to the load. The harness links the draft animal to the cart or implement.

In some parts of Africa, donkeys, horses or mules are used with withers yokes, similar to those used for cattle. The yoke is a bar or frame of wood which locks two animals together, one at either end of a bar carried on the withers or strapped to the horns. Harnesses are linkages of adjustable leather straps and pads used primarily for horses, donkeys, and mules. These animals have broad chests and strong shoulders, and so their harnesses are made to fit against this area. The use of harness can increase the power of oxen, but the expense of leather and difficulty of ensuring fit have limited acceptance of this practice.

Harnessing or hitching systems

As the donkey walks, its shoulders move backwards and forwards. To prevent rubbing the skin, the harness must be able to move in line with the shoulders. Ideally, the traces should be attached to a swingle or swingle tree and not directly to the implement. Linking two donkeys to a cart or implement requires the use of an evener. The implement is normally pulled from the centre of the evener, but if one animal is stronger than the other, the trek chain should be attached closer to the side of the stronger animal to compensate for the inequality in pulling force. If the traces are made from rope, notches should be filed in the wooden swingle tree so they cannot slip off.



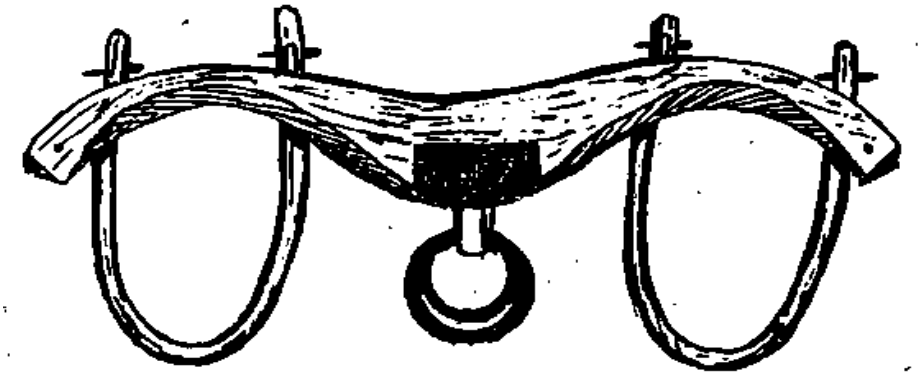
to hitch together a pair of donkeys *compensating for a weaker animal*

Figure 22: Suggested sizes for the swingle trees and evener.

1. Harnessing of draft cattle

1. Bow Yoke

The bow yoke is an inexpensive and efficient device for harnessing the power of cattle. When the team pulls, the wooden crosspiece or stock presses back against the muscle and cartilage which forms the front of the animals' withers. The yoke is held in place by bows, U-shaped pieces of wood or metal which fit into the stock from underneath. Broad wooden bows provide more surface area than most peg thong or round-iron varieties, and give the animal extra surface to push against with its shoulder. However, there is great advantage in a bow that locks and unlocks under the neck; these bows are easy to remove if a team has fallen.



Wooden Bow Yoke with Carved Stock, Solid Bows, Draw Ring and Pole Ring.

Advantages

- ✓ Animal flexibility and in the field or forest
- ✓ The animals can move faster with more flexibility
- ✓ Yoking time is fast and no need for horns

- ✓ One yoke can be used on many teams and different bows can be used to allow the same yoke to be used as animals grow.

Dis advantages

- ✓ Less animal control
- ✓ Animals can fight each other
- ✓ Sore necks and bruised shoulders can easily develop if not fitted properly

2. Head or horn Yoke

Most head yokes lock behind the horns and are tied to the forehead and horns with straps. The stock is carved out to accommodate the backs of the horns, and so once the yoke is on, the team becomes an extremely tight unit. Single animal yokes fit either behind or in front of the horns. Lengths of rope, chain or leather (called traces) connect the ends of the yoke to the load. The head yoke offers a number of advantages over the neck yoke. They provide more animal control and restraint.

Ad vantages

- ✓ Better animal control
- ✓ no sore necks
- ✓ can be used to eliminate problems like sore necks, animals fighting each other or not holding their heads in the correct position when in the neck yoke

Dis Advantages

- ✓ Animals have to have rugged horns
- ✓ The yoke is more complicated to make and fit
- ✓ yoking time is slow

3. Withers/shoulder yokes

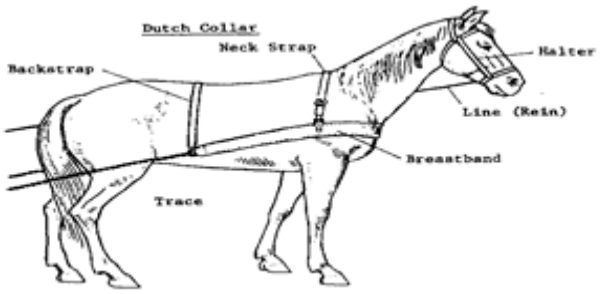
A withers yoke is a yoke that fits just in front of the withers or the shoulder edges, of the oxen. The yoke is held in position by straps, either alone or with a pair of wooden staves on either side of the ox's withers; the pull is however from the yoke itself, not from the staves. Withers yokes are the most important system of harnessing in the world. They are almost universally used in Asia and Ethiopia, and are widely used in parts of western, eastern and southern Africa and areas of Europe and the Americas.

