CHAPTER ONE: INTRODUCTION

Animal Traction in the World.

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 are cattle, horses and Mules, but Donkeys, camels, Domestic water buffalo, yaks, Reindeer and even elephants are used for traction in some parts of the world. 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.

1.1. Definition of Terminologies

Grooming: keeping coat clean and in good condition.

Halter straps: or cords around head of animal which can be pulled by hand, rope or rein to control its head.

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 mouldboards 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.

Scarified: a cultivator with rather light tines made from spring steel.

Tillage: preparation of land for crop-bearing.

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.

1.2. 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 an easing 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. New tools are expensive. 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. With careful planning and application, the investment can pay for itself in a few years. 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.) Often new opportunities arise in marketing and agro-industry

1.3. Major Constraint of Draft animal power Utilization (assignment)

1.4. Feeding, selection and housing of equine

1.4.1. Feeding

Draft animal need several important feed components - 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.

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, and 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. Supplements are most important in the following circumstances:

- Local grazing is poor because of drought or over-grazing.
- Animals must walk long distances for food.

Forage feeding.

In general, forage consists of leaves and stalks of plants (grass, maize Stover, etc.). Draft animal need 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 and even shredded paper (if it does not contain too much ink).

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.

Concentrates feeding.

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 do forages. And they are generally more expensive.

The choice of concentrate feed will depend on local availability and costs. Good (but expensive) concentrated feed includes milled grains such as maize, sorghum and millet. Soiled grains considered unsatisfactory for human consumption can be used, provided they are not mouldy. Cottonseeds, cottonseed cake, groundnuts, and groundnut cake are all good. Dried cassava root can be used, as can green bananas. If they are available, brewer's grains or citrus pulp can be fed.

Draft animal like molasses, which provides energy and can be poured on top of bran or forage. Many by-products of grain are cheaper but less nutritious than grains.Maize bran from traditional pounding is very good. 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. In some countries commercially made concentrates are sold for cattle. If these contain special additives (antibiotics or chemicals such as *Monensin* or *Rumensin)* they should **not** be fed to draft animal.Do not feed male donkeys concentrates on days in which they are not working, unless they are very thin. On the other hand, mothers and foals may need to be fed concentrates every day. Feed one half

These are needed for growth and reproduction and they may be lacking in local forage. Cattle mineral licks contain these minerals, but avoid cattle licks that have more than five p.p.m. of iodine, as these can be toxic to foals. If licks are not available, try to ensure that the donkeys have some feeds rich in calcium (like legume fodder leaves, groundnut hay, and molasses) and phosphorus (such as wheat bran, bone meal). Calcium can be supplied from crushed limestone (one teaspoon a day mixed with the salt). Bone meal can be made locally by boiling and crushing bones.

Selection

Selection of Individual Draft Animals

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

Age of Bovine Animals

Ideally, fanners should raise their own draft cattle or purchase them when they are very young. This allows the farmers to provide proper nutrition during the critical growth stage as well as to observe and shape the animal's behavior long before it is put to work.

Oxen are, normally put to work between the ages of three and four years. They may be trained at two to three years of age and given light work for a season. However, before the age of three, oxen have little power, and hard work can stunt their growth or cause abnormal development of bone and muscle. After the age of four, animals may be difficult to handle and train; they must be broken of old habits before their power can be used.

Although oxen can work until they are 12 or older, many farmers prefer to sell them as soon as their work capacity tapers off. A common practice is to work oxen hard until age seven or eight, use them as a reserve or alternate animal (or pair) for a season or two, and then sell them for butchering.

When buying an ox, the purchaser-can determine the animal's age by counting its teeth. Because the approach of an unfamiliar person may cause the animal to shy or to struggle, it is best to have

the owner open the animal's mouth. Otherwise restrain the animal and pry open the mouth by pulling up on the nostrils and down on the lower jaw.

Cattle have front teeth only in the lower jaw. Temporary teeth appear, at one month. The first permanent teeth appear at age two. By age five, the animal has a full set of permanent teeth. The age of. Older animals can be determined by observing the wear patterns of the teeth and matching them to the patterns shown in the illustration on the next page. An alternate method is to count the number of rings oh the animal's horns; each ring corresponds to one year of growth, the first ring appearing at age two.

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 slant; the entire mouth elongates. Compare the side views of the four- and thirty-year-old horse and note the increased pointing of the jaw.

The correct method for opening the animal's mouth is as follows:

- Place the palm of one, hand under the animal's jaw;
- Insert the thumb and middle finger into the animal's mouth on either side of the lower jaw, at a point behind the teeth;
- 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

Housing of equine

The housing of donkeys can be kept very basic.

- Depending on the climate and season, a small shelter is sufficient.
- It should have at least a roof and three closed sides that face the prevailing wind directions.
- There must be enough space to lie down and the floor should not be damp or cold.
- Barbed wire enclosures should not be used for enclosing donkeys.

- Many donkeys will try to get through or jump over and injure themselves.
- The fence or shelter does not have to be very strong since donkeys will not use great force to get through a fence.

CHAPTER TWO: 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. The word ass is now mainly confined to archaic, zoological or colloquial writings and the statistics published by FAO (the Food and Agriculture Organization). 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.

Origins and expansion

The recorded history of animal power in Africa starts about 6-5000 BC in Egypt. These, together with the engravings of oxen and plows in early Mesopotamian civilizations, appear to constitute some of the earliest records of animal traction anywhere 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.

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 experienced a proportionate 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. It is believed that the ard plow was introduced 2600-3000 years ago by Semitic-speaking peoples invading from South Arabia. Another view is that the plow was already in use at this time, having spread from Cushitic speaking peoples of Nubia in northeast Sudan. Linguistic evidence suggests that the ard was in use ‘several millennia’ before the South Arabian invasion, which might make the Ethiopian plow the oldest.

The Ethiopian *maresha* is not only old, it is highly persistent. To the present day, it is almost universally used by smallholder farmers, for the cultivation of the tef grain crop. 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. Under the Pharaoh Pepi II (c. 2270 BC) caravans with pack donkeys were trading with Punt (Ethiopia). Donkeys have long been important in the history of the salt trade in northern Ethiopia and are represented in traditional Ethiopian art.

The population of donkeys has been rising in recent history. With about five million donkeys, Ethiopia now has the second largest population of donkeys in the world. 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 owed much to 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 20th 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. In the rest of the world, most carts pulled by one donkey have parallel shafts that pass on either side of the animal. The donkey pulls from a collar or breast band, and the weight is taken by a band between the two shafts that passes over a back saddle. In contrast, the Ethiopian carts are pulled from converging shafts attached to a simple pack saddle. 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 20th century, these carts have been spreading rapidly in the Rift Valley where they are used for the transport of water, straw and other materials. The development and rapid spread of these carts has been within the informal sector. It contrasts with the low uptake of the more expensive steel carts promoted by government agencies in the 1980s and 1990s.

Stationary applications of 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. Elsewhere, notably in circum-Saharan Africa and the Horn of Africa, animals are also bused to pull water from simple wells. Such systems are most common in pastoral areas, where large numbers of animals must be watered at the same time.

Threshing

The use of animals is reported in Egypt, North Africa and Ethiopia and Northern Somalia for threshing. In this operation, the animals walk round in circles over beans or cereals, separating 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 18th Dynasty, a practice also confirmed by Herodotos. 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.

Threshing is a seasonal operation and the species used are those that are readily available because they are maintained for other work. 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 cereal, *tef*. In the Ethiopian Rift Valley, a 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, 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, if not millennia. 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 15th century European seafarers concerning the Khoi-Khoi of South Africa. These rode cattle and used them for pack transport. Some cattle were trained for use in battles.

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. In much of the continent, different tribal groups have specialized in animal-rearing and in crop production. Thus many crop-growing farmers did not own potential work animals.

Moreover, many traditional farming systems have been based on bush-fallow rotations. The bush is cut down and burned, and seeds or tubers planted in the cleared area. There is no need to till the land with a plow. In any case this would be difficult since the soil is full of roots. Seeds can be scattered or planted in small pockets, for which a simple digging implement is appropriate. In farming systems with long periods of bush fallow, weeds do not present major problems. Provided the fallow periods are long, such systems can be quite productive in terms of yield per unit of human labour.

It is only when human population pressures necessitate short fallow periods that it becomes justified to clear the land of roots and stumps and to plow. Thus, in much of sub-Saharan Africa, the necessary social, environmental and agricultural conditions to favour the use of plows have not really existed. Indeed, there are still parts of Africa where the plow is not really economically justified. The failure of animal traction to spread into some semi-humid areas in recent decades is partly explained by the lack of the appropriate preconditions.

Another important constraint on the spread of the plow in pre colonial times was the presence of tsetse flies and trypanosomiasis in virtually all lowland areas. The relatively low human populations that obtained almost everywhere in Africa meant that hunting pressure on wild animal vectors was insufficient to eliminate reservoirs of trypanosomiases. Pastoral cattle that can survive when well-fed or moved regularly by expert herders have a much accelerated death rate from disease when subjected to work-stress. It is possible that both wheeled vehicles and plows were introduced experimentally in prehistory, but failed due to disease constraints. Increased human population in the colonial era following improved health-care both allowed major clearance of regions of bush and eliminated large populations of tsetse vectors. This helped to make animal traction a viable proposition in many areas.

CHAPTER THREE: ROLE OF DRAFT ANIMAL POWER IN DEVELOPING COUNTRIES

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, 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 and includes 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.

- Oxen should get appropriate feeding regimen according to the amount of work performed

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 wheelbarrow. 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 being available, timely and affordable.

Tractors vs. animal power

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 disempowering 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 FOUR: Distribution of Draft animal power in Developing Countries

Animal power for transport and cultivation has been used in Africa for over 5000 years. Animal traction has been an integral part of farming systems in North Africa and Ethiopia for at least two millennia. The use of animals for riding and pack transport has a long history in many parts of Africa, although details of its origins and spread are not well understood. The use of animal power for wheeled transport and soil tillage does not appear to have spread in sub-Saharan Africa, prior to the 'contact' and colonial periods. In the past five hundred years, the use of animal-power for wheeled transport spread slowly from ports and colonial bases.

The animal drawn plow was introduced into South Africa by colonists in the seventeenth century, and it spread slowly to neighboring territories. In most other sub-Saharan countries, it was introduced in the twentieth century by colonial authorities wishing to increase agricultural production. In most villages in Africa, animal-drawn plows were introduced in living memory. Many successful colonial and post-independence promotional schemes involved the provision of implements, training, credit and marketing channels. In circumstances where implements were readily available through private-sector traders, animal traction sometimes spread without any Promotional schemes.

Following the introduction of animal traction technology, many innovations were developed and spread through informal farmer-to-farmer processes. At the end of the twentieth century, animal traction was still spreading in most of sub-Saharan Africa, and appeared likely to continue to increase in the foreseeable future.

Donkeys are maintained as pack animals in many African countries, particularly in North Africa, the Sahel, Ethiopia and parts of eastern Africa. Their employment has often been a long-standing tradition. When donkeys are used for pack work, it is normal to place some form of protective padding over their backs. This may be sheepskin, sacking or discarded cloth. Soft loads such as sand, fertilizers, canvas water containers and straw are placed symmetrically over the back and held in place by one (or more) leather or rubber straps around the girth or belly, and under the base of the tail. Hard loads such as firewood, stones or rigid containers are generally supported on simple wooden symmetrical saddle frames sitting on light padding and held in place with tail and girth straps. Simple pannier baskets may also be used .In Ethiopia, donkeys are widely used

as pack animals and animals averaging 100-110 kg bodyweight regularly carry loads of 25-50 kg over distances of up to 20 km.

The distribution of donkeys in Africa is restricted by several ecological factors, notably the disease trypanosomiasis. With cattle being much more readily available, there has been some interest in the potential of cattle as pack animals. While cattle do not readily take loads on their back, they can certainly be trained to do so. In parts of Mali and Chad cattle may be ridden for personal transport by farmers and some pastoralists in Sudan and Somalia use cattle to transport their effects when moving between sites. Bovine pack saddles were developed in Tanzania (King, 1940), but were not adopted.

As animals can pull greater loads than they can carry, in most areas will probably be more productive than trying to develop systems of using cattle as pack animals. Where narrow paths restrict the use of conventional carts, it has been suggested that transport of goods could be on sledges or very narrow carts 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 levelling.

- Ethiopia has the second largest donkey population in the world, estimated to be in the range of 4-5 million. The majority of donkeys are found in the high lands with the region of Shoa, Gondar, Tigray, Gojjam and Wello having the greatest numbers. There are about 27 donkeys per 100 people, which is a high density by the world standard. According to the data collected from Woredas agricultural offices in Amhara region there are about 514880 donkeys which is 70.6% of the total equines in the region. (Bereau of rural development, April 2013)

- But, studies in several countries show that donkeys have survived draught years better than cattle. This combined with the high cost of oxen and or the effects of animal disease, has caused many farmers to turn to the donkey as an alternative power source.

CHAPTER FIVE: DRAFT AND PACK ANIMAL SPECIES AND THEIR ATTRIBUTES

5.1. Cattle

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. In some texts, the word oxen have been used to describe any working cattle. Since working cattle are generally castrated males, the two uses of the word generally overlap. Nevertheless, confusion can occur in regions where cows or bulls are used for work. In this text, an ox is a castrated bull of any breed that is used for work. The term bovid encompasses the animals that are closely related to cattle, including water buffaloes and yaks.

- Among cattle oxen are often preferred, because they are well-muscled and have good temperaments.
- An ox is a bull which has been castrated and trained to pull loads.

Taxonomy

- ✓ Kingdom: Animalia (Animal)
- ✓ Phylum: Chordata (Vertebrate)
- ✓ Class: Mammalia (Mammal)
- ✓ Order: Artiodactyla (Eventoed)
- ✓ Family: Bovidae (Rumination)
- ✓ Genus: Bos Species: Bostaurus (Domestic cattle of Europe/Asia/Africa ancestry)
- ✓ Bosindicus (for zebu breeds)

5.2. Buffaloes

The domestic buffalo is used extensively as a draft animal in Asia; less commonly in Egypt and the Near East. Buffalo work at a slower rate than oxen, but are generally considered to be stronger and better adapted to wet terrain. Swamp buffalo are employed extensively for draft in South and Southeast Asia for rice production. They are generally considered stronger, although slower than cattle. Buffalo are commonly trained at 3 to 4 years of age, although depending on the country and/or region, training may begin as early as 2 years or as late as 8. Similarly, the age at which work animals are castrated ranges from as early as 9 months in Laos, to 5 years in India, where the operation is delayed until the animals' offspring can be judged for qualities of type and draft. Castration may not be practiced in some areas due to religious beliefs.

