

A history of animal traction in Africa: origins and modern trends



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THE AUTHOR]**

Roger Blench
Kay Williamson Educational Foundation
8, Guest Road
Cambridge CB1 2AL
United Kingdom
Voice/ Ans (00-44)-(0)1223-560687
Mobile worldwide (00-44)-(0) 7847-495590
E-mail rogerblench@yahoo.co.uk
<http://www.rogerblench.info/RBOP.htm>

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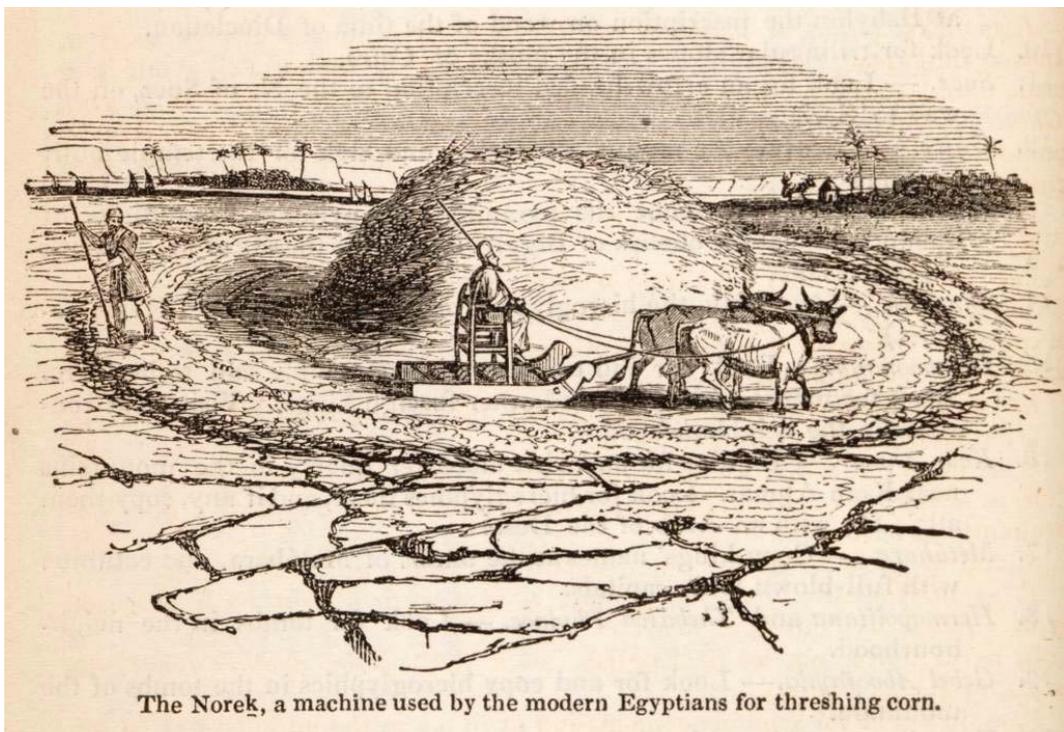
ABSTRACT

Animal traction is the use of animals to assist human beings in work, especially agricultural. It has a long history in Eurasia, as well as Egypt, the Maghreb and Ethiopia. In the remainder of Sub-Saharan Africa it is strongly associated with the history of European contact. The paper reviews the history and current status of work animals in Africa, beginning with the earliest evidence from the Nile Delta, Ploughing, carting, sledges, water-raising and animal mills are all described. A brief historical review of the introduction of traction is given, a summary of the current status of animal traction and a discussion of the prospects for animal traction in the twenty-first century. The optimistic projections given in the 1990s have been toned down in the light of massive social and economic change, and some of the constraints on the continuing spread of animal traction are identified.

Keywords; Africa; animal traction; history; archaeology

ACRONYMS

AD Anno Domini
BC Before Christ
BP Before present



1. Introduction

Animal traction includes both 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. Animal traction has been essential to the rural economies of Eurasia and Africa for millennia. Displaced by machinery from the eighteenth century in Europe, it has been gradually disappearing through most of Asia. The SE Asian water-buffalo, so much part of a romantic image of the region, is rarely to be seen these days. Animal traction remains an essential element in some African economies, although it is also in decline in parts of the continent for some of the same reasons. The most important review of animal traction in Africa is Starkey (2000) and the present paper is designed as an update, following a similar sequence of headings. Starkey covered the use of all work animals, including pack animals and riding; these are not discussed in the present overview. Starkey (op. cit.) concluded with a relatively upbeat assessment of the prospects for animal traction in Africa, which probably seemed reasonable in the 1990s. However, the situation is very different in the 2010s, with animal traction in decline across most of its range. A lack of interest in these technologies by both government and international agencies means that recent descriptive and statistical data is virtually absent¹. This paper² explores the use and spread of animal traction in Africa from both chronological and geographical perspectives and concludes by describing the present situation and current trends.

2. Origins

The earliest evidence for ploughs is from Mesopotamia where they are first depicted at the end of the fourth millennium BC on clay tablets from Uruk. The image shows a beam-ard pulled by oxen, which scratches a furrow without turning the soil. Seed ploughs, with a funnel through which seed was dropped into the furrow, are shown on seals from 2300 BC onwards. Animal power in Africa begins with the first drawings of oxen and ard ploughs in the Egypt of the III Dynasty [2778 – 2723 BC] (Haudricourt and Delamarre 1955).

Early Egyptian ard ploughs were clearly illustrated in wall paintings (Photo 1) and on papyri. Further evidence comes both from intact ploughs found in some tombs and also from detailed models of

Photo 1. Egyptian ard



Source: CC

ploughing teams. The ploughs comprised a long wooden beam that pulled a horizontal wooden plough body fitted with a metal share, controlled by two handles. The ard ploughs widely used in Egypt to this day are not dissimilar to the ancient designs. The early drawings and models show animals ploughing in yoked pairs (Photo 2).

Several ancient Egyptian illustrations clearly show that the animals used for ploughing were cows, not oxen (Brewer et al. 1994). One possible explanation is that the ox was considered more sacred than the cow. In most parts of the world, oxen are the first bovids to be used for work. Cows are only used when smallholder farming becomes intensive, animal feed resources are limited and work operations are light or highly seasonal. These

¹ It is very striking how web searches for current information about animal traction in Africa produce documents that are as much as two decades old. Recent descriptive materials are extremely scarce.

² This paper is being pre-circulated for the Brain Circulation Conference, to be held in Kyoto, February 6-7th, 2015. I would like to thank the organisers for inviting me to present at this meeting, especially Toshikazu Tanaka.

conditions may well have developed early in Egypt, particularly as equids were available for certain transport tasks (year-round work). In present-day Egypt, almost all animals used for ploughing are cows.

Some ancient Egyptian illustrations show cattle pulling sledges. In the Papyrus of Ani (about 1300 BP), oxen are seen pulling a funeral sledge (Rossiter 1984). Wheeled ox-carts do not appear to have been common in ancient Egypt although drawings and models of ox-carts in nearby Mesopotamian civilisations date back about 5000 years ago (Haudricourt and Delamarre 1955).

The use of horses in Egypt appears to have followed the use of donkeys (Blench 2000). They do not appear until the about the 13th Dynasty [ca. 1800-1750 BC]. Many Egyptian illustrations 3000-3500 BP show horses hitched in pairs pulling two-wheeled chariots. A ceremonial chariot with lightweight spoked wheels was found in the tomb of Tutankhamun (1342 BC). However, there is no evidence that donkeys were used to pull carts in ancient Egypt (Clutton-Brock 1992).

Photo 2. Wooden model of Ancient Egyptian plough



Source: Courtesy British Museum

Water buffaloes were probably introduced into Egypt around 1300 years ago (FAO 1977). Their numbers have grown so that their population in Egypt now equals that of cattle. Buffaloes are used for some ploughing and water raising, but cows (with their superior tolerance of heat) remain the main ploughing animals in Egypt. Water buffaloes have not spread from Egypt to other parts of Africa.

3. Animal traction in North Africa

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. Ethnographic evidence suggests that animal traction technology spread from ancient Egypt both southwards into Sudan and westwards into the Maghreb (Laoust 1918, 1930). The technology was probably widespread along the coast of North Africa by 500 BC (Camps & Spruytte 1985; Camps 1989). Initially all ploughing was with cattle, but once camels were introduced around 0 AD, they were rapidly adopted (Bulliet 1990). Camels are herded for meat, used for riding and pack transport and may be part of tillage operations or irrigation equipment. Photo 3 shows one of the earliest representations of a working camel in North Africa from a frieze in Tripolitania.