They are almost always made of wood, although a few projects in Africa and Asia have made yokes from steel pipe. In their simplest form they are just wooden poles with small descending pegs sticks to restrict lateral movement. These pegs, also known as staves or skies, may be joined by a loose rope, chain or strip of hide, but this has no draft function and does not pull against. Withers yokes can be lightly padded, and in Ethiopia the traditional yoke is padded with sheepskin or cloth covered with cowhide. Withers yokes particularly suit zebu cattle, which have high humps on their withers and also widely used in Africa and India, where zebu cattle are common.

2. Harnessing of donkeys, horses and mules

A. Breast band Harness (Dutch Collar)

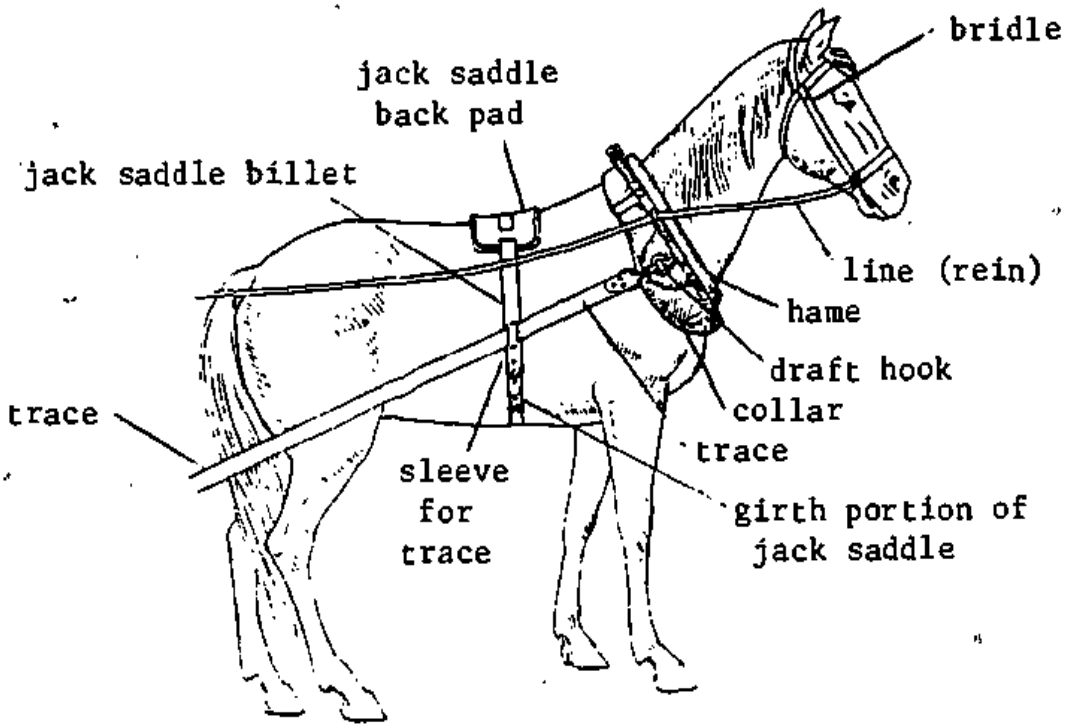
This is the simplest type of equine harness. The breast band is a broad band of leather which circles the animal's chest and connects to traces which in turn connect to a swing tree and the load. The band is" held in place by straps. The forward strap, the neck strap, adjusts so that the breast band can be raised or lowered for correct position on the chest. The back strap holds up the ends of the breast band where the traces attach. The breast band must be high enough on the chest so it does **not interfere with movement** of the shoulder. This type of harness is not as efficient as the collar harness for equine because the animal's push is concentrated on a comparatively small band of leather. However, it is quite adequate for light or medium tillage, or cart work. It is cheaper and easy to make and fit than collar harness.