Buffalo are used to transport goods in Bulgaria and Yugoslavia and for hauling water casks in Turkey. They also supply power for the operation of grain mills. In Burma, they are employed to drag teak logs from the edge of the forests to the nearest point at which they can be loaded for carting to mill, railhead, and raft.ng place or to streams for floating

Taxonomy

- ✓ Kingdom: Animalia (Animal)
- ✓ Phylum: Chordata (Vertebrate)
- ✓ Class: Mammalia (Mammal)
- ✓ Order: Artiodactyla (Eventoed)
- ✓ Family: Bovidae (Rumination)
- ✓ Subfamily: Bovinae
- ✓ Genus:Syncerus
- ✓ *Bubalus* Specios: S.caffer(African buffalo)

  B.babulis(water buffalo)

5.3. HORSES

A horse is a four-legged, hoofed (,large solid-hoofed herbivorous ungulate) mammal with long hair on its neck and a long tail of hair. The male parent of a horse, a stallion, is commonly known as the *sire* and the female parent, the mare, is called the *dam*. Both are genetically important, as each parent provides half of the genetic makeup of the ensuing offspring, called a foal. (Contrary to popular misuse, the word "colt" refers to a young male horse only; "filly" is a young female.) Though many horse owners may simply breed a family mare to a local stallion in order to produce a companion animal, most professional breeders use selective breeding to produce individuals of a given phenotype, or breed. Alternatively, a breeder could, using individuals of differing phenotypes, create a new breed with specific characteristics.

Taxonomy

- ✓ Kingdom: Animalia (Animal)
- ✓ Phylum: Chordata (Vertebrate)
- ✓ Class: Mammalia (Mammal)
- ✓ Order: Perrisodactayla(odd dactayla)
- ✓ Family: Equidae(horse, asses,zebra)
- ✓ Genus:Equss
- ✓ Spp: E.cabalus(domestic horse)

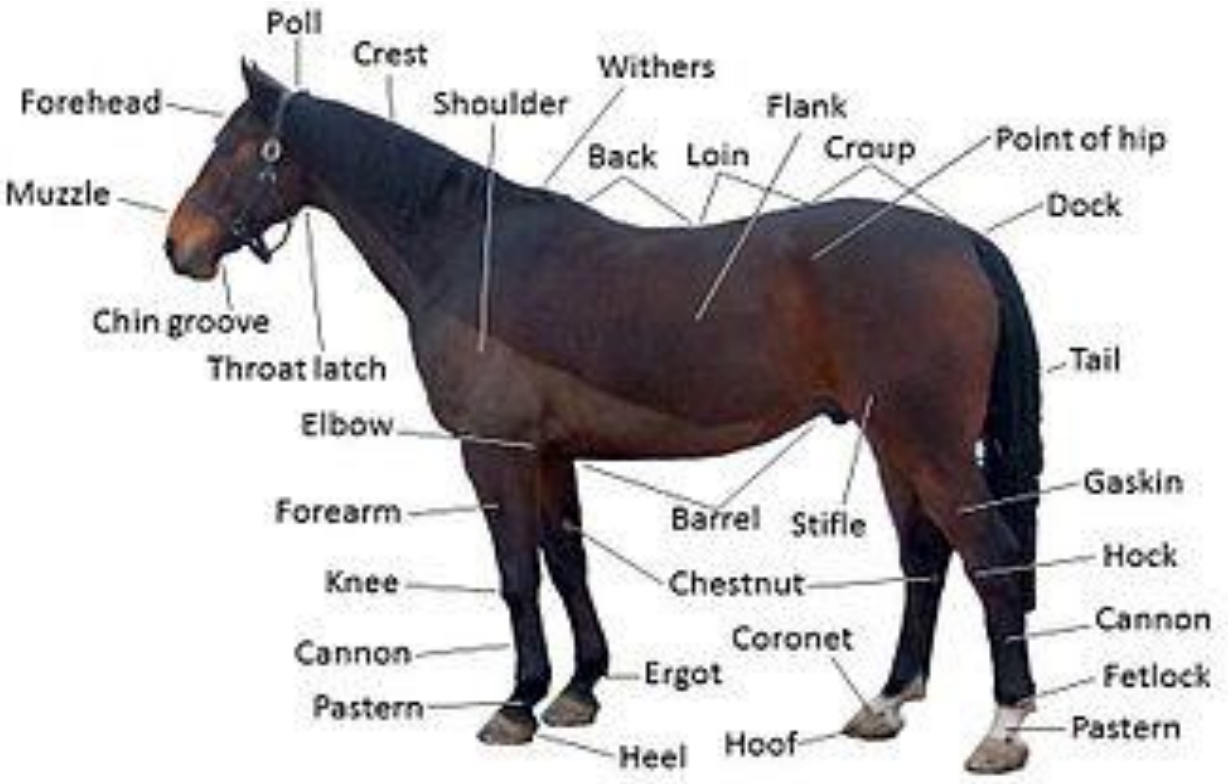
  E. ferus(wild horse)

Breeds of horse

A breed is a group of animals with a common origin. Each group, or breed, has definite breed characteristics not commonly found in other breeds. These characteristics are fixed in the genetic makeup of the breed and will be passed from parents to offspring.

- **Ponies: -** are small horses less than 14.2 hands in height at maturity.

- Some examples of different horse breed:-
  - ✓ American paint horse
  - ✓ American quarter horse
  - ✓ Andulisian
  - ✓ Apalusa
  - ✓ Arabian
  - ✓ Belgian
  - ✓ Morgan
  - ✓ Paint horse
  - ✓ Quarter horse



Estrous cycle of the mare

Estrous is a period when a mare is sexually receptive toward a stallion, and helps to physically prepare the mare for conception. The estrous cycle lasts about 19–22 days, with the average being 21 day . A period when she is not sexually receptive, known as anestrus.

This cycle contains 2 phases:

- Estrus, or Follicular, phase: 5–7 days in length, when the mare is sexually receptive to a stallion.Estrogen is secreted by the follicle. Ovulation occurs in the final 24–48 hours of estrus.
- Diestrus, or Luteal, phase: 14–15 days in length, the mare is not sexually receptive to the stallion. The corpus luteum secretesprogesterone.

Depending on breed, on average, 16% of mares have double ovulations, allowing them to twin, this does not affect the length of time of estrus or diestrus.

Effects on the reproductive system during the estrous cycle

Changes in hormone levels can have great effects on the physical characteristics of the reproductive organs of the mare, thereby preparing, or preventing, her from conceiving.

- **Uterus**: increased levels of estrogen during estrus cause edema within the uterus, making it feel heavier, and the uterus loses its tone. This edema decreases following ovulation, and the muscular tone increases. High levels of progesterone do not cause edema within the uterus. The uterus becomes flaccid during anestrus.
- **Cervix**: the cervix starts to relax right before estrus occurs, with maximal relaxation around the time of ovulation. The secretions of the cervix increase. High progesterone levels (during diestrus) cause the cervix to close and become toned.
- **Vagina**: the portion of the vagina near the cervix becomes engorged with blood right before estrus. The vagina becomes relaxed and secretions increase.
- **Vulva**: relaxes right before estrus begins. Becomes dry, and closes more tightly, during diestrus.

Hormones involved in the estrous cycle, during foaling, and after birth

The cycle is controlled by several hormones which regulate the estrous cycle, the mare's behavior, and the reproductive system of the mare. The cycle begins when the increased day length causes the pineal gland to reduce the levels of melatonin, thereby allowing the hypothalamusto secrete GnRH.

- **GnRH (Gonadotropin releasing hormone)**: secreted by the hypothalamus, causes the pituitary to release of 2 gonadotrophins: LH and FSH.
- **LH (Luteinizing hormone)**: levels are highest 2 days following ovulation, then slowly decrease over 4–5 days, dipping to their lowest levels 5–16 days after ovulation. Stimulates the follicle to mature, which then in turn secretes estrogen. Unlike most mammals, the mare does not have an increase of LH right before ovulation.
- **FSH (Follicle-stimulating hormone)**: secreted by the pituitary, causes the ovarian follicle to develop. Levels of FSH rise slightly at the end of estrus, but have their highest peak about 10 days before the next ovulation. FSH is inhibited by inhibin (see below), at the same time LH and estrogen levels rise, which prevents immature follicles from continuing their growth. Mares may however have multiple FSH waves during a single estrous cycle, and diestrus follicles resulting from a diestrus FSH wave are not uncommon, particularly in the height of the natural breeding season.
- **Estrogen**: secreted by the developing follicle, it causes the pituitary gland to secrete more LH (therefore, these 2 hormones are in a positive feedback loop). Additionally, it causes behavioral changes in the mare, making her more receptive toward the stallion, and causes physical changes in the cervix, uterus, and vagina to prepare the mare for conception (see above). Estrogen peaks 1–2 days before ovulation, and decreases within 2 days following ovulation.
- **Inhibin**: secreted by the developed follicle right before ovulation, "turns off" FSH, which is no longer needed now that the follicle is larger.
- **Progesterone**: prevents conception and decreases sexual receptibility of the mare to the stallion. Progesterone is therefore lowest during the estrus phase, and increases during diestrus. It decreases 12–15 days after ovulation, when the corpus luteum begins to decrease in size.
- **Prostaglandin**: secreted by the endrometrium 13–15 days following ovulation, causes luteolysis and prevents the corpus luteum from secreting progesterone
- **eCG - equine chorionic gonadotropin - (also called PMSG (pregnant mare serum gonadotropin)**: chorionic gonadotropins secreted if the mare conceives. First secreted by the endometrial cups around the 36th day of gestation, peaking around day 60, and decreasing after about 120 days of gestation. Also help to stimulate the growth of the fetal gonads.

- **Prolactin**: stimulates lactation
- **Oxytocin**: stimulates the uterus to contract

Breeding and gestation

Mares signal estrus and ovulation by urination in the presence of a stallion, raising the tail and revealing the vulva. A stallion, approaching with a high head, will usually nicker, nip and nudge the mare, as well as sniff her urine to determine her readiness for mating. Once fertilized, the oocyte (egg) remains in the oviduct for approximately 5.5 more days, and then descends into the uterus. The initial single cell combination is already dividing and by the time of entry into the uterus, the egg might have already reached the blastocyst stage. The gestation period lasts for about eleven months, or about 340 days (normal average range 320–370 days). . The fetus gender can be determined by day 70 of the gestation using ultrasound. Halfway through gestation the fetus is the size of between a rabbit and a beagle. The most dramatic fetal development occurs in the last 3 months of pregnancy when 60% of fetal growth occurs.

Colts are carried on average about 4 days longer than fillies.

Care of the pregnant mare

Domestic mares receive specific care and nutrition to ensure that they and their foals are healthy. Mares are given vaccinations against diseases such as the Rhinopneumonitis (EHV-1) virus (which can cause abortions) as well as vaccines for other conditions that may occur in a given region of the world. Pre-foaling vaccines are recommended 4–6 weeks prior to foaling to maximize the immunoglobulin content of the colostrum in the first milk. Deworming the mare a few weeks prior to foaling is also important, as the mare is the primary source of parasites for the foal.

Mares can be used for riding or driving during most of their pregnancy, and it's healthy for them to have exercise. But only moderate exercise, especially when they become heavy in foal. Exercise in excessively high temperatures has been suggested as being detrimental to pregnancy maintenance during the embryonic period - it should however be noted that ambient temperatures encountered during the research were in the region of 100 degrees F and the same results may not be encountered in regions with lower ambient temperatures.

During the last 3–4 months of gestation, rapid growth of the fetus increases the pregnant mare's nutritional requirements. Energy requirements during these last few months, and during the first few months of lactation are similar to those of a horse in full training. Trace minerals such as Copper are extremely important, particularly during the tenth month of pregnancy, for proper skeletal formation. Many feeds designed for pregnant and lactating mares provide the careful balance required of increased protein, increased calories through extra fat as well as vitamins and minerals. During the first several months of pregnancy, the nutritional requirements do not increase significantly since the rate of growth of the fetus is very slow. However, during this time, the mare should be provided supplemental vitamins and minerals, particularly if forage quality is questionable. Overfeeding the pregnant mare, particularly during early gestation, should be avoided, as excess weight may contribute to difficulties foaling or fetal/foal related problems.

Foaling

Mares due to foal are usually separated from other horses, both for the benefit of the mare and the safety of the soon-to-be-delivered foal. In addition, separation allows the mare to be monitored more closely by humans for any problems that may occur while giving birth.

some breeders, particularly those in remote areas or with extremely large numbers of horses, may allow mares to foal out in a field amongst a herd, but may also see higher rates of foal and mare mortality in doing so.

Most mares foal at night or early in the morning, and prefer to give birth alone when possible. Labor is rapid, often no more than 30 minutes, and from the time the feet of the foal appear to full delivery is often only about 15 to 20 minutes. Once the foal is born, the mare will lick the newborn foal to clean it and help blood circulation. In a very short time, the foal will attempt to stand and get milk from its mother. A foal should stand and nurse within the first hour of life.

To create a bond with her foal, the mare licks and nuzzles the foal, enabling her to distinguish hers from others. Some mares are aggressive when protecting their foals, and may attack other horses or unfamiliar humans that come near their newborns.

After birth, a foal's navel is dipped in antiseptic to prevent infection, it is sometimes given an enema to help clear the meconium from its digestive tract, and the newborn is monitored to

ensure that it stands and nurses without difficulty. While most horse births happen without complications, many owners have first aid supplies prepared and a veterinarian on call in case of a birthing emergency. People who supervise foaling should also watch the mare to be sure that she passes the placenta in a timely fashion, and that it is complete with no fragments remaining in the uterus, where retained fetal membranes could cause a serious inflammatory condition (endometritis) and/or infection. If the placenta is not removed from the stall after it is passed, a mare will often eat it, an instinct from the wild, where blood would attract predators.

Foals develop rapidly, and within a few hours a wild foal can travel with the herd. In domestic breeding, the foal and dam are usually separated from the herd for a while, but within a few weeks are typically pastured with the other horses. A foal will begin to eat hay, grass and grain alongside the mare at about 4 weeks old; by 10–12 weeks the foal requires more nutrition than the mare's milk can supply. Foals are typically weaned at 4–8 months of age, although in the wild a foal may nurse for a year.

