Improving animal-drawn transport technology in Tanzania: work on ox carts and bearings

by

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Abstract

This paper gives background information on animal traction in Tanzania and the type of animal traction equipment in use. It then describes research and development work done on the wheel bearings for animal-drawn carts, and describes some advantages, disadvantages, failures and successes in the course of development of different types of bearings. The main objective of this work is to make available to the farmer a locally made, good quality, durable and affordable product.

Introduction

Tanzania covers an area of 945 000 km^2 in three climatic zones:

- the coastal belt north of Dar es Salaam, with an annual rainfall of 1000–1900 mm in two rainy seasons
- the Lake Victoria region, with rainfall of 750–1000 mm per year uniformly distributed
- the northern and southern mountain areas, the central plateau and the coastal zone to the south of Dar es Salaam, where rainfall (750–1200 mm a year in mountainous areas, and 250–750 mm a year elsewhere) is concentrated between December and April.

The population of Tanzania is about 24 million, with an annual growth rate of 3.7%. Average population density is 25 people/km^2, but the population is unevenly distributed. About 90% of the population are peasants.

The country has about 10 million hectares of arable land; about six million hectares are actually cultivated, and the cultivated area is increasing. Agriculture is greatly diversified owing to the special climatic and geological characteristics of the country. Crops grown include cotton, coffee, sisal, tea, tobacco, wheat, rice, maize, beans, millet, potatoes, cassava, groundnuts, sunflowers, sesame, sugar cane, cashew nuts and bananas.

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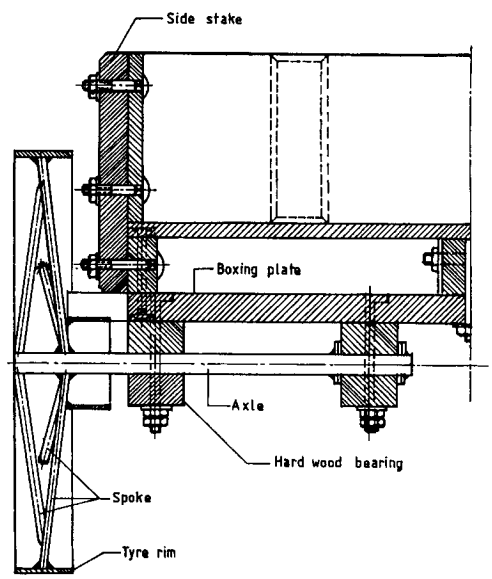
Use of animal traction in Tanzania

The cattle population in Tanzania is estimated at 12 million of which which about 10% are used for draft work. They are unevenly distributed in Shinyanga, Tabora, Mwanza, Mara, Singida and Arusha Regions. Donkeys are used to a limited extent as pack animals and, occasionally, for pulling carts.

Ox cultivation was introduced in the country some 50 years ago by settlers from southern Africa, almost extensively by the use of the single-furrow, steel mouldboard "Victory" plow. This type of plow is still the main implement; more than 250 000 of them have been manufactured by local factories and the annual demand is estimated at 20 000. Few harrows, planters, inter-row cultivators or ridgers are in use, but their numbers are increasing. Carts have been introduced only recently, but their use is increasing rapidly.

The multipurpose wheeled toolcarrier is almost unknown in Tanzania. In 1960 a toolcarrier designed