B. Collar Harness

Horses, donkeys and mules have no natural padding to absorb the pressure of a yoke. For this reason, a pad is provided before ' the yoke is applied. The pad is called a collar. Properly fitted, collar harness provides excellent draft for cattle' and buffalo. These animals have relatively narrow chests and the collar must be shaped so it does not interfere with movement of the shoulder. The hames, which are joined at the top with a strap, are placed over the wither and seated into grooves in the collar. When the animal pulls, the collar presses against the chest and shoulders and transmits the power to the load through the" traces (straps or chains connecting the hame to the swing tree behind).

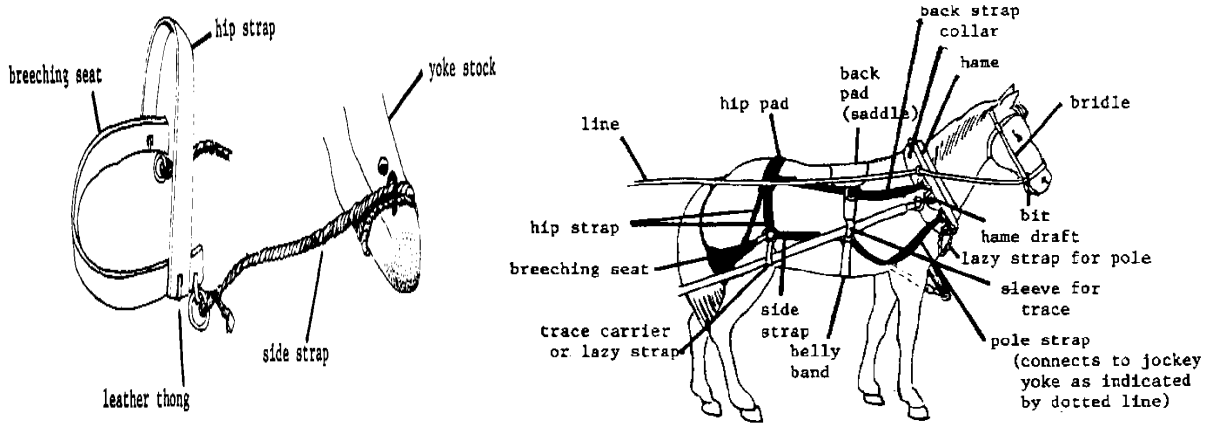
The point where the trace meets the hame is called the point of draft. The attachment is made by trying or hooking the end of the trace to a ring on the hame called the hame-draft. The strap may be used to hold up the shafts of a cart, and in this case it is furnished with a pad to protect the back. The strap with the pad attached is called a jack saddle. The last part of the collar harness is the bridle. It is similar to a halter, but instead of controlling the muzzle or nose, it controls the mouth. It is a system of straps designed to hold a metal bar or bit in the animal's mouth. A line is attached to either end of the bit, allowing the driver to turn the head. An even pull on both lines brings the head down and toward the chest, stopping the animal. The lines usually pass through supporting rings on the hames; the rings are called terrets.



Collar Harness Consisting of Collar and Hames, Jack Saddle, Traces, and Bridle with Lines

C. Breeching harness

Breeching (britching) harness is a kind of harness that enables a team of animals to exert backward pressure on the shaft of a wagon or cart, causing it to brake or back up. It can be used with all types of yoke and harness. Breeching harness looks like a breast band collar worn around the **rear quarters**. Its main part, called the **breeching seat**, is a wide band of leather that circles an animal's rumps. It is held in place by a band which passes over the top of the rump. The band is called a **hip strap**. The breeching is connected to the yoke or harness by a pair of straps (or ropes) called **sidesteps**, hold-back straps, or pole straps. The side steps tighten and pull against the yoke or harness the same way traces tighten and pull against a swingle tree. The yoke or harness pulls back on the front of the wagon shaft and the vehicle backs up. Back straps are needed when breeching is used. These connect the hip strap to the collar and help to stabilize the entire harness.



Full Collar Harness with Breeching Parts Highlighted

D. Load Carrying and Pack Saddles

Simple saddles can be padded wooden frames, broad straps or ropes over an animal's back which helps to stand vertical loads. These are widely used with horses, donkeys and camels that pull carts. Research at the University of Edinburgh demonstrated that the positioning of pack saddles on zebu cattle and buffaloes was critical. If the saddle was forward, over the shoulders, the animals accepted it more readily, and it required less energy to carry loads than if it was more central on the back. A saddle harness was widely used in Japan for cultivation and transport and in the 1960s it was found to be more efficient than withers yokes during on-station trials in India.

