Experiences with the use of a single ox for cultivation in the Ethiopian highlands

by

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Abstract

Tests on the use of a single ox with a modified maresha *plow were carried out in Ethiopia at the International Livestock Centre for Africa (ILCA) Debre Berhan station, on farmers' fields at Debre Zeit, and on a test track at the Agricultural Implement Research and Improvement Centre (AIRIC) near Nazareth. The power developed by a single local zebu animal using the V-yoke was 0.3 kW under field conditions and varied between 0.15 and 0.19 kW on the test track; a pair of oxen is capable of producing 0.4 kW.*

In 1985 the ox/seed project was started in the Ankober and Seladengay Woredas of Northern Shoa Province to help drought victims. A total of 1800 farmers were each supplied with an ox, grain seed, a modified maresha *and a V-yoke. There were problems with disseminating the use of single oxen in these areas. Extension of the technology was made difficult by the physical environment (steep slopes, high percentage of stone cover and hard soils) and by the farmers' negative social attitude towards the technology. Also, the farmers were not given adequate training in the use of the single ox with the modified* maresha. *The adoption rate of the technology was therefore low.*

Introduction

Oxen pulling the traditional plow (*maresha*) provide the main draft power for tillage operations in Ethiopia. The oxen used for traction are indigenous zebu breeds weighing 270–330 kg (Goe, 1987). A typical farmer uses a pair of oxen for 450 hours a year for cultivation and threshing (Gryseels, 1983).

The major constraint to crop production in Ethiopia is the inadequate availability of draft power, a result of the unequal distribution of oxen among households (Gryseels et al, 1984). According to the Ministry of Agriculture (MoA, 1980) 29% of Ethiopian farmers have no oxen, 34% have one, 29% have two and 8% own three or more. As oxen are traditionally paired for work, more than 60% of farmers have to rent or borrow at least one animal for cultivation.

Ox ownership and cropping pattern

Surveys by the International Livestock Centre for Africa (ILCA) (Gryseels et al, 1984) have shown that the number of oxen owned by a farmer strongly influences both the area cultivated and the cropping patterns.

To ensure timely cultivation, farmers with less draft power till smaller areas rather than spread the available draft power over larger areas, which may result in lower yields. In the Debre Zeit area, where land is intensively cropped, the surveys found a linear relationship between the number of oxen owned and the area cultivated (Table 1).

Because crops vary in their cultivation requirements, the choice of crops is influenced by the availability of draft power. Land preparation for cereal crops is more labour intensive and requires more draft power than preparation for pulses. Thus only farmers with adequate draft power are able to concentrate on growing cereals (Table 1). Furthermore, because the market value of cereal crops is about twice that of pulses, farmers with less draft power have lower

Table 1: Impact of ox ownership on area cultivated and cropping pattern at Debre Zeit, Ethiopia, 1980

Number of oxen owned by farmers	*Average area cropped per farm (ha)*	*Percentage of area sown to cereals*	*Percentage of area sown to pulses*
None	1.2	54	46
One	1.9	44	56
Two	2.7	67	33
Three or more	3.6	92	8

Source: Gryseels et al (1984)

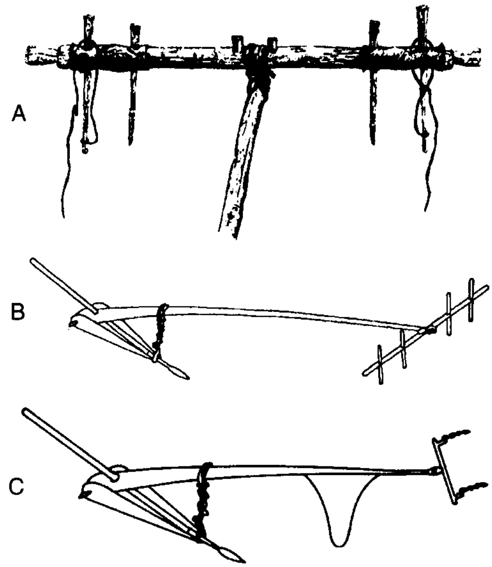

Figure 1:
A) Traditional Ethiopian double yoke (after Goe, 1987)
B) Yoke attached to traditional maresha *plow*
C) Skid and swingle-tree attached to traditional maresha *plow, to allow it to be used by a single animal*

incomes than their counterparts with an adequate supply of draft power.

The availability of draft power is therefore a major factor affecting food production and income distribution.

Modified yoke and *maresha*

During 1983 ILCA developed a yoke and modified the traditional *maresha* to enable it to be used by a single ox. The traditional withers yoke used by a pair of oxen (Figure 1) was replaced by a V-yoke. The V-yoke is made of wood padded with processed animal skin (Photo 1); two hooks are bolted on each cross member of the V-yoke to tie the two trace ropes joining the swingle-tree. In the modified *maresha* a metal skid is attached under the shortened beam to overcome the tipping force in the absence of the counterbalancing force exerted by animals using the withers yoke.