Deciding to breed a horse

Breeding a horse is an endeavor where the owner, particularly of the mare, will usually need to invest considerable time and money. For this reason, a horse owner needs to consider several factors, including:

- Does the proposed breeding animal have valuable genetic qualities to pass on?
- Is the proposed breeding animal in good physical health, fertile, and able to withstand the vigors of reproduction?
- For what purpose will the foal be used?
- Is there a market for the foal in the event that the owner does not wish to keep the foal for its entire life?
- Does the owner of the mare have the expertise to properly manage the mare through gestation and parturition?
- Does the owner of the potential foal have the expertise to properly manage and train a young animal once it is born?

There are value judgements involved in considering whether an animal is suitable breeding stock, hotly debated by breeders. Additional personal beliefs may come into play when

considering a suitable level of care for the mare and ensuing foal, the potential market or use for the foal, and other tangible and intangible benefits to the owner.

If the breeding endeavor is intended to make a profit, there are additional market factors to consider, which may vary considerably from year to year, from breed to breed, and by region of the world. In many cases, the low end of the market is saturated with horses, and the law of supply and demand thus allows little or no profit to be made from breeding unregistered animals or animals of poor quality, even if registered.

Artificial insemination

Artificial insemination (AI) has several advantages over live cover, and has a very similar conception rate:

- The mare and stallion never have to come in contact with each other, which therefore reduces breeding accidents, such as the mare kicking the stallion.
- AI opens up the world to international breeding, as semen may be shipped across continents to mares that would otherwise be unable to breed to a particular stallion.
- A mare also does not have to travel to the stallion, so the process is less stressful on her, and if she already has a foal, the foal does not have to travel.
- AI allows more mares to be bred from one stallion, as the ejaculate may be split between mares.
- AI reduces the chance of spreading sexually transmitted diseases between mare and stallion.
- AI allows mares or stallions with health issues, such as sore hocks which may prevent a stallion from mounting, to continue to breed.
- Frozen semen may be stored and used to breed mares even after the stallion is dead, allowing his lines to continue. However, the semen of some stallions does not freeze well. Some breed registries may not permit the registration of foals resulting from the use of frozen semen after the stallion's death, although other large registries accept such usage and provide registrations. The overall trend is toward permitting use of frozen semen after the death of the stallion.

A stallion is usually trained to mount a phantom (or dummy) mare, although a live mare may be used, and he is most commonly collected using an artificial vagina (AV) which is heated to simulate the vagina of the mare. The AV has a filter and collection area at one end to capture the semen, which can then be processed in a lab. The semen may be chilled or frozen and shipped to the mare owner or used to breed mares "on-farm". When the mare is in heat, the person inseminating introduces the semen directly into her uterus using a syringe and pipette.

5.4. Donkey

Origin, domestication and zoological classification of donkey

Origin

The **African Wild Ass** (*Equus africanus*) is a wild member of the horse family,Equidae. This species is believed to be the ancestor of the domestic donkey which is usually placed within the same species. They live in the deserts and other arid areas of northeastern Africa, in Eritrea, Ethiopia and Somalia; it formerly had a wider range north and west into Sudan, Egypt and Libya. About 570 individuals exist in the wild.

Domestication

Donkeys were first domesticated around 4000 B.C.E. or before and have spread around the world in the company of humans. They continue to fill important roles in many places today and are increasing in numbers (although the African wild ass is an endangered species, as a result of anthropogenic factors). As "beasts of burden" and companions, donkeys have worked together with humans for centuries, reflecting the nature of all organisms to fulfill both a purpose for the whole and a purpose for the individual (the latter contributing to their reputation for stubbornness.

A male donkey is called a *jack*,, a female a *jennet* or *jenny*, and a baby a *colt*. In the western United States, a donkey is often called a **burro.**

Types of donkeys

The domestic donkey traces its ancestry to the wild asses found in Egypt, the Sudan, Somalia and

Ethiopia. The two recognized races of the wild ass are: Equus asinus africanus and Equus asinus Somaliensis . About 2500 wild individuals are present in the Danakil Depression and Nogal Valley in the Horn of Africa. Based on average size and coat colour four types of donkeys are recognised in Ethiopia: Jimma, Abyssinian, Ogaden and Sennar.

Taxonomy

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Perissodactyla (horses, tapirs, rhinos)

Suborder: Hippomorpha (horse-like mammals)

Family: Equidae (wild and domestic horses, donkeys, kiang, onager, zebras, extinct quagga)

Genus: *Equus*

Species: *Equus asinus* - domestic donkey (or burro, or ass)

Species: *Equus africanus* - African Wild Ass

Subspecies: *Equus africanus africanus* - Nubian Wild Ass - Critically Endangered

Subspecies: *Equus africanus somaliensis* - Somali Wild Ass - Critically Endangered

Species: *Equus hemionus* - Asian Wild ass or onager (plus 6 subspecies)

Species: *Equus kiang* - Tibetan Wild Ass

Species: *Equus quagga* - Extinct Quagga

Species: *Equus zebra* - Mountain or Hartmann's Zebra

Species: *Equus grevyi* - Grevy's Zebra

Species: *Equus burchelli* - Plains or Burchelli's Zebra

Species: *Equus ferus* - Wild horse

Subspecies: *Equus ferus Przewalskii* - Prezwalski's Wild Horse

Species: *Equus caball*us - domestic horse

Subspecies: *E. a. africanus*, *E. a. atlanticus*, *E. a. somaliensis*

Different authors consider the African Wild Ass and the domesticated Donkey one or two species; either view is technically legitimate, though the former is phylogenetically more accurate. The species name for the African Wild Ass is sometimes given as *asinus*, from the domestic donkey whose specific name is older and usually would have priority. But this usage is erroneous since the International Commission on Zoological Nomenclature has conserved the name *Equus africanus* in . This was done to prevent the confusing situation of the phylogenetic ancestor being taxonomically included in its descendant. Thus, if one species is recognized, the correct scientific name of the Donkey is*E. africanus asinus*.

Terminology

- A male donkey is called a jack.
- A female donkey is a jennet (sometimes written as jenny, but both pronounced the same).
- Castrated male donkeys are donkey geldings.
- Young donkeys are called jack foals or jennet foals.

The equine species can interbreed and will produce hybrid offspring that are usually infertile. The most common hybrids are the mule and hinny which are produced by the following combinations:

Sire	**X Dam**	=	**Foal**
Stallion (Horse)	**X** Jennet (Donkey)	=	Hinny
Jack (Donkey)	**X** Mare (Horse)	=	Mule

Donkeys in Culture and Religion

In ancient Greece, the donkey was associated with Dionysus, the god of wine. In ancient Rome, donkeys were used as sacrificial animals. In the Bible, donkeys are mentioned about 100 times, most famously in the stories of Samson and Balaam in the Old Testament and in the story of Jesus in the New Testament. According to the Bible, Jesus rode into Jerusalem on a donkey,

fulfilling an Old Testament prophecy. His mother, Mary, is often pictured riding a donkey and donkeys are a traditional part of nativity scenes at Christmas time.

Physical Characteristics

Body Weight: 275 kg (606 lb)
Head/Body Length: 200 cm (6.6 ft)
Tail Length: 42 cm (17 in)
Shoulder Height: 125 -145 cm (4.2-5.5 ft)

Note: Domestic breeds vary in height at shoulder: 80-150 cm (2.6-4.9 ft)

General

- *Equus asinus* (donkeys). A small, short- legged equid with exceptionally long ears.
- *Equus africanus somaliensis* (Somali wild asses) have dark barring on legs; patterns vary geographically.
- 40-42 teeth (6 upper incisors, 6 lower; 2 canines upper jaw, 2 lower; 6 or 8 premolars upper jaw, 6 lower; 6 molars upper jaw, 6 lower))
    - Simpler molar tooth pattern for donkeys and asses compared to caballine horses. (Bennett 1980)

Other Physical Characteristics

- Donkeys have 62 chromosomes (domestic horses have 64)
- Hooves are the narrowest of any equid and quite small; these animals are very sure-footed as a result
- Mane is upright, long, and thin; no forelock
- Tail is tufted.
- Donkey ears 200 mm (7.9 in) or longer
- Somali wild asses ears 187-200 mm (7.3-7.6 in)

Gestation

Jennet will carry a foal an average of 12 months before giving birth. however, the length of gestation ranges from 11 to almost 14 months.

5.5. MULE

A mule is the offspring of a male donkey and a female horse. Horses and donkeys are different species, with different numbers of chromosomes. Of the two F1 hybrids between these two species, a mule is easier to obtain than a hinny (the offspring of a male horse and a female donkey). While there is no known instance of a male mule siring offspring, female mules have on very rare occasion given birth to viable offspring. An aficionado (special character) of the mule claims that they are "more patient, sure-footed, hardy and long-lived than horses, and they are considered less obstinate, faster, and more intelligent than donkeys.

A female mule that has estrus cycles and thus, in theory, could carry a fetus, is called a "molly" or "Molly mule," though the term is sometimes used to refer to female mules in general. Pregnancy is rare, but can occasionally occur naturally as well as through embryo transfer. One of several terms for a gelded mule is a "John mule.

Size and performance

The median weight range for a mule is between about 370 and 460 kg (820 and 1,000 lb). Although it depends on the individual animal, an army mule can "carry up to 72 kg and walk 26 km without resting. The average equine in general can carry up to approximately 30% of its body weight in "live" weight, such as a rider. However, while a few mules can carry live weight up to 160 kg (350 lb) the superiority of the mule becomes apparent in their additional endurance.

One of the virtues of the mule is that a mule has the size and ground-covering ability of a horse, but is comparatively stronger than a horse of similar size and inherits the endurance and disposition of the donkey father. Mules also tend to be more independent than most other domesticated equines other than the donkey. For their size mules also tend to require less food than a horse of similar size.

6.2 Characteristics

With its short thick head, long ears, thin limbs, small narrow hooves, and short mane, the mule shares characteristics of adonkey; in height and body, shape of neck and croup, uniformity of coat, and teeth, it appears horse-like; the mule comes in all sizes, shapes and conformities. There

are mules that resemble quarter horses, huge draft mules, fine-boned racing mules, shaggy pony mules and many more types.

A mule does not sound exactly like a donkey or a horse. Instead, a mule makes a sound that is similar to a donkey's but also has the whinnying characteristics of a horse (often starts with a whinny, ends in a hee-haw).

The mule possesses the even temper, patience, endurance and sure-footedness of the donkey, and the vigour, strength and courage of the horse. Operators of working animals generally find mules preferable to horses: mules show more patience under the pressure of heavy weights, and their skin is harder and less sensitive than that of horses, rendering them more capable of resisting sun and rain. Their hooves are harder than horses', and they show a natural resistance to disease and insects. Many North American farmers with clay soil found mules superior as plow animals.

Mules are generally less tolerant towards dogs than horses are. They are also capable of striking out with any of their hooves in any direction, even sideways if needed.

Mules exhibit a higher cognitive intelligence than their parent species. This is believed to be the result of hybrid vigour, similar to how mules acquire greater height and endurance than either parent.

Mules are highly intelligent. They tend to be curious by nature. A mule generally will not let the rider put it in harm's way.

6.4 Color and size variety

Mules come in a variety of shapes, sizes and colors, from minis under 50 lb (20 kg) to maxis over 1,000 lb (500 kg), and in many different colors. Mules from Appaloosa mares produce wildly colored mules, much like their Appaloosa horse relatives, but with even wilder skewed colors. The Appaloosa color is produced by a complex of genes known as the Leopard complex (Lp). Mares homozygous for the Lp gene bred to any color donkey will produce an Appaloosa colored mule.

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 female mules have produced offspring when mated with a purebred horse or donkey. Heroditus, gives an account of such an event as an ill omen of Xerxes conquest of Greece in 480 BC. "There happened also a portent of another kind while he was still at Sardis,—a mule brought forth young and gave birth to a mule" (Heroditus "Histories" 7:57).

Since 1527 there have been more than 60 documented cases of foals born to female mules around the world. There are reports that a mule in China produced a foal in 1984. In Morocco, in early 2002, a mare mule produced a rare foal. In 2007 a mule named Kate gave birth to a mule son in Colorado. Blood and hair samples were tested verifying that the mother was a mule and the colt was indeed her offspring.

5. 6. Camels

Camels are used as pack animals through much of the Sahara. In Mauritania, Niger, Chad, Mali and Senegal they are used to supply power for drawing water; occasionally they are used to draw plows or light weeding implements.

CHAPTER SIX: SELECTION AND TRAINING OF DRAFT ANIMAL POWER

6.1 Selection of Draft animal power

6.1.1. Qualities to be considered During Selection of Animal

1. Conformation

Conformation refers to the form or shape of an animal. A shape 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. However, an animal with a swayback, bad legs or impaired vision will be a constant source of trouble.

Good draft animals, regardless of species or breed, will have the following qualities:

- head, well proportioned; squarish, sculptured look
- 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 unusual boniness; no turning in or out of knees or hoofs; free movement of limbs
- Feet straight, hard; normal angulations of hoof.

1. Temperament

- Select or retain animals with a responsive behaviour.

- Eliminate very nervous animals that get easily frightened and those that are aggressive to other animals and to people.

HEALTH:

- Discard cattle suffering from major injuries, diseases or defects like:
- Limping or lame animals
- Deaf animals
- Animals that don't see properly or are totally blind
- Weak or sick animals
- Discard pregnant females, especially those which are 2 months away from delivery
- Discard those with breathing problems: irregular or fast breathing, because they will get exhausted after moving for a very short time and will fail to pull the implement to the end.

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, 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 routines or maintenance and training, behave well in a pair, and prove to be a spirited yet steady paced and manageable worker.

A basically lethargic bull, for example, may become very alert or nervous at the approach of a stranger, exhibiting a fierceness 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.

The animal has no physical handicaps that - require it to compensate with aggressive or stubborn behavior. An animal with bad vision or hearing, an unsound leg or joint, or with a chronic respiratory or muscular weakness, protects itself by balking, spooking, shying, refusing to be harnessed or lying down during work.

Its temperament is affected or shaped by its physical condition.

• The animal accepts 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.

• It does not shy or kick at other animals.

The buyer should try to be present when it is being turned out with a herd or put into a corral with other animals. If an animal is unusually aggressive or cowardly, 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 cowardly animals' may refuse to step evenly with their mates, lagging behind.

3. Animal Breed:

Select local cattle breeds as they are used to the environment: the local disease challenge, prevailing climate conditions, quantity and quality of food available and the traditional management systems.