Common pack saddle designs

3. Harnesses for camels

Camels are widely used for pack transport in arid areas and sometimes they are used to pull carts and power irrigation systems or grinding mills. The fact that camels have a high value for transport operations generally restricts their employment for agricultural operations. The long legs of camels allow them to cover ground quickly, but this height poses some problems for effective harnessing. Unless the traces of a camel harness are long (making turning difficult), the angle of pull is quite large, giving a significantly higher ratio of "lift" to "pull" than with less tall animals. Camels are used much more widely for transport than for pulling implements. For cart transport, **a broad padded withers harness** is often used to provide the forward movement while **a saddle** over the hump takes much of the vertical load by supporting one or more straps, cords or even chains attached to the shafts.

Chapter 8.

Performance assessment of Draft animal power

Comparative draft and packing performance

Percentage of body weight exerted as draft or packed by animals is variable. Wide ranges occur among reported values for maximum performance tests and daily work due to differences in methods of measurement and duration of experiments. While tests of maximum performance indicate animal reserve strength, they do not reflect ability to work for extended periods of time. In general, most animals can develop a draft of 10 to 14% of body weight when traveling at a speed of 2.4 to 4.0 km per hr. An increase in speed will cause a reduction in draft exerted or length of work period. Large differences exist between species regarding percentage of body weight that can be packed. Horses and mules can pack 12 to 15% of body weight while camels and reindeer are reported as capable of carrying loads equivalent to 27 to 40%. Large differences exist between species regarding percentage of body weight that can be packed.

8.1. Dietary Energy Requirements of Working Animals

Animals burn many more calories when working than when idle or grazing. This means that the energy requirements of an animal will increase with the work load. Experience and research in tropical areas have shown that animals need about twice their normal energy maintenance requirement when they are used for medium-intensity draft work. Without this additional food, draft animals grow thin and weak, because they must burn body tissue in order to produce the energy needed to perform work. Not only do these animals lose strength, they become increasingly susceptible to injury and disease

The classifications of animal as light, medium, and heavy are commonly used to designate nutrient requirements of working animals. These classifications are based on the number of hours work was performed, but do not consider that energy requirements vary directly with the rate at which work is accomplished, work done for a specified period of time at one rate will require more or less energy than work done at a different rate. Applying a general category to work performed, based on time alone, and may not adequately cover energy costs. Rather, both intensity (percentage of body weight developed as draft) and rate of work (hp) should be included when calculating energy needs. Comprehensive assessment of animal performance must include information on the energy expended by the animal in doing useful work and on the physiological responses of the animal to work. The power demand of a cultivating implement is the product of the horizontal draught force and the speed of progression.

8.2. Energy Available for Work

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. It

causes the animals to become inefficient workers, lazy, stubborn, and ill-tempered. A basic knowledge of the dietary needs of draft animals and of the nutritional content of available feeds will enable owners to plan a feeding program that will help their animals to work to their full potential. Grazing draft animals' need supplemental feeding for two reasons:

A. To increase energy intake and prevent protein, vitamin-and mineral deficiencies.

B. Because of limited grazing time or limited forages availability.

An adequate diet is especially important to young draft animals because their growth may be stunted or their conformation affected if food normally used to build bone and muscle must be converted into work energy during the critical early years. Working animals have limited time to eat, since they work during the time they would normally be grazing or foraging for food. In the time remaining after work, they may not be able to find and eat enough grass to replace the calories lost during work.

8.3. Basic units to Measure Performance of animals

The efforts of draft animals are often viewed only in terms of work accomplished, e.g., a plowed field, a harrowed rice paddy or goods transported. The basic physical principles such as friction, force, and speed which influence the process of doing the work are less considered; consequently, the power generated by animals is utilized inefficiently and less work is completed. An understanding of the physical principles involved when using animal power is essential for comparing the working ability and efficiency of draft animals between and among species.

1. Force

The standard unit of force is a Newton (symbol N). 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's. Thus although some traditionalists may object, for all practical purposes a Newton can be simply considered as a unit of force equivalent to 100 grams weight. Thus 10 N is equivalent to one kilogram (1 kg or 2.2 lb). Newton units are the accepted international standard, and will be found in other references. Older texts have generally referred to kilograms force (1 kgf ~10 N). Some authors have used deca newtons (dN) which are broadly equivalent to kilograms and some have used kilo-Newton (kN) equivalent to 100kg force. However for most people it should be sufficient to remember that dividing the Newton figure by 10 will give the kilogram equivalent. By way of illustration, a low-draft implement such as a light seeder might impose a draft resistance force of about 200N; a small moldboard plow in light soils might require a tractive force of 500N while a double mouldboard plow in heavy soils might require a force of 2000N.

2. Work

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. 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.