On-station trials

On-station tests of the V-yoke and modified *maresha* (performed at Debre Berhan) revealed no technical problems (Photo 2). An adequately fed zebu ox could cultivate some 60–70% of the area plowed by a pair, although depth of cultivation was slightly shallower than with the traditional *maresha* (Gryseels, 1983). However, these trials were carried out on clay loam soils and on relatively flat fields with few stone outcroppings; these conditions are not typical of most of the farmers' fields in the area.

In 1983 a more detailed 23-week experiment was conducted by ILCA to determine the effect of diet restriction on work performance and body weight loss of crossbred (Friesian x Boran) and local zebu oxen. Animals were worked as singles with the V-yoke and modified *maresha* in farmers' fields in Debre Zeit. Cultivation started with the first plowing and continued until a proper seedbed had been prepared. The soils on all the fields were Vertisols. Ten local zebu and four crossbreds were divided into two groups to receive normal (control) and restricted diets. Average body weights were 450 kg for each crossbred ox and 300 kg for each local zebu ox. There were significant differences between breeds on depth of plowing, area plowed and cultivation rate (Table 2). However, diet did not have a significant effect on work performance.

The average force exerted by the local animals was 600 N with a power output of 0.30 kW; for the crossbreds the force averaged 680 N with a power output of 0.34 kW. Even though the force exerted by the crossbreds was significantly higher than that by the local zebu animals, power differences between the breeds were not significant. Power developed is a function of force and speed and the speed of animals varied considerably depending on the force and the ox handler. The large difference in the power developed between and within breeds could be attributed to the ox handlers' skills.

A more controlled test to compare the rigid withers yoke with the V-yoke, using a single animal, was carried out on a circular track at the Agricultural Implement Research and Improvement Centre (AIRIC) near Nazareth. The ox used weighed

Table 2: The effects of breed on depth of plowing, area cultivated and cultivation rate

Breed	*Number of observations*	*Mean plowing depth (cm)*	*Area cultivated (m^2/day)*	*Cultivation rate (m^2/minute)*
Friesian x Boran cross	256	14.6 a	998 a	4.04 a
Local zebu	613	13.9 b	920 b	3.67 b

Values in the same column followed by a different letter differ significantly (P<0.01)
Source: Abiye Astake, Reed and Butterworth (1986)

300 kg. A loading device fitted with a hydraulic brake mounted on a trolley across the top of the inner wall of the track enabled three levels of pull (300, 450 and 600 N) to be applied. Every day the animal worked for four hours in the morning followed by two hours rest and two hours work in the afternoon for three consecutive days for each yoke at each level of pull. The animal was rested for one day before the yoke was changed and for one week before the level of pull was changed. The type of yoke used and level of pull applied were determined at random.

Speed and power output obtained using the improved V-yoke were slightly higher than those obtained using the rigid withers yoke at all levels of pull (Table 3). For both yokes, the highest power output was obtained at 450 N pull.

The increase in physiological stress was greater during the four hours of work in the morning than during the two hours of work in the afternoon, for both yokes. However, working with the rigid withers yoke induced higher respiration rate, rectal temperature and pulse rate than working with the V-yoke. The modified version of the V-yoke was more effective because it provided a larger contact area for efficient utilisation of the animal's strength (Kebede and Kelemu, 1988). In another set of field trials using the V-yoke and the AIRIC single animal cart, an ox weighing 300 kg was able to pull up to 600 kg pay load on the dirt track for five hours a day without showing signs of fatigue.


Photo: Paul Starkey

Photo 1: Skin-covered single yoke

Table 3: Speed and power output of a single ox using V-yoke and the rigid withers yoke

	V-yoke		*Rigid withers yoke*	
Draft force (N)	*Speed (m/s)*	*Power (kW)*	*Speed (m/s)*	*Power (kW)*
300	0.53	0.15	0.51	0.15
450	0.44	0.19	0.43	0.18
600	0.32	0.18	0.30	0.17

Source: adapted from Kebede and Kelemu (1988)

Use of single ox on farm

During 1984 an extended drought in the lower altitude areas of the northern and central plateaux of the Ethiopian highlands caused acute food shortages

Photo 2: On-station demonstration of use of single ox at Debre Berhan


Photo: Paul Starkey

for millions of farmers. As food and seed grain stocks were depleted, livestock were selectively sold (first small stock such as sheep and goats, young cattle and equines, then cows and finally draft oxen) to provide cash to buy food grain (Gryseels and Jutzi, 1986). Cropping practices in the highlands rely heavily on draft animals so the loss of animals seriously jeopardised the ability of the farmer to cultivate sufficient land. To aid the drought victims, the ox/seed project was started in 1985 within the Ankober and Seladengay Woredas of Northern Shoa Province, 180 and 220 km north-east of Addis Ababa, respectively. A total of 1800 farmers received food aid and were also supplied with one ox each, sufficient seed grain, a single ox plow and the V-yoke on credit. Studying how drought-affected families re-establish agriculture and the role animals could play in post-drought recovery were some of the objectives of the ox/seed project (Gryseels and Jutzi, 1986).