Photo 3. Stone frieze of working camel and cattle in Tripolitania



Source: CC

Horses are owned for riding, recreation and pulling carts, and some transport horses also assist with cultivation. Photo 4 shows a modern-day horse-drawn harrow in the Nile Delta. Mules are mainly used for pulling carts and wagons in both urban and rural areas and may also assist with soil tillage. While motorised 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.

Photo 4. Horse-drawn harrow, Egyptian Delta



Source: CC

For the cultivation of heavy soils, notably in the irrigated fields along the Nile, cows remain the main type of working animal. Although ox-carts were used in North Africa in historic times, they are very rarely seen today. Animal-drawn carts in North Africa are almost invariably pulled by equids. Prior to the introduction of tractors in Morocco, some oxen were used for ploughing. However, nowadays there is little economic justification for maintaining oxen that walk quite slowly and are relatively

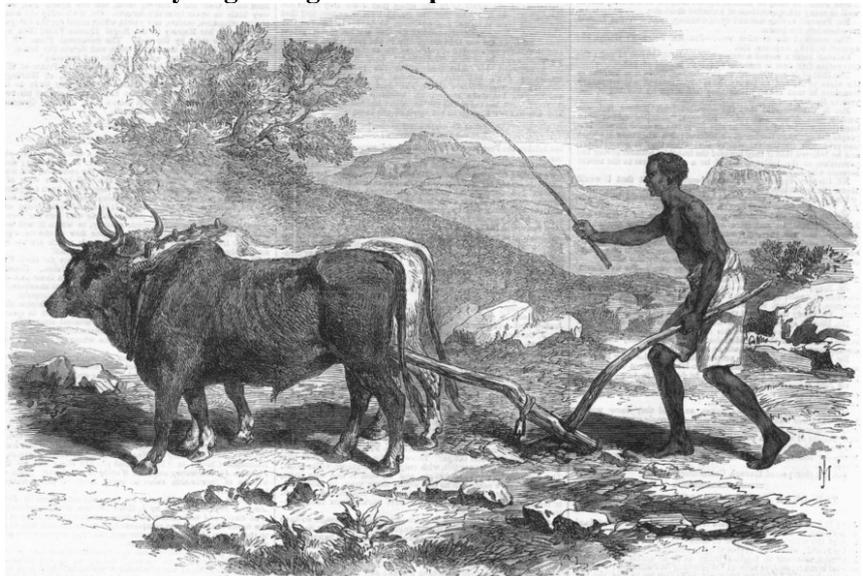
expensive to own. Ploughing is now either performed by tractors or by other animals that have more uses during the rest of the year (horses, donkeys, mules, camels and cows). The displacement of traction animals by mechanised cultivation is strongly related to the growth of capitalist enterprise; south of the Sahara, well-meaning tractorisation schemes have repeatedly failed because a failure to maintain machinery suggests the enterprise was never established on sustainable economic lines.

In the Maghreb region (Morocco, Algeria, Tunisia), pairs of animals tilling the land are almost invariably harnessed with an unusual belly-yoke system characteristic of this region. The belly yoke is a wooden bar suspended from straps around the withers (the beginning of the back) and which hangs under the chests of the two animals without touching them. Historically, farmers ploughed with long-beamed wooden ards, and these are still used in the Maghreb. Short-beamed metal ploughs and cultivators have been slowly spreading during the twentieth century. Since the yoke is suspended a set height above the ground, it can be used to harness animals of different sizes and types.

4. Ethiopia and the Horn of Africa

Ethiopia, as so often, seems to have quite a different history from elsewhere in Africa. The plough characteristic of Ethiopia, an ard that fractures and disturbs the soil, seems to have been introduced following the migrations of Ethiosemitic speakers across from Yemen. Stiehler (1948) suggested the ard plough was introduced 2600-3000 years ago by Semitic-speaking peoples invading from South Arabia. Another view is that the plough was already in use at this time, having spread from Cushitic-speaking peoples of Nubia in northeast Sudan (Simoons 1965). The claim in Ehret (1979) that linguistic evidence suggests that the ard was in use 'several millennia' before the

Photo 5. Early engraving of Ethiopian *maresha*



Source: CC

South Arabian invasion, which might make the Ethiopian plough the oldest in Africa, simply false. The Amharic term for plough, *maräša*, ማረሻ, has been borrowed into all the main languages of Ethiopia. Even where this term is not used, the local terms for plough turn out to be constructs ('hoe of cow', and so on), which indicate its recent adoption. Barnett (1999: 24) canvasses ideas of introductions from Arabia or Egypt around 2000–1000 BC, but the linguistic evidence suggests a more recent date. Neither the design of the Ethiopian plough nor its name points to external origin, and it is quite likely it was constructed locally through stimulus diffusion; that is, a plough seen elsewhere was redesigned for local conditions.

The single-handed Ethiopian scratch plough is very different in design from the two-handed plough used in Egypt. The *maresha* is more like a spear, pulled through the soil using a long beam. Goe (1987) reviewed several theories concerning its origins or introduction. Drew (1954) reproduces rock paintings from Eritrea that clearly show a *maresha* plough, but their dating is uncertain. 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 development programmes have attempted to introduce short-beamed steel ploughs since the 1950s, there has been almost no adoption of these. The ploughing animals are generally oxen, yoked in pairs with withers yokes, and controlled by a single person.

Photo 6. Ethiopian *maresha* in use



Source: CC

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) (Kitchen 1993) and exploring the routes across the Western Desert into Central Africa. Donkeys have long been important in the history of the salt trade in northern Ethiopia (Wilson 1976, 1991) and are represented in traditional Ethiopian art. Pack donkeys are extremely important in both rural and urban economies. 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. Horses and mules are mainly used for riding. Simple passenger-carrying two-wheel horse-drawn carts became common in Ethiopian cities around the middle of the twentieth century. They were banned by the authorities from central Addis Ababa around 1963, but remain common in other towns. They are almost invariably used as passenger taxis for hire, and there is negligible use of horse carts for freight purposes.

Donkeys have not been traditionally used for pulling carts. However, an innovative design of low-cost donkey cart started to be seen in the Rift Valley of Ethiopia in the 1970s. 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 twentieth century, these carts were 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 and contrasts with the low uptake of the more expensive steel carts promoted by government agencies in the 1980s and 1990s.

5. Animal power in sub-Saharan Africa

5.1 General

All forms of animal traction have an ancient history in North Africa and, in theory at least, the plough could have been transmitted across the Sahara with the caravan trade along with food crops and irrigation techniques (Bulliet 1990). Indeed, as Bernus (1981: 286) points out, simple camel-drawn ground-preparation tools (*ashek n egdri*) are used in Saharan oases by the Tamasheq. Ethiopia, together with neighbouring 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. At the end of the nineteenth century, and in the early years of the twentieth century, animal power played a crucial role in the agricultural, mining and transport sectors of the growing economy of South Africa. Animals were used for urban and rural transport, they worked in the mines and they ploughed for both large-scale (white) and small-scale farmers.

5.2 Ploughs

Although there is a case for the diffusion of some implements across the Sahara, to a large extent sub-Saharan Africa seems to have followed its own path with respect to agricultural tools (Blench 2014). The most notable example of an implement that failed to spread is the plough; ploughs were unknown in sub-Saharan Africa until introduced by missionaries and the colonial authorities in the 1920s. Photo 7 shows a typical ox-plough in Sierra Leone, adopted during the colonial era. Various factors that may be responsible for the late adoption of ploughs in sub-Saharan Africa. In much of the continent, different tribal groups have specialised 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 plough. 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. Only when human population pressures necessitate short fallow periods, is it justified to clear the land of roots and stumps and to plough. Thus, in much of sub-Saharan Africa, the necessary social, environmental and agricultural conditions to favour the use of ploughs have not really existed. Indeed, there are still parts of Africa where the plough 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 (Starkey 1986a, 1992; Pingali, Bigot and Binswanger 1987).

Photo 7. Ox-plough, Sierra Leone



Source: CC

Another important constraint on the spread of the plough 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 Sub-Saharan Africa meant that hunting pressure on wild animal vectors was insufficient to eliminate reservoirs of trypanosomiasis (Blench 1999). 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 (Blench 1987; Bourn et al. 2001). It is possible that both wheeled vehicles and ploughs were introduced experimentally in prehistory, but failed due to disease constraints. Photo 8 shows petroglyphs from Dhar Tichitt clearly representing ox-carts, which were no longer present by the era of early European contact, pointing to a failed experiment. 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.

