Environmental influences on the adoption of animal traction

by

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Abstract

In sub-Saharan Africa, variations in the natural environment have a strong influence on the spread of animal traction. There is a long tradition of animal traction use especially in the high-altitude zones of Ethiopia. It has spread to the semi-arid and sub-humid zones but is still marginal in the arid and wet zones. In the semi-arid and sub-humid zones, animal traction is used for extensive farming and not for agricultural intensification; this is not as was planned by development programmes. Irrational agricultural practices, including improper use of animal traction, have often aggravated environmental degradation. Animal traction has generally led to an expansion of cropped area and the development of cash crops, but it has rarely raised crop yields per unit area. It has often been used for other, more profitable, purposes including transport, livestock production, land ownership and contract labour.

Introduction

In sub-Saharan Africa, the gap between population and agricultural growth rates has widened over the past three decades. In 1989, the annual growth rate was 3% for population, compared with 1.8% for agricultural production (World Bank, 1989).

In many agricultural situations, the traditional long-duration fallows, which ensured sustainability, cannot be continued because of land pressure due to population growth. In certain areas, the situation has led to irrational land use (excessive land clearing, overcultivation), which is an important cause of erosion, desertification, loss of soil fertility, and ultimately the degradation of natural resources.

Strategies that can check this downward trend are complex. They should be based on an analysis of local farming systems and their changes. Animal traction can serve as a basic component of these strategies as it has a positive effect on labour productivity, production factors, and soil fertility. It has become an imperative for raising the currently low agricultural performance in developing countries, where more than 70% of the farmers have only hand tools.

In 1990 sub-Saharan Africa had 12 million of the 400 million draft and pack animals in the world (FAO, 1990). Animal traction is suited only to certain physical conditions and markets; it is not a panacea. Animal traction has rarely been used by farmers for intensive farming, as originally planned by research and development programmes. Despite this it has a significant, though varied, impact.

During the past 20 years, in certain francophone countries of western Africa, animal power technology has grown four-fold and has almost reached saturation point—it is used on more than 80% of the farms in southern Mali (Gueguen, 1993) and in the groundnut basin of Senegal (Havard, 1993). These figures, however, obscure the wide disparities between different regions, where the natural environment is a decisive factor in the spread of animal traction.

Environmental influences on the development of animal traction

Sub-Saharan Africa can be divided into four general ecological zones based on average annual rainfall. These are arid (<400 mm), semi-arid (400–800 mm), sub-humid (800–1200 mm) and humid (>1200 mm). In addition, there are the high-altitude zones, where the average day temperature is lower than 20 °C (Higgins et al, 1978).

Constraints linked to the physical environment

Dense vegetation, stumps and roots are physical obstacles to the use of draft animals and cultivation implements. However, unlike tractor

Table 1: Distribution of draft animals in Senegal, 1980

	Semi-arid zone[1] (%)	*Sub-humid zone[1] (%)*	*Total ('000)[2]*
Horses (total)	96	4	222
Donkeys (total)	93	7	206
Draft cattle	74	26	90

1) Percentage based on regional distribution of draft animals
2) Estimated proportion of female animals: 45% for horses, 35% for draft cattle in the semi-arid zone
Source: Livestock department, Senegal

cultivation, animal traction can be used even if there are some trees. Limited shrub cover and possibilities of livestock production are therefore two factors that favour animal traction in the high-altitude, semi-arid, and sub-humid zones. In the high-altitude zones, animal traction requires less land preparation and road work than tractor cultivation.

Heavy soils can be cultivated more easily with animal traction than manually. Very heavy soils, however, need more powerful mechanised equipment.

Despite its dense vegetation and sparse population, the humid zone is not suitable for most large domesticated animals because of tsetse fly infestation; also there is often inadequate forage. The possibilities for animal traction improve near the edge of the zone and outside it.

Constraints linked to disease risk

Fodder supply, cleared land availability, and health conditions are satisfactory at the edge of the most humid zone; in this zone the only livestock are trypanotolerant oxen. Other animals (zebu-ox cross breeds, donkeys, humped oxen, horses, camels) can be used in less wet areas. Livestock distribution between the semi-arid and sub-humid zones in Senegal is linked to the disease situation (Table 1).

Large numbers of horses are found in the semi-arid zone, whereas donkeys predominate in the sub-humid zone. Both animals can be used as draft animals, as in Botswana where more than 75% of the horse and donkey population is used for traction (FAO, 1992). Trypanotolerant cattle predominate in the sub-humid zone, and the humped ox in the semi-arid zone. The potential for developing animal traction is high as the proportion of trained animals in many countries is very low, often about 5% (Table 2).