Figure 1: Wananchi ox cart, with wooden block bearings



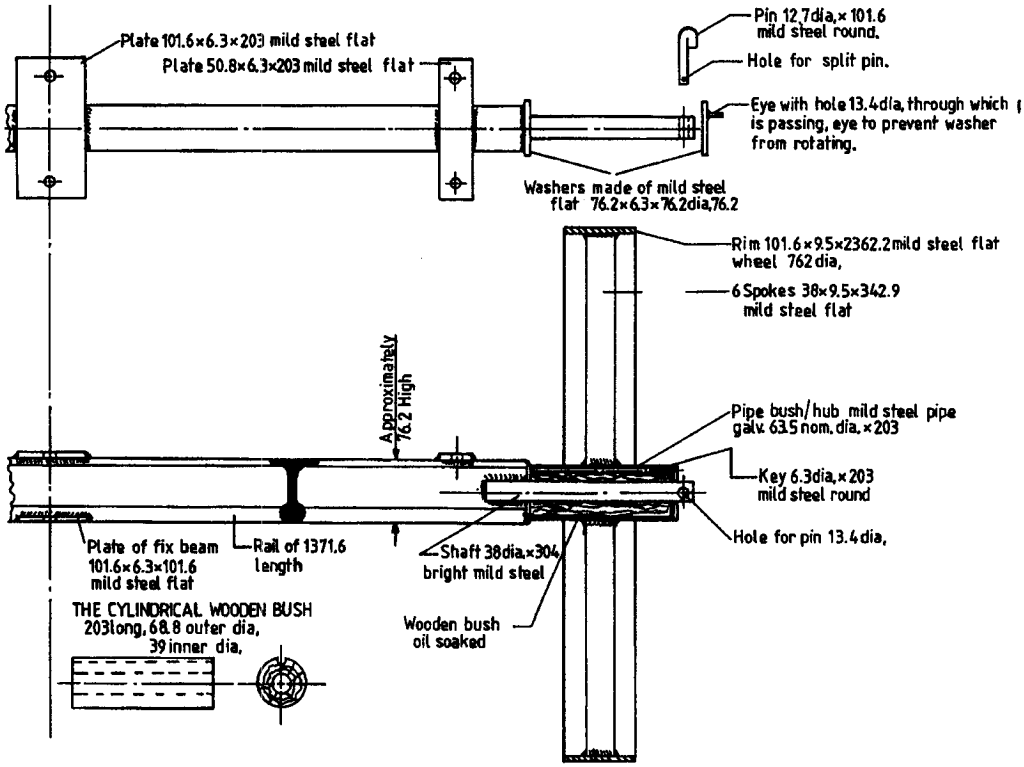
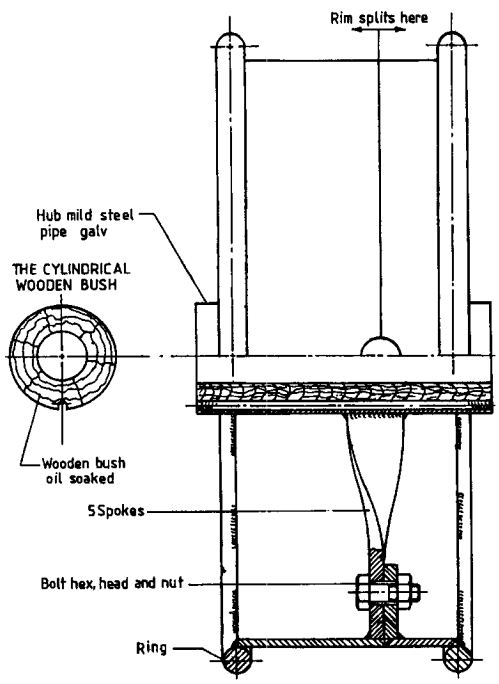


Figure 2: Wooden bush rail axle system (dimensions in mm)

Figure 3: Locally made rim for tyre



by the National Institute of Agricultural Engineering was tested at the Tanganyika Agricultural Machinery Testing Unit (TAMTU) and a modified prototype was developed. Due to a lack of an appropriate draft animal power extension service this implement was not tested extensively and its acceptance by farmers has been neglibible.

Problems with animal traction

Although the use of animals in agriculture represents a great advance over the use of the hand hoe, some farmers are still opposed to using their animals for draft work. Extension service staff are trying to educate these farmers on the advantages of having their animals trained, and actually offer such training free of charge. Even in areas where animal-drawn implements are in common use, animal power is not used for all agricultural operations; major bottlenecks are in weeding (inter-row cultivators are not common) and in harvesting and processing the crops. Ox-drawn planters and inter-row cultivators and simple threshers and hullers are gradually being introduced in an effort to solve these problems.