5.3 Carts

Traders and colonial powers had contact with Africa's offshore islands and ports, before the hinterland was colonised. In most countries, the use of animal-powered wheeled transport was first introduced in coastal and river ports in the seventeenth, eighteenth or nineteenth centuries (Law 1980). In a few cases where social, economic and ecological conditions proved favourable, the use of animal-powered transport gradually spread from the coastal region, through the activities of traders, settlers, missionaries and the administering authorities. Animal-drawn cart technology spread inland in South Africa (and neighbouring territories), French West Africa (from Saint Louis) and in East Africa. However, with the notable exception of South Africa (and nearby countries), the introduction of animal power for agriculture was largely a twentieth century phenomenon. In present times, ox-carts have become a crucial element in rural transport across much of the Sahel, in part because of the availability of cheap iron and rubber tyres from the inevitably high numbers of crashed and scrapped vehicles (Photo 9).

Photo 9. Ox-drawn water-cart, Niger



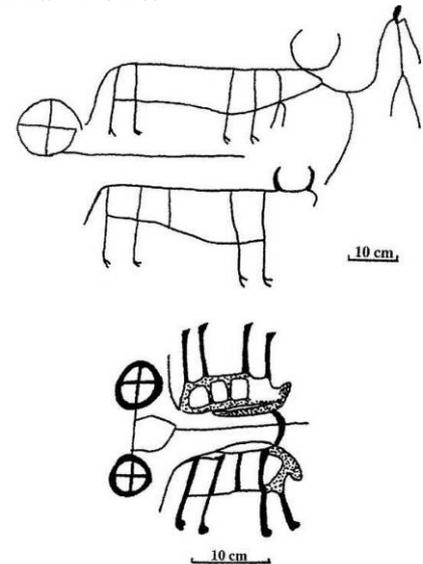
Source: CC

Africa, an infrastructure based on animal-powered transport was developed by miners, traders, missionaries and the administrative and military authorities. Horses were used for riding and military purposes. Transvaal used a mixed team of zebras and mules to pull its coaches. Donkeys worked in the mines, and donkey carts were common for local transport. Following the outbreak of rinderpest in 1896, donkeys became important for a time for long-distance transport. Caravans of wagons, each pulled by 16-20 donkeys carried produce and goods in what is now Zimbabwe.

5.4 Sledges

The origin and spread of the animal-pulled sledge is not clear. Simple triangular sledges are now very widely used throughout eastern and southern Africa, in parts of Ethiopia and also in Madagascar. However, they are seldom, if ever, seen in West Africa, where they should be similarly useful as basic and cheap means of transporting materials. There is a wide range of sledge types and this suggests there has been considerable farmer innovation in the design of sledges. Three main types have been identified in Zambia, the dug-out log (*umulangu*), and the flatter carved board (*mula*) and the simple Y-branch (Müller 1986). There is some uncertainty as to whether or not the *umulangu* was in use in Zambia prior to the arrival of the traders and missionaries in the nineteenth century (Müller 1986). However, despite the different sledge designs, they are almost always pulled in a similar way. Oxen are used in pairs (one or more pairs) to pull the sledges by means of a steel chain attached to a standard withers yoke. This suggests that the present system of pulling sledges has spread in post-colonial times.

Photo 8. Ox-cart petroglyphs at Dhar Tichitt



Source: redrawn from Holl (1986)

When the Dutch settled in the Cape in 1652, they bartered goods for oxen and used these to pull carts. Ox-carts transported goods to and from ships and building materials for the new settlement. Horses, mules and donkeys were imported within a few years and were also used for transporting people and goods. Although there are reports of settler farmers ploughing with oxen as early as 1657, crop production was not a major activity of the early colonists. Hunting, trading and stock farming were more important. For these activities, the colonialists built four-wheel wooden wagons, pulled by large teams of oxen (Burman 1988; Joubert 1995). Behind the trekking settlers in Southern

Madagascar is partly Austronesian in culture, and animal power has been long-established in SE Asia. However, the islands of SE Asia where the Malagasy originated had not generally adopted animal traction Van Nhieu (1982) suggested that animal traction was introduced into Mantasoa region during the regency of Queen Ranavalona 1 (1828-1861), broadly in line with the period of 1850-1880 mentioned by Bigot (1985). The animal-powered soil tillage implements in use in Madagascar today are steel ploughs, based on European industrial designs. Had there been a long-standing use of animal power for soil tillage prior to the nineteenth century, there should be some evidence of traditional long-beamed ploughs, such as those still widely used in North Africa, Ethiopia, the Middle East and South Asia. Although such implements do not appear to have been used, animal power was used for soil preparation in the rice fields. In the traditional *piétinage* system, cattle are made to walk round and round in rice fields, thereby creating a puddled soil suitable for rice cultivation. Wooden ox-carts with large, spoked wheels became important for trade within the island in the nineteenth century, and such carts are still widely-used today. The technology for making wooden cart wheels was also established in Zanzibar and Pemba islands, although it does not seem to have transferred to the East African mainland.

Lamu island, off the Kenyan mainland, was for a long time an important Arab trading entrepot, and pack donkeys were widely used for local transport. In the nineteenth century, European traders, explorers, settlers, military expeditions and missionaries set off to explore the mainland from a variety of bases on the east coast including Lamu, Pemba, Zanzibar, Tanga and Beira. Animal-drawn carts (generally ox-carts) were used for establishing forts, trading posts, settlements and mission stations. Individual early European traders, settlers and missionaries may have used animals for crop cultivation in East and Central Africa in the nineteenth century. However, the impact of such examples was small, for by the beginning of the twentieth century, animal traction was still largely absent from the agricultural systems in these countries.

6. Stationary applications of animal power

In Egypt there has been a long history of using work animals to raise water for irrigation (Nicholls 1918). The ingenious *sakia* (ساقية, *sāqīya*), irrigation wheel first appears in a Hellenistic tomb painting in Ptolemaic Egypt from the 2nd century BC (Stead 1986). It shows a pair of yoked oxen driving a compartmented waterwheel, also depicted for the first time (Olesen 2000). Traditional *sakia* wheels have internal spirals, allowing them to efficiently raise water that is within two metres of the surface (Löwe 1986). They remain in occasional use in present-day Egypt

Photo 10. Donkey-powered waterwheel, Egypt



Source: CC

Photo 11. Threshing tef in Ethiopia



Source: CC

and may be turned by cows, buffaloes or donkeys or less commonly, horses or camels (Photo 10).

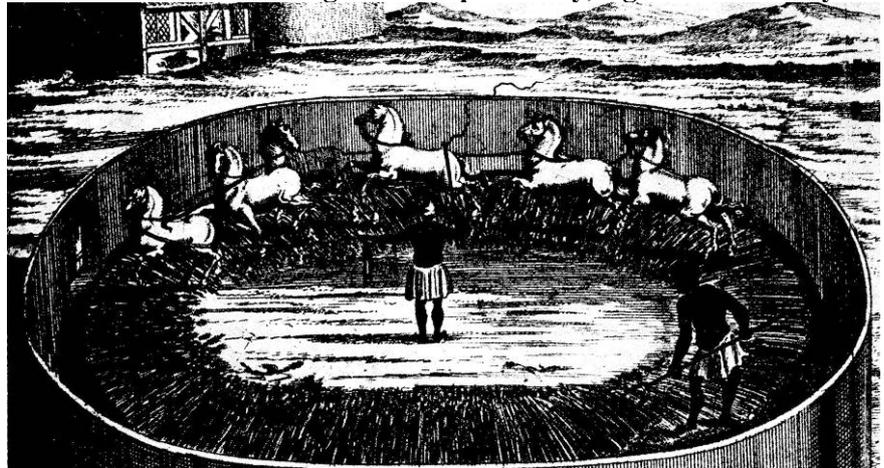
Animals may also be used to pull water from wells. In North Africa, mote systems are employed, where an animal walks down a slope and pulls on the rope attached to a leather water bag (Löwe 1986). Some motes have self-emptying systems. Descending the slope makes it easier for the animal to raise the water. All types of work animals may be used. Elsewhere, notably in circum-Saharan Africa and the Horn of Africa, animals are also used to draw water from simple wells. Such systems are most common in pastoral areas, where

large numbers of animals must be watered at the same time. Pulleys to ease the workload have only been introduced in recent times and remain susceptible to poor maintenance.

Lagercrantz (1950) has reviewed the use of animals 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. In Egypt, a special threshing sledge, *nōrag*, may be pulled by the animals to accelerate the process. Pigs were used for work in Ancient Egypt, both treading and threshing seed in the eighteenth Dynasty, as Herodotus noted (Zeuner 1963:262). 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. The frontispiece shows the Egyptian threshing sledge, the *nōrēg*, which is confined to the Nile Delta and parts of modern Tunisia.