4. AGE

Young animals are light, cheap, easy to train, and they can accept commands. The selected young animal must have good growth potential; this will profit the farmer when he sells it for meat. Young animals also have a longer working life.

***To obtain the age of the animal look at the teeth*.** This is done by determining the number of front teeth at the lower jaw of the animal, in other words, looking at (temporary and permanent) teeth to work out the age of the animal, as shown below.

2 years 3 years 4 years 5 years

Note:

From five years onwards, cattle will have developed a full set of permanent teeth, and from eight years onwards the teeth will start to wear down.

If they are older than three years, they are too old to learn and accept the training commands. But also if they are younger than 18 months, they will not have developed enough, physically, to work.

5. WEIGHT

- Select a young local Zebu weighting between 150 - 300 kgs.
- Select only those animals with a potential to gain weight.

Thus, eliminate an animal which falls below or goes above the recommended weight limit, because the animal will either be too light to pull the draft during the training or too heavy to manoeuvre during the training

6.1.2. Cattle Selection

• Oxen are some of the most powerful draught animals, but they are slow and labour intensive.

• They are generally used for heavy work where speed is not essential (ploughing and pulling Heavy carts and wagons).

• Cows can be used where the work is light and infrequent (planting and cultivating).

• Bulls can also be used as part of a span

Not all cattle are suitable for draft work. The suitable ones must be selected at the age of two to three years, when they are still growing. If they are well fed and properly cared for, they will grow into well built animals with a live weight of 400 kg or more at the age of five years. At that weight, one pair of suitable draft cattle is heavy enough to pull a plough working at 20 cm depth or a ridger.

The ideal draft animal is a healthy, docile male castrate (an ox) of local breed. He has a wide, deep chest, prominent hump and straight back and legs. He weighs at least 400 kg when grown up and has the stamina to do draft work for up to six hours a day.

1. Suitable Cattle Breeds for Draft Animal Use

Local cattle breeds are usually best suited for draft work because they are well adapted to the local climate, food and diseases. Exotic breeds which are not adapted to the environment, may

not take the added stress of draft work well, they require good care and are likely to be sick more often than local cattle.

Cattle bred for meat production or for both, meat and milk production, are generally well suited for draft work because they grow big and strong. Dairy breeds tend to be less well muscled and require better feed and management; they are therefore less suitable as draft animals, especially if they originate from temperate countries and are newly introduced into tropical countries.

.2. Sex of Draft Cattle

A herd of cattle consists of different animals:

- a bull (bulls) is a grown-up, male animal
- a cow (cows) is a grown-up, female animal
- a calf (calves) is a young animal of less than 12 months
- a heifer (heifers) is a young female which has never been pregnant.
- An ox or bullock (oxen, bullocks) is a grown-up animal which has been castrated

The ox is the most suitable animal to begin with draft animal cultivation, because:

-he is as strong as a bull

-he is less wild, hence easier to train and to handle than a bull

-he is stronger and easier to maintain than a cow.

However, an experienced oxen farmer can also train and work with bulls and cows and use them for reproduction at the same time.

3. What Does the Body of Good Draft Cattle Look like (Conformation?)

In general, the animals you choose for work should be strong, heavy, healthy, docile and intelligent. They should be calm but not lazy.

Which are the most important parts of the body of a draft animal?

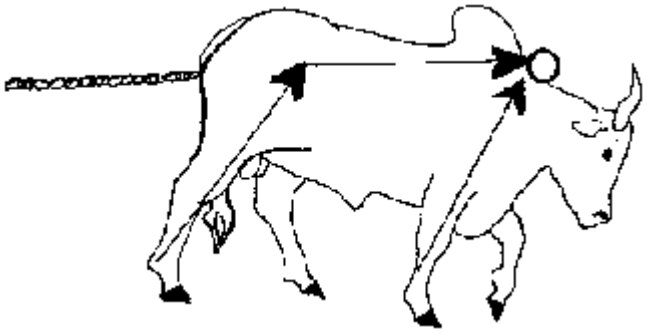


Fig. 1.6: A draft animal must have strong and well conformed legs, a straight back and the correct neck to carry the yoke.

The legs must be normal. If they are not normal the joints wear out soon.

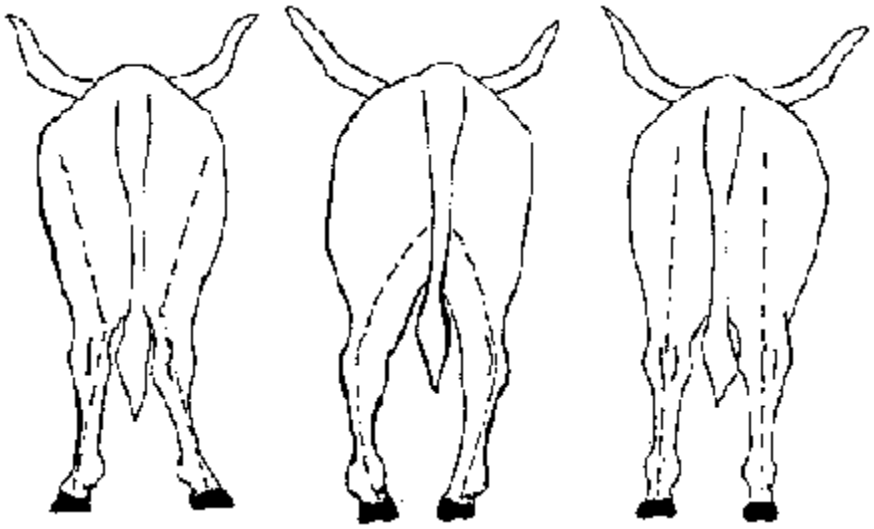


Fig. 1.7: No! It must not have X-legs!; Fig. 1.8: No! It must not have O-legs!; Fig. 1.9: Yes! The legs are normal

Fig. 1.10: No! The foot must not be too straight!; Fig. 1.11: No! It must not be bent too much!; Fig. 1.12: Yes! It must be slightly bent!

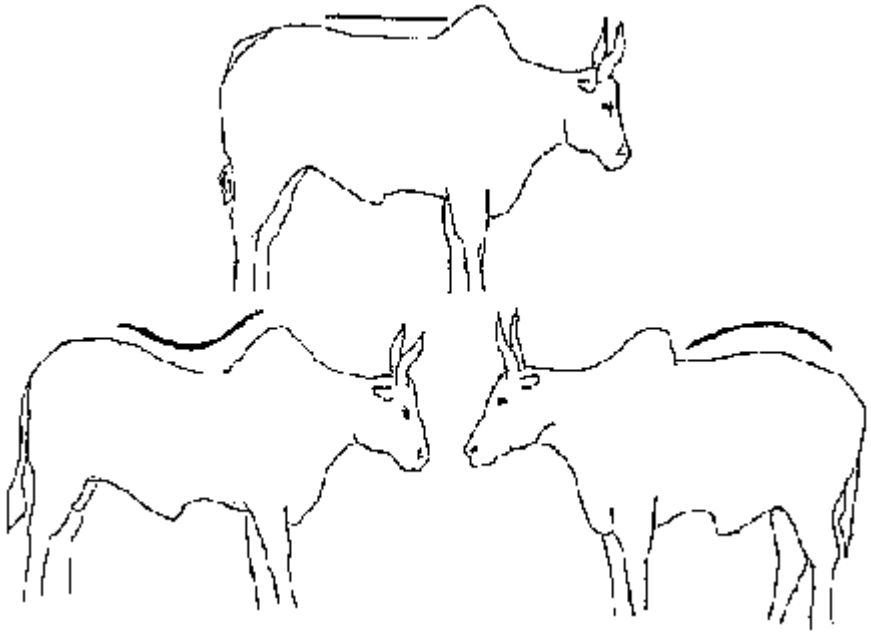


Fig. 1.13: Yes! The back must be straight!; Fig. 1.14: No! It must not be bent down or concave; Fig. 1.15: No! it must not be bent up or convex.

4. The Temperament of Draft Cattle

- A good draft animal should be active, intelligent and lively, but not wild and fierce.
- An animal which is too calm and therefore easy to train can be lazy while working.
- An active animal is more difficult to train than a calm one. But later on during work, you only have to control it; you don't have to push it forward.
-

6.1.3. Selection of Donkey, Horses and Mule

Selection characteristics

Before describing the characteristics of a working donkey, some basic knowledge is needed of English names of parts of the animal, as shown in the figure below.

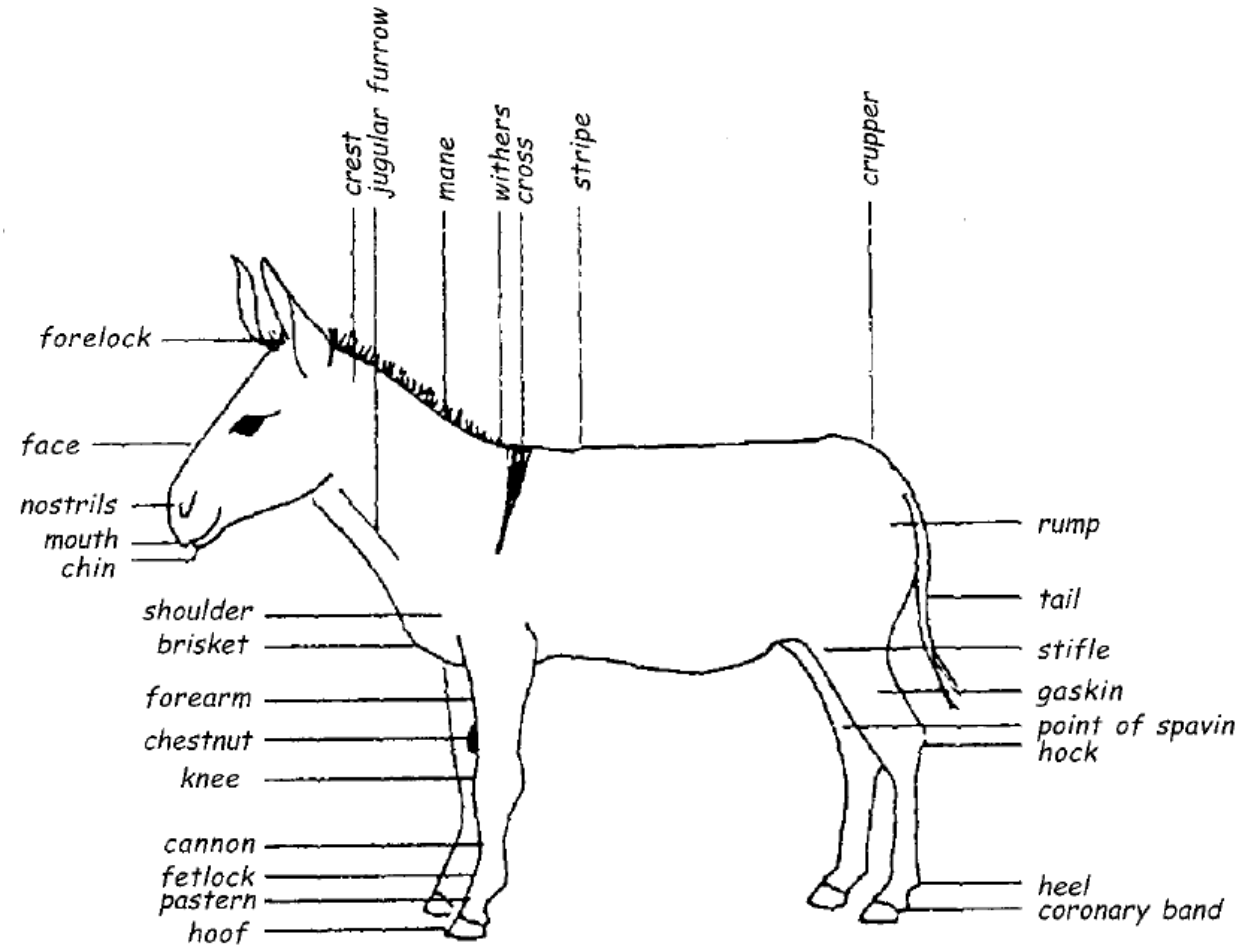


Figure 1: Names of the parts of a donkey.

When selecting an animal for work certain physi-cal 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, but even in a large-kneed foal, the knees should not touch.The donkey should have good eyesight and agility (liveliness) 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.

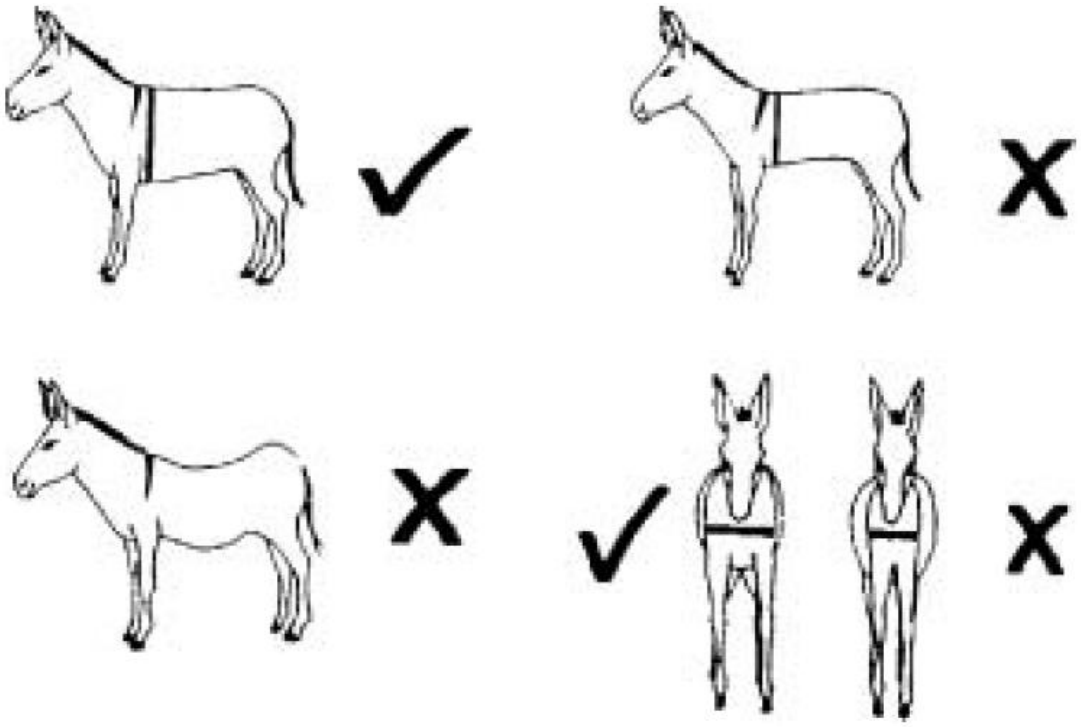


Figure 2: Desirable and undesirable conformation features in donkeys.