3. Power

Although cattle appear to have been first used in 3200 BC., by the Sumerians for transport, plowing, and threshing of grain (Zeuner, 1963), it was not until the 18th century that the power produced by animals while doing work was actually measured. The unit of measure was termed horsepower by James Watt, inventor of the first practical steam engine. To put his steam engine on the market, Watt needed to determine the number of horses his steam engine could replace. The amount of power was determined by using horses to pull a rope passed over a pulley attached to a weight at the bottom of a deep well. One horse could easily raise a weight of 100 lb (45 kg) while walking at 2.5 mi (4 km) per hr. 1hp is about 745.7or746 watts.

Horse power is the rate at which work is performed and is calculated using two components; work (force x distance) and time. The amount of hp required to do work is dependent on the rate at which the work is performed. For example, to plow 1 ha of land requires the same amount of work whether the land is plowed in 6 hr with two animals or in 1 hr with six animals. However, the faster the rate of work the more hp needed. A more accurate term to use when describing the amount of power an animal can produce is tractive hp. Tractive hp is measured at the point where an implement or lever is attached and is the power required for pulling an implement, e.g., plow, cart, or operating a machine, e.g., mill, press. Tractive hp can be calculated by recording the speed of travel (distance x time) and determining the resistance of the load (draft) by means of a dynamometer. The distance traveled in a given amount of time multiplied by the resistance recorded by the dynamometer and divided by a constant equals the tractive horse power produced.

$$Tractive\ hp = \frac{Draft\ (kg) \times speed(\frac{km}{hr})}{270}$$

For example, the draft required to pull a 40.6 cm sulky plow through a 15.2 cm deep Sudan grass sod is 227.3 kg. If three horses pulled the plow at a rate of 3.2 km per hr, the tractive horsepower would be: tractive hp = $\frac{227.3 \text{ kg X } 3.2 \text{ km/hr}}{270} = 2.7$

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 kg of force to move a 50 kg log. If the movement is accomplished by pulling, rather than by lifting, or carrying, the force is called draft. The draft capacity of an animal increases with its weight. A generally accepted rule is that an animal can exert a constant pull on a load which equals approximately one-tenth of its body weight. The rule applies when the animal is allowed to assume a natural speed and expected to produce an extended rather than a concentrated effort. A 300 kg bull, for example, can pull a 30 kg log' all day, but if it is made to pull 130 kg, it will work only three or four hours before it tires. If it is made to pull at a faster speed, it also will tire sooner.

A draft animal must be able to produce extra force as well as work at a steady speed. Under normal conditions, 30 kg of force may be required to pull a log, but if it must be dragged up a hill, or if the log catches in a gap, the force needed (draft requirement) increases. Horses, mules and oxen are preferred draft animals because they can pull loads over long distances at reasonable speeds and, when necessary they provide extra pulling capacity.

8.4. Measurements at Field Condition

Determining Weights of Animals

To determine an animal's weight, first measure the length of the animal from point of shoulder to point of rump (A-B) and the circumference of its chest at point of heart (C) with a tape or ro pe.

When taking the chest or girth measurement, observe these rules:

- Measure in the morning before the animal drinks. Don't give it hay the night before.
- Have the animal stand squarely with its head in a normal position.
- Pull the rope closely around the chest at behind the shoulders.

Next, follow the following formulas:

1. for bovine animals: - Substitute measurements A-B (length) and C (circumference of chest at point of heart, or girth) into this formula: - **Weight = $\frac{\text{Girth X girth x length}}{300}$.**

For this formula, measurements must be taken in centimeters. If a metric tape or rope/rule is used to measure the animal, cm must be converted to inches before the formula can be used. One inch = 2.54 cm.

Example: Girth of bull measures 152 cm and its length measures 135 cm. How much the weight will measure? First we must change cm into inches …

A, 152/2.54 = 60 inches (girth) B, 135/2.54 = 53 inches (length)

Then W= $\frac{60 \text{ X } 60 \text{ X } 53}{300}$ = 636 lbs in pound

Since one kg = 2.2 lbs, the weight of the animal in kg is obtained by dividing 2.2 into the answer above (636 lbs).Then **W** = $\frac{636}{2.2}$ = 289 kg in kilo gram.

The bull weighs 636 lbs or 289 kg. An alternate method for estimating the weight of a steer (castrated bull):

2. for equine animals: - Substitute measurements A-B (length) and C (girth) into this formula:

Weight = $\frac{\text{Girth X girth x length}}{300}$ +50 Ibs

Measurements must be taken in cm, or converted into inches, before the formula is used.

Example: Donkey's girth measures 37 inches and donkey's length measures 35 inches. How much the weight of the donkey will measure?

W= $\frac{37 \text{ X } 37 \text{ X } 35}{300}$ + 50 = 160 +50 = 210 lbs or to be expressed in kg. 210/2.2 = 95 kg.

Chapter 9.