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.

Photo 12. Horse-threshing in the Cape Colony, eighteenth century



Source: Reproduced from Lagercrantz (1950)

Animal threshing occurs in both the Canaries and the Azores, probably as a result of European introductions. It was also brought to South Africa by European settlers, and Lagercrantz (1950:23) reproduces an early eighteenth century engraving of horse-threshing in the Cape Colony (Photo 12). Through the agency of missions, animal threshing spread to Namibia and to the Sotho-speaking areas.

Photo 13. Donkey-powered olive mill in the High Atlas



Source: CC, Photo by Jerzy Strzelecki

Animal power is used for milling in the Maghreb and in a band stretching from Somalia to Chad. Oilseeds such as olives, 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 crushes the seeds, extracting the oil. Photo 13 shows a donkey-powered olive mill in the High Atlas. The animals are often oxen but camels may be used in Sudan and Somalia. This grinding technology is pre-colonial but its exact origin is unknown. Similar mills are found in the Seychelles and on the Indian sub-continent, but they have not spread elsewhere in sub-Saharan Africa.

Horses are not used as work-animals in Nigeria, with the exception of powering a specific device, the sugar-mill, *masankwela*. This crushes the sugar cane, and the liquid is boiled to produce heavy cakes of brown sugar. Goodban (1944) describes the operation and economics of sugar-crushers near Zaria during the Second World War. At that time, the production of brown sugar was very profitable, because of the disappearance of imported sugar. The virtual collapse of sugar-crushing followed the widespread availability of modern 'white' sugar in the 1980s. The horse-mills that still survive are dependent on the market for cakes of brown sugar that are still popular in traditional Hausa areas. In 1991 there were some five mills still operating on a seasonal basis in Bauchi, Sokoto and Katsina States (RIM 1992). The millers have a number of operating sites and they move from one to another on a seasonal schedule. They buy up stocks of cane in each region and then crush it, make cakes and transport them away for sale; then continue to the next site.

7. Colonial promotion of animal traction in agriculture

During the first half of the twentieth century, the colonial authorities or agricultural production companies in parts of sub-Saharan Africa attempted to introduce animal traction for cultivation. The aim was to increase agricultural production in the colonies by teaching the indigenous population how to use work animals for ploughing. One of the earliest schemes took place in 1900 in Togo, then under German control. Hoping to increase cotton production, a team of black American experts from Alabama were hired by the Berlin Colonial Economic Committee to introduce animal power for cultivation. Although the idea of animal traction was not totally rejected, there was little adoption in Togo at that time. Even with further attempts at introduction in the 1950s, there were probably fewer than 1000 ploughs in use at the time of independence in 1960 (Westneat, Klutse & Amegbeto 1986).

In Guinea, the French colonial authorities discussed the idea of using animal power in local farms as early as 1910 (Bigot 1989). One aim was to increase agricultural production: at that time Guinea exported both groundnuts and rice. A pilot farm, *ferme indigène*, was established in 1914, in the Niger valley near Kankan. Indigenous N'dama oxen were trained and found to work well. By 1931, there were reported to be 5700 ox-ploughs in Guinea, compared with 2000 ploughs and cultivators in the whole of the rest of Francophone West Africa, including what is now Benin, Burkina Faso, Côte d'Ivoire, Mali, Mauritania, Niger and Senegal. The very rapid growth in animal traction slowed in the 1930s as the policies and practices of the support services (credit and equipment provision) varied, and certain ecological limits to animal traction were noted (Bigot 1989).

Information concerning the success of the animal traction scheme in Guinea reached neighbouring Sierra Leone, then under British administration. In 1927, the British authorities banned the domestic slavery practised by the Mandinka people. The Mandinka elders asked how they could cultivate their rice fields without their traditional labour supply. The Sierra Leone Department of Agriculture, based at Njala, had already experienced problems with the first few tractors introduced, and so suggested the use of animal power. This was a new and innovative technology in the farming systems of Sierra Leone, where human labour was the only power source. Three Sierra Leonean agricultural instructors were sent to Kankan in Guinea in 1928 to learn how to work with N'dama oxen. One of the original agricultural instructors sent to Guinea reported that his great grandchildren were ploughing his farm using oxen (Starkey 1982).

Animal traction did not spread as fast in Sierra Leone as it did in Guinea for two main reasons. The area of introduction in Sierra Leone was on the southern margin of the main cattle zone in West Africa, where cattle were few and ecological conditions were not particularly favourable. Secondly, work oxen were being introduced for basic food production, and not for an export-oriented cash crop. Thus, there was little financial incentive on the part of the authorities or the private sector to provide the same level of back-up services (produce marketing, credit, supply of equipment, training, animal health care) which had proven essential in

Guinea. Both the contemporary reports of the Department of Agriculture and interviews with farmers suggested that shortage of equipment and lack of a support programme restricted the speed of adoption. Although animal traction had been firmly established in Sierra Leone since 1928, its expansion was slow until there was further formal promotion. Promotional schemes in the 1950s and again in the 1980s led to further adoption, encouraged by support services such as equipment provision, credit and training (Starkey 1981,1994a; Bangura 1990).

In Uganda, colonial farmers and the British authorities introduced ox-ploughs for cotton production in the Teso District at the beginning of the twentieth century. Uptake was rapid, with a favourable combination of training centres, available animals and implements and a cash crop. A variety of implements were tested, including wooden implements from India. Eventually, the British Ransome plough was considered the most suitable. Following the success in Teso, the technology spread in neighbouring Lango district, where there were 68 ploughs in use in 1930. This increased to about 2500 in 1940, 10,000 in 1950 and 15,000 in 1960 (Kinsey 1984).

In 1903, European farmers and traders started to settle in the Machakos District of Kenya. They used heavy ploughs that required teams of six animals. There was no formal promotion of animal traction, but ploughs were available from trading stores. Some local Kamba farmers apparently started using ox ploughs in 1910. By 1912, the District Commissioner had noted an increase in farm size and cash-crop production associated with the innovation. By 1933, there were 600 ploughs in use. The lighter Ransome Victory plough became available in the 1940s, and became the most popular implement. By the late 1950s, almost all farmers in the District were making use of animal power, through ownership or hire. This high rate of adoption had taken place as a result of private-sector sources of equipment and without any formal extension or credit programmes (Tiffen, Mortimore and Gichuki 1994).

Because of its large rural population and importance within the colonial economic system, Nigeria has been an important focus of both livestock development and experiments to introduce and improve animal traction (Blench 1987, 1997). The main types of traction in Nigeria are: ploughing, carting and drawing water. The species used are cattle, camels, donkeys and horses (Blench 1995 & Table 1). Of these, cattle, camels and donkeys are used for ploughing; cattle are used for carting; cattle, camels and donkeys for drawing water; and horses are used for turning sugar-mills. These latter are of virtually no economic significance.

Table 1. Species used for Animal Traction in Nigeria

| Use | Camels | Cattle | Donkeys | Horses |
|--------------------|--------|--------|---------|---------|
| Ploughing | + | + | v. rare | v. rare |
| Carting | + | - | v. rare | - |
| Water-Drawing | + | rare | + | - |
| Cane-Crushing | - | - | - | + |
| Pack Animals | + | + | + | - |
| Personal Transport | + | + | + | + |

Walker (1979) provides an abbreviated history of the livestock services and Tiffen (1976) describes the operation of arable farming extension in the post-colonial era. The encouragement of animal traction has a long tradition, described in King (1939) and Corby (1941) for the pre-Second World War period. The motivation for this type of extension was essentially the encouragement of smallholder cash-cropping, particularly cotton, as the trade-name of the locally manufactured plough, EMCOT (= 'Empire Cotton') indicates. The colonial literature on animal traction in Nigeria is mostly concerned with the economic benefits of the introduction of the plough (e.g. Faulkner and Mackie 1933; King 1939; Turner 1940; Laurent 1968). In most of this literature, plough-users are referred to as 'mixed farmers'. This term only later came to have the more general meaning of farmers practising a variety of integrated livestock/cropping enterprises. Tiffen (1976) and Mirchalaum (1976), respectively, describe the introduction and spread of ploughing in Gombe Emirate of Bauchi State and Longuda District of Gongola State. Blench (1987) analysed the constraints on animal traction along its southern limit, based on interviews with former plough-users. Credit for ox-ploughing was established as early as the 1930s; loans were generally for the plough itself, for trained oxen and sometimes for a cart. These loans were made by the 'Native Authority', approximately equivalent to the present Local Government system, established in the post-colonial era. This practice was continued into the late 1970s in certain places, notably Adamawa.

