HOW WILL GLOBAL WARMING INFLUENCE THE AVAILABILITY OF FORAGE FOR TRANSPORT AND DRAUGHT ANIMALS IN SEMI-ARID REGIONS AND WHAT EFFECTS MIGHT THIS HAVE ON FARMING?

J. Rowland

Introduction

I am making the assumption that transport animals are frequently used for agricultural traction as well as for moving people and goods from place to place. We can best focus the problem by considering animals for agricultural draught; those used for transporting manure and harvested crops, ploughing, secondary cultivation, seeding, weeding and perhaps harvesting (eg groundnuts). In this presentation I will consider some typical forages and fodders available in the Third World, and then go on to look at how adopting dryland farming methods in areas becoming more arid might affect cropping systems and draught animals. Finally I will discuss possible ways of improving the supply of fodder, particularly at the critical time around the beginning of the rains.

Many factors influence the adoption and use patterns of draught animals in Africa. Some of these factors will in turn be affected by climate change. The following are mainly taken from Anne Stroud (1993).

Intensification (population pressure)

As farming systems become more intensive, and fallow periods become shorter, it is easier to introduce animal draught. The use of animals enables farmers to overcome labour bottlenecks. On the other hand, long fallows lead to greater bush growth, and it becomes harder and more labour consuming to clear land adequately for animal cultivation. But intensification can also lead to privatisation of land (enclosure, ranching) and this is sometimes less flexible in coping with dry season fodder and water deficits than pastoralism. It will become necessary to plan fodder conservation (utilizing crop residues, cut-and-carry, fodder trees, surplus grains), but if water and/or food supplies are not sufficient for the herd it will be necessary to move it out onto communal land.

Availability of animals and grazing

In semi-arid areas there may be much land unsuitable for cultivation, but ideal for grazing, though dry season food supply will be a challenge. Will any increase in the extent of semi-arid areas and rangelands with global warming be a factor creating demand for animal draught, or facilitating its adoption?

Soil type

Yield increases and other benefits from animal cultivation may be greater on heavy soils. For example, in the Kangole area of Karamoja in the 1950s, previously uncultivable land was opened up very successfully. However, heavy clay soils (such as Black Clays in tropical Africa) cannot be worked if too wet or too dry. The ‘window of opportunity’ for cultivation is small. Sandy loam soils may be extremely hard when dry, and relatively easy to plough when wet, but they may become very compacted due to trampling by animals and the action of rain. They then require breaking up to a depth, which can only be done after rain has penetrated sufficiently.

Crops and cropping patterns

Sometimes a cash crop (in colonial times, cotton) is a stimulus for adoption, in which case the use of animals may be sensitive to changes in crop prices. In West Africa, economic returns from animal cultivation are greater from rice than from groundnuts (this may also be linked to soil type).

In-migration

As has been seen in Kenya, the new farmers may be familiar with the animals and technology, or have the cash to finance it.

Spread of trypanosomiasis and tick-borne diseases

The risk of trypanosomiasis increases as bush spreads, leading to restriction of grazing. This could occur with climate change. Reduction in annual range burning may allow tick populations to get out of hand.

Equipment problems

Equipment has proved one of the most difficult problems to solve in seeking to utilize draught animals both widely and effectively.

In semi-arid areas, the period over which animals can be used is shorter than in more favoured regions (unless implements and skills for weeding, harvesting and haulage are available). Worse, the animals may not be in condition in time to utilize the short period effectively. In this paper we will focus particularly on the problems of semi-arid regions.

<u>Sources of Forage and Fodder</u>

The most common animal food sources include:

- Natural grazing; local to family home, or more distant, involving transhumance. Only in the most intensive systems is forage likely to be cut and carried to the animals for immediate consumption;
- Forage trees and bushes;
- Weeds and grazed crop residues. These may be grazed at any time between harvest and ploughing;
- Conserved stover;
- Cultivated fodder; a rarity in resource poor semi-arid farming, but are there any possibilities? A drought-resistant fodder species may be planted among the growing crop (eg lablab *Lablab purpureus*) so that it will take over after harvest and utilize residual water and late rain. This crop will often also commence vegetative growth again after harvesting the pods, and this regrowth is valuable as high protein fodder. Some indeterminate cowpea varieties may do the same;
- Process residues, such as brewing waste, bagasse or cotton seed cake;
- Occasional use of human foods, such as stored grains or dried tubers (eg cassava). Usually the poorest quality or damaged foods are used in this way.