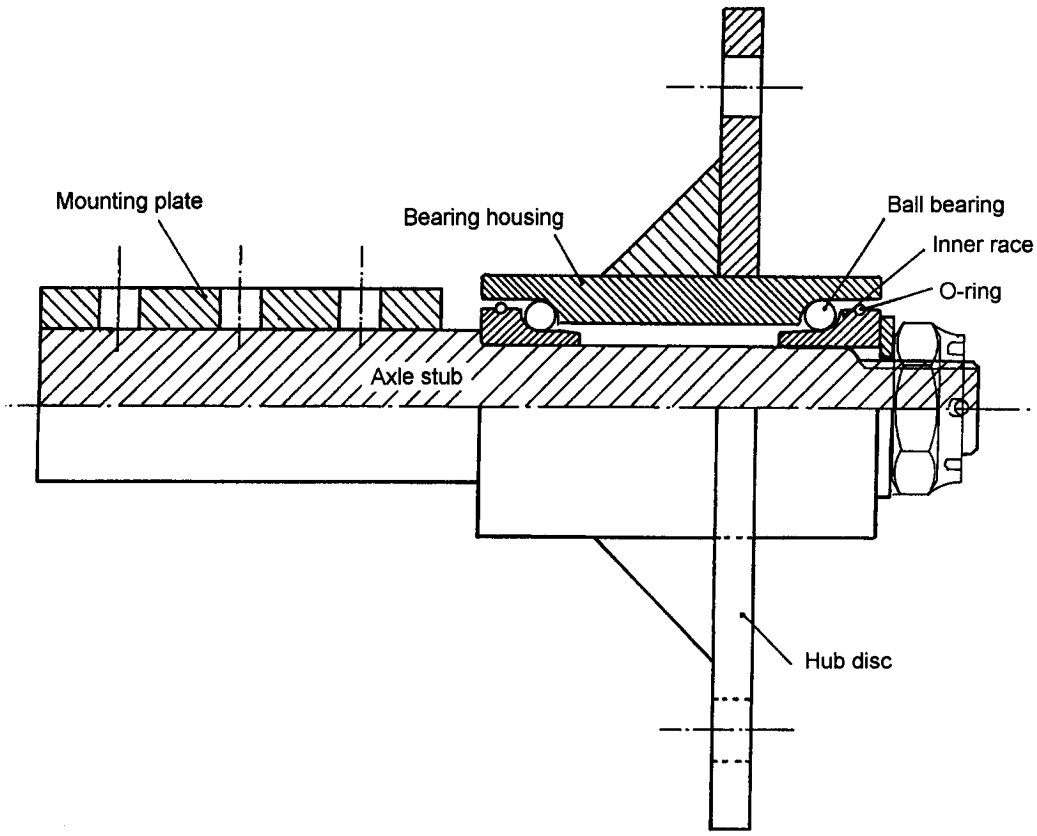


Figure 4: Ball bearing hub

Rural transport and ox carts

Rural transport is a major bottleneck for the Tanzanian farmer. The introduction of ox plows has enabled farmers to increase their crop production, but they are still faced with the problem of transporting their produce from the field to the homestead and from the homestead to market. This need for rural transport has led to the development of the ox cart.

Ox carts were first used in Tanzania in the early 1960s when local artisans tried to copy imported carts found on settlers' farms. The basic raw materials for making the carts were scrap front or rear car axles which still had their original wheels with pneumatic tyres. But because the supply of scrap car axles was limited, few carts could be made. (Such carts are, however, still being made in urban areas where scrap car axles are available; they are mainly used as hand carts.) The lack of suitable axles led to the development of axles made from locally available raw materials.

