Animal traction in Africa: analysing its environmental impact

by

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Abstract

The relationship between the adoption of animal traction and the environment in sub-Saharan Africa has so far been little explored in the literature. The paper argues that analyses should not be divorced from the broader socio-economic matrix of change; that where agricultural projects are involved, there is also a change in both crops and inputs. Similarly, where yields have declined in hand-hoe systems, traction may be a way of increasing surface area cultivated, in order to compensate. Animal traction should also be placed in a comparative frame with hand-hoeing and tractors; often all types of cultivation option have environmental costs.

Introduction

The relationship between the use of animal power, the environment and the sustainability of production systems remains an under-researched topic. There are two main reasons for this:

- chronological: research on all types of animal power is relatively recent
- technological bias: research has tended to emphasise technical aspects over socio-economic and environmental impact.

As a result there is remarkably little concrete information about the environmental impact of animal traction and most of that is anecdotal. There are also strong vested interests against in-depth exploration of these issues. On one side is a substantial NGO interest, promoting various types of 'alternative' technology; animal traction is almost ideal as a 'smokeless' and sustainable intervention. On the other, are large projects intended to increase the incidence of smallholder cash-cropping through animal power, sometimes at the expense of both the environment and food security.

This paper looks at the relationship between environment and farmers' animal power strategies and also the factors that might determine animal power's present-day distribution in Africa. A variety of charges have been laid against animal traction in terms of its impact on the environment; the validity of these are also examined.

Animal power in the context of projects

Throughout most of sub-Saharan Africa, where animal power is not traditional, its spread is strongly associated with colonial agricultural departments and in the post-Independence era, with agricultural development projects (Starkey, 1998). Plows have very commonly been made available at subsidised rates while training and loans are provided to make oxen more accessible to smallholders. Such activities are of course, not entirely disinterested; they reflect a desire to transform agriculture from subsistence into cash-crop production. This was quite explicit in the colonial era; the first plow introduced into Nigeria was the EMCOT ('Empire cotton') plow intended to expand smallholder cotton production to feed the mills of the north of England. This tradition very much continues with the addition of occasional mechanisation (see documentation in Tersiguel (1995) for the 1980s and 1990s in Francophone West Africa). The introduction of animal traction is thus usually bound up with major changes in the cropping system, often switching to high-input cash crops such as maize, cotton and groundnuts with a corresponding tendency to mine rather than manage the soil. In exploring environmental change it is therefore crucial to simultaneously narrate the social and economic pressures on farmers.

Evaluating alternatives

Animal power is never an isolated alternative in the present; it exists within a matrix of costs which include hiring additional hand labour or using tractors. As an investment it also reflects relative security of tenure; if a farmer is unsure about long-term access to land then investing in animal power is often unattractive compared with strategies that turn over cash within a single agricultural year. In other words, the impact of animal power use must be evaluated within the

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matrix of alternatives available to the farmer (see discussion in Munzinger 1982; Guibert 1984; Roupsard 1984; Bigot & Raymond 1991; Tersiguel 1995). For example, plowing on hillsides causes soil loss and increased runoff, but hand cultivation would cause much the same problems. The same is true with mechanical erosion around wells, or along transport routes.

