Developing suitable yokes for draft oxen in sub-Saharan Africa

by

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Abstract

There are two main types of harnessing systems: yokes and collars. Collars are the most efficient for cattle, horses and donkeys, but are inappropriate for developing countries because of their complexity and cost. Yokes are therefore commonly used. However, in sub-Saharan Africa, where there has not been a long tradition of their use, lack of expertise and appropriate harnesses often leads to problems of injury to animals and lack of control over them. In sub-Saharan Africa, humped cattle, such as zebu, tend to be yoked with withers yokes, whilst for non-humped cattle, such as N'dama, neck yokes are used most often. However, the type of yoke used is less important than its quality, weight and proper use. In cooperation with the Cameroonian animal and veterinary research institute, CIRAD-SAR has developed an 'improved' double yoke and the 'ATECam' single-ox yoke. In trials of both of these yokes power output was improved. Their low cost makes them suitable for manufacture in developing countries.

Introduction

Although animal traction has been used for centuries in North Africa and Ethiopia, it has only recently been introduced to the rest of the continent. The Boers and French Huguenots brought it to South Africa in the 18th century. Around 1890, the French army, followed by the colonial agricultural services and trading companies, introduced animal traction to Madagascar and subsequently to West Africa in around 1920 (Bigot, 1985).

But it was only in the 1960s that animal traction really developed in western Africa and Madagascar through the efforts of research organisations, agricultural development corporations, religious missions, and, more recently, non-governmental organisations. Their know-how was based on the practices followed in their region in Europe. As a result, a wide variety of harnessing systems and animal-drawn equipment were introduced to Africa.

Historical and geographical development of harnessing systems

In animal traction terminology, 'harness' denotes a set of items that serves to link the draft animals and implement, so that energy generated by the animals can be used to carry out a specific operation. There are two distinct methods for harnessing oxen: yokes and collars. For yokes the main traction component is placed either in front of the withers (withers yoke), on the neck, behind the horns (neck yoke), or in front of the breast (breast straps). With a collar harness, the main component allows the application of tractive forces at other points of contact. These harnesses are more suited to the structure of the animals and distribute effort evenly.

The collar is the most efficient harness for horses, oxen and donkeys. The large contact surface, comfortable padding and convenient positioning of the trace attachments in front of the shoulders but slightly above the shoulder points, all combine to allow the animal to apply maximum force. However, production of collars is a sophisticated and expensive process. For these reasons they cannot be used widely in developing countries. The three-padded collar, which was tested about 20 years ago, has seldom been adopted, despite promising experimental results.

Europe: coexistence of different types of harnessing systems

References to withers and neck yokes can be found even in ancient documents (Columelle, 1st century, quoted by Delamare, 1969). In Europe, ox-team drivers and farmers have always differed about the merits of the two systems. Critics of the

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head yoke believe that it is too tight and can injure the animal. Nevertheless, this yoke was widely used and even replaced the withers yoke in some regions (particularly in Spain) from the 16th century onwards. The withers yoke is still used, however, in certain parts of Spain (Galicia), Portugal, France, and Italy (Le Thiec, 1991). The two systems have, therefore, coexisted in Europe through the centuries.

The neck yoke was preferred for deep plowing and transport. It is comparatively better suited for braking carts while descending slopes and for reversing. Animal teams can also coordinate their efforts better as they are yoked closer together; they therefore do not need so much training. The production of head yokes required skills that only specialists had. The profession disappeared in the 1950s when ox-drawn implements were replaced by power-driven equipment.

Despite their apparent handicaps, withers yokes are used throughout the world because they are not costly and can be easily adapted to different animals (oxen, donkeys, mules).

Development of harnesses in Africa

Apart from the Mediterranean region and Ethiopia, there is no real tradition of animal traction in Africa. Proper use of harnesses has therefore not developed. The withers yoke is more widespread than the neck yoke. It is well suited to the *Bos indicus* or humped type of zebu, and is therefore common in the Sahelo-Sudanian zone, which has a high population of these animals. Draft cultivation is highly developed in this zone.

The neck yoke is recommended for taurine cattle. It is mainly seen in the Sudano-Guinean zone and in Guinea, Sierra Leone, and Côte d'Ivoire, where the taurine cattle predominate. However, an Italian cooperation project has successfully promoted a withers yoke of Piedmont origin in Lower Zaire, particularly in Luala, for N'dama oxen (Le Thiec, 1991).