Carts were introduced into Nigeria later than ploughs, and they seem never to have enjoyed quite the same degree of success. Haynes (1965) describes some of the early models of ox-carts. The use of carts is much less widespread than ploughs even in northern Nigeria. In part this is because ploughs were introduced and their use extended for a specific economic motive, the cultivation of cotton. Carts were introduced for more disinterested reasons, and only in certain areas. The diffusion of carting came to a virtual halt at the end of the 1970s with the development of cheap transport networks based on motor vehicles for both people and produce.

Similar schemes to promote animal traction were initiated by the colonial authorities in many sub-Saharan African countries between 1900 and 1960. The success tended to be very localised, and associated with semi-arid areas where there was a clear market for produce. By the time of independence, there were still some countries and many administrative regions in which animal traction was very rare.

8. Post-independence promotion of animal traction

Most sub-Saharan African countries achieved independence from the colonial authorities in the decade 1957-66 (1974-75 for the Portuguese colonies). In some countries, it was assumed that the rapid tractorisation seen in Europe in the previous decades would follow swiftly in Africa. For this reason, many Ministries of Agriculture placed initial emphasis on the import of tractors. Following the failure of most smallholder tractor hire schemes of the 1960s and 1970s, together with the increases in the oil price in the 1980s, animal traction became a major feature of development strategies in many countries in sub-Saharan Africa. Donor-supported development projects promoting animal traction became increasingly common from the mid 1970s to late 1980s. However, in a few areas, animal traction spread rapidly in the immediate post-independence period.

Senegal provides an example of one of the most dramatic increases in the period immediately after independence in 1960. In Senegal, horses and donkeys had been used in the ports and towns since the nineteenth century (Law 1980a). In the early twentieth century, some of the transport horses were brought to work on pilot farms, pulling tine cultivators (*houes*) rather than ploughs. During the 1920s, the agricultural authorities concentrated on promoting the use of horses and tine cultivators to assist in the production of groundnuts as an export crop in the groundnut basin of Thiès. The *Programme Agricole* was launched in 1958 (the year Senegal achieved internal self-government). Several institutions were created to support farmers through credit, training, provision of animal traction implements and other farm inputs and the marketing of crop products. The programme ran until 1980, and led to the rapid adoption of animal traction technology. To help meet the demand for animal traction equipment a local factory was established by a group of French firms. Although the programme was highly successful, funds ran out in 1980, and the period of rapid growth ended. With the ending of the credit, sales dropped and the factory went bankrupt, although it was subsequently re-launched under a new name. However, the technology had been transferred to the rural population, and it remains in use to this day. The technology has been gradually spreading into new areas, for example, into the rice-production systems of the southern province of Casamance (Fall 1990).

A similar post-independence pattern of very rapid adoption of animal traction based on a cotton crop was seen in Chad (BDPA 1966). Although there were long-standing traditional systems of using animal power (packing, riding, milling) there are no reports of ploughing before the 1950s. Promotion by government agencies started just before independence in 1960, when there were only about 100 ploughs in use. By 1966 there were 7000, and by 1990 this had risen to about 115,000. This rapid rate of adoption was assisted by credit (almost all ploughs were bought with credit), the provision of inputs and a market for cotton. The proximity of northern Cameroun may also have been important, for by the time the promotional scheme started, news of an earlier, successful campaign in that country had been widely circulated (Starkey 1993).

There were many other examples of rapid localised growth of animal traction in West Africa resulting from promotional schemes, for example, in the semi-arid cotton zones of Burkina Faso, northern Cameroun, Côte d'Ivoire, Ghana and Guinea Bissau (Bonnet, Guibert, Robinet and Lhoste 1989; Peltre-Wurtz and Steck 1991; Starkey 1991; Mahdavi 1992; Houssou et al. 2013). As a result of the various public-sector initiatives and farmer-to-farmer diffusion, tillage with animal power had become part of the normal farming systems in most of semi-arid West Africa by the 1990s. The use of animal-drawn carts, pulled by oxen or donkeys also increased dramatically. In many places where the use of animal power for cultivation or cart transport had been

non-existent or very limited prior to 1960, 60-95% of the rural population were using draught animals by the 1990s.

Further south, in the more humid parts of West Africa, there were some other examples of promotional schemes in the 1970s and early 1980s that resulted in low adoption rates. Disappointing schemes tended to be near the margin of the forested area, for example southern Guinea, Sierra Leone, Ghana, Togo and the North-western Province of Cameroun. This proved to be a marginal zone for animal traction at this stage. Some projects faced major problems with animal sickness, and mortality rates as high as 50% were cited. The de-stumping of land to allow ploughing was a serious labour constraint, and one that did not always seem justified. Some projects blamed social constraints, such as lack of tradition of animal husbandry and unfamiliarity with cattle. This overlooked the fact that similar constraints were rapidly overcome elsewhere, provided animal traction was economically profitable, assisted by supporting services, including credit and animal health and a good market for crops grown (Munzinger 1982; Starkey 1986).

The situation in the forest-cropland interface zone was changing quite rapidly in the last two decades of the twentieth century. The boundary of the semi-arid zone appeared to be moving southwards in West Africa, and deforestation was increasing in all zones. The ecological and disease balances appeared to be changing. While the overall adoption of draught animals in the semi-humid zone was still low, compared with the semi-arid zone, animal traction was often increasing rapidly from a low base. For example, in the 1980s, numbers of draught cattle increased from 2000 to 38,000 in Côte d'Ivoire and 2000 to 12,000 in Togo (Westneat, Klutse and Amegbeto 1988; Starkey 1992).

In eastern and southern Africa, immediate post-colonial promotion of animal traction during the 1960s and 1970s involved mainly national Ministry of Agriculture extension services. At this time, while national agricultural engineering services were placing emphasis on the development of tractor hire services, some centres were established to develop new 'appropriate technology' implements and carts. Some centres were established by national Ministries, while others were developed by non-governmental organisations: few worked closely with the end-users and few produced implements that were adopted by farmers. By the 1980s, national 'top-down' extension programmes and services appeared to have limited impact, and there was increased emphasis on area-specific, donor-assisted development projects. Some integrated projects had specific animal traction components, some of which proved highly effective. By the 1990s, there was increasing emphasis on participatory and farming systems approaches and linking projects that were working on animal traction (networking).

In Tanzania, ox training centres were established throughout the country to promote animal traction in the 1960s, 1970s and 1980s. Little attempt was made to concentrate animal traction extension in areas of greatest potential. An appropriate technology centre was established and an ox-plough factory was opened in 1970. Animal traction continued to spread slowly in the country, mainly through farmer-to-farmer diffusion of knowledge. In the 1980s, donor-assisted projects with animal traction teams worked in several parts of the country including Mbeya, Tanga and Maswa, and attempted to identify and alleviate some of the constraints to the spread of animal traction, including the provision of credit, and the supply of implements, carts and animals (donkeys in Tanga region). In 1991, a national network was formed to link animal traction programmes in the country (Sosovele 1991; Starkey and Mutagubya 1992; Starkey and Grimm 1994).

At the time of independence in 1964, animal traction in Zambia was mainly found in the Southern Province. During the colonial period, the spread of the use of ox-ploughs had been assisted by several favourable conditions. The smallholder farmers who were cultivating crops in the good agricultural zone had a tradition of cattle ownership. Ox ploughs were well known, having been used on colonial farms since the beginning of the century. Ploughs and spare parts manufactured in what is now Zimbabwe were readily available through private sector stores. There was a market for produce along the line of rail. The technology had penetrated a little into some other areas, notably to the west and the east, probably through farmer and worker migration and/or the influence of various missions and traders. In the 1970s and 1980s, donor-supported integrated development projects in several regions started to actively introduce animal traction, through extension, credit and assistance with the provision of inputs. Some appropriate technology organisations developed and promoted wooden-wheeled carts (which were largely rejected). In some areas, uptake of ox power was rapid, and one project in the northwest had particular success in introducing animal-powered transport by providing credit and a supply

of ox carts. In the more humid areas, where few cattle were owned, uptake was low, and mortality among the cattle acquired from other regions was high. In 1985, a national animal draught power programme was launched. This helped co-ordinate animal traction work in the various projects, as well as related research, implement production and training activities (Starkey, Dibbits and Mwenya 1991; Löffler 1994).