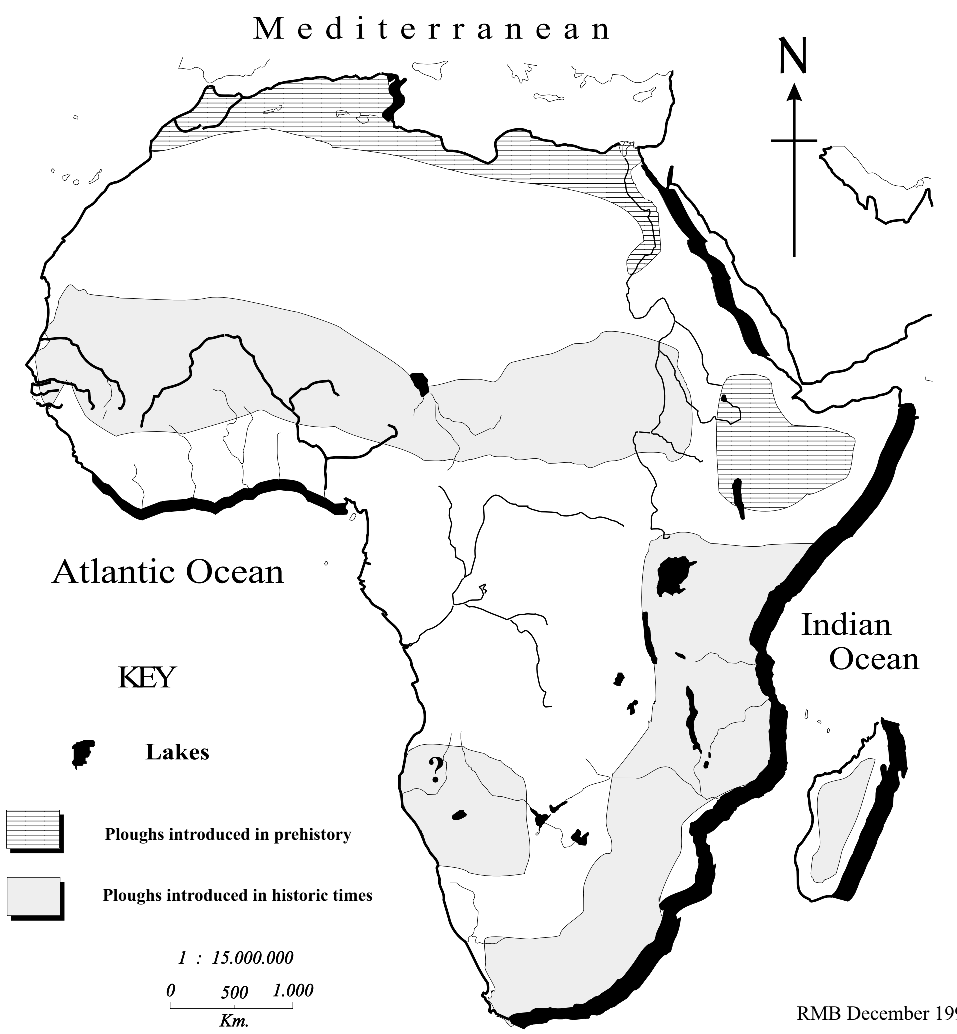
Distribution of animal traction: historical versus environmental constraints

A striking aspect of the distribution of animal traction in Africa is the contrast between three major regions of Africa:

1) North Africa and Ethiopia
2) West-Central Africa
3) Eastern and Southern Africa

The approximate distribution of these regions is shown in Map 1. Animal traction is ancient in Region 1 and thus may be presumed to have spread to the limits of its ecological acceptability. In other words, farmers who do not use it are not limited by either unfamiliarity or chronology. It is striking, however, that much the same appears to apply in Region 2, West-Central Africa, where the further geographical spread of animal traction appears to be limited by ecology. Havard (1993)

Map 1: The distribution of animal-powered plowing in Africa



reports that saturation point has been reached in parts of Francophone West Africa. In other words, wherever animal traction is feasible, it is likely that users will exist.

Between regions 2 and 3 lie the Republics of Chad and Sudan, both of which have been severely affected by civil war in the last decades. Information about animal traction is sketchy in both cases, although it appears that there was no plowing in pre-colonial northern Sudan despite the presence of cattle-powered *shaqiyas* and camel-powered oil-mills (Croxton, personal communication). Plows were introduced in both Chad and western Sudan as part of cotton schemes in the colonial era and it is presumed that these persist.

Region 3, Eastern and Southern Africa, however shows a quite different pattern: animal traction is spreading out year by year from the centres of original introduction. Even though animal traction is not essentially of different vintage from West Africa in this region it has spread more slowly and more patchily. Somalia and Angola are excluded, because no current information is presently available.

This state of affairs is largely connected with the patterns of diffusion in the different regions. The spread of animal traction in Region 1 took place in prehistory and is thus largely irrecoverable. However, in Region 2, studies such as Roupsard (1984), Faure & Djagni (1989), Bigot & Raymond (1991), Guegen (1993) and Blench (1997a), have documented this process in some detail. A distinctive feature of the West African Region is that draft technologies are the same over large areas; in Nigeria, for example, the same ridger is used in all parts of the country. Much the same is true of the Niger Republic. Donkey-cart axles manufactured in Abidjan, Côte d'Ivoire are used in much of Sahelian West Africa. By contrast, in Southern Africa, a wide variety of animal power systems are found, often retaining a very local distribution (Starkey, 1995). Even technologies that appear to have a much wider regional application remain anchored in one area.

Socio-economic context of environmental change

The adoption or evolution of animal traction takes places within distinctive socio-economic matrices. Broader social and economic trends within a given region are often not clearly distinguished from those specific to animal traction. This section looks at some of the main issues relating to the context of traction.