In Guinea, farmers have preserved and transmitted the technique of manufacturing (correct shape of yoke bows) and utilisation (use of cushioned covering) of yokes (Le Thiec, 1985). This know-how has endured for more than 25 years, despite an unfavorable agricultural policy that neglected animal draft cultivation since Guinea attained independence; the farmers therefore had no support from extension services and technicians.

In Senegal, the Bambey research center and development corporations supported large-scale draft cultivation between the 1960s and the 1980s. From the beginning, they opted for the neck yoke even though the animals were zebus and crossbreeds.

Apart from these instances, manufacture and utilisation of yokes have not developed adequately in Africa. Neck yokes are usually cut and shaped carelessly and not properly fitted on the neck of the animal. They are loosely fastened to the horns, often with thin ropes that abrade the horns when the animal tosses its head. Withers yokes are often simple wooden beams, whose sharp edges are not planed off. As the yoke bows are not properly curved, the angular edge of the beam presses on the withers when the animal is in motion and makes any effort painful. Not surprisingly, the animals are difficult to manage and train.

The hames of the withers yoke are made of metal (round bars) or wood. The thin ropes tied around the throat of the animal to join the hames at their lower ends compress the windpipe. The yoke rotates constantly as it aligns with the line of traction. It moves forwards and backwards between the throat and the dewlap and almost chokes the animal.

Both the withers and neck yokes tend to be extremely heavy, often weighing up to 15 kg. Normally, their weight should not exceed 10–12 kg. Use of some lightweight, sturdy woods could reduce the weight to only 5–6 kg. However, it is commonly believed that a more massive yoke is better for making holes to facilitate hitching. The design, quality, and utilisation of yokes are therefore more important than the type.

Guidelines for better results

Animal team

Certain guidelines should be followed to obtain maximum output from draft animals, to keep them physically fit, and to increase their longevity:

- average effort should be 10–12% of the harness mass
- paired animals should be similar in size and strength for proper coordination of their work

- the harness and all the elements that transfer energy should not hinder movement of the animals or injure them; the animal should be able to freely move its head and joints, especially shoulder joints. They should also not block respiration and blood circulation.

The withers yoke is recommended because it does not constrain the animal. Moreover, it is easier to produce and use than the neck yoke.

Yoking

The guidelines for yoking also apply to the different links (yoke-shaft, yoke-chain, yoke-implement) in addition to the yoke.

The plane of the contact surface (tangent of the yoke bow curve) should be perpendicular to the line of traction and the surface should be as large as possible. This prevents the yoke from rotating during traction and the animal from choking. The minimum width of the yoke bow should be 10–12 cm, approximately the diameter of the yoke.

The yoke should not have any sharp edges. The surface that rests on the animals should be suitably rounded. Careless shaping is more harmful that none. The wooden pole used for the main piece of the yoke is naturally rounded and should be left as it is, rather than be incorrectly shaped.

The attachment point on the yoke should be lowered to reduce the angle of the line of traction. The points of contact should thus be lowered toward the shoulder points. The ideal position for the hitching hook is at the point of equilibrium on the contact surface. Only yokes with padded openings in the form of collars and those covering the shoulders offer this possibility. The optimum position is two-thirds less than the distance between the withers and the shoulder point.

Many authors have explained the diagram of the different forces and discussed the influence of the angle of traction (Ringelmann, 1908). This point will not be discussed in this paper. In practice, it is more important to reduce wastage of energy. A steep angle of the line of traction increases the vertical component of the traction effort and the work loss translates as a waste of energy. The line of traction should be so inclined that part of the load is transferred to the vertical component, which prevents the yoke from slipping onto the back of the animal. This way, the animals have a better ground grip, especially when heavy effort is required. An angle of 15–16° offers the best compromise. Table 1 gives some typical values of the traction parameters of withers and neck yokes in Africa.

Recommendations for production of yokes

Certain rules must be observed when linking the yoke to the shaft or the chain:

- the yoke hook should be fixed so that it is within the extended line of traction and it does not turn when under pressure
- the axis of hames should be perpendicular to the line of traction to prevent choking of the animal
- the tangent to the yoke bow should be perpendicular to the line of traction.

The hitching hook is thus fixed on the yoke to a metal double ring or a double loop made of braided leather strips that are passed around the yoke and left to rotate freely (Figure 1). Lateral slipping of the double loop is prevented by cutting two grooves on the upper surface in which the ring can turn half a circle, or by using staple nails.