The oxen used for traction in the project were mostly purchased in the drought-affected areas of the lowlands and were therefore generally in weak condition, weighing between 230 and 275 kg. Although they were given supplementary feed before being distributed to farmers, they still weighed less than the 300–350 kg that good draft oxen weigh under normal conditions. Gryseels and Jutzi (1986) observed that many farmers received oxen only in June, in the middle of the plowing season. Although the farmers had already started plowing using pairs of oxen under labour exchange agreements, they found the soils too hard, after the drought, to do the first plowing with a single ox. The farmlands of both Ankober and Seladengay were on steep slopes and were covered with stones. Kebede (1988), who also surveyed the project area, reported that the farmlands were heavily eroded and confirmed a good spread of rock outcrops in the fields. He also observed that on farms where the stone cover exceeded 50%, a single ox was ineffective and farmers resorted to pairs of oxen to pull the plow.

Of the 20 farmers monitored, 17 used the single ox plow in the first year, mainly after the third plowing and for planting and seed covering. Initial plowings were done with paired oxen. Because of the short period available for planting, farmers found the single ox useful because they could do the work without having to wait for neighbours' oxen to make up pairs. Comparison of the labour input for planting and seed covering indicates that single ox plowing required 33% more time than using a pair: a single ox needed 57 hours/ha for one pass against 43 hours/ha for a pair of oxen (Gryseels and Jutzi, 1986).

The single ox technology was introduced with the aim of coping with the low draft power at the disposal of farmers. But only less than half of the project farmers wanted to try the single ox technology because of low traction power (especially on stony fields), potential low farm income, and a bias against using a single ox (Kebede, 1988). The farmers' reluctance may also be attributed to inadequate training in the use of the single ox technology.

Problems encountered

Technical

There were several technical problems with the technology. The power that can be developed by a pair of local zebu oxen on hard strong soils after prolonged fallow is 0.4 kW at a working speed of 0.38 m/s (Goe, 1990) The power output of a single ox ranges from 0.2 to 0.3 kW and is therefore inadequate for deep plowing of the same hard soils. So more time is needed to plow with a single animal. But the major problem of using a single animal is that it is difficult to manoeuvre the implement on stony fields or sloping ground. Where a single ox was used for plowing, patches of ground were often left uncultivated; this problem did not arise when a pair of animals was used. These problems were not encountered in the on-station trials at Debre Berhan or during the tests on farmers' fields in Debre Zeit, as these were carried out on relatively moderate slopes (<10%) with no stone cover. On the heavy clay soils in Debre Zeit, plowing with the single animal was conducted during or after the small rains (March/April) when the soil was moist and soft and therefore required less draft power for cultivation.

The other problem was the farmers' unfamiliarity with controlling a single animal as opposed to a pair of oxen. Most farmers use vocal commands when working with pairs of animals, but the implement itself is also used to control the movement of the animals. If the animals move beyond the end of the field, the *maresha* is angled to penetrate the soil deeper to stop the animals. No reins are used in the traditional system for controlling animals. With the use of the single ox and the modified *maresha*, the implement could not be used to control the animal, and the expectations were that the animal would respond to the vocal commands. However, this was often not the case, and the farmers had problems controlling the animal. Also, the skid on the modified *maresha* bent frequently when used on a stony field and had to be changed for a stronger one.

Social

The attitudes of farmers towards a technology must be considered carefully if a high rate of adoption is to be achieved. Gryseels and Jutzi (1986) pointed out that even though the local farmers of the project area were friendly and hospitable, they had little contact with the outside world and were therefore extremely cautious about the introduction of new technologies. Many farmers expected that there were other, less noble, motives behind the project. Kebede (1988) also found that one of the causes of low adoption rates of the single ox technology in the project area was the existence of a cultural practice that goes against it. If these factors had been studied before the introduction of the technology, then decisions could have been made on whether or not to promote it.

Conclusion

The power developed by the single ox is, as expected, lower than that developed by a pair of oxen. For cultivation work, the single ox technology has to be used on lighter soils or on moist and workable Vertisols. Very steep slopes and stony ground should be avoided. Training of farmers in the proper use of the technology is an essential component of its dissemination.

Topographical and soil conditions in the project area were generally not suitable for the technology. Moreover, there was a traditional bias against using a single ox to pull the implement. Also, the project had a wide range of objectives, and it was difficult to concentrate just on the dissemination of the single ox technology. Because of all these reasons, the adoption rate of the use of a single ox with the modified *maresha* was low.

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