Tables 1a and 1b compare the nutritive values of some typical animal feeds. For ruminants, the N content of a food can be converted to crude protein by multiplying by a factor of 6.25. Supplementing natural grazing and stovers with cracked grains or dried tubers can help meet the increased energy demands of draught work. If at all possible, such supplementary feeding should be started well before ploughing starts.

Table 1a: Nutritive values of some animal feeds

Fodder	Dry Matter %	Crude fibre % of DM	Crude protein % of DM	Total Digestible Nutrients(a) %
Panicum maximum 15-28 day growth	19.4	30.9	12.2	10.2
Cynodon dactylon, hay	87.4	32.0	13.2	43.2
Cassava roots	37.1	4.3	3.5	31.6
Cracked maize	87.2	4.3	10.5	66.5

(a) percentage of fresh weight

Source: Payne, W.J.A. *An Introduction to Animal Husbandry in the Tropics* 4th Edition, Longman

Table 1b: Nutritive values of some crop residues commonly cultivated in South America

Crop residue or by-product	DM (dry matter, % of fresh weight)	N (nitrogen, % of fresh weight)	IVDMD (in-vitro dry matter digestibility)
Maize stalk	83.2	0.67	40.4
Sorghum straw	82.6	0.83	54.0
Cassava foliage	26.1	3.36	52.9
Cassava tubers	32.0	0.58	79.0
Rice straw	89.0	0.69	42.3
Sweet potato foliage	14.6	2.32	74.6
Bean haulm	92.0	0.61	45.6
Cotton seeds (whole)	91.6	3.66	76.6
Sugarcane tops	24.0	0.86	69.3
Sugar cane bagasse	48.41	0.39	30.3
Sugar cane molasses	75.0	0.65	>95.0
Banana pseudostems	6.8	0.38	77.4
Banana leaves	21.8	1.95	45.9
Coffee pulp	20.0	2.13	61.2
Coffee hulls	89.6	0.48	48.0

Source: Quiroz, R.A. *et al*. (1997) Dynamics of feed resources in mixed farming systems of Latin America, in C. Renard (ed) *Crop Residues in Sustainable Mixed Crop/Livestock Farming Systems*. ICRISAT/CAB

We cannot, in the time available, discuss all these types of fodder in detail, but by way of example we can consider stovers and forage trees very briefly.

Stovers

Stovers vary considerably in their feed value, as much due to their age and condition as to species differences. Leguminous crop stovers are of the best quality when green, but probably should be grazed or fed with cereal crop residues to make best use of them. If the plants desiccate during the dry season, much of the value will be lost as leaves shatter and blow away. Pigeonpeas (*Cajanus cajan*) which are semi-perennial, often remain green and in Northern Uganda for instance, they are very useful in mixed plantings with finger millet. Several crops may be taken from them, and then the plants left in the field for forage, or they may be *ratooned ie* cut back and allowed to grow again. Some leguminous stovers should *only* be fed together with other roughages to avoid adverse effects on the livestock, such as bloat.

Sorghum stover: Sorghum is widespread in the tropics and sub-tropics, and is particularly suited to dry sub-humid and semi-arid areas, where its grain is a staple food, especially for resource-poor farmers. The stover is usually grazed. In Northern Nigeria, the Fulani cultivate little themselves, and are very dependent on grazing crop residues on the farms of neighbouring tribes. There may be various arrangements whereby the Fulani loan or hire animals to the farmers for cultivation. Mutually beneficial arrangements such as these are common between pastoralists and crop farmers in Africa, though there are tensions too, at times. In India sorghum stover is carefully cut and stacked in the homestead until needed by animals, particularly draught animals. Near towns, the value of the stover crop may exceed that of the grain, and it is often sold to owners of milk buffalo or transport animals. Tall sorghums are more suitable because they give more stover. In the All India Sorghum Trials, the yield of fodder is assessed, as well as grain yield. Varieties show marked differences.

The grain to stover ratio (the ratio of grain yield to yield of stem and leaf) reflects the apportionment of dry matter accumulated during growth between grain and stover, which for the farmer may be seen as being between human and livestock food. Usually breeders of grain crops aim for efficiency in grain production at the expense of leaf and stem production. The use of the stover as a forage may be under-valued. In water-scarce situations, quick-maturing, short varieties with big heads or pods and minimum leaf and stem are usually considered ideal. But these are likely to produce less fodder. Traditional sorghums typically produce 1.8-2.0 times as much usable stover as grain; conventional improved varieties 1.3-1.7 times; and modern high yielding ("Green Revolution") varieties may produce similar amounts of each. Also, dryland farming techniques depend to a great extent on agronomic practices which alter the balance between stover and grain production, to maximize the production of grain for each unit of rain received. This balance is also much affected by extremes of rainfall and the incidence of pest damage. In areas where rain becomes more limiting as a result of global warming, there may be less stover available for draught animals, especially as the needs of human populations become more difficult to meet.