Pipe axle with wooden block bearings

The first axle developed by TAMTU consisted of a 75 mm steel pipe with a metal wheel on one end revolving in two wooden block bearings which were fixed to a wooden 50 x150 mm plank. Further development changed the pipe to a 38 mm steel shaft, but still with the hardwood block bearings (Figure 1).

Further tests and use of these block bearing carts brought about the development of, and eventual change over to, the rail axle with a shaft welded on either side with wooden bush bearings in a wheel hub revolving round the shafts.

Rail axle with wooden bush bearings

In 1968 TAMTU developed, and put into production, a rail axle with metal or pneumatic tyred wheels with wooden bush bearings pressed in the hubs (Figures 2 and 3). The standard chosen for the wheel was the 16 inch split rim; this is the size of Land Rover tyres which are plentiful in Tanzania. The rim is deliberately split to obviate the use of tyre levers when repairing punctures.

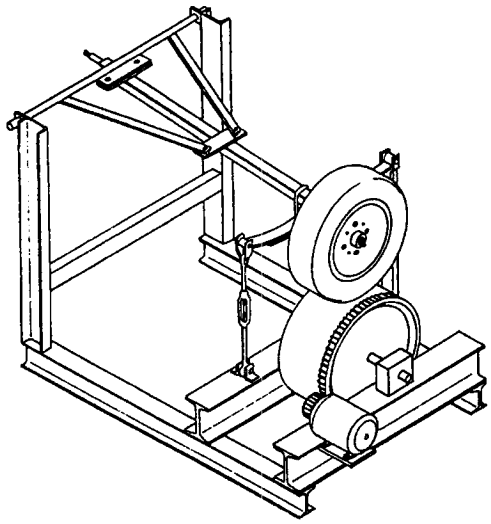


Figure 5: Wheel bearing test rig

Wooden bush bearings do have some disadvantages:

- they wear out very fast if they are not greased (and farmers rarely grease them)
- bearings are replaced by knocking the new one in with a hammer, and this sometimes smashes the bush
- farmers tend to use any wood that is readily available instead of the recommended hardwood; softer wood wears even more rapidly.

The advantages of these bearings, however, are that they are cheap, are easily replaced and require very little maintenance.

Rail axle with ball bearings

In response to an increasing demand for bearings with less friction, the design department of the Centre for Agriculture Mechanisation and Rural Technology (Camartec) developed a new axle assembly to incorporate a simpler and lighter 16 inch split rim and a hub on ball bearings (Figure 4).

The stub axle bearing system is similar to that of a bicycle, but considerably bigger. The original design used 6 mm balls, as used in the rear hub of a bicycle; these could be bought from local shops and were relatively cheap. However, tests showed that these bicycle balls could not withstand loads higher than 500 kg, and so they were abandoned in favour of SKF class 3 balls. The whole hub, including the hardened bearing races, is manufactured in the Camartec workshop.

It is interesting to note that encouragement for this development was found in old engineering books. We reasoned that if it was possible to manufacture satisfactory ball bearings as early as 1923, it must be possible for us to produce such bearings using design methods of that time. These bearings cannot be loaded as highly as modern bearings, but they fully satisfy our needs for a maximum load of 1000 kg.

It may be argued that this development was unnecessary because imported bearings could easily be bought locally. But imported bearings cost over 10 times as much and are meant for larger loads and higher speeds.

Although an ox cart with the new ball bearing hub system costs 25% more than a cart with the old wooden bush stub axle system, the advantages to the farmer justify the increased price and the farmers are prepared to pay more.

Future plans

Tests to check the performance of the new bearings are being carried out on Camartec's test rig (Figure 5). This can simulate various road conditions, such as "moving" at 5 km/hour over a bumpy surface with a load of 300 kg, or being pulled by a tractor, with a load of 500–1000 kg. These tests have covered "a distance" of more than 500 km, and results so far are encouraging.

Finally, Camartec would be interested to hear the experiences of researchers in eastern and southern Africa who are currently doing work on rural transport, particularly on bearings.