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).

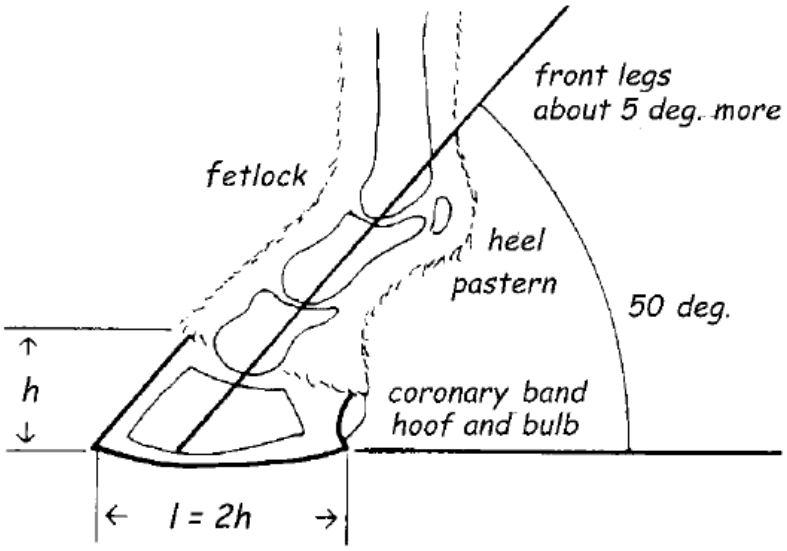


Figure 3: Hoof and bones showing correct angles and dimensions.

In addition to sound 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 cruel or inconsistent

6.2. Training Working Animal

Training animals for traction involves an understanding between the trainer (yourself) and the animals. The animals need to trust you. For that we need to be patient and reward them for good behavior.

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.

Note:

In order to train animals, a trainer must follow some principles to achieve good results during the whole exercise. The reason for this is that cattle are not used to work unless they know the training steps.

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. To carry out the training you need the following items: a trained animal, a proper kraal, a good Pegged training field and tools (ropes, different types of yokes, ploughs, weeders, loads and Sledges).

6.2.1. Training Principles

When the farmer has completed the selection process, he has a number of cattle that he judges to have the Potential for draught work. Training is the next stage necessary to develop that potential so the draught animal can perform the desired operations efficiently and obediently. The behavior of cattle will change following training. Well-trained animals carry out field operations accurately. They are easy to control and can pull heavy loads for long periods. They are well balanced, strong and consistent in their movements. They co-operate well with both the operator and the other animals in the span.

To successfully train draught cattle, the extension workers, ox trainers, farmers and craftsmen should follow some basic principles. They differ substantially from the common practices of training plough oxen.

The key features of the training procedure described here are:

• The program is built up systematically and divided into steps

• The draught animals are given enough time to fully adapt to each step

• The draught cattle are not used for fieldwork until they have learned all the draught work training steps properly and are under full control of the trainer/operator.

Initially, most draught animal training for conservation tillage is the simple upgrading of the skills of the existing plough oxen. This means that the animals already have some training on how to pull a plough. In this way it is possible to go through some of the training procedures more quickly than with untrained young steers. However, to avoid confusion, the training procedure is based on semi-wild young steers, and inexperienced district extension workers as potential trainers in animal drawn conservation tillage techniques.

The village extension worker should be able to arrange and implement training of the different steps of improved draught animal training for conservation tillage. He/she should also make sure that the traditional methods are improved along the recommended principles. The basic approach should be to train the farmers how to train the oxen. The number of operations the oxen are used for will give a good indication of how well the village extension worker has managed to introduce the improved ox-training technique. The number of female farmers using oxen is also an important factor when determining progress. Furthermore, the area weeded by oxen is a top priority question when determining the success of ox training.

There are six basic principles of training that aim at reducing fear and uncertainty in the cattle when strange people, new behavior, noise and implements confront them. These principles are also important guidelines for people who are not used to cattle and oxen:

1. The trainer’s approach must be calm, firm, patient and consistent.

2. Routines and repetition of training steps must be strictly followed when training the animals in new behavior.

3. Rewards reinforce correct behavior. Any positive effort made by the cattle during training must be rewarded in some way, such as praise words (animal’s name…very good!), a short break

or an offer of food. Incorrect behavior is not rewarded but should be corrected immediately. In this way correct behavior will become more desirable to the animal.

4. Completion of a step in the training programme must be achieved before progressing to the next step.

5. Training aids should be used to achieve a training objective and then they should be discarded.

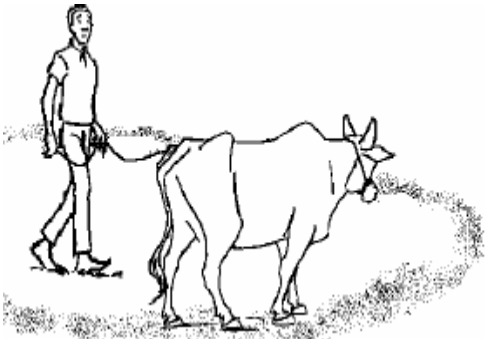
6. Spoken commands should be few, simple, logical and in one language.

6.2.2. Training stages and Duration of training

STEP 1: Roping and Walking

The purpose here is for the trainer to get used to the new animal, to create friendly conditions and to remove fears/suspicions from the animals.

You should tie the oxen with ropes and make them walk in circles without yokes. To tie you can use halters or nose punched animals (as explained below). Each time you train, you reduce the rope that separates you from the animal, so that you come closer to it and this one keeps on gaining trust



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.

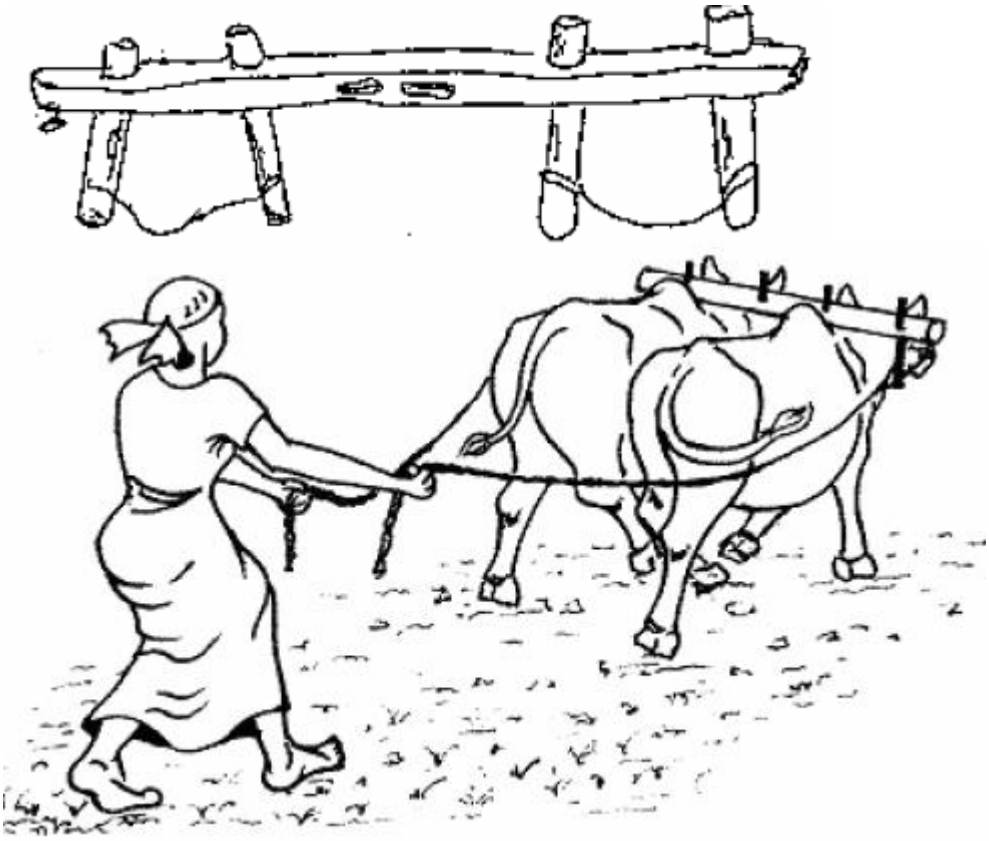
This step ends when a trainer is able to move closer to the animal, to put a rope around the neck, name the animals, make them walk or move and stop using simple commands.

STEP 2: Harnessing and Walking the Animals

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.

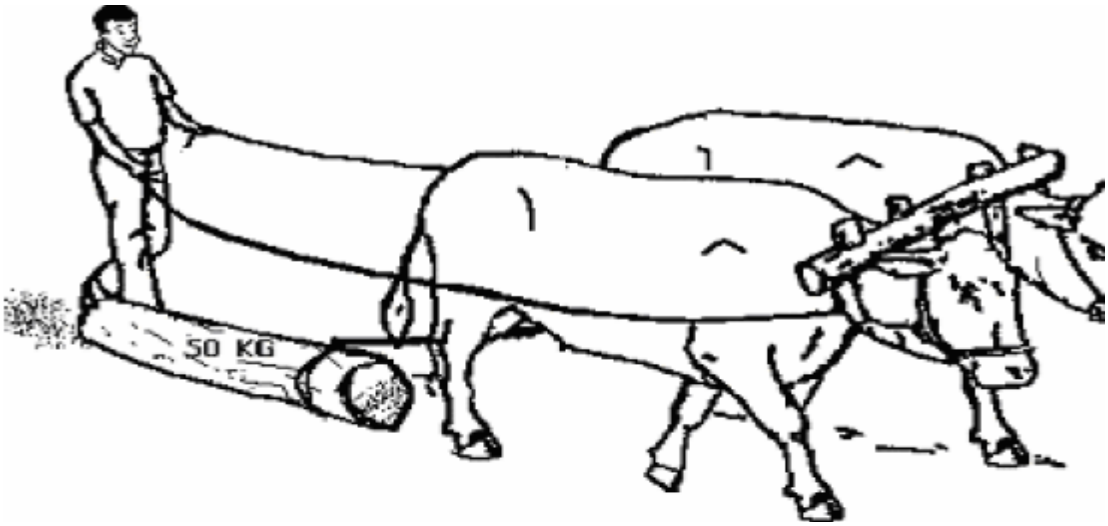
The items used here include a yoke, ropes, a kraal, a training field and trained animal



These exercises should take 3-4hours per day for 7-10 days

STEP 3: Pulling Loads

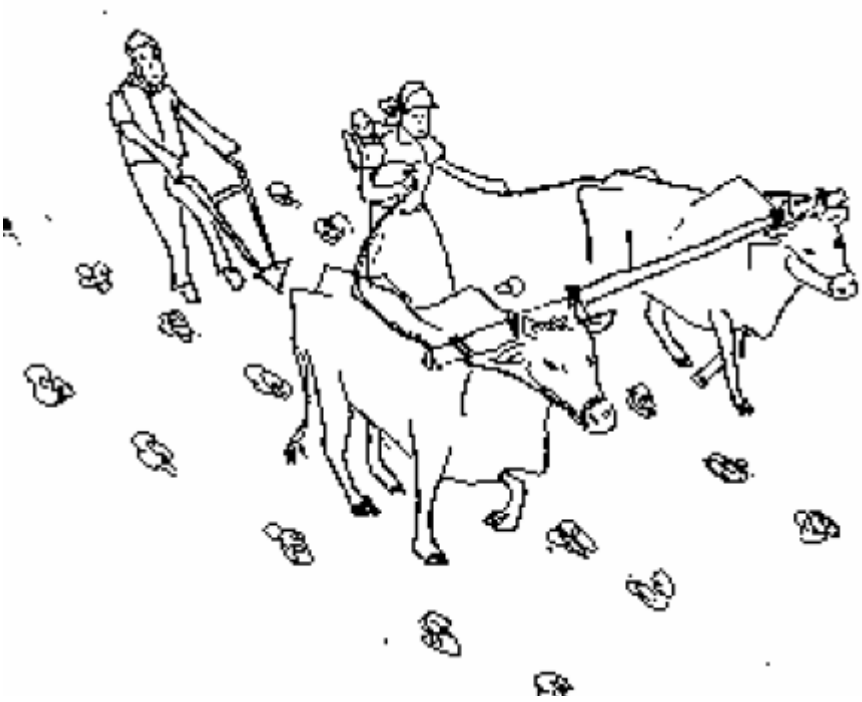
The purpose is to train the muscles of the animals and for them to gain strength to pull heavy loads. During this step, varying loads are introduced from 20, 30, 40, 50 kg /log.



These exercises are done in the field, 2 hours per day, for 7-14 days.

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

6.2.3. The Qualities of Good Trainer

Training of animals requires patience, firmness, perseverance and above all, consistency. 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, upsetting noises and physical restraints such as harnesses, halters and equipment.
They must become accustomed to all of these and also learn to follow clear instructions.

During training, an animal trainer can administer one of four potential consequences for a given behavior: positive reinforcement, negative reinforcement, positive punishment, and negative punishment. Positive reinforcement occurs when an animal's behavior is followed by a stimulus that increases occurrences of the behavior in the future. Negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus and occurrences of the behavior increase in the future. Positive punishment occurs when a behavior is followed by the addition of an aversive stimulus and this decreases occurrences of the behavior in the future. Negative punishment occurs when a behavior is followed by the removal of a stimulus and occurrences of the behavior decrease in the future.

Behavior analysts emphasize the use of positive reinforcement for increasing desirable behaviors and negative punishment for decreasing undesirable behaviors. If punishment is going to be used to decrease an undesirable behavior, the animal must be able to receive positive reinforcement for an alternative behavior

The following points may therefore be useful to the trainer (who is preferably the farmer):

- Keep a calm, patient and consistent approach to the animal(s).
- 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.