In some circumstances sorghum stover may be toxic due to the presence of the cyanogenic glycoside dhurrin. Wilting of young growth can concentrate the dhurrin and so can ratooning (re-growth after harvest which is potentially useful for dry season grazing). Varieties differ in their dhurrin content. The content may decline somewhat as the crop ages (young growth is most toxic) and can be reduced to safe levels by cutting and sun drying and probably also by prolonged standing in the field during the dry season.

Ratooning: varieties of sorghum differ in their ability to ratoon. This regrowth is favoured by late rain, and by cutting the old stems close to the ground soon after harvest. Ratooning may help pests and diseases to survive and multiply during the dry season. But it may produce useful extra fodder, and possibly some grain, too.

Forage Trees

Table 2 gives feed value information for a number of commonly utilized fodder trees in Latin America. There are remarkable differences in protein content and digestibility. In sub-Saharan Africa, *Acacia albida* (syn. *Faidherbia albida*) is particularly valuable for semi-arid areas. It often grows along seasonal water courses, but in West Africa this tree is deliberately encouraged or preserved in cultivated land because it has a beneficial effect on soil fertility, as well as being a good fodder species. In some localities it sheds leaves during the rainy season, and is green during the dry seasons, so it competes little with growing crops and still provides valuable dry season fodder. Its pods are very nutritious and young branches may be cut down for the animals to graze.

Fodder trees may also yield valuable fruits, timber and firewood, and provide shade, windbreaks and a source of honey. In managing these different economic yields the fodder needs of draught animals may not have the highest priority.

Table 2: Food values of some tree foliages used for animal feeding in Latin America humid lowland tropics

Tree Species	CP (% of dry matter)	IVDMD (%)
Leucaena leucocephela	22.0	52.7
Morus spp.	24.2	79.3
Cnidoscolus acutinifolium	41.7	84.4
Guazuma ulmifolia	15.6	54.1
Cassia siamea	13.9	60.6
Acacia augustissima	19.9	23.2
Albizia falcataria	20.3	42.2
Calliandra calothyrsus	20.3	21.0

Source: Quiroz, R.A. *et al.* (1997) Dynamics of feed resources in mixed farming systems of Latin America, in C. Renard (ed.) *Crop Residues in Sustainable Mixed Crop/Livestock Farming Systems*. ICRISAT/CAB

Consequences of poor nutrition at beginning of rains

Draught animal species differ in their ability to utilize poorer diets and to thrive under adverse conditions. Horses are relatively delicate. Donkeys are often in better condition than oxen at the end of the dry season but to utilize them requires special harnesses and many farmers find it difficult to use them other than for transport work. Camels (if the people have the necessary skills to train them) are ideal for the driest agricultural regions.

As the dry season lengthens, the condition of draught animals frequently deteriorates. Indeed, in semi-arid areas there may be deaths due to starvation and disease. In general, the time of peak utilization of these animals tends to coincide with a low point in the animals' physical condition, and at first they will be able to work only very short periods before becoming exhausted. Unfortunately, this is just the time when it is most important to work fast to prepare land and plant before optimum planting time has past. For example, at Agadi in the Sudan, where rainfall is marginal, a delay of 6 days in planting sorghum reduced yields by 63%. This effect is not only due to loss of the growing period, it can also be due to missing the flush of soil nitrogen that coincides with the first rains, and to increasing pest populations.

Dryland Farming

In agricultural regions which become drier as a result of global warming, dryland farming methods are likely to be adopted. Taking into account lengthening dry seasons and general increasing aridity, fodder may become increasingly difficult to find at the very time that draught animals need to be built up and fed well to sustain their use in land preparation.

Many "dryland farming" techniques are much easier to put into practice if trained draught animals are available. Some of these techniques are shown in Table 3. However, there are some problems in using draught animals effectively in semi-arid areas.

The drier the climate, the harder in general it is to make an early start to cultivation and planting, and to use animals effectively. Timeliness of operations is the key to success but is difficult, particularly if "grass rains" become less reliable. The length of the dry season is crucial, particularly in areas having only one rainy season (mono-modal). Areas with a bi-modal rainfall distribution often have two distinct dry seasons, each relatively short, and of course two rainy seasons. If the Inter-Tropical Convergence Zone in the Sahelian region progresses further north during its annual cycle, we may expect a shift from mono-modal to bi-modal rainfall in some areas, as well as a lengthening of the single rainy season closer to the desert fringe. This will greatly affect the farming systems and crops and varieties grown. And in such areas the use of draught animals may become easier as the year-round fodder supply becomes more dependable.