Sustainability

Many development strategies of recent years have been based around the concept of sustainability; classically, for example, tractor programmes are 'not sustainable', whereas animal traction is. However, sustainability is a problematic concept. Usually intensification occurs when a system has become unsustainable; in other words it is often a catalyst for technological change. Classically, for example, low fertility due to shortening bush-fallows means that a household cannot support itself through hand cultivation (Pingali, Bigot & Binswanger 1987). This becomes an incentive to adopt animal traction and cultivate a larger area. However, when the boundaries of farms cultivated by animal traction begin to press on one another, traction may be dropped again in favour of more intensive systems of recycling nutrients, either for example, by adopting pigs, as in some parts of highland Kenya, or the Communal Areas of Zimbabwe or on the escarpments of the Jos Plateau in Nigeria. Technological change is therefore consequent on non-sustainable systems; farming moves to a different phase.

Deforestation

Deforestation and land clearance usually take place whether cultivation is manual, animal-powered or mechanical. However, since one of the significant advantages of traction is that a larger surface area can be cultivated, farmers tend to clear more land. Indeed animals can assist in stumping, weeding or in other ways accelerate this process. This type of clearance is driven by higher population densities, by the consequent fall in soil fertility or by land consolidation following wealth stratification, ie wealthier farmers accumulating larger plots of better land. When one group of farmers succeeds, they are able to buy up or otherwise acquire the better land, usually level and accessible lowlands. Poorer farmers are left with the choice of either moving up hills to cultivate more marginal slopes or moving further out to drier areas or regions of uncultivated bush. In both cases, farmers can be stimulated to adopt

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animal traction, either to produce more surplus for sale or simply to keep subsistence production to former levels. Once the best plains land has been consolidated, animal traction may well be used to open up hillsides. This can be a potential source of erosion, largely because farmers are not immediately familiar with the soil conservation techniques necessary to exploit such slopes effectively. However, without the intervention of effective extension services, a period of learning intervenes before new soil management practices are evolved.

Persistent poor rainfall also motivates an increase in the size of mean holdings as more plants must be sown to maintain the overall yield. This process was already reported in Zambia by Lancaster (1981) for a dry period in the 1960s. Even without wealth stratification, drought can motivate the exploitation of marginal and fragile ecosystems.

Plows and trees

Tractorisation always implies complete land-clearing. In particular, all the stumps must be cleared from a piece of land for a tractor to operate. In traditional savannah farming systems this is often problematic. In West-Central Africa, trees such as the locust, *Parkia biglobosa*, the shea, *Vitellaria paradoxa,* the baobab, *Adansonia digitata* and the oil-palm, *Elaeis guineensis,* play a crucial role in household economic strategies. They assist fertility regeneration by reducing soil erosion as well as improving soil structure (Kessler, 1992). Most species also have marketable fruits and the sale of these provides income, usually to women (see for example Bigot, 1983; Peltre-Wurzt, 1984).

Hand-hoes have always been able to work round such economic trees and to a limited extent animal plows have the same capacity. Farmers who wish to plow their land usually get rid of saplings and bushes and retain the larger trees. The result is a land use pattern often known in the literature as 'farmed parkland', levelled land with evenly dispersed mature economic trees. Animal power therefore usually creates an intermediate state of tree conservation, reducing biodiversity but retaining a pool of selected species which help maintain soil fertility.

Animal power and changes in cropping systems

Apart from changes in area and location, animal power is often associated with changes in the cropping system. A new cash crop, such as cotton or groundnuts, may be introduced and farmers come under administrative pressure to increase the area cultivated. Such systems have never been designed with sustainable agriculture in mind and are often associated with inappropriate application of inputs and soil erosion. Charrière (1984) reports on this situation in Chad and concludes that widespread adoption of animal traction has resulted in erosion, leaching and eventual desertification. Tersiguel (1995) recounts some of the strategies adopted to try and restore fertility in systems of intensive cotton production in Burkina Faso, but concludes that in most cases, the cultivation methods cannot return as much as they take out. In such cases, the use of animal power is essentially secondary to the overall environmental impact, which is primarily a result of the socio-economic changes induced by new crops.

Traction technologies

Animal power strategies are often determined by the availability of specific technologies, or the agendas of different types of development agency. Thus, if a local manufacturer is producing a specific type of heavy share designed for oxen, it is difficult for a farmer to acquire lighter shares more appropriate for donkeys. Nigeria is a good example of this, where a single type of ridger dominates almost all agricultural work in almost all environments (Haynes, 1965). The farmer may therefore use a tool which will increase erosion in some agro-ecological zones.