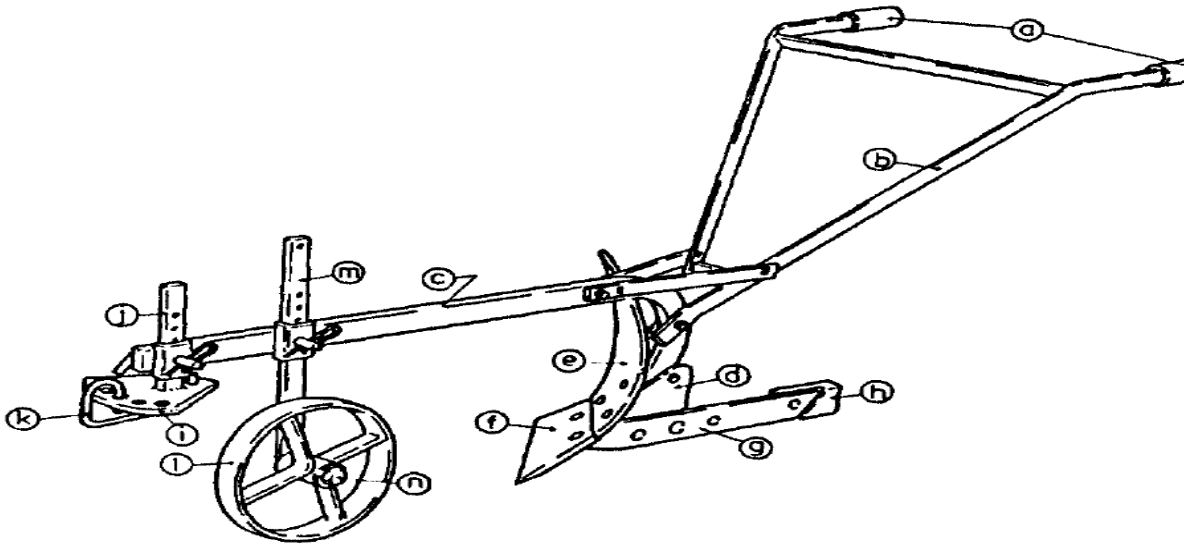
CHAPTER SEVEN: ANIMAL DRAWN IMPLEMENTS

7.1. Primary Tillage Implements

Primary tilling is performed by different types of plows, discs, rot tillers, and spading machines. The moldboard plow is one of the oldest implements used for soil preparation; it consists of one or more curved pieces of metal, called bottoms, attached to a frame. The bottoms are pulled through the soil to cut and then invert, either partially or wholly, the soil. One- to 4-bottom plows are common for small-scale production, and each bottom requires approximately 10 to 15 horsepower from the tractor. Plows come in various shapes and sizes, which determine the depth of the plow and how it moves the soil. Disc coulters can be added to the front of the plow to cut the soil so that the bottom penetrates the soil more effectively.

Tillage involves the disturbance of soil to create the best conditions for seed germination and eventual plant growth. Tillage serves three main purposes: to control growth of weeds by destroying them or by inverting the soil and burying them; to increase the infiltration and reduce the runoff of water from rain or irrigation supplies; To disturb and aerate the soil to a depth which allows the plant roots to penetrate deeper.

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. Various animal-drawn implements are available. The choice depends on climatic conditions, soil type and farming system. In this chapter the following will be discussed: mouldboard plough, ard, scarifier, ripper and ridger



a,b: handles	f: share	j: vert. regulator
c: beam	g: landside	k: hitch shackle
d: frog	h: heel	l: wheel
e: mould board	i: hor. regulator	m: wheel arm

Figure 31: Parts of the Rumptstad Sandy III plough.

Ard

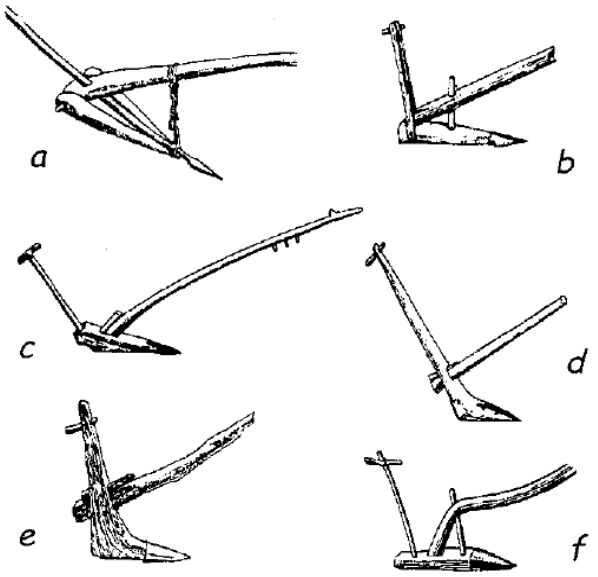
The practice of removing organic matter and residues is common, for example by burning or by the grazing of animals. Measures for applying extra organic material, such as green manure and animal dung, are not being exploited in most regions. In that case, inversion of soil may not be desirable as it may increase the rates at which soil moisture is lost and humus is decomposed. 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. Among the design features commonly found 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.

Numerically, ards are the most important animal-drawn implements in the world.

An ard plough is symmetrical on either side of its line of draft. 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.

Ards (araire in French) are sometimes known as "breaking prows" or "scratch prows". Different types of ard have been in use for thousands of years and numerically they are the most important animal-drawn implements in the world. Their development over the centuries and the different designs currently in use in different regions of the world has been well reviewed by Haudricourt and Delamarre (1955) and Hopfen (1969).

Through the ground, the soil is fractured and disturbed equally on either side. Unlike a mouldboard prow, soil is not systematically inverted. Typically the ard comprises a long wooden beam that Connects with the yoke. The plow body is made of wood to which an iron share is fitted. Many arcs have a single wooden handle and the symmetry of design makes it easy to control the implement with one hand (Fig. 7-1, 7-2). Some arcs, including those widely used in Egypt, have dual handles although one-hand control is common when soil conditions are favorable.

Some ard prows (including the Ethiopian maresha beam arc) till a narrow width at a shallow depth (hence the description scratch prow), leaving small and irregular ridges and furrows. Weed control and seedbed preparation are achieved through a series of cultivations (usually at least three) each at an angle to the others. By repeated cultivations most of the soil in a field becomes disturbed, with the later passes achieving a similar effect to that of a harrow. Weeds are not covered but are generally uprooted and remain with stones and other trash at the surface, and in semiarid areas this may result in quite effective weed control.

Other ard prows (including some body arcs and sole arcs in use in India and North Africa) have quite large wooden plow bodies (Fig. 75). These follow the steel share through the earth, breaking up relatively wide tracts of the soil (hence the description breaking prows). Although such arcs do not fully invert the soil, they can often be used to systematically plow fields in a single pass, leaving most of the soil cultivated and weeds uprooted, buried or disturbed. This allows an appropriate seedbed to be rapidly achieved through subsequent harrowing using, for example, a blade harrow or ride-on leveling board.

Scarifies

Another practice in semi-arid regions, where heavy weed growth has not developed, is the use of a scarified. The scarifier is normally equipped with rather light tines made from spring steel. These vibrate, loosening the soil and reducing the risk of damage when encountering obstacles. 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 times. 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 Houe Manga that each tine be aligned in the direction of advance

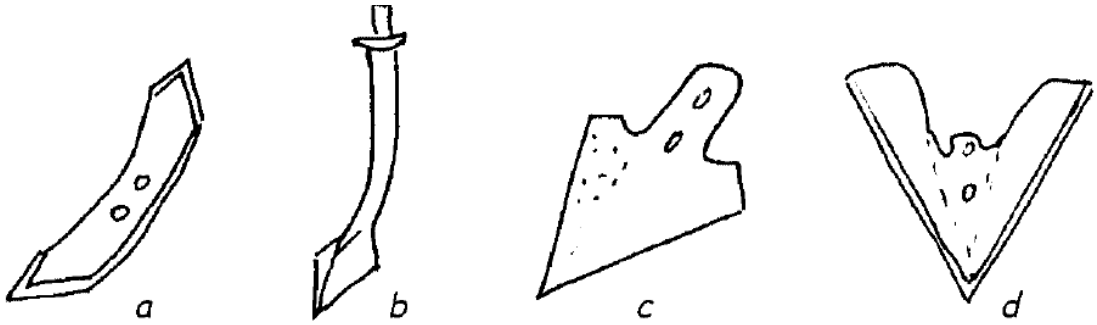


Figure 36: Several examples of a scarifier tine: (a) The reversible point for scarifying harder soils. (b) The rigid point. (c) The duck-foot point for scarifying lighter soils and general weeding operations. (d) The sweep used for weeding.

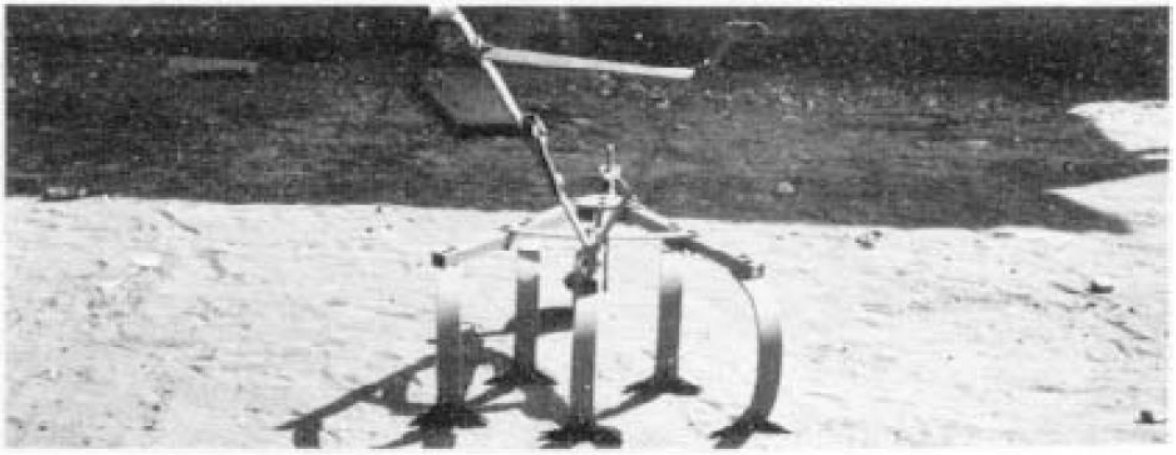


Figure 37: The Houe Manga in this illustration has the four left-hand tines correctly alligned. The right-hand tine, however, needs adjusting.

Ripper

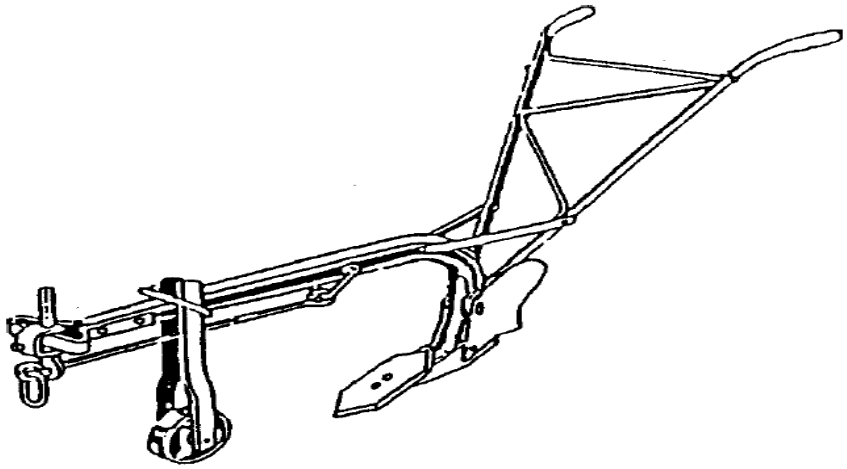


Figure 38: Magoye ripper attachment on plough beam.

Ridging plough (Ridger)

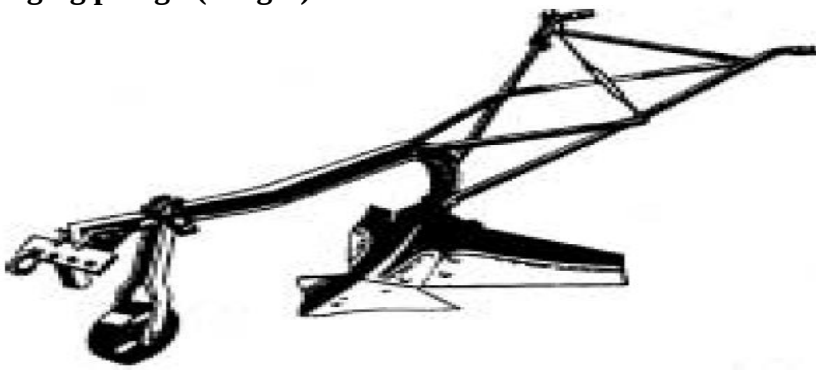


Figure 39: "Inkunki" high wing ridger, manufactured in Zimbabwe.

7.2. Secondary Tillage Implements.

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

Depending on how rough or crusted the soil is and how much plant residue remains, using secondary tillage equipment can further refine and level the soil before seeding or planting. Harrowing is used for shallow tillage and is most commonly practiced after plowing.

Harrows can be used to break down the furrow slices caused by the plow, reduce clods, smooth out the soil surface, and kill young weeds. The types of harrows include light disc harrows, chain-link harrows, spring-tooth harrows, and spike-tooth harrows. If sod has been plowed under, the disc harrow will not bring lumps of sod up to the soil surface—unlike the spring-tooth or spiketooth harrow. Although spike-tooth harrows do not pulverize the soil as well as other types of harrows, they can sometimes be used to cover broadcast seed.

Field cultivators consist of a toolbar with different implements mounted on it. They are heavier than harrows and are used when the soil is too rough, is too compacted, or has too much residue for a harrow. The toolbar usually has C-shanks or S-shanks with sweeps, tines, chains, or rollers attached to the bottom.

Transport Equipment

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

7.5.1. Sledges, Carts and Wagons

1. **Sledges**

Wooden sledges are quite widely used in certain areas of eastern and southern Africa, Madagascar and parts of Asia and Latin American southern Africa simple sledges are made by joining two wooden beams in the form of a V, or by selecting a naturally occurring fork in the branch or trunk of a tree.

The **advantages** of sledges are that 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. However, there are many **disadvantages**. 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.