There are also risks for animals worked too hard before they are in adequate condition. There could be further loss of condition and weakening of health, and possible effects on fecundity.

Table 3: Dryland farming methods for resource poor farmers

Technique	Animal draught helpful?	Implications For animals
Early planting Dry planting Note: dry planting depends on dependable start to rains	Yes – if in adequate condition and available in time	• Where animals graze at a distance from the home area, draught animals must be brought home and provided with feed • Animals must be prepared nutritionally for work at a time when fodder is scarce
Minimum tillage Note: not always appropriate. Most likely to be useful on black clay soils previously well cultivated	Yes	• Lower power requirement; easier for animals not in peak condition
Deep tillage to break up hard pans which inhibit water and root penetration	Yes	• Difficult for weakened animals. On sandy loams it is usually necessary to wait until the soil is generally wet to 20-30 cms
Adapted varieties and crops Examples: quick maturing, short stature, high grain to stover ratio	Very	• May be less quantity and variety of crop residues on which they can feed
Line planting (basic to control of plant population and spatial arrangements)	Very	• Training of animals (and farmers) may be required for use of new equipment or simple planting methods
Wide rows to ration water use	Yes	• Will reduce quantity of fodder available after harvest • Will favour use of animals in row weeding
Early and thorough row weeding to cut water use by weeds	Very	• Will extend the use of draught animals through the growing season, reducing recovery periods, and necessitating improved feeding
Intercropping / relay cropping to maximize land and water use in some circumstances	Probably	• mixed stovers (e.g. cereal + legume) provide better quality (and often greater quantity) of fodder for animals

Table 4 summarizes some farming system changes that might improve fodder supply at the critical period at the beginning of the planting season. All changes have potential negative as well as positive effects. Some negative impacts can be minimized fairly simply. For example, manual harvesting of stover for storage in the homestead can leave the soil exposed to erosion. By selectively harvesting the most nutritious portions of the residues, or leaving long stubbles, enough material can be left behind to protect the soil from wind and rain.

Table 4: Some possible ways of improving draught animal fodder supply at the beginning of the planting season

Possible solution	Pros	Contras
Conserve crop residues and weeds in the field NB Intercropping may improve value of residues (e.g. cereal/ legume crop mixture)	• Protects soil from erosion • Low labour requirement • Animals grazing them drop dung ready to be ploughed in	• Often cannot be protected from communal grazing • Harbour crop pests over dry season • Losses of quantity and quality due to weathering and termites
Cut and conserve crop residues and weeds in storage areas	• Protection from unauthorized grazing • Easier to ration to selected animals (e.g. draught animals) • Might reduce weed spread if removed before flowering	• Must protect from termites • May harbour crop pests and rats or snakes • Labour for collecting • Leaves soil exposed to erosion
Conserve dedicated (possibly communal) natural grazing close to cultivated area or home	• Larger area might be set aside	• Requires negotiation for use • May still need some protection
Semi-nomadism or transhumance	• Can take the animals to best dry season grazing and water supply • May be part of a risk management strategy	• Must have experience/ culture of pastoralism • Requires adequate labour for herding, especially if herd is split • Can separate members of families for long periods
Plant fodder trees, or preserve existing trees	• May also serve as shade and windbreaks • May utilize land difficult to exploit with other crops (e.g. gulleys, stream banks, rocky areas) • May promote bee-keeping • May also provide fruits, wood and other products	• Labour and possibly cash cost for planting and protection over several years • Ownership may be understood as communal

Feed grains and food by-products as supplements to fodder Examples: cereals, brewing residue, pumpkin seeds, sunflower seeds	• Can use poorer quality grains • Energy rich	• Potential competition with humans (brewing residue may be a relatively nutritious food for children)

Summary

We will have to wait to see how far current predictions of climate change prove to be accurate, and how it will affect any particular region or zone in which we have a special interest. Undoubtedly, in addition to the widely anticipated general warming of the planet there will be changes in rainfall, both as regards annual total rainfall and seasonal distribution and in rates of evapotranspiration. Some dry subhumid and semi-arid regions may become more marginal for agriculture and in these, draught animals will become both more important and at greater risk. On the other hand where rainfall increases, fodder availability may improve and work be spread more evenly. These can only be generalizations, but perhaps they may help us to be aware of issues that may become more important over the next few decades.

Reference

Stroud, A. (1993) The Use of Draught Animals. In J.R.J. Rowland (ed) *Dryland Farming in Africa* CTA/Macmillan, London and Basingstoke