Impact of climate on cultivation technology

The choice of cultivation techniques depends on climatic conditions and, in Senegal, their distribution is evidenced from the type of equipment in use, see Table 3 (Havard, 1993). Efficient control of weed growth (particularly difficult in the sub-humid zone) makes it necessary to perform plowing or ridging before planting. More plows and ridgers are found in this zone. In the semi-arid zone, the rainy season being shorter, farmers are obliged to plant rapidly without tillage; the number of seeders is therefore much higher compared with that of plows.

Development of animal traction and population growth

Improvement of public health conditions has led to high population growth in Africa. Large populations and the high rate of increase make population growth one of the most important factors of change in sub-Saharan Africa. It also influences the spread of animal traction. The first consequence of population growth is more intensive hand clearing of land. Conditions are thus improved for livestock production as fodder supply increases and disease risk is reduced. The shift to animal traction is facilitated when stump removal has developed.

As population density increases even further, land and labour management also change. Animal traction does not always develop in areas with high population density and low wages. Different combinations of hand-tool, animal traction and mechanical-power technology and a wide variety of equipment can be observed in these areas. The

Table 2: Estimated numbers of potential traction animals and the proportion used for draft in sub-Saharan Africa in 1990. All population estimates in thousands.

	Cattle		*Donkeys*		*Horses*	
	Total	***% traction***	***Total***	***% traction***	***Total***	***% traction***
Animal traction in the semi-arid zone						
Botswana	2616	14	152	92	33	75
Senegal	2740	5	310	50	400	50
Mali	5000	5	550	27	62	48
Zambia	2861	9	2			
Burkina Faso	2900	3	450	12	70	7
Chad	4173	3	240		200	
Cameroon	4697	1	40	12	26	
Gambia	400	5	nd	nd	nd	nd
Niger	3609	<1	512	2	302	
Total	28996	4	2256	23	1093	25
Animal traction in the sub-humid zone						
Ethiopia	30,000	20	5000		2650	
Kenya	13,793	5	nd	nd	2	
Zimbabwe	6711	10	103		24	
Tanzania	13,047	4	174			
Uganda	4200	14	nd	nd		
Angola	3100	10	5	100	nd	nd
Madagascar	10,254	3	nd	nd	nd	nd
Lesotho	530	34	130		122	
Nigeria	12,000	1	700		250	
Guinea	1800	5	1		2	
Mozambique	1370	7	20		nd	nd
Côte d'Ivoire	1046	6	1		1	
Malawi	1100	5	2		nd	nd
Benin	951	4	1		6	
Ghana	1250	2	10		2	
Togo	250	4	3		2	
Central African Republic	2595	<1	nd	nd	nd	nd
Guinea Bissau	340	1	3		1	
Sierra Leone	330	<1	0	0	0	0
Zaire	1550	<1	nd	nd	nd	nd
Total	106,217	9	6153		3062	
Grand total	**135,213**	**8**	**8409**	**7**	**4135**	**6**

Sources: FAO, 1992; Goe 1990 *Notes: nd - no data, Sudan not included*

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Table 3: Regional differences in the types of implements used in Senegal, 1958–1980

Equipment	*Semi-arid[1] (%)*	*Sub-humid zone[2] (%)*
Toolbars (Houes)	45	30
Seeders	42	22
Plows	2	37
Lifting implements	11	5
Ridger bottoms		6
Total number	650,000	150,000

1) Estimates based on equipment distributed
2) Based on annual reports from the Department of Agriculture, Senegal

rural market for trade, labour, and even land ownership is also better structured in these areas.

Adoption of animal traction and population pressure do not necessarily lead to intensification of the cropping systems. The objective is often to reduce the work load, in which case animal traction may not be a suitable response to the challenges of agricultural development in high population density areas.

Impact of animal traction at farm level

Development programmes often recommend animal traction for the sole purpose of improving cultivation practices (tillage, planting, crop maintenance), whereas it could add value in many other ways on the farm (livestock production, available labour, transport) or outside it (contract labour). This study of the impact at farm level was based in western Africa and Madagascar.

Impact on cropping systems and land ownership

Farms using animal traction are usually larger and grow more cash crops, but yields per hectare are not higher than those on farms using hand-tool technology (Table 4). In many cases, expansion of cropped area is a prerequisite for adopting animal traction. Such capital accumulation is necessary to meet the high investment in animals and equipment.

Large farms also have abundant labour so that animal traction and hand-tool technology can be combined easily. They often have large herds of animals as well. Animal traction allows better management over a larger area (Table 5).