9. Animal traction and development practice

While official extension services and projects have proved successful at introducing animal traction for the first time, they have been less successful with 'improvements'. Many innovative implements and harnessing systems have been developed and promoted by government services in Africa with negligible acceptance and adoption by farmers. Starkey (1988) in his delightfully-titled 'Perfected yet rejected' details the history of the animal-drawn wheeled tool-carrier, a triumph of engineering, and perfect example of how success stories spread despite being quite untrue. Starkey found no evidence that the wheeled tool-carrier was adopted anywhere by any farmer except on a trial basis. Much the same could be said about the ox-drawn scoop supposedly to excavate ponds in the highlands of Ethiopia (Astatke et al. 1986). Despite successful trials, and an abundant literature, no Ethiopia farmer ever adopted the scoops.

Wherever there is a long history of animal traction, including North Africa and Ethiopia, one person works with a team of animals. In areas of introduction, animals may not be well-trained in the initial years and farmers may lack confidence. Thus, immediately after the adoption of animal power, between two and four people may work with a single pair of animals. In much of sub-Saharan Africa, it is still common for at least three people (one may be a child) to work with animals in the field. Although extension services are meant to train farmers how to adjust ploughs 'properly', the vast majority of ploughs in Africa are not adjusted and used according to conventional agricultural engineering wisdom. In contrast, many innovations that have spread, such as use of donkeys or cows, have done so despite the disapproval of extension services.

When animal traction is first adopted, the animals are generally only used for primary soil tillage. The mechanisation of subsequent operations such as weeding may not follow for many years. Farmers are generally reluctant to allow their animals into fields with crops, lest they damage them. However, weeding is a labour-intensive operation, and animal-powered weeding is becoming more common in most African countries. In countries and areas with long experience of animal power, including southern Mali, Senegal, South Africa and Zimbabwe, the majority of animal-using farmers now weed with animal power. In other areas, including much of Malawi, Tanzania and Zambia, only a minority (albeit an increasing one) use weeders. While the introduction of weeding technology has sometimes been associated with a specific extension programme, in several areas weeding appears to have developed as a result of farmer-innovation. For example, in the Machakos area of Kenya, farmers weed using their ploughs (Tiffen *et al.* 1994).

Oxen are generally used when animal traction is first adopted which makes sense when animals and feed resources are plentiful. Cattle herds produce surplus male animals and cows are mainly valued for their reproductive and milk-producing capacities. Cows may replace oxen when animals are in short supply or expensive, when farming systems intensify, when feed resources are short and/or when work operations are light or highly seasonal. Cows are used widely in Egypt and North Africa and an increasing use of work cows has been reported in Senegal, Zambia and Zimbabwe. Such innovations are generally farmer-led, and not the result of extension programmes (Lhoste 1983; Starkey et al. 1991; Starkey 1994b).

In most sub-Saharan African countries (with the notable exception of Senegal), oxen were promoted and used as the main work animals. Horses were of high status and expensive and in tropical Africa generally only thrived in near arid or highland areas. Donkeys were considered too weak to plough, and were mainly used for pack transport. However, the range of the donkey is spreading in much of Africa. This expansion has been associated with changing climatic and agro-ecological conditions, including droughts and deforestation. Donkeys are increasingly used for pulling carts, for which they are well-adapted. In many cases, they are taking over from oxen for cultivation, for example in The Gambia, and they are becoming more important in Namibia, South Africa and Zimbabwe. The move from oxen to donkeys has generally been a farmer-led innovation, which has sometimes been ignored or actively discouraged by agricultural authorities (Starkey 1987, 1994b, 1995). The heavy ploughs used by farmers in Nigeria have generally discouraged the adoption of donkeys as traction animals, but light custom implements are made in Niger, and some farmers have been importing these to facilitate a switch to donkeys. A related trend is the increasing use of camels for ploughing. A single camel

can pull a heavy plough, with only an improvised rope harness, and works faster than a bovine. Camels eat a wide variety of plant foods including the thorns characteristic of degraded landscapes and thus the farmer is under less pressure over feed resources. As a consequence, camels are being used by farmers increasingly further south in semi-arid West-Central Africa. Their only disadvantage is that they do not reproduce in these regions; when a camel is unable to work, it must simply be replaced.

Animals are not only being used increasingly for tillage in sub-Saharan Africa, but also for transport. In much of Africa, head-loading has been the main means to transport for domestic water, fuelwood and market produce. But in semi-arid sub-Saharan Africa, animal-drawn carts are being used increasingly for trade, farm and domestic transport and local hire. In addition to within-village work, animal-drawn carts often deliver and distribute the goods that are transported to and from towns by motor vehicles. Motor vehicles are on the rise for transport of people and goods in both rural and urban areas. The light motorbike is now very common for transporting farm produce both from the farm and onwards to collection markets. As Seignobos (2014) shows, its flexibility allows cash crops such as cotton to be transported long distances to market. The two systems will co-exist for some time as access to motorised transport is highly dependent on the market economies of individual countries and external factors such as the price of fuel and spare parts.

In areas of Africa where agricultural land is privately owned, the pattern of tractor mechanisation has been similar to that of other parts of the world. Tractorisation has been associated with large and increasing farm sizes. Where farmers have access to large areas of land suitable for crop production, tractor power is tending to replace animal power for primary cultivation. This trend has been seen in the second half of the twentieth century in several countries with large-scale farmers, including Kenya, Morocco, South Africa and Zimbabwe. Ironically, Zimbabwe is a good example of how political developments affect rural economies and thus households. Since the 1990s, almost all large-scale farmers in Zimbabwe have been driven off the land, which has been redistributed either to African farmers or cronies of the ruling ZANU-PF. The tractors which used to dominate tillage of larger farms have largely disappeared and the faltering economy has meant they are not replaced. As a consequence, Zimbabwe may well be one of the few countries where animal power is again on the increase.

Photo 14. Motor-cycle taxi in Liberia



Source: CC

A major factor which has transformed rural transport and been responsible for the rapid decline of the donkey and other equids is the availability of cheap motorbikes. In the 1960s and 1970s these were principally Japanese in manufacture and rarely

cheap enough to become mass transport in rural areas. However, the 2000s saw the importation of Chinese brands on a very large scale. Often priced at under \$500, these have become the workhorse of rural Africa in many parts of the continent. For carrying crops from the farm, moving between villages, carrying patients to hospital and acting as urban taxis (Photo 14), they have effectively out-competed other transport solutions. Seignobos (2014) describes an intriguing case study where Camerounian cotton farmers used massed motorbike caravans to sell their cotton harvest in Nigeria in 2011, negotiating insecure and hazardous terrain in the process. No work animal is likely to ever be so cost-effective.

10. Current situation and trends

In the early twenty-first century the prognosis for animal traction in Africa is highly uncertain. Starkey (2000) concluded his review with cautious optimism and in the 1990s it seemed likely that animal traction was the sort

of sustainable solution to rural poverty that could and should expand. However, in the intervening decades, much has changed. The key elements can be summarised as follows;

- a) Mismanagement of rural development by ‘experts’ has led to dramatic increases in world food prices, which has had the paradoxical effect of increasing rural incomes
- b) The rise of China has made key technologies such as motorbikes and mobile phones comparatively cheap and thus accessible to rural populations
- c) Inefficient government sector management of agricultural training and supplies has resulted in its privatisation and collapse. This has paradoxically allowed farmers to realise a greater proportion of the monetary value of their crops
- d) Rising insecurity in some parts of the continent has the consequence that traction animals are hard to protect from banditry; fat cows are easy to kill and sell
- e) The marked expansion of counter-season horticulture, at least in parts of West Africa, has meant that farmers invest less in rainfed cereals, a trend accelerated by cheap imports of staples
- f) Spiralling human populations accelerate the trend towards all types of intensive production and the area of extensive rainfed cultivation suited to animal traction is rapidly disappearing.
- g) Rising urban populations are increasingly out of sympathy with institutions such as rural credit, which frequently assisted farmers to buy animals and implements in the past
- h) Development agencies and NGOs are increasingly staffed by career-oriented bureaucrats whose knowledge of agriculture is minimal

For all these reasons, animal traction may have peaked in the 1990s and has been on a gradual slide since that period. This is very difficult to assess, since the main centre for the collation of agricultural statistics, the Food and Agriculture Organisation (FAO), publishes no data on animal traction and its discussion papers are now decades old. This in itself is not evidence that animal traction is disappearing, but evidence must be largely anecdotal, as there is no systematic data collection (as indeed in many other areas of African rural economy).

The picture throughout the continent appears broadly similar. The use of tractors by smallholder farmers to grow normal, rainfed crops is economically unsustainable in many circumstances. It is not possible to predict the long-term future of mechanisation, due to unknown technological developments and changing socio-economic conditions. However, in the immediate, foreseeable future, animal power is unlikely to be rapidly replaced by tractor power in the smallholder sector. Animal power may only be replaced by tractors where large land-holdings are possible and where people consider the economic cost of tractors to be justified for social reasons.