Some types of animal traction cause erosion, especially through transport of goods and people. Carts and sledges cause tracks to become wide and muddy and occasionally cause soil loss on slopes. Carts have varying levels of technological sophistication; pneumatic tyres can coexist with heavy iron wheels, as in Mali. Where heavy wheels are very numerous, they can be responsible for highly visible erosion. Sledges in Eastern and Southern Africa, and animal tracks near deep wells in the Sahel are similarly held responsible for environmental damage. However, it could be argued that *any* route of communication which is sufficiently popular will become eroded and that the formation of this type of track is probably preliminary to the construction of a surfaced road. It is difficult to see what mechanisms could be invoked, aside from aeroplanes, that would not cause at least comparable damage to the environment. Focusing on traction without considering the alternatives is to avoid putting animal traction solutions in a cost-benefit frame.

Different technologies are appropriate for different situations; socio-economic and environmental factors must be weighed up before making policy choices between tractors, animal power and hand tools. Such policy decisions must also be informed by an appreciation of household economics; there is little point in making technological choices for households too poor to implement them.

Changing species in response to environmental change

Broad climatic trends in sub-Saharan Africa are hard to determine although the decades since 1970 appear to have been a story of ever-decreasing precipitation, especially in Eastern and Southern Africa. Similarly, pasture degradation through overgrazing, once thought to be a certain environmental trend has been increasingly called into question as the elasticity of response of Sahelian pastures becomes better-known. Nonetheless, the vegetation of sub-Saharan Africa has never come under such extreme anthropic pressure as at present. More land has been cultivated and larger herds of cattle than ever before are grazing the rangelands. The consequence has been a low horizon of visibility for many pasture species, notably the grasses and sedges most suitable for bovine nutrition.

This has had two consequences; as the capacity of the semi-arid regions to support cattle declines, new savannahs are simultaneously opened up through the cutting down of the forest in the subhumid zone (Blench, 1994). This situation is less marked in Eastern and Southern Africa, where the potential for creating anthropogenic savannahs from rainforest appears to be less. Moreover, beyond the southern limit of the Maasai, there are no pastoral peoples with very large herds to place the same type of pressure on the environment familiar from West-Central Africa.

The effect in West Africa has been a general shift southwards of all cattle populations and a consequent shift southwards of the ‘traction line’, the southern limit of widespread animal traction (Blench, 1997a). As the plows move gradually southwards, maintaining cattle for traction at the northern limit becomes increasingly difficult, due to the disappearance of pasture grasses. One response can be to switch to cattle breeds more specialised in digesting browse. In West Africa, this has led to the widespread adoption of the Sokoto Gudali breed in preference to others (Blench, 1997b).

Another response, however, is to switch to species specialised in browse, notably the camel and the donkey. These are generally hardier than cattle and can largely be relied upon to find their own food. The disadvantage is that they do not reproduce through most of the region where they are required for traction and so must be sold for meat at the end of their working life and a new animal bought. Professional camel and donkey breeders usually live in the arid zone proper and there is a permanent flow of males or castrates from this region further south.

In Eastern and Southern Africa the situation is somewhat different. Drought has certainly affected most of the region since approximately 1980; in many regions it has been so severe that farmers’ herds of cattle have all died. Farmers frequently have no capital to rebuild their herd, nor the willingness to risk continuing aridity. The response has therefore been to switch to donkeys. Donkeys have been in use throughout most of South Africa proper since before the drought, but they are presently spreading northwards from Zimbabwe and southwards from Tanzania as a traction option.

Does the spread of donkeys affect the environment?

The belief that donkeys are damaging to the environment appears to be somewhat local in Africa and thus probably more a reflection of the culture of those who assert it than a well-considered empirical observation. Starkey (1995) reports that this belief is extremely widespread in South Africa and has had the somewhat unfortunate consequence that administrators have initiated campaigns to shoot donkeys, to the dismay of their owners. It can safely be said that such a belief would be regarded as absurd in most parts of West-Central Africa. Donkeys can digest a wide variety of browse

