Harnessing techniques and work performance of draft horses in Ethiopia

by

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Abstract

A study was carried out to select suitable harnesses for horses and to generate indicative data on draft performance of horses. Three types of harness were used: collar harness, breastband harness and local neck yoke modified for a single horse. The weight of the horse used was 275 kg. A sledge-type loading device was used to apply three levels of pull: 25%, 30% and 35% of the body weight of the horse. The study was carried out on an oval test track. Data were collected on pull exerted, speed of work and on changes in body temperature, pulse rate and respiration rate of the horse.

The collar harness was found to be the most suitable. It offered more contact area for efficient utilisation of the strength of the horse and performed better in terms of speed, energy and power output compared to breastband and yoke harnesses.

The average working speed of the horse was 0.75 to 1.07 m/s for the collar harness,which is higher than that of Ethiopian oxen (0.4 to 0.5 m/s). With this range of speed the horse was able to generate up to 25 to 35% of its body weight (275 kg),which is 68 to 96 kgf. The working speed of the horse while pulling a maresha *ard plow was 0.86 m/s and the actual field capacity was 0.1 ha/h.*

Introduction

Despite the great progress of motorised agriculture, manual workers and draft animals will still continue to provide the main source of power for the farmers of many regions where the use of tractors and tractor equipment does not yet pay for itself. Different draft animals such as oxen, male buffaloes, camels, donkeys, mules and horses are used for draft purposes (Hopfen, 1969)

Oxen are the main source of draft animal power in Ethiopia. Of the 60 million hectares that are cultivable, only 6 million hectares are cultivated in any one year. Ninety-five percent of this is cultivated by small-scale farmers with five million oxen. The distribution of the oxen is not uniform: less than one third of the farmers own two or more oxen, about one third of them own only one ox and the rest do not own oxen. Thus farmers face acute lack of draft power for tillage which has limited the area of land cultivated and crop management practices.

There are 1.6 million horses, 1.5 million mules and 3.9 million donkeys in the country (Fielding and Pearson, 1991). These mules and donkeys are used mostly for pack work. Only a small percentage of horses are utilised for draft, mainly in the Northern parts of the country: Gojjam, Wello, Gondar and Northern Shoa (Pathak, 1988). In Inewari area (Northern Shoa), the use of horses is becoming very important. This shift from oxen to horses is attributed to the fact that horses can be grazed on herbage types which are not grazable by cattle, horses are multipurpose animals, on flat plots power output of horses is considerably higher than that of oxen and the cost of acquiring or replacing a horse is less than that required for an ox.

Oxen are harnessed in pairs using a yoke that is known locally as *kenber*. The yokes are made of light wood and are 140 cm long with a diameter of about 7.5–8 cm. Horses are commonly hitched with the same yoke using an artificial hump. Yokes are used on horses for convenience and simplicity as equine harnesses are not easily obtainable and yokes for oxen are already available (Starkey, 1989). However, yokes are unsuitable for horses, mules and donkeys since these animals are built differently from cattle. Their main strength is in their shoulders and chests. To improve their work output it is necessary to improve or select the harness and thereby improve the work efficiency of the animals. The design of the harness can help