These changes are typical in the less populated cotton-growing areas of southern Mali, western Burkina Faso, and northern Côte d'Ivoire, particularly among indigenous farmers (Dugué, 1993; Gueguen, 1993). It is less common among immigrant farmers, who usually have smaller households and limited agriculture rights. But in densely populated areas, confronted by land shortage, expansion of cropped area does not have a significant effect and farmers' strategies are aimed at reducing the work load and at providing services, as in northern Togo (Fauré and Djagani, 1989). This strategy is observed in cases where access to land ownership is difficult, even if population density is low, as in northern Cameroon, where contract labour is frequent. Farm households that possess equipment but lack labour

Table 4: Comparison of farms using animal traction and farms using manual cultivation in sub-Saharan Africa

Parameter	*Total number of farms*	*Positive effect of animal traction*	*No difference*	*Positive effect of manual labour*
Yield/ha	14	4	8	2
Farm area	17	17	0	0
Area/labourer	19	19	0	0
Cash crops	19	12	7	0

Source: Pingali, Bigot and Binswanger, 1987

Table 5: Characteristics of farms using hand-tool technology and animal traction in the cotton-growing areas of Burkina Faso, Mali and Togo

	Burkina Faso[1] *(1984)*		*Mali*[1] *(1986)*		*Togo*[2] *(1985)*	
	Hand	***Animal***	***Hand***	***Animal***	***Hand***	***Animal***
Area cultivated (ha)	3.4	8	3.3	12.1	5.7	7.5
Manpower	8	12	6	19	10	15
Area/labourer (ha)	0.4	0.65	0.5	0.65	0.57	0.5
Cotton area (%)	16	23	31	38	12	17

Sources:
1) Bigot and Raymond, 1991 (data of Guibert, 1985 and Persoons, 1987); 2) Fauré and Djagni, 1989

may also resort to contract labour, even if there is no ceiling on acquiring land for new crops.

The decision to acquire equipment may also be part of a land ownership strategy. Such a purchase is probably necessary to support an application for clearing land or to reinforce a right to cultivate land by plowing, or it may be prerequisite for acquiring or purchasing a plot (Lassaux and Garin, 1994). Farms may therefore be over-equipped in terms of technical ratios.

The small size of the fields, their irregular shape and scattering are often cited as constraints to mechanisation. However, farmers have often shown considerable adaptability in reorganising their land when they see profit in animal traction. In cases of extreme land scarcity, for example due to population growth, or hilly terrain, adoption of animal traction is unfeasible.

Animal traction can serve to promote contract labour on other farmers' land. Sharecropping and similar solutions are growing more common, particularly in northern Cameroon and Madagascar (Lassaux and Garin, 1994).

Expansion of cropped area is often observed for cash crops, particularly when farmers shift to animal traction (Table 3). Such is the case in western Africa for groundnut (Havard, 1993) and cotton (Bigot and Raymond, 1991). These crops had a significant influence on the number of machines introduced. The spread of animal traction was also linked to the economic and financial organisation of the cotton and groundnut subsectors. In eastern Africa, the same occurred with maize, and in Madagascar with rice.

The farm operations that are a priority tend to be mechanised first and so determine the distribution of animal traction practices and associated equipment. Planting is most common in the dry zone, weeding in the wetter zone, and tillage in the very humid zone, with a diversity of situations lying outside considerations on crops, equipment, and soil types.

Contrary to popular belief, animal traction can be used for soil tillage in intercrops and catch crops. Subsequent operations are the same for both hand-tool and animal traction technologies.

On-station trials have often demonstrated that, all conditions being equal, plowing has generally positive (15–70% surplus yield), although variable, effects for different crops (Le Moigne and Nicou, 1990). However, there is less evidence of this effect in farmers' fields (Table 3). Farmers do not usually follow recommendations on equipment, weed control, and fertiliser application. There is no improvement in per hectare yields although cropped area per labourer and overall output may increase following the introduction of animal traction.

Observations reveal that there is no difference in the planting period on farms using hand tools and those using animal traction to extend the cropped area. Planting dates and yields do not differ for the two types of farms (Faure, 1994). Animal traction does not necessarily improve work quality; manual

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soil tillage is sometimes done more carefully. In practice, farmers are less concerned with the quality of the work, their main objective is to cover a large area, as in the lake Alaotra region (Lassaux and Garin, 1994).

Impact on livestock production

The presence of draft animals can modify existing livestock systems and even contribute to changes in the land ownership system. Farmers possessing animal teams and fields managed for animal traction do not have the same interests as those with traditional forms of livestock and land management. Crop by-products and fallows serve as a source of fodder. Such farmers have a more individualised approach. In certain cases, farms using animal-draft technology form a relatively interdependent group with respect to others.

Fattening of draft animals at the end of their lifetime performance can modify the livestock market. However fattening possibilities do not necessarily combine with animal traction. Herd composition therefore changes around the areas where farmers rely on animal traction.