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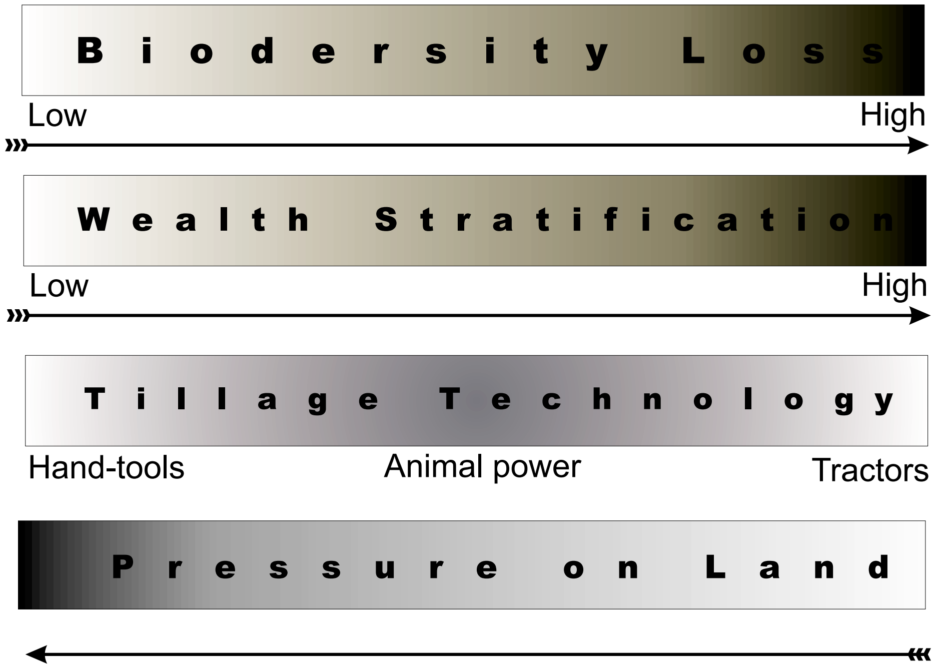

Figure 1: Schematic parameters for analysis of animal-power interventions

including extremely thorny plants, thereby making use of vegetation that few other species eat. Moreover, unlike goats, donkeys do not have the tendency to uproot the bushes they browse and may thus be an environmentally safe option.

Traction animals and humid environments

Animal traction in Africa is largely confined to highlands, semi-arid and northern subhumid regions (Map 1). This reflects the dominance of large cattle as traction animals, as the other traction species, camels and donkeys are even more constrained by ecozone. However, cattle of some type are found in all ecological zones, even in south-east Nigeria, which, with a rainfall of over 4000 mm annually, is one of the wettest regions of the world. Experiments in Sierra Leone have shown that traction with trypanotolerant Ndama cattle is perfectly feasible, and in Guinea-Bissau even very small Muturu are used for traction (Starkey, personal communication).

Given these examples, it is unclear what has constrained the development of traction in these regions. The answer may well lie in vegetation density rather than mean aggregate rainfall. Clearing secondary forest in very wet areas is an extremely time-consuming and energetic task. Traditional vegecultural farming systems in these regions, without cereals and based around yams and tree-crops, did not require open plots of cleared land and thus the motivation to make use of traction was traditionally limited. If the land is clear in a high humidity zone for whatever reason then farmers will experiment. Farmers in Benin Republic, where the open savannah comes nearly down to the coast of West Africa, are using crossbred Muturu x Zebu for traction far south of the limit in Nigeria (Blench, 1997a).

Conclusions and recommendations

Cost/benefit analysis for policy research

All types of intensification must cause some environmental change and usually some damage. However, blaming any specific technology for its effects without prior evaluation of the alternatives cannot be rational planning. All proposed interventions should be subject to cost/benefit analysis in comparison to the alternatives. Figure 1 shows schematically some of the relationships such analysis would have to take into account. In the real world, of course, boundaries are never so neat; almost all systems consist of mixture of these variables.

Information flow

Animal traction is a technology in transition and as such, many householders are in a situation of incomplete information. In a country such as Ethiopia, where the use of the ard is an ancient technology, farmers can be presumed to have tested a wide variety of strategies for improving productivity. The fact that interventions proposed in this century have had very little impact on Ethiopian farmers suggests that they have reached a sort of equilibrium of knowledge, balancing their socio-economic situation with the technical constraints of agronomy.

However, in the rest of sub-Saharan Africa, both available technologies and equipment are driven by contingent economic circumstances and knowledge of long-term effects on the soil and the environment remain limited. There is evidence that inappropriate tools and species are used in many parts of Africa. A very simple programme of testing and extension could help substitute more appropriate technologies, if these can be disentangled from the vested interests of NGOs and the goals of agricultural projects. This in turn leads to political decisions which are far outside the technological realm: the choice between rural food security and cash-crop production.

The relation between animal traction and the environment remains an under-researched topic. If this paper has any conclusion it is that animal traction cannot be taken as a 'smokeless' intervention simply because it does not use motorised power. As development projects increasingly include environmental assessment in their design it will become more and more important to evaluate the impact of particular animal power technologies. One method of moving the subject forward would be calling a small workshop to focus on this topic with the specific brief of gathering together existing research and making concrete recommendations for new research and monitoring practice.

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