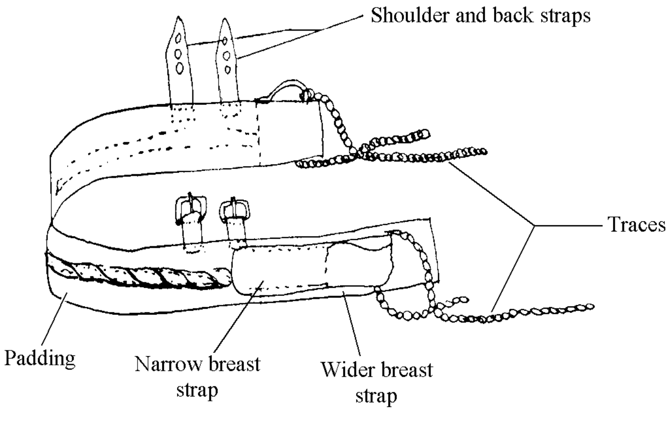

Figure 1: Breast band harness

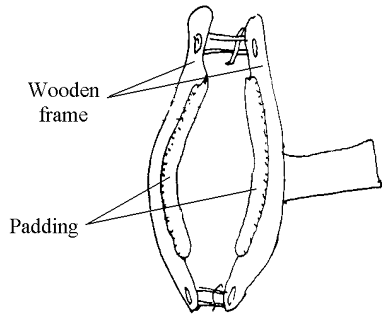

Figure 2: Collar harness

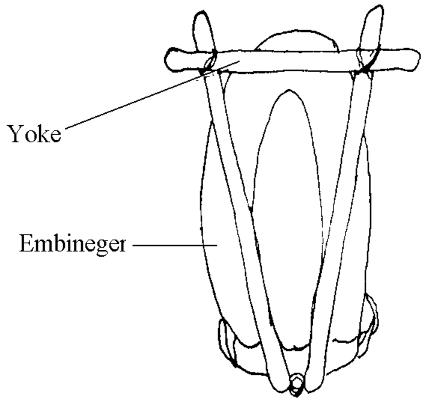

Figure 3: Yoke with embineger *artificial hump*

in tapping the full power of the animals, making them more economical and useful to the farmers.

On this basis a study was carried out at Agricultural Implements Research and Improvement Center to select suitable horse harnesses and to generate indicative data on draft performance of horses and the permissible draft requirement of horse-drawn implements.

Methodology

Three types of harnesses: collar harness, breast band harness and local neck yoke modified for single horse with an artificial hump 'Embineger' (Figures 1, 2 and 3) were used. A horse weighing 275 kg was used to test the three harnesses. The study was carried out on an oval test track. Prior to testing, the horse was trained with each harness on the test track. Observations made prior to testing indicated that pull levels below 25% of body weight allowed the horse to move faster than needed for work animals, whilst at pull levels above 35% of body weight the speed of the horse was too low and the horse showed signs of fatigue in a short time. Therefore three levels of pull: 25%, 30% and 35% of the horse's bodyweight (68, 82 and 96 kgf) were applied using a sledge-type loading device. For each of the three pull levels each harness was used for three consecutive days in a week. The horse was allowed to rest for the remaining four days. During the non-work days the horse was allowed free grazing. On the working days supplementary feed (grain) was given to the horse.

The horse was made to work continuously for three hours. An electrical load cell of 0–5 KN capacity was used to measure the pull. The variation of friction between the sledge and the track from one point to another was negligible. The angles of pull for all the harnesses were measured and were kept constant for the three levels of pull.

Speed of the horse was measured by recording the time taken to complete five rounds of the track throughout the working period. Body temperature was measured using a rectal thermometer before starting work, every hour during work and at the end of work. Pulse rate was measured at the throat latch of the animal at the same time as temperature was measured. Respiration rate was also measured at the same time by keeping the flat of the palm on the animal's flank. Data on ambient atmospheric

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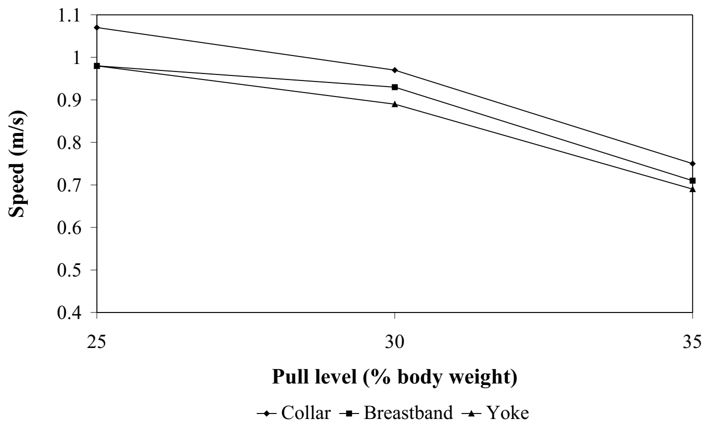