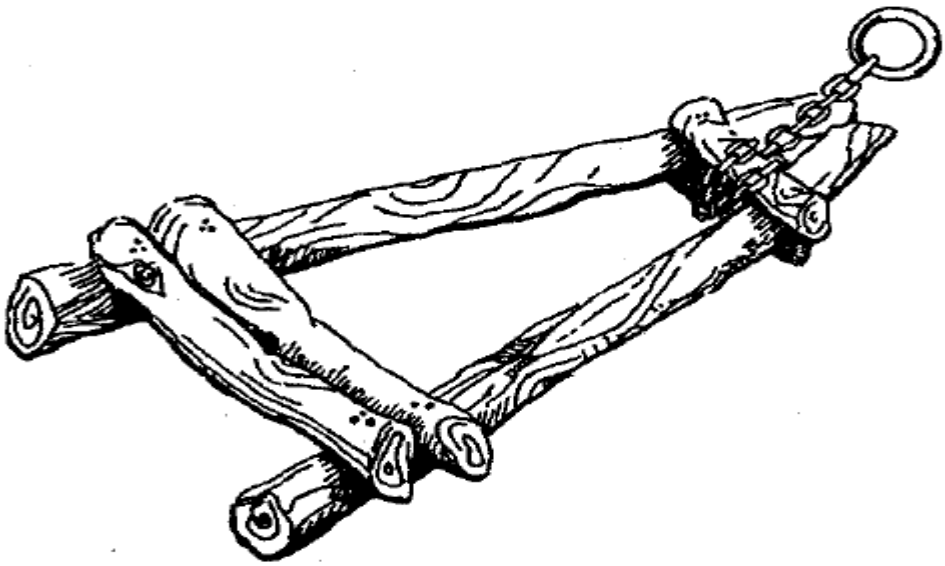


Figure 27: Simple wooden sledge as used in eastern and southern Africa.

2. Carts

Carts pulled by animals are widely used for rural transport; there may be 40 million in operation worldwide, the majority in Asia. Many carts are constructed in a way that combines artisanal skill with traditional folk arts. Most carts employed in the world are made mainly of wood, and use traditional designs of wooden poked wheels. However carts with steel frames and pneumatic tyres are becoming increasingly common. Once a suitable and affordable cart design becomes available, the adoption of carts can be quite rapid and even eclipse the agricultural usages of draft animals

Two-wheeled animal-drawn carts are much more common than four-wheel carts due to their lower cost, lighter weight, lower complexity and greater maneuverability cities and market towns, carts may be operated full-time on a hire basis by transport entrepreneurs. Only about ten percent of African farmers who own draft animals have a cart, but the importance of carts to the agricultural sector is much greater than the simple numbers imply. While other implements are used for a small number of days each year, carts are generally used throughout the year. Thus in terms of overall implement usage in Africa, the total number of cart-days each year would be second only to the number of prow-days.

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 maneuverability 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.

7.5.2. Pack Transport

Donkeys and mules are the main pack animals in most regions of the world. Mules are produced by crossing a female horse with a male donkey. Mules are larger and stronger than donkeys, but donkeys are cheaper to buy and to maintain. The reliability of donkeys is legendary. Once trained, donkeys can follow particular routes with minimal supervision; they will wait patiently for several hours and they can often be trusted to return "home" unattended. Horses can be fast and efficient pack animals, although they are not as hardy as donkeys. Being more expensive to purchase and maintain than donkeys, horses are used mainly for high-value or strategic

operations. Camels are excellent pack animals, unrivalled in their ability to cope with severe desert conditions, but they also are more costly than donkeys. Llamas and yaks are locally used in the foothills of the Andes and Himalayas. It is rare for cattle to be used as pack animals.

Donkeys are maintained as pack animals in many African countries, particularly in North Africa, the Sahel, Ethiopia and parts of eastern Africa. Their employment has often been a long-standing tradition. When donkeys are used for pack work, it is normal to place some form of protective padding over their backs. This may be sheepskin, sacking or discarded cloth. Soft loads such as sand, fertilizers, canvas water containers and straw are placed symmetrically over the back and held in place by one (or more) leather or rubber straps around the girth or belly, and under the base of the tail. Hard loads such as firewood, stones or rigid containers are generally supported on simple wooden symmetrical saddle frames sitting on light padding and held in place with tail and girth straps. Simple pannier baskets may also be used .Pannier baskets with opening bottoms that allow loads to be shed easily have been used in Western Samoa (FAO, 1986). In Ethiopia, donkeys are widely used as pack animals and animals averaging 100-110 kg bodyweight regularly carry loads of 25-50 kg over distances of up to 20 km.

The distribution of donkeys in Africa is restricted by several ecological factors, notably the disease trypanosomiasis. With cattle being much more readily available, there has been some interest in the potential of cattle as pack animals.

While cattle do not readily take loads on their back, they can certainly be trained to do so. In parts of Mali and Chad cattle may be ridden for personal transport by farmers and some pastoralists in Sudan and Somalia use cattle to transport their effects when moving between sites Bovine pack saddles were developed in Tanzania, but were not adopted .As animals can pull greater loads than they can carry, in most areas work relating to ox-carts will probably be more productive than trying to develop systems of using cattle as pack animals. Where narrow paths restrict the use of conventional carts, it has been suggested that transport of goods could be on sledge or very narrow carts.

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 ought to be comfortably loaded. An even 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

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

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 noxious bacteria. Several layers of cotton material or sheepskin are ideal for this purpose.

The second layer should provide a cushioning effect. Well-suited are a folded blanket or a straw-filled sack. With the latter it is important to sew the bag into sections to prevent the straw or other filling (animal hair or kapok) from falling to one end. A protective piece of skin or leather or a plastic sheet may cover the cushioning layer.

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.

This system can be used to train donkeys. Light sacks are used of which the weight can be gradually increased as the animal becomes used to the load. Although this system is convenient, the pack-frame shown in figure 9 is preferably used to carry heavier and/or bigger sacks.

CHAPTER EIGHT: HARNESSES SYSTEMS OF DRAFT ANIMAL POWER

The harness links the draft animal to the cart or implement. So, to be effective, it has to tap the power of the animal in the right places. In some parts of Africa, donkeys, horses or mules are used with withers yokes (also called neck yokes), similar to those used for cattle. The **breast band** is the simpler and cheaper harness. The work force is primarily taken from a broad band of leather, rubber or strong canvas material across the animal's chest. Traces (ropes or chains) or shafts attached to either end of the breast band pass back to the implement.

8.1. Some mechanical principles

8.1.1. A very simplified approach to some mechanical principles

Simple principles (rather than learned rules) can be useful when it comes to assessing the advantages and disadvantages of various designs, and the significance of any modifications and adjustments.

In addition to some basic mechanical principles, it will be helpful to be familiar with the main units of measurement relating to animal-powered implements. The day-to-day application of such units is not essential because comparative performances are more relevant than absolute values in the majority of field situations: farmers are more concerned with whether a particular combination of animals and implement can achieve acceptable work in a reasonable time, than with numbers illustrating weights, draft and power. Nevertheless there are great advantages in using standard units of measurement since this facilitates exchange of information between people in different countries, in the past meaningful exchange has been hampered by the wide range of different units that have been used when assessing animal drawn implements (horsepower, kilowatts, kilogram force, pound force, Newton's, joules, miles per hour, kilometers per hour, meters per second, square meters per hour, hours per hectare, acres per day, etc.). Whenever practicable, internationally accepted standard units have been used in this book. Such units are merely convenient measures of magnitude, and do not convey any information as to the authority or reliability of numbers. While measurements obtained under accepted standard and repeatable test conditions can be widely applicable, there are very few standard measurements relating to animal draft, other than implement and animal weight and physical

dimensions. When draft animals work pulling implements in a farmer's field or at a research station there are so many highly specific variables influencing the situation that the actual figures may have little relevance away from the conditions in which they were obtained. Thus although the use of international units is to be encouraged, these should not be confused with international test standards, and great care should be taken when interpreting data obtained in different circumstances Similarly, because local conditions are so variable, it is generally unwise to ascribe "typical" values to agricultural operations.

8.1.2. Forces and vectors

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

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 purists 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).

In scientific terms "weight" is actually a force, since it depends on the acceleration of gravity. A body can appear "weightless" in space, even though its "mass" does not change. The standard units of mass are grams and kilograms while it has been noted that the units of force are Newton’s. A spring balance, even one calibrated in kilograms, actually measures weight not mass, and will give slightly different readings at different altitudes. Purists would calibrate spring balances in Newton’s, whether they are to be used as weighing instruments or as dynamometers for measuring draft forces. However for those concerned mainly with tilling the earth's surface, gravity can be considered approximately constant, and the interchange of the words "mass" and "weight" is unlikely to be a source of confusion. For this reason, the word "weight" will often be used in this book in the loose, colloquial sense, in which weight is measured in kilograms, rather than Newton’s.

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

8.1.3. Work and power

Work involves moving a force through a distance. As an implement is pulled through the soil, the animal or team exerts a tractive force and as it moves across a field, it performs work. Work done is not a function of time, so that however long an operation takes, the actual work done is the same. Plowing a field to a particular standard and depth entails the same amount of work (in principle) whether it is completed in one morning, in one day or in many days, whether the work is done by a single animal, a pair, or by a large team, and whether the animals pull a narrow plow through a long distance or a wide plow through a shorter distance. (In practice there may be some small differences since some frictional forces vary with speed and surface to volume ratio). Although the actual work achieved in terms of plowing will be the same in all the cases cited, the number of animals and the rate of work may well have significant implications for total energy expenditure. (Animals are constantly using metabolic energy for maintenance, in a way comparable to the non-stop idling of a vehicle engine, so that a slow job or one involving more than one animal may involve higher metabolic energy expenditure; animals also perform work moving themselves, so that the shorter the distance they travel, the less work they do moving themselves; in such cases pulling a wide implement though a short distance will involve less energy for walking than pulling a narrow implement through a long distance).

Power is the rate of doing work, and therefore unlike work, power is a function of time. Historically power was assessed in terms of what a draft animal might perform, and was measured in units called horsepower (hp), units that are still quoted today in some countries. The "imperial" horsepower unit was suggested by James Watt who timed a horse and also his new steam engine as they pulled weights up a well shaft: he concluded that a horse could work at a rate equivalent to lifting a 550 pound weight through one foot in one second.

It should be noted that while many of the terms such as force, draft, work and power have specific scientific definitions, they are also used in a more general and loose sense by

agriculturalists and farmers. Subjectivity and context can bring to these words a wide variety of meanings. For example, oxen are often said to be more "powerful" than horses.

Harnesses link animals to implements; while they do not alter the actual draft of the implement, they can influence how the draft is partitioned between vertical and horizontal vectors. Harnesses do vary slightly in their efficiency as transmission systems, so that greater or lesser amounts of energy are dissipated in the harnessing system itself or in unproductive work. Harnesses do not affect the intrinsic power of an animal, which is determined largely by its species, size, weight and past history. However through ergonomic aspects of design, notably those relating to comfort, harnesses may influence an animal's ability and/or willingness to use its power.

8.1.4. Levers

Much to do with equipment design and adjustment can be explained by reference to principles of levers. The "eveners" used in the harnessing of multiple teams are simple levers, as are yokes. In either case if the position of attachment of the hitching is moved from a central position, levers of unequal length are created. The weaker animal requires a longer lever to help it, while the stronger can make do with the shorter one. Pressing down on the handle(s) of a plow can be thought of as a lever action. The rear of the plow-body acts as a fulcrum (pivoting point) so that downward leverage on the handle(s) causes the share to move upwards to a shallower depth. (Such a movement is one of the many reflex responses associated with plowing; it is most obvious when plowing at a reasonable speed in light soils; in heavier soils and at low speeds the plow is unlikely to be sufficiently in equilibrium to allow the operator to distinguish between the different leverage effects).

The width and pitch adjustments of a plow can also be understood in terms of levers. Moving the chain attachment or adjustment from a central position will cause a slight leverage effect, pivoting around that central attachment point. Moving the chain in either horizontal direction will cause the plow beam to pivot round a little, and the plow body will move through the soil slightly crabwise, as shown (exaggerated) in Fig. 2-6. If the movement is towards the unplowed land, the share will be skewed so that it is even more angled to the direction of movement, and thus it will cut a smaller slice of soil. If the traction chain movement is in the direction of the plowed land, the share will be pulled round so that it cuts a wider furrow. The pitch adjustment on the hake can be viewed in a similar way, as shown in exaggerated form in Fig. 2-5. Moving

the chain upward causes the plow to pivot so that the heel rises and the share points downwards. Moving the chain down causes the heel to press down and the share to point upwards.

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

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

8.2 Harnessing

In both English and French, the word harness (harnais) has been predominantly used in the relatively narrow sense of the straps and fittings used for hitching and controlling horses or donkeys, and dictionaries in both languages generally define harness with reference to horses.
The harness links the animal to the cart or implement. So, to be effective, it has to tap the power of the animal in the right places. In some parts of Africa, donkeys, horses or mules are used with withers yokes (also called neck yokes), similar to those used for cattle.

8.2.1. Types of harnesses

8.2.1.1 Yokes

For working oxen, the hitching together has generally involved a rigid yoke ("joug" in French), and historically the word "yoke" could also be used to describe a team of oxen. The French word "attelage" has no single word equivalent in current English usage but refers to the system of hitching animals together whether it be the yoking of oxen or the harnessing of horses.

The wide range of yoking types falls into two main categories, those tied to the horns of the animal and those taking power mainly from the withers. The `''withers" of an animal refers to the part of the back that is over the shoulders, directly above the first thoracic vertebra. In Zebu (Bos indicus) cattle the withers are immediately in front of the hump.

A. Forehead yoke (rare).
B. Horn/head yoke (regionally common).
C. Withers/shoulder yoke (common).
D. Three-pad collar (rare).
E. Breeching strap (rare).
F. "Withers" of the animal.

8.2.1.2 Collar and Breast Band Harnesses

The webbing breast band may be made from strips of webbing which are sewn together to fit the donkey. The width of the breast band is about 6 cm. The neck strap is 4 cm wide and not adjustable.

Leather parts are used to reinforce the breast strap at the connections with the neck strap and the triangular ring. Short breast bands with one neck strap have the advantage of connecting the traces near the power point. Long breast bands with two back straps are required where the implement needs a certain amount of lifting, like single mould board ploughs without a support wheel.

A similar design can be made with rubber from an old car tire. The breast band is cut from the tread of the tire (6 cm wide) and the neck strap from the tire casing (5 cm wide). The joints are stitched together with thin wire. To avoid hurting the donkeys' skin, make sure that the wire is pulled tightly toward the outer side while stitching, so that the wire is well sunken into the rubber on the inner side of the breast band, which touches the donkey. Edges should be rounded. Conveyor belts, joined by bolts, can also be used instead of tire rubber. Padding must be applied to absorb sweat and to protect the skin.