The growing fodder market is gradually integrated in the livestock or general distribution channels. Forage crops and the use of crop residues have also developed. Demand for feed concentrates has fallen although they are preferred to forage crops. Preference for concentrates depends on product availability and adequate farmer income.

The use of draft animals helps constitute a livestock production basis within the farm. In such a case, females can also be trained for traction, which is technically easy. Positive examples of this can be found in central Senegal and northern Cameroon.

Impact on labour

The introduction of animal traction in agriculture has an impact on labour productivity and distribution (between individuals and over time). The total amount of labour rarely decreases because not all the operations can be mechanised. As farms grow larger, additional manual labour is required for planting, weeding and harvesting. Although the per hectare duration decreases, the overall workload increases (Table 6). Animal traction makes certain tasks easier. This aspect is greatly appreciated by farmers although it is difficult to evaluate the advantage.

Peak periods and the distribution of tasks are often modified. Sometimes, planting on the expanded farms involves less labour than weeding and harvesting, which are done by women. The workload is heavier during the dry season when jobs include watering and feeding of draft animals, stump removal, land clearing of large areas, equipment maintenance and transport. Children have more work as they have to guide the draft animals and watch over them. One adult (usually a man) and two children are needed per animal team. Much needs to be done to reduce labour requirements to just one person per team.

Labour productivity is higher for mechanised operations (plowing, planting). For manual operations, the quantity of work increases with the area. Farms made up of several households are better able to manage the additional work involved in adopting animal traction. They can easily reorganize themselves and redistribute the tasks (including herd management) among the household members.

The dependency relationships created for hand-tool technology are reinforced within and between farms that supply or receive labour. The

Table 6: Average labour requirements and productivity in the cotton-growing area of northern Côte d'Ivoire

	Hand cultivation	*Animal traction*
Total person-days per year	185	225
Cultivated area per labourer (ha)	0.85	1.20
Person days per hectare	220	190

Source: Bigot and Raymond, 1991

introduction of animal traction tends to emphasise socioeconomic differentiation. Farmers using animal traction no longer have the same interests as others for exchanging work. Work exchanges take place within the same group of farmers (ie, either between farmers using animal traction, or between farmers relying on hand tools), and any exchange between groups is increasingly organised on the basis of monetary payment.

Impact on transport

The introduction of animal traction has boosted transport activities. Acquisition of carts has become a priority even if they are expensive and are not covered by bank credit. Transport of goods has increased because of the growing scarcity of natural resources (wood and water), remoteness of fields from the homestead (harvest transport), and more frequent exchange between towns and villages (migration, food aid).

Carts are also needed for certain technical innovations, for example construction of stone barriers to control erosion, sedentary livestock production based on forage crops, production of farmyard manure and compost from straw, crop residue processing, water transport. The use of carts motivates farmers to introduce and maintain draft animals even in areas where agricultural output is low. However, in areas where animal traction increases agricultural output, transport equipment is given lower priority than farm equipment.

Conclusions

Although sufficiently large numbers of livestock that can be used for animal traction are found in the arid zone, they cannot be used as agriculture is not well-developed. They are used for drawing water and for transport. In the humid zone, disease incidence is a major constraint. Animal traction is most developed in the high-altitude regions, where it has the longest tradition in sub-Saharan Africa.

Developed farming systems and livestock availability in certain parts of the semi-arid and sub-humid zones are favourable to the spread of animal traction. In western Africa, it was first introduced in the semi-arid zone and continues to develop. The sub-humid regions, despite the high potential, were slower to adopt animal traction, but now record the highest development rates. Horses and donkeys are more suitable for the arid zone, and trypanotolerant cattle for wetter zones.

The introduction of animal traction has not led to crop intensification as planned by most development programmes. Instead, it has responded to farmers' objectives of extensive farming, reduction of the work load at certain periods, and control over the land. The total volume of work is rarely lower on farms using animal traction because the operations are not mechanised entirely. Additional manual labour is needed for planting, weeding, and harvesting when farmers expand their cropped area.

The share of cash crops increases when the area is extended; yields, however, remain the same as on farms using hand tools. In densely populated areas with a shortage of available land, introduction of animal traction does not necessarily increase the area cultivated per labourer. Contract work can then be a source of substantial income.

In traditional livestock regions, conditions are clearly more favourable for animal traction and various solutions exist for distributing livestock to other areas. Meat production and animal traction do not necessarily go hand in hand. Special breeding programmes for draft animals are not needed in traditional livestock regions.

Animal traction has aggravated environmental degradation, although it is also observed on farms using hand tools. The reasons are: shorter fallow, disappearance of woody plants, increased soil erosion, and reduced soil fertility.

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