Figure 4: Speed at different pull levels for the three harnesses

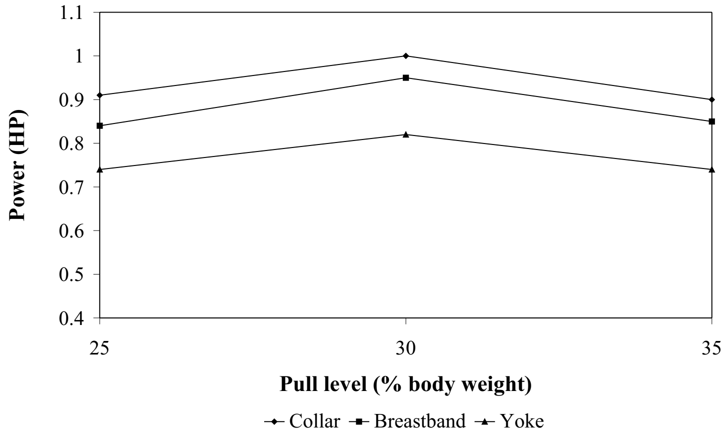

Figure 5: Power output at different pull levels for the three harnesses

conditions during the study period were obtained from the Nazareth Research Center weather station. The mean temperature and relative humidity for the test duration were 25ºC and 49.5% respectively.

Results and discussion

The results are shown in Table 1 and Figures 4 to 6. Figures 4 and 5 show the relationship between draft, speed and power for each of the harnesses. As the draft was increased, the speed of the horse decreased for all types of harness. Although the differences in the speed and power output of the horse at different levels of pull were not significant among the three harness, the collar harness performed relatively better followed by the breast band harness. As the draft was increased there was frequent stoppage and so continuous beating was required to move the horse while working with the yoke harness. The yoke harness had poor stability against the animal's neck and was found to cause sores at higher pull levels, despite the padding. The breast band harness needed accurate positioning, otherwise it interfered with the movement of the animal resulting in sores around its chest.

The power output increased up to a pull level of 82 kgf, 30% of body weight of the horse, after which it started to decline as shown in Figure 5. The average speed of the horse at the lighter load, 64 kgf, was 1.1 m/s using the collar harness. With an increase in draft the average speed decreased to 0.75 m/s at a load of 91 kgf. Because of the decrease in speed, the power output started to decline as the draft was increased.

The change in speed during the work is shown in Figure 6. The horse's body temperature, respiration rate and pulse rate increased considerably during the first hour of work and then tended to stabilise. After the 1st and 2nd hour of work the respiration rate and pulse rate in most cases started to decrease slightly for all the harnesses. This can be attributed to the decrease in the speed of the horse, especially after the 1st and 2nd hour, indicating that the physiological responses are more dependent on the speed of the horse than the pull exerted.

Implement modification and testing

The results of the study have shown that the draft power output of a horse is sufficient to perform tillage operations, provided appropriate implements are available. In addition, the collar harness was found to be the most suitable harness for the horse. Therefore the local plow was modified for a single horse as shown in Figure 7

Table 1: Work performance of a horse with three different harnesses

Pull level (% body weight)	*Collar harness*			*Breastband harness*			*Neck yoke*		
	Draft (kgf)	*Speed (m/s)*	*Power (HP)*	*Draft (kgf)*	*Speed (m/s)*	*Power (HP)*	*Draft (kgf)*	*Speed (m/s)*	*Power (HP)*
25	64	1.1	0.9	65	1.0	0.8	57	1.0	0.7
30	78	1.0	1.0	78	0.9	1.0	70	0.9	0.8
35	91	0.8	0.9	91	0.7	0.9	82	0.7	0.7

and it was tested at Inewari (central Ethiopia) on heavy soil with a moisture content of 13% and bulk density 1.1 g/cm^3. The test results are shown in Table 2. The working speed of the horse while pulling the *maresha* ard plow was 0.86 m/s and the actual field capacity was 0.1 ha/h.