Management of different Draft animal power

Humans and their domestic animals are mutually dependent. Human progress depends on the utilization of animal and natural resources in a balanced way. Human self-interest alone could provide sufficient motivation for proper animal care and management. A draft animal's value is based on the special training and management that enables it to work. Farmers must keep their animals strong, healthy, and even-tempered through proper handling, a good feeding program, and prompt medical attention when necessary.

9.1. Housing of Draft animal power

Quality of Animal Shelter

Shelters or simple houses of animals should have a sloping floor to allow run-off to keep them dry and clean, and dung should be removed daily to reduce the problem of flies. Good hygiene is essential and more harm than good can be caused by allowing houses or shelters to become dirty. Houses should be periodically disinfected and clean bedding provided. Troughs for food and water should be provided and cleaned. **Agood quality shelter has the following advantages:-**

- Is easy to collect and produce manure
- Protects the manure against rain and sun
- Protects the animals against theft
- Protects the animal against poor weather conditions
- Allows the oxen to rest and ruminate well. This improves their strength and health.
- Provides storage room for tools, crops and additional feeds
- Allows easy harnessing of the oxen and horses
- Allows easy treatment of the animals (de ticking, deworming)

Housing for Cattle

Living place or house of cattle is simply known as cattle housing. Good housing is required for raising cattle. Because suitable housing is needed for keeping the cattle safe from storm, rain, sun, hot temperature, excessive cold climate and other adverse weather conditions. 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 cattle 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 better to build on

high ground so water drains away. The wall should situate to blocks prevailing winds, and the roof made on the side opposite the wind. An earthen floor is needed, but straw or sand should be kept in the area where the animal sleeps, or "beds down." Manure and urine-soaked straw should be collected regularly to reduce fly populations and hoof infections. It makes excellent compost, but should not be piled or stored near the stable area. A smoke fire made from a green log or slog burning stump helps keep the shelter area free of mosquitoes and flies. Trough or rack can be built into the wall of the lean-to to hold hay, grain, salt licks or water buckets.

Housing for horses

Housing facilities should be designed and constructed to provide for the horse's welfare and Horses should be provided with a clean, dry area for lying down. In all types of housing systems horses should be free to stand up or lie down comfortably at all times. Housing facilities should provide for enough height to permit horses 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 Band maintained to provide good traction, proper drainage, and comfort and prevent injury. The design of housing facilities and the materials used in their construction should permit systematic cleaning and disinfection from time to time.

Loose boxes (or traditional stables) are the most common form of stabling individual horses. Groups of horses can be out-wintered together in communal barns. This form of loose housing is often the most practical system for managing young-stock or brood mares that have already formed social groups whilst at grass during the summer. Loose housing is economical and labor saving but care must be taken to ensure that all horses fare equally well.

Segregation

The introduction of a new horse or horses to an existing group can result in bullying. This may be alleviated by increasing the space allowance or penning the new animal adjacent to the existing group for a short period. The shy horse not getting sufficient food or being bullied must be removed and given individual attention. A horse that is aggressive to others should also be removed.Segregation of incompatible animals is particularly important where communal or loose housing systems are used. Horses should not be hind-shod in these systems.

Ventilation

Ventilation systems in horse stables/housing should be capable of maintaining an air change rate to prevent excessive heat and moisture levels and to remove major dust and gas contaminants that can be damaging to the respiratory system of horses and humans.

Mechanically ventilated stables should be equipped to introduce and uniformly distribute fresh air/or to exhaust foul, moisture-laden air. Stables may be adequately ventilated through the use of air intakes and

exhaust openings to give reasonable air exchange without creating draughts. The use of a half door solely as a means of ventilation is not adequate. Air movement should not cause discomfort to horses in stables.

Lighting

Horse stables/housing should be well ignited to permit proper observation of all horses. Any light source within a stable should be positioned so that it is inaccessible to the reach of horses. It should be fitted with waterproof protective covering, as required under National Rules for electrical insulation. Natural light sources should be utilized as much as possible in the design of the facility.

Bedding Material

Adequate suitable bedding material is necessary to provide warmth and protection from draught animals, to prevent injury and jarring of the legs, to enable the horse to lie down in comfort, to reduce the risk of the horse and to encourage the horse to urinate. Bedding material must be non-toxic and provide effective drainage (and/or be absorbent), to maintain a dry bed and to keep the air free from dust and ammonia.

Various types of bedding material are available, such as straw, wood shavings, paper, and hemp. Whichever bedding material is used, it must be of good quality and well managed.

The effectiveness of all bedding material diminishes if they are poorly maintained or if insufficient quantities are used.