Table 1: Average values of traction parameters for withers and neck yokes in Africa

Parameter	*Neck yoke (N'dama)*	*Withers yoke (Zebu)*
Withers-ground height (m)	1.1	1.3
Implement hook-ground height (m)	0.3	0.3
Implement hool-withers height (m)	0.8	1.0
Angle for 2.5m chain	18	23
Angle for 3m chain	15	19

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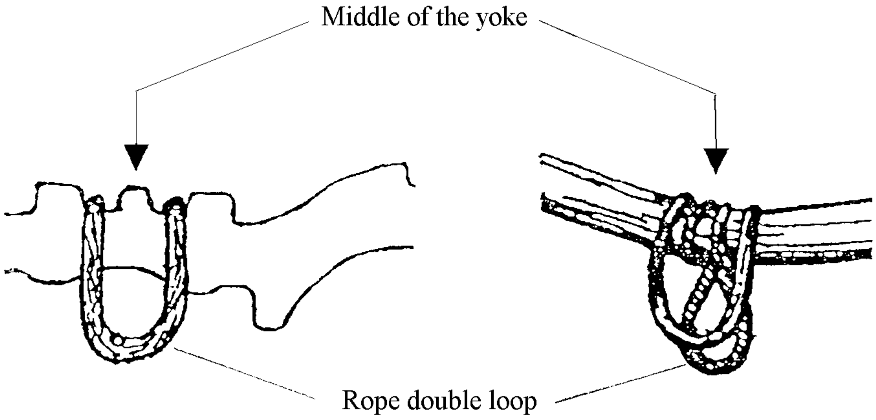

Figure 1: Centre attachment systems

Need for research on harnessing systems

Between the 1960s and 1980s, much research focused on the equipment, animals, and farming systems for draft cultivation. However, little research was carried out on harnessing systems.

The force generated by the animal depends on the type of harness, its condition, and the links that connect it to the implement. The output of the animal team depends on that of all the elements linked to it. We therefore attempted to identify harnessing systems and related elements that ensured optimum output. We compared harnesses adopted elsewhere – particularly in Europe – over the years. The original processes and know-how were analysed for a possible transfer of the technology to developing countries. We were aware that we were dealing with only one of the constraints to optimum output. Nutrition, care, and training of the animals and the farmer's ability to handle them also contribute significantly to better output.

CIRAD-SAR sought to increase the capacity of the traditional yokes through certain necessary improvements at a minimum cost. The result was the 'improved' double yoke and the single-head ATECam yoke.

The 'improved' double yoke

The design of the 'improved' double yoke (Figure 2) aims at a maximum lowering of the point where the chain is attached, the angle of the line of traction is reduced and rotation of the yoke is stopped. The contact surface is increased for a better distribution of effort by adding prefabricated padding. In addition, the design easily allows local production of the yoke.

Trials were conducted in Burkina Faso from 1989–1991 to compare the performance of the improved double yoke and a traditional yoke. They were conducted jointly by the Burkinabe Agricultural Research Institute INERA; the Silsoe Research Institute, UK; and CIRAD-SAR. The trial protocol aimed to collect data on the total effort produced during two hours of uninterrupted work (Le Thiec, O'Neill and Bano, 1992).

The animals were made to pull a sledge to ensure maximum uniformity and control of experimental conditions. The load on the sledge was varied to obtain a range of data on efforts obtained on track and in closed circuit. The results showed that, compared with the traditional yoke, the double yoke improved energy output, which is particularly advantageous as the load is increased (Table 2).

ATECam single yoke

In 1993–1994 CIRAD-SAR developed a single yoke (Figure 3) for a research-for-development project in northern Cameroon in collaboration with CIRAD's livestock production department CIRAD-EMVT, and the Cameroonian animal and veterinary research institute IRZV.

The design specifications were: adequate contact area on the withers, no slipping of yoke when the