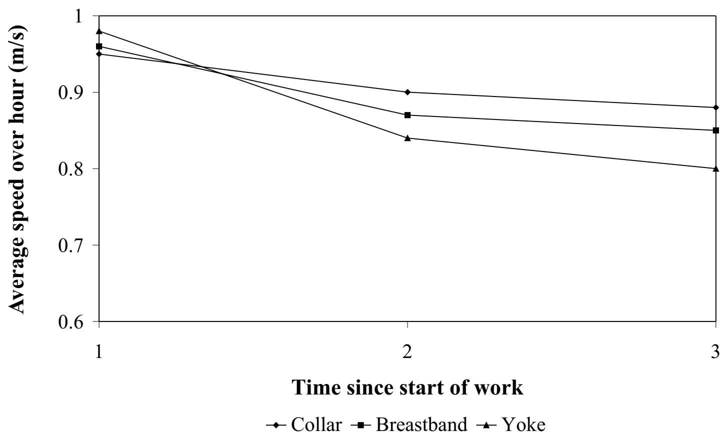

Figure 6: Change of speed with time since start of work. The figures for each harness are averaged over the three levels of pull

Conclusions

The results of the comparative test among the three harnesses indicate that the collar harness shown in Figure 2 is the most suitable. It provides more contact area for efficient utilisation of the strength of the horse compared to the breast band and yoke harness. It performed better in terms of speed, energy and power output compared to the breast band and yoke harnesses. Yoking is the most common practice in parts of Ethiopia where horse are used for draft purpose. However, yokes have a higher angle of pull, and are unsuitable and inefficient for horses, mules and donkeys. Therefore, for heavy draft it is advisable that the collar harness is used. For lighter work the breast band harness should be used since it is relatively cheap. In addition, no physical injury was observed using the collar harness, unlike the breast band and yoke.

Figure 7: The maresha *ard plow modified for use with a single horse*

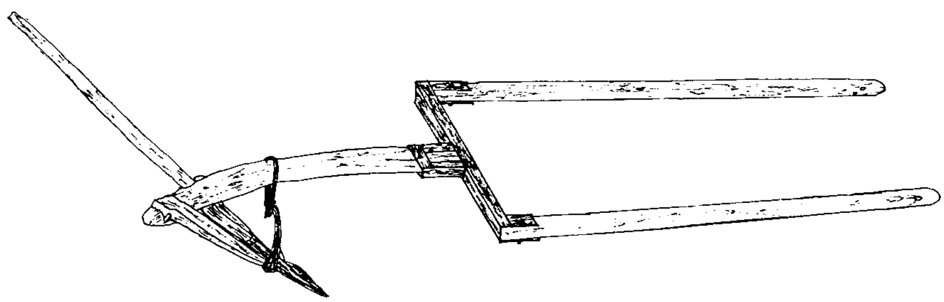

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Table 2: Tests of a *maresha* ard plow modified for a single horse

Plot	*Soil bulk density (g/cm^3)*	*Soil moisture content (%)*	*Depth of work (cm)*	*Cross sectional area of work (cm^2)*	*Capacity (ha/h)*	*Forward speed (m/s)*	*Draft (kgf)*
1	1.1	14	11	175	0.1	0.8	51
2	1.1	14	13	179	0.1	0.9	49
3	1.1	12	13	183	0.1	0.9	58
Mean	**1.1**	**13**	**12**	**179**	**0.1**	**0.9**	**53**

The average working speeds of the horse were 0.75 to 1.07 m/s for the collar harness, which is significantly higher than that of Ethiopian oxen which range from 0.4 to 0.5 m/s. With this range of speed the horse was found to generate pull from 25 to 35% of its body weight (275 kg), which is 68 to 96 kgf.This is adequate to perform secondary tillage operations and to pull moderate loads under most soil and surface conditions provided appropriate implements are available. This range of draft output is also adequate to meet the draft requirement of primary tillage implements on light soils.

Performance tests of the *maresha* ard plow for primary tillage on light soil using a pair of oxen has shown the working speed of the oxen to be 0.66 m/s with an actual field capacity of 0.05 ha/h. Therefore, a single horse can work more area per unit time (0.1 ha/h) than a pair of oxen. However, a horse can work for a shorter duration per day compared to an ox. In areas where there is a shortage of draft animal power and where horses are available, it could be a good option to the farmer to use this implement modified for a single horse along with the collar harness.

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