Effect of draft work on lactation of F_1 crossbred dairy cows

by

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Abstract

In Ethiopia, the use of crossbred cows for traction could improve total on-farm production by decreasing the need to maintain draft oxen year-round and a follower herd to supply replacement oxen, provided that lactation and reproduction are kept at levels comparable to non-working cows.

In a study to estimate the effect of draft work on milk production and reproduction, 40 F_1 crossbred dairy cows were assigned to four treatments (non-working non-supplemented, non-working supplemented, working non-supplemented, working supplemented). Working cows consumed more dry matter compared to non-working cows and supplemented cows more than non-supplemented cows. Milk production was greater in supplemented cows, but was similar in working and non-working cows. Body weight loss was greater for non-supplemented cows. Work considerably decreased reproductive ability of non-supplemented cows but only delayed onset of oestrus and conception in supplemented cows. Results indicate that feeding had a greater effect than work on milk yield and reproductive performance. Feeding strategies for draft cows are proposed.

Introduction

In Ethiopia, oxen are only worked for short periods of time, primarily for land cultivation and threshing. The opportunity costs for farms supporting them are considerable. The use of cows for traction would be of obvious benefit to total animal production from the farms by alleviating the need to maintain draft oxen year-round and a follower herd to supply replacement oxen. However, a prerequisite is that lactation and reproduction are kept at levels comparable to non-working cows (Jabbar, 1983; Barton, 1991; Matthewman, Dijkman and Zerbini, 1993). The use of cows, instead of oxen, might be particularly beneficial in areas where major inputs of exotic blood have been made for dairy development schemes in smallholder farming.

An available supply of crossbred cows is one of the most important factors for their adoption as draft animals in Ethiopia. Yet farmers in remote rural areas may not accept the risks of a reduction of herd size and of disease and injury—factors which would limit land cultivation capabilities. On the other hand, around urban areas where crossbreeding programmes and milk collection schemes are implemented, the introduction of cows for the dual purposes of draft and milk production could be feasible. Farmers in areas with profitable milk prices and available feed supplements and veterinary services would more readily accept the introduction of crossbred cows for draft (Gryssels and Goe, 1984).

A study conducted by the International Livestock Centre for Africa (ILCA) on the effect of work on productive and reproductive performance of crossbred dairy cows in the Ethiopian highlands indicated that work had no significant effect on milk production, lactation length, days open, calving interval and services per conception (Agyemang et al, 1992). Cows worked only 84 and 140 hours in the first and second lactation, respectively. These working times were sufficient to cultivate 2.5 ha of land, but are lower than normal working hours for farm oxen. In addition, all cows were supplemented with an average of 3.5 kg concentrate per day during lactation, although such supplements may not be available to smallholders. The study suggested that, with adequate feeding and low work levels, dairy cows could be used for draft with minimal effect on production performance.

Results from an on-farm trial with farmers using crossbred cows for land cultivation in the Debre Zeit area indicated that work had only a minimal effect on lactation. However, a necessary condition was the availability to farmers of sufficient forage, concentrate and adequate management (Gryssels and Anderson, 1985).

An ILCA study relating the effect of lactation and work on feed intake (Lambourne and Zelleka Getahun, 1989), using lactating F_1 Friesian x zebu cows and zebu oxen, would suggest that feed intake has greater influence on lactation than does plowing.

The objective of this on-going study is to investigate in detail the functional relationship between milk production, reproduction, feed utilisation and draft work in *Bos taurus* x *Bos indicus* crossbred dairy cows in the Ethiopian highlands.

Materials and methods

The cow traction study is part of a collaborative project between the Ethiopian Institute of Agricultural Research (IAR) and ILCA (Zerbini and Takele Gemeda, 1991). It is carried out at Holetta IAR Research Centre, 50 km west of Addis Ababa.

Animals

Forty F_1 crossbred dairy cows (20 Boran x Friesian and 20 Boran x Simmenthal), each with 3–5 completed