11. Conclusions

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. Animal power for wheeled transport and soil tillage did not spread in sub-Saharan Africa prior to the colonial period. In the past five hundred years, the use of animal-power for wheeled transport spread slowly outwards from ports and colonial bases. The animal-drawn plough was introduced into South Africa by colonists in the seventeenth century, and it spread slowly to neighbouring territories. In most other sub-Saharan countries, it was introduced in the twentieth century by colonial authorities to increase agricultural production. In most villages in Africa, animal-drawn ploughs were introduced in living memory. Many successful colonial and post-independence promotional schemes provided implements, training, credit and marketing channels. Where implements were readily available through private-sector traders, animal traction sometimes spread without additional promotion. Following the introduction of animal traction technology, many innovations were developed and spread through informal farmer-to-farmer processes. At the beginning of the twenty-first century, the use of animal traction has probably peaked in most of sub-Saharan Africa, and probably will not spread and develop further in the foreseeable future. It is possible powered tillage implements similar to those in SE Asia will make a significant impact on African farming systems, just as cheap motorbikes have impacted rural transport.

References

- Astatke, A., Bunning, S. & Anderson, F. 1986. *Building ponds with animal power in the Ethiopian highlands: a manual*. Addis Ababa: ILCA.
- BDPA 1966. *La culture attelée et la modernisation rurale dans le sud du Chad*. Paris : Bureau pour le Développement de la Production Agricole (BDPA).
- Bangura, A.B. 1990. Constraints to the extension of draught animal technology in the farming systems of Sierra Leone. In: Starkey, P. and Faye, A, (eds), *Animal traction for agricultural development. Proceedings of the Third Regional Workshop of the West Africa Animal Traction Network, held 7-12 July 1988, Saly, Senegal*. 324-327. Ede-Wageningen: Technical Centre for Agricultural and Rural Co-operation (CTA).
- Barnett, Tertia 1999. *The emergence of food production in Ethiopia*. BAR International Series 763. Oxford : Archaeopress.
- Bernus, E. 1981. *Touaregs nigériens*. Paris: ORSTOM.
- Bigot, Y. 1985. Quelques aspects historiques des échecs et des succès de l'introduction et du développement de la traction animale en Afrique sub-saharienne. *Machinisme Agricole Tropical*, 91: 4-10.
- Bigot, Y. 1989. Un siècle d'histoire d'une technologie agricole: la traction animale en Guinée. In: *Economie de la mécanisation en région chaude. Actes du IX séminaire d'économie rurale, 12-16 Sep 1988, Montpellier*. Raymond G, Bigot Y and Bordet D (eds), 36-52. Montpellier : Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD).
- Blench, R.M. 1987. *Determinants of Animal Traction adoption in Central Nigeria*. Report to Agricultural Research Unit, The World Bank and the International Livestock Centre for Africa.
- Blench, R.M. 1995. A History of Domestic Animals in Northeastern Nigeria. *Cahiers de Science Humaine*, 31(1):181-238. Paris: ORSTOM.
- Blench, R.M. 1997. *Animal traction in West Africa: categories, distribution and constraints on its adoption and further spread: a Nigerian case study*. ODI Working Paper 106. London: Overseas Development Institute.
- Blench, R.M. 1999. Animal traction in Africa: analysing its environmental impact. In: *Meeting the challenges of animal traction*. P. Starkey & P. Kaumbutho eds. 52-59. Zimbabwe: ATNESA/ London IT Publications. <http://www.atnesa.org/challenges-blench-environment.pdf>
- Blench, R.M. 2000. A history of donkeys, wild asses and mules in Africa. In: Blench R.M. and MacDonald K.C. (eds): *The origins and development of African livestock: archaeology, genetics, linguistics and ethnography*. 339-354. London: UCL Press.
- Blench, R.M. 2014. African agricultural tools: implications of synchronic ethnography for agrarian history. In: Stevens, C.J., S. Nixon, M.A. Murray & D.Q. Fuller eds. 243-257. Walnut Creek, California: Left Coast Press.
- Bonnet, B., Guibert, B., Robinet, O. and Lhoste, P. 1989. Conduite, gestion des carrières et valorisation des bœufs de trait in zones cotonnières (Burkina Faso, Côte d'Ivoire et Mali). In: *Economie de la mécanisation en région chaude. Actes du IX séminaire d'économie rurale, 12-16 Sep 1988, Montpellier*. Raymond, G., Bigot, Y. and Bordet, D. (eds) 132-152. Montpellier: Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD).
- Bourn, David et al. 2001. *Environmental change and the autonomous control of tsetse and trypanosomiasis in Sub-Saharan Africa*. Oxford: Environmental Research Group. Oxford.
- Brewer, D.J., Redford, D.B. and S. Redford 1994. *Domestic plants and animals: The Egyptian origins*. Warminster: Aris and Phillips.
- Bulliet, R.W. 1990. *The Camel and the Wheel*. (2nd Edition). New York: Columbia University Press.
- Burman J. 1988. *Towards the far horizon*. Cape Town: Human and Rousseau.
- Camps, G. & Spruytte, J. 1985. Attelage. *Encyclopédie berbère*, 7: 1035-1043.
- Camps, G. 1989. Araire. *Encyclopédie berbère*. 6:844-848.
- Clutton-Brock, J. 1992. *Horse power: a history of the horse and the donkey in human societies*. Cambridge, Massachusetts: Harvard University Press.
- Corby, H.D.L. 1941. Changes being brought about by the introduction of mixed farming. *Journal of Farm Economics*, 11(3):106-110.
- Drew, S.F. 1954. Notes from the Red Sea Hills. *South African Archaeological Bulletin*, 9:101-2.
- Ehret, C. 1979. On the antiquity of agriculture in Ethiopia. *Journal of African History*, 20: 161-177.
- FAO 1977. *The water buffalo*. Rome: Food and Agriculture Organisation of the United Nations (FAO).
- Fall, A. 1990. Adoption et principales contraintes : la diffusion des équipements de traction animale en Basse Casamance, Sénégal. In: *Animal traction for agricultural development. Proceedings of the Third Regional*