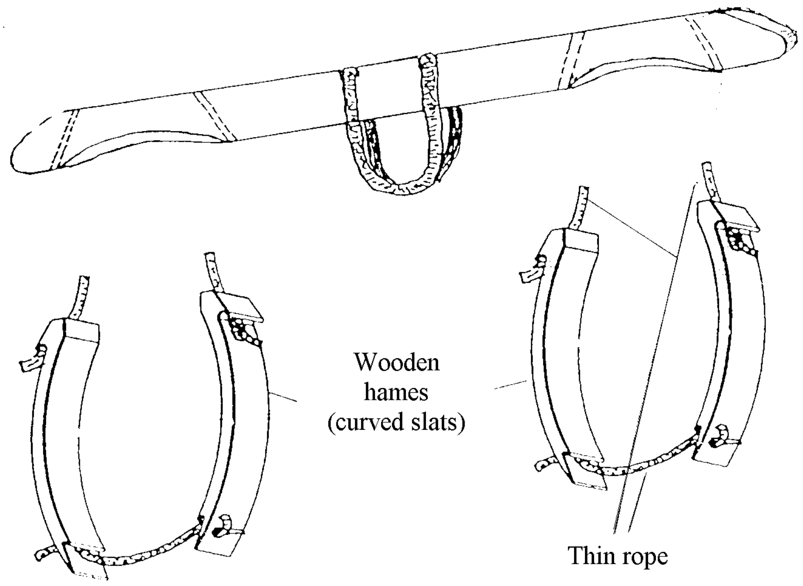

Figure 2: The 'improved' double yoke

animal is stationary, automatic alignment with the line of traction during work, weight close to 5 kg, and low-cost production by artisans.

The prototype with the best results was called ATECam:

- A for its general shape
- TE (in French) for equilateral triangle; the two hames measure 60 cm each and as does the distance between the two points where the traces are fixed. The measurements can be reduced to 50 cm for smaller animals.
- Cam for Cameroon, where the preliminary trials were conducted (Garoua in northern Cameroon).

The two beveled hames are joined face together with a wooden bolt (TRcc 10 x 120 mm) at the top of the triangle. The wooden contact area on the withers remains in place because of it is designed to fit closely. The yoke opening is 120 mm wide near the withers, but it can range between 100 mm and 150 mm depending on the size of the animal. During work, the hames are automatically aligned with the line of traction. The strap around the throat and under the dewlap should be sufficiently

Table 2: Comparison of the increase in energy output of the 'improved' double yoke and the traditional yoke

Yoke	*Average effort (% of the yoke weight)*	*% increase in energy*
Traditional yoke	10	+4.8
	12	+8.4
'Improved' double yoke	9	+10.6
	15	+12.4

Source: Le Thiec, O'Neill and Bano, 1992

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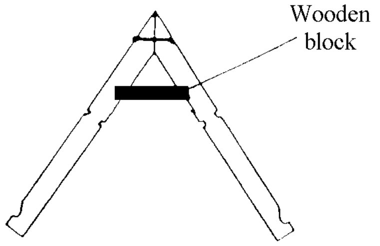

Figure 3: Cross section of the 'ATECam' yoke

long to allow this alignment and prevent the yoke from slipping on the hump when zebus are used.

The yoke weighs 6 kg. The traces are made from light material, either synthetic straps or a nylon rope. Metal chains are not recommended. There are no traction hooks. Semicircular grooves are cut at both ends of the swingle tree to fix the traces. The hitching hook ends in a ring which is gripped around the middle of the swingle tree and avoids its piercing it.

In trials with an animal in excellent condition the traction effort was 20% of the animal's weight for more than one hour (Le Thiec, 1994).

Conclusion

The CIRAD-SAR study highlights the importance of quality, proper design and production, and correct use of yokes.

The use of the withers yoke in Europe for many hundreds of years has shaken the traditional rigid dichotomy of the humped ox–withers yoke and ox without hump–neck yoke associations.

In Africa, harnesses are often considered of secondary importance in draft cultivation. The know-how acquired over the centuries in northern countries obviously cannot be transferred directly to the south. The socio-cultural context has a profound influence on the attitude, and sometimes affection, of the farmer towards the animals.

These aspects should not, however, hinder research on the design and development of harnesses. Although quality is perceived differently in Africa and may not be up to European standards, the techniques used in Europe or tested elsewhere need to be proposed to the African farmers so that they assimilate the basic principles of this know-how. These principles ensure optimum utilisation of the potential draft power. The application of these principles enables us to develop improved yokes for these regions.

The experiments conducted by INERA, SRI, and CIRAD-SAR demonstrate that better finish and greater comfort can translate into a substantial increase in output. Qualitative improvement of harnesses becomes even more significant during intensive work periods, such as at the start of the cropping season in the Sahelo-Sudanian zone.

Single ox traction is not common in Africa, probably because of the absence of an appropriate single yoke. The development of the ATECam single yoke could fill the gap.

The low technology level of the local craftsmen and limited financial capacity of the farmers are important considerations for the application of the findings. The proposed improvements therefore focus on the fundamental principles; they are simple, low-cost solutions that ensure maximum efficiency. More sophisticated improvements requiring precise production methods can be introduced once this generation of farmers has acquired solid experience in animal traction.

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