Handling

Horses should be handled quietly with good care to avoid injury, pain or distress. Handling and restraining devices must be used humanely by experienced operatives and with regard to the horse's natural movement, temperament and physical capabilities. All halters, head collars and other equipment used to restrain or handle horses should be fitted with a method of quick release in case a horse becomes entangled in the equipment. Where animals are kept in a semi-feral state and have not halter, special handling facilities may be required for routine management (e.g. worming or hoof trimming) and treatment of minor diseases. Eg, Crushes and other stunning mechanisms. These should be built for the purpose and designed to induce the least amount of stress to the animal and to avoid danger to either animals or handlers.

Grooming

Grooming refers to the process of cleaning animals so that their coats are free of dust, dirt, manure and sweat. To groom animals, a person needs two tools **A) curry comb** and **B) brush**. A curry comb is an oval shaped plastic or metal brushing device which is used to loosen sweat, manure and other materials from the animal's coat. The brush is used to remove the materials loosened during currying.

Importance of Animal Grooming;

1. At night, animals may lie in manure, water or urine-soaked ground. When this material hardens on the coat (hair), it attracts flies and other insects which are a problem to the animal and which may carry

disease. Sometimes this material contains parasites such as hookworm, which can enter the skin and seriously affect the animal's health.

2. Then sweat evaporates, it leaves a mat of stiff hair. A harness or yoke rubbing against this mat will pull some of the hair loose and harder clumps of hair will rub against the exposed skin. This results in a burn or raw spot which becomes increasingly tender and finally an open wound. These wounds are called girth-sores or yoke galls. They can cause pain which makes animals extremely irritable and hard to handle.

3. Daily grooming results in closer physical contact between owner and animal. This association develops trust between them. The owner learns about the animal's moods, sensitivities, and reactions. The animal becomes familiar with the owner's voice, movements, and commands, and becomes easier to handle. Daily grooming lets the owner take a close look at the animal each day. Minor problems like ticks, scratches, muscle strains, harness sores, and stones in the hoof can be detected and treated before they become serious problems.

9.2. Feeding and Nutritional Requirement of Draft animal power

Draft animal need several important feed components or nutrients which includes energy, protein, vitamins, minerals and water. Different feeds contain these components in different amounts. Provided natural pasture is abundant and feeding of draft animal should not be a major problem. Besides forage (or roughage) from grazing, the animals may be fed additional forage and concentrates provided by the farmer, depending on age and workload. Age, sex, amount of draft generated, and duration of work will determine energy requirements. Mature oxen for example, have requirements for maintenance and work, while immature animals and pregnant or lactating cows employed for draft have additional needs. Available data on energy requirements for working animals and attempts to categorize three areas: maintenance, growth, and work.

A. Maintenance

Energy requirements for draft animals at maintenance level are similar to those for non-working animals. Given that maintenance needs of animals are partially set by the level of body reserves available, an animal lacking adequate energy for work will utilize these reserves to meet energy needs, resulting in weight loss.

B. Growth

Employing immature animals for draft requires that, adequate energy should be provided for growth. The national Research Council (N.R.C., 1976) recommended that immature cattle (100 to 400 kg), gaining 0.5 to 1.0 kg per day, be fed 0.5 to 3.5 kg of TDN above maintenance. Calculations from energy values given by the N.R.C. (1966) for immature draft horses indicate that animals attaining

mature weights of 270 to 635 kg need 0.7 to 0.8 of TDN per day, in excess of maintenance requirements.

C. Work

The classifications light, medium, and heavy are commonly used to designate nutrient requirements of working animals. These classifications are based on the number of hours work was performed; work done for a specified period of time at one rate will require more or less energy than work done at a different rate. Applying a general category to work performed, based on time alone, and may not adequately cover energy costs. Rather, both intensity (percentage of body weight developed as draft) and rate of work should be included when calculating energy needs.

Supplementary Feeding of Draft animal power

The amount of extra feed that draft animal need depends on their size, the amount of work done, the quantity and quality of pasture available and the type and quality of feed used for supplementation. Draft animal have stomachs designed for frequent small meals (such as when grazing naturally) so the more often they are fed the better. It is not a good idea to feed a lot of forage in the morning before work. Give small amounts then and during rest periods in the day. Supply supplementary forages in the afternoon and evening, allowing donkeys to feed during the night. A nursing jenny needs the feed equivalent of about 2 - 3% of her body weight a day if she is only fed forage. A working donkey needs about 3 - 4% of its body weight a day. Thus an average donkey will need about 4 to 6 kg of fodder a day if nursing or working. A jenny that is both nursing and working will need more feed. If a donkey cannot obtain this amount from available grazing, it will need supplements. In any case, if donkeys are fed concentrate each working day, they will require less grazing, and learn that work brings rewards. If a donkey is fed well, but is still thin, it probably has internal parasites which need treating.