- Workshop of the West Africa Animal Traction Network, held 7-12 July 1988, Saly, Senegal.* Starkey, P. and Faye A (eds) 267-275. Ede-Wageningen: Technical Centre for Agricultural and Rural Cooperation (CTA).
- Faulkner, O.T. and Mackie, J.R. 1936. The introduction of mixed farming in Northern Nigeria. *Empire Journal of Experimental Agriculture*, 4(1): 89-96.
- Goe, M.R. 1987. *Animal traction on smallholder farms in the Ethiopian highlands*. PhD Thesis. Cornell University.
- Goodban, J.W.D. 1944. The Zaria brown sugar industry. *Farm and Forest*, V(4): 185-186.
- Haudricourt, A.G. and Delamarre, M.J. 1955. *L'homme et la charrue à travers le monde*. Géographie Humaine No. 25. Paris : Gallimard. [Republished 1986 by Manufacture, Lyon, France]
- Haynes, D.W.M. 1965. The development of agricultural implements in Northern Nigeria. *Proceedings of the Science Association of Nigeria*, 6:101-107.
- Holl, Augustin 1986. *Economie et société néolithique du Dhar Tichitt, Mauritanie*. Vol. 69. Paris: Editions Recherche sur les civilisations.
- Houssou, N., Kolavalli, S., Bobobee, E., & Owusu, V. 2013. *Animal traction in Ghana*. (No. 34). Washington: International Food Policy Research Institute (IFPRI).
- Joubert, B. 1995. An historical perspective on animal power use in South Africa. In: *Animal power in South Africa: empowering rural communities*. Starkey, P. (ed). 125-138. Gauteng: Development Bank of Southern Africa.
- King, J.G.M. 1939. Mixed farming in Northern Nigeria. *Empire Journal of Experimental Agriculture*, 7:271-298.
- Kinsey, B.H. 1984. Equipment innovations in cotton-millet farming systems in Uganda. In: *Farm equipment innovations in Eastern and Central Southern Africa*. Ahmed, I. and Kinsey, B. H. (eds) 209-252. Aldershot: Gower Publishing.
- Kitchen, K.A. 1993. The land of Punt. In: *The Archaeology of Africa. Food, Metals and Towns*. T. Shaw, P. Sinclair, B. Andah and A. Okpoko (eds), 587-608. London: Routledge.
- Lagercrantz, Sture 1950. *Contributions to the Ethnology of Africa*. Studia Ethnographica Upsaliensia, I. Lund: Håkan Ohlssons.
- Laoust, E. 1918. Le nom de la charrue et de ses accessoires chez les Berbères. *Archives berbères*, 3:4-30.
- Laoust, E. 1930. Au sujet de la charrue berbère. *Hespéris*, 10:37-47.
- Laurent, C.K. 1968. The use of bullocks for power on farms in Northern Nigeria. *Bulletin of Rural Economics and Sociology, University of Ibadan*, 3(2):235-261.
- Law, R. 1980a. *The Horse in West African History*. Oxford: Oxford University Press.
- Law, R. 1980b. Wheeled transport in pre-colonial West Africa. *Africa*, 50(03): 249-262.
- Lhoste, P. 1983. Développement de la traction animale et évolution des systèmes pastoraux au Siné Saloum, Sénégal (1970-1981). *Rev. Elev. Méd. vét. Pays tropicale*, 36 (3): 291-300.
- Löffler, C. 1994. Transfer of animal traction technology to farmers in the North Western Province of Zambia. In: *Improving animal traction technology*. Starkey, P. Mwenya E and Stares J (eds) 354-359, Wageningen: Technical Centre for Agricultural and Rural Cooperation (CTA).
- Löwe, P. 1986. *Animal powered systems: an alternative approach to agricultural mechanization*. Vieweg, for German Appropriate Technology Exchange (GATE). Eschborn: GTZ.
- Mahdavi, G. 1992. Development of animal traction in cotton areas of French-speaking African countries. In: *The role of draught animals in rural development. Proceedings of an international seminar held 2-12 April 1990, Edinburgh, Scotland*. Den Hartog, G. and van Huis, J.A. (eds), 83-87. Wageningen: Pudoc Scientific.
- Mirchalaum, P.T. 1976. *The diffusion of ox-plough innovation in Longuda district of Gongola State, Nigeria*. Department of Geography, Occasional Paper No. 6. Zaria: ABU Zaria.
- Müller, H. 1986. *Oxpower in Zambian agriculture and rural transport*. Socio-economic Studies in Rural Development No. 65, Edition Herodot. Aachen: Rader Verlag.
- Munzinger, P. (ed), 1982. *Animal traction in Africa*. Eschborn: GTZ.
- Nicholls, W. 1918. The saqia in Dongola province. *Sudan Notes and Records*, 1:21-4.
- Oleson, John Peter 2000. Water-Lifting. In: *Handbook of Ancient Water Technology, Technology and Change in History 2*. Örjan Wikander ed. 217-302. Leiden: Brill.
- Peltre-Wurtz, J. and Steck, B. 1991. *Les charrues de la Bagoué: gestion paysanne d'une opération cotonnière en Côte d'Ivoire*. Paris: ORSTOM.
- Pingali, P., Bigot, Y. and Binswanger, H. 1987. *Agricultural mechanisation and the evolution of farming systems in sub-Saharan Africa*. Baltimore: World Bank in association with Johns Hopkins Press.
- RIM 1992. *National Livestock Resource Survey*. [6 volumes] Abuja: Final report to Federal Department of Livestock and Pest Control Services, Federal Government of Nigeria.

- Rossiter E, 1984. *The book of the dead: papyri of Ani, Hunefer, Ahhai*. Geneva: Liber.
- Seignobos. C. 2014. La moto chinoise: une révolution urbaine et rurale. In: *Les échanges e la communication dans le bassin du Lac Tchad*. S. Baldi and G. Magrin eds. 243-262. Naples: Università degli Studi di Napoli L'Orientale.
- Simoons, F.J. 1965. Some questions on the economic prehistory of Ethiopia. *Journal of African History*, 6(1):1-13.
- Sosovele, H. 1991. *The development of animal traction in Tanzania: 1900-1980s*. PhD. Dissertation. University of Bremen.
- Starkey, P. 1981. *Farming with work oxen in Sierra Leone*. Ministry of Agriculture, Freetown, Sierra Leone.
- Starkey, P. 1982. N'dama cattle as draught animals. *World Animal Review*, 42: 19-26.
- Starkey, P. 1986. *Draught animal power in Africa: priorities for development, research and liaison*. Network Paper 14, Farming Systems Support Project, University of Florida, Gainesville, USA.
- Starkey, P. 1987. Brief donkey work. *Ceres*, 20, 6: 37-40.
- Starkey, P. 1988. *Perfected yet rejected: animal-drawn wheeled tool-carriers*. Vieweg for German Appropriate Technology Exchange, GTZ, Eschborn, Germany.
- Starkey, P. 1991. *Animal traction in Guiné-Bissau: status, trends and survey priorities*. Report of a consultancy mission carried out from 22 February to 5 March 1991 in association with Pan Livestock Services, Reading University and Gaptec, Lisbon Technical University. Animal Traction Development, Reading, UK.
- Starkey, P. 1992. Changes in animal traction in Africa and Asia: implications for development. In: *The role of draught animals in rural development. Proceedings of an international seminar held 2-12 April 1990, Edinburgh, Scotland*. Den Hartog, G. and van Huis, J.A. (eds), 11-24. Wageningen: Pudoc Scientific.
- Starkey, P. 1993. *La traction animale au Chad: politiques et approches*. Unpublished report. Oxford : Oxfam.
- Starkey, P. 1994a. The transfer of animal traction technology: some lessons from Sierra Leone. In: *Improving animal traction technology*. Starkey, P. Mwenya E and Stares J (eds) 306-317, Wageningen: Technical Centre for Agricultural and Rural Cooperation (CTA).
- Starkey, P. 1994b. A world-wide view of animal traction highlighting some key issues in eastern and southern Africa. In: *Improving animal traction technology*. Starkey, P. Mwenya E and Stares J (eds) 66-81. Wageningen: Technical Centre for Agricultural and Rural Cooperation (CTA).
- Starkey, P. 1995. (ed). *Animal power in South Africa: empowering rural communities*. Gauteng, South Africa: Development Bank of Southern Africa.
- Starkey, P. 2000. The history of working animals in Africa. In: *The origins and development of African livestock: archaeology, genetics, linguistics and ethnography*. Blench R.M. and MacDonald K.C. (eds) 478-502. London: UCL Press.
- Starkey, P. and Grimm, J. 1994. *The introduction of animal traction in the Tanga Region, Tanzania*. Unpublished report. Eschborn: GTZ.
- Starkey, P. and Mutagubya, W. 1992. *Animal traction in Tanzania: experience, trends and priorities*. Unpublished report. Ministry of Agriculture, Dar es Salaam, Tanzania and Natural Resources Institute, Chatham, UK.
- Starkey, P. Dibbitts, H. and Mwenya, E. 1991. *Animal traction in Zambia: status, progress and trends*. Unpublished report. Ministry of Agriculture, Lusaka in association with IMAG-DLO, Wageningen.
- Stiehler, W. 1948. Studien zur Landwirtschafts und Siedlungsgeographie Aethiopiens. *Erdkunde*, 2: 257-282.
- Tiffen, Mary 1976. *The enterprising peasant*. London: Her Majesty's Stationery Office.
- Tiffen, Mary, Mortimore, M, and Gichuki, F. 1994. *More people, less erosion: environmental recovery in Kenya*. Nairobi: African Centre for Technology Studies.
- Turner, R. 1940. Some economic aspects of the groundnut industry of Northern Nigeria. *Empire Journal of Experimental Agriculture*, 8,29: 39-50.
- Van Nhieu, J.T. 1982. Animal traction in Madagascar. In: *Animal traction in Africa*. Munzinger, P. (ed). 427-449. Eschborn: GTZ.
- Westneat, A. S., Klutse, A., and Amegbeto, K.N. 1988. Features of animal traction adoption in Togo. In: *Animal power in farming systems. Proceedings of workshop held 19-26 Sept 1986, Freetown, Sierra Leone*. Starkey, P. and Ndiame F (eds) 331-339. German Appropriate Technology Exchange (GATE), Eschborn: GTZ.
- Wilson, R.T. 1976. Some quantitative data on the Tigre salt trade from the early 19th century to the present day. *Annali Instituto Università l'Orientale, Napoli*, 36:157-164.

- Wilson, R.T. 1991. Equines in Ethiopia. In: *Donkeys, mules and horses in tropical agricultural development. Proceedings of colloquium held 3-6 September 1990, Edinburgh, UK.* Fielding D. and Pearson R.A. (eds) 33-47. Edinburgh: Centre for Tropical Veterinary Medicine, University of Edinburgh.
- Zeuner, F.E. 1963. *A History of Domesticated Animals.* London: Hutchinson.