When made out of leather, a 12-cm wide strap is folded twice. Over the seam a 3-cm wide strap is fixed for taking the stress (figure 1). This compiled leather strap (about 5 cm wide) distributes the pressure on the breast and acts as a cushion at the same time. Fewer sores develop from this

arrangement as the major stress is on the middle of the strap instead of on the edges. In this more expensive design, the neck strap has a pad on the top to distribute the weight and it has adequate adjustment possibilities to fit many donkeys.

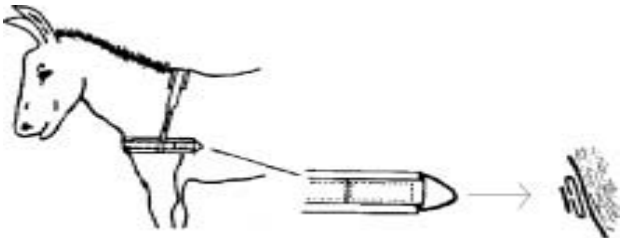


Figure 1: Adjustable leather breast band harness.

Make sure the harness is properly adjusted for the donkey. The breast band strap should run across the chest just above the point of the shoulder. When fixed too high, there is a danger of choking the donkey; when fixed too low, the two ends may run over the shoulder points where the front leg bones attach to the main skeleton, making walking very uncomfortable for the donkey. The space for a breast band is actually very limited on the chest of a donkey, which is a major drawback for this type of harness.

Breast protectors

Most sores and wounds are caused by poor quality or ill-fitting breast bands in combination with traces that are fixed directly to a rigid part of the cart and not to a swingle tree. Instead of heavy cloth or sheep skin as padding for the above-mentioned breast bands, one may also make a simple removable and therefore easily washable breast protector. It is a cushion made of foam rubber and canvas placed between the strap and the donkeys' breast, which can be buttoned to the breast strap.

Collar harness with straight hames

A recent design made in South Africa uses straight wooden bars padded with sheepskin. The hame straps are made of home-tanned leather. They are simply tied together in a way that will easily allow adjustment. The saddle shown is part of the full harness, including a breeching made from old fire hose, needed for pulling a cart.

Three-pad collar harness

A special donkey collar harness developed in Kenya is modeled after European cattle and horse collars. The harness comprises two wooden hames, hinged by leather straps at the top and joined

by a leather strap at the bottom. The hames are shaped to match the contours of the animal. The shoulders are protected from direct contact with the hames by two pads, made of canvas and stuffed with cattle tail hair, recovered from butcheries. The third pad is made of leather and is attached to the lower of the two top straps, which rests on the withers. The load is passed by nylon traces from the hames to a swingle tree. For pulling operations, a back and girth strap with trace holders are used to prevent entanglement of the traces and the donkeys' hind legs.

Three-pad collar harnesses are expensive compared to harnesses discussed previously, because they are produced by artisans using good quality materials like hardwood, leather and canvas. However, over one thousands of them have been made in Kenya on demand and those who can afford them like them very much for their comfort, power, efficiency and durability.

8.2.1.3. Load Carrying and Pack Saddles

Simple saddles can be padded wooden frames, broad straps or ropes over an animal's back which help bear vertical loads. These are widely used with horses, donkeys and camels that pull carts. Since the desirability of loading the backs of bovines seems somewhat controversial, it is interesting to note that while cattle can be successfully used for riding and pack purposes, there are few parts of the world where this is actually practiced. Yaks are used as pack animals in some mountainous parts of Asia. Asian water buffaloes are occasionally used to carry produce to and from the fields. In parts of Mali and Chad, farmers and children ride oxen without fitting saddles. In several regions of Africa, including the Sahel and the rangelands of eastern Africa, pastoralists use simple basketwork panniers to enable cattle to carry household belongings when moving between sites.

In the humid and semi-humid areas of Africa, disease generally prevents donkeys being used as pack animals and luxuriant vegetation and watercourses restrict the use of animal-drawn carts. In such circumstances farm produce and materials are generally head-loaded by women and men, and there would seem to be scope for using pack animals (Spencer, 1988). However such areas are generally those where cattle populations are low, people are unfamiliar with cattle husbandry and the presence of tree stumps makes it difficult to use draft animals for crop cultivation. Moreover the effort required to train, saddle, load and drive a pack ox, may well be greater than the transport value of relatively small quantities of materials. There have been several small-scale attempts to introduce the use of pack oxen. One systematic attempt in Tanzania was described by King (1940) who provided details of how to manufacture pack saddles and pannier

baskets of a design similar to those used by pastoralists in northeast Africa. King considered that ox pack transport was "an essential prerequisite to the extension of mixed farming on account of the increased movement of crop residues, grass roughage and manure". However despite the apparent technical success of the panniers, the extension efforts and initial adoption by a few farmers, the technology does not appear to have spread. Other, smaller projects have had similar experiences. Thus it would seem that the use of bovine pack saddles is only likely to be worth investigating if transport is clearly a critical constraint and if it is impossible to use ox carts or pack donkeys.

8.2.1.4 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. Nevertheless it is not uncommon for camels to be used for crop cultivation in parts of North Africa, the Middle East, Pakistan and Rajasthan in India. In Sub-Saharan Africa the number of camels used for crop cultivation is very low, but it is reported that camels are being increasingly used for plowing in parts of Sudan, Ethiopia, Mali, Niger and Nigeria. Although collars can be used with camels, simpler and cheaper systems are usual. These had padded wooden hames and were held in place by back and belly straps, but it was found that withers yokes were actually more appropriate for cultivation work. The single camel withers yokes used in Niger were made from old lorry springs, well-padded and fitted with large rings at each end to take the traces.

In other countries, including Ethiopia, a broad piece of padded leather or webbing can act as a single withers yoke, with traces running from this harness to the implement or swingle tree. The harness may be held in place by a breast band and also by a strap or cord passing behind the hump (Mukasa-Mugerwa, 1985) 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 NINE: PERFORMANCE ASSESSMENT OF DRAFT ANIMAL POWER

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%.

9.1. Dietary Energy Requirements of Working Animal

Horses, with the exception of those kept strictly for breeding, are subjected to some level of work. Nutrient recommendations are often based on these three levels of work effort:

- Light work: 2–3 hours per day
- Medium work: 4–5 hours per day
- Heavy work: 6–8 hours per day

It must be recognized that the intensity of work within these levels may vary greatly. The "medium" worked horse may be called upon to expend more energy in 5 hours than the "heavily" worked horse is in 8 hours. Therefore, the recommendations based on these work levels must be used only as a rough guide. It is up to the horse owner to adjust the feed ration accordingly.

Table: Daily Recommendations for Working Horses (Mature Weight = 900 kg = 1980 lb)

Level of work	DE (Mcal)	CP (Kg/Lb)	Ca (g)	P (g)
Light	42	1.38 (3.04)	63	38
Medium	48	1.55 (3.41)	72	52
Heavy	62.1	1.55 (3.41)	72	52

Note: Light work is equivalent to "moderate exercise," medium work to "heavy exercise," and heavy work to "very heavy exercise" for riding horses as listed in "Nutrient Requirements of Horses" 6th ed., National Research Council.

There are substantial increases in the energy needs of working horses as would be expected when you consider that energy is the major expenditure in performing work. This rather notable increase in the need for energy necessitates a change to higher energy feeds, particularly in the heavily worked horse.

Even though the recommendations for protein, calcium and phosphorus increase with increased work, the increases are less than the increase for energy. Protein is used primarily to rebuild muscle tissue. Calcium, phosphorus, and other minerals are lost at greater rates during work via sweating and urination. A good well balanced mineral mix with loose salt (fed free-choice) can easily meet the needs of the working horse.

9.2. 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. Excess calories are stored as fat, causing 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:

- To increase energy intake and prevent protein, vitamin-and mineral deficiencies.
- Because of limited grazing time or limited forages availability. Pulling loads is hard work.

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. An adequate diet is especially important to young draft animals because their growth may be stunted or their con-

formation affected if food normally used to build bone and muscle must be converted into work energy during the critical early years.

Work 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.

9.3. Basic units to Measure Performance

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 inanimate physical principles such as friction, force, and speed which influence the process of doing the work are seldom 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. This chapter defines these principles and evaluates the effects on animal performance.

9.3.1. 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 purists 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).

9.3.2. 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. Work done is not a function of time, so that however long an operation takes, the actual work done is the same. Plowing a field to a particular standard and depth entails the same amount of work (in principle) whether it is completed in one morning, in one day or in many days, whether the work. 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.

9.3.3. 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 or 220 ft (67.1 m) per min. This accomplished 22,000 ft lb (3041.6 kg m) of work). Watt increased this by 50% to allow for friction in his engine and for good measure, thus establishing 33,000 ft lb (4562.4 kg m) er min or 550 ft lb (76kg m) per sec as the unit of power or 1 horsepower./ (hp). One metric hp is equivalent to .99 English hp or 4516.8 kg m per min. Horsepower 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.

CHAPTER TEN: MANAGEMENT OF DIFFERENT DRAFT ANIMAL POWER

10.1. Housing of Draft animal power

10.1.1. Quality of Animal Shelter

Because of their value, draught animals offer one of the best ways of introducing improved animal husbandry methods to local farmers. A simple shelter or lean-to would provide the necessary protection from rain. Shelters 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.

10.1.2. Housing for Cattle

It is important to give work animals a place where they can eat and rest unbothered by weather, insects, other animals, and uncomfortable restraints such as hobbles, short ties, and narrow stalls. In the tropics, animals do not need elaborate shelters, but stabling them in dry, comfortable surroundings contributes to their overall soundness and work value.

A lean-to with a straw roof provides shelter from heat, rain, and wind .A simple lean-to is a wall four or five meters long and two and a half meters high, with a canopy on one side. It is built on high ground so water drains away. The wall is situated so it blocks prevailing winds, and the roof made on the side opposite the wind. An earthen floor is adequate, but straw or sand should be kept in the area where the animal sleeps, or "beds down."

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.

10.1.3. Housing for Equines

Draft animal house should be prepared using local simple material (i.e. wood, mud briks) to keep the cost to minimum.

In warm dry climate roof supported by poles, however in cool areas half or three quarters of walls is solid. The space requirement of the individual animal is 1.5 -2 ms wide. A yoking bar is fixed at height of 90cm -150cm from the ground used during feeding and watering, harnessing and health care routine.

Horses often prefer standing to lying on a hard, cold, or wet surface, so owners should make special efforts to ensure that bedding is ample.

10.2. Feeding and Nutritional Requirement of Draft animal power

10.2.1 General Management of Feeds

Draft animal need several important feed components - 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.

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, and 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. Supplements are most important in the following circumstances:

- Local grazing is poor because of drought or over-grazing.
- Animals must walk long distances for food.

In general, forage consists of leaves and stalks of plants (grass, maize Stover, etc.). Draft animal need 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 and even shredded paper (if it does not contain too much ink).

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 moldy 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.

10.2.2 Nutritional Requirements of Draft animal power

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. Many of the estimated requirements in the literature are based on standards used for draft of non working animals in temperate regions and are often not representative of animal needs under "actual farming" conditions. This section examines available data on energy requirements for working animals and attempts to categorize three areas: maintenance, growth, and work.

Maintenance requirements:

- Can be defined as the amount of nutrients that will result in no loss or gain in body weight.

- Energy requirements for draft animals at maintenance level are similar to those for non-working animals.
- In order to provide consistency, the unit total digestible nutrient (TDN) has been selected.

Growth

- Although animals are commonly trained for work from 2.5 to 4 years, it is unlikely they will have attained their mature weight.
- Employing immature animals for draft necessitates that adequate energy 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

Work

- For work additional feed is required over maintenance requirements.
- The feed requirement for work depend on the light, medium, and heavy work

. 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 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.

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.

10.3. Health care and welfare of Draft animal power

An animal in good health is one that is sound in body; and free from physical disease and pain. Health, together with welfare, is fundamental to a productive working animal.

Pearson (1986) makes the important point that little benefit will be gained from better feeding, training and improved harnessing and implement design if health is neglected. Care is required to prevent stress and subsequent loss of health to ensure the animal can carry out timely work.

Draught animal husbandry should be as stress-free as possible. If animals are handled frequently, stress caused by contact with human beings will be negligible. Animals should be groomed (washed and brushed) and inspected daily for wounds, skin infections, signs of harness-rubbing and ticks. Hooves should be inspected and trimmed as necessary.

Prior to the main cultivation season, attention should be given to health and condition to ensure that animals will be able to complete the work necessary. Since stress can arise because of poor nutrition, attention at this time to building up body condition is important.

Good vaccines are available against rinderpest, anthrax, black quarter, contagious bovine pleuro-pneumonia, haemorrhagic septicaemia, pasteurellosis and tetanus, and drugs are available for protection against trypanosomiasis. It should be borne in mind that vaccinations should be given at a time that work stress does not interfere with the immune response. Animals should be tested for tuberculosis, brucellosis, trypanosomes, piroplasmosis, Johne's disease and helminths. Cattle can be sprayed strategically against ticks using hand sprays or washing. Routine drenching against roundworms and flukes is recommended, particularly where animals are working in wetter areas.

Ectoparasites such as lice can be treated with insecticides. Brushes should also be treated to stop the spread of mange. Ringworm, which is more common in younger animals, can be treated with tincture of iodine daily on the lesions. Wounds and scratches can predispose to other infections

such as streptothricosis and should be washed and disinfected. Healing ointment will help protect the wound and keep flies off.

Proper nose rings should be used rather than rope to reduce irritation and laceration of the nasal septum. Horn injuries from tight ropes end neck and shoulder injuries from harnesses can easily be avoided by careful attention to harnessing methods. Ropes and harnesses should be disinfected regularly. Attention should be given to the possible dangers end causes of lameness in the locality where animals work or graze. Stones and earth can become stuck in the hoof, as well as thorns and other sharp objects. Strains and sprains need complete rest.

10.4. Record Keeping

10.4.1. The Importance of Record Keeping

Records are information preserved in permanent form, especially in writing. Sound and images can also be recorded. Farmers need to know the detail about their draft animals, price, age, and condition. Without records it will be difficult to remember the amount and condition of each animal.

Records expose strengths and weakness of an enterprise.

Importance of record keeping;

- Aids in selection of animals, which are most suitable for draught.
- Enables monitoring of farm implements and other accessories, procurement, depreciation and movement. E.g.: borrowing.
- Enables the stockowner to monitor profit or loss and take remedial.
- Provide use full information for planning, budgeting and securing of loans.