Supplements are most important in the following circumstances:

- When local grazing is poor because of drought or over-grazing.
- If animals must walk long distances for food.
- If donkeys do not get at le ast six grazing hours each day.
- When female donkeys are in the last three months of pregnancy or they are nursing.
- For young foals at growing, especially between 6 and 18 months of age.

9.3. Health care and welfare of Draft animal power

Health of draft animals

The health and welfare of work animals is fundamental to maximize their productivity, work efficiency and wellbeing. Draught animals may suffer in a variety of ways throughout their working life. Animals need to be kept free from disease, injury and harmful parasites. Preventative and remedial vaccines and

treatment should be undertaken on time where applicable. Operations (e.g. castration) should be performed by people with the necessary skills to ensure the methods used are safe, effective and humane. Animals are often forced by beating, to make them carry loads beyond their capacity or work longer hours. Sick and injured animals may be put to work. The state of health of draught animals is poor, as they are not fed adequately to replenish the energy required for work. Implements, carts and other devices may be attached to animals by ill-fitting harnesses, thus causing unnecessary pain; neck injuries often lead to callosity and/or cancer. Most of this suffering could be reduced through the application of technology and management. Unfortunately, adequate legislation is lacking and the policy can do little to help. The solution is to make the policy force legally responsible for protection of animals, which requires amendments to existing laws.

Signs of ill health in animals

- has a very warm muzzle, pasterns and feet;
- has a nervous or depressed expression;
- hangs its head;
- has a rough coat with hairs standing up;
- stands with all four legs close under it;
- sweating before work;
- Does not pass faces or urine, or if these are abnormal.

Welfare of draft animals

In simple terms, welfare can be defined as ‘wellbeing’. Arguably, the most widely recognized and accepted definition of welfare is that of the ‘Five Freedoms’ which over time have been revised and are currently accepted as:

- Freedom from starvation or physical discomfort
- Freedom from pain, injury or discomfort
- Freedom from thermal or physical discomfort
- Freedom from fear or distress
- Freedom to express natural behavior.

The owner should care for and feed the animal well, protect it from predators, parasites, disease, injury, pain and extreme weather. In addition the animal should be worked within its physical abilities and treated humanely. The animal in turn will work for the owner and fulfill the needs for transport and power. Geneally speaking the welfare of the animal should encompass their psychological and physical wellbeing.

9.4. Record keeping

To keep records is simply to collect relevant information that can help you to take good decisions and to keep track of activities, production and important events on a farm.

Importance of Records in animal farming

- To keep track of all animals (Identification records)
- Evaluation of livestock for selection (breeding records; financial records; production records)
- Control of inbreeding and aid in breeding planning (breeding records)
- Aid in selecting animals with the right characteristics for breeding (production, health, feed efficiency) to improve the herd or flock
- To rationalize labor requirement
- Aids in feed planning and management
- Aids in disease management; keeping track about treatment (disease records)
- To assess profitability/losses (financial records)

Types of Records

1. Identification record
2. Breeding record
3. Production record
4. Feeding record
5. Disease and treatment records
6. Financial records

1. Identification Records

Methods of identification can be subdivided into two categories: permanent and non-permanent.

a) Permanent Identification:- includes Tattooing (ear or under), Brand (Hot iron, freeze and chemicals), ear-notching, and ear-tags,etc.

b) Non-Permanent identification:- includes Collars or neck or leg straps ,Paint and dyes

2.Breeding Records

the most important data in breeding records include: Pedigree/parentage (name or other identification of parents and grandparents)**,** Fertility (dates of all services, dates of giving birth**,** Birth details (number and weight of newborns, was assistance necessary?

3. Production Records

These records are useful in measuring the performance of the animals and the herd. It contributes greatly to the economic appraisal of the enterprise.

4. Feeding Records

Feeding records give information about the amount, type and quality of the feed. Feeding records can be used both for day to day management and adjustment of the feed ration. The important feeding records are: Produced and available fodder on farm; quantity and quality of the different feeds. Including content of energy, protein and minerals , feeding plan which tells how much feed is required per day per animal in different age groups, left-over feed if any (per head and per feed, if possible), Spoilage (per batch)

5. Disease and treatment records

Disease and treatment records are necessary to keep track of the disease events in which each animal is involved during its lifetime. Disease and treatment records involves:- Disease occurrence and date, all handlings to cure disease, Vaccination, Dipping/spraying,Treatment,De-worming etc.

6. Financial Records

The records of the costs and earnings related to the animal farming are kept for cash analysis and enterprise appraisal. Economic records are of paramount interest in providing the farmer with information concerning the profitability of his farm. Moreover they are of great help in decision making at the right time. For example, is it profitable to feed concentrates, is it advisable to apply for a loan or credit to invest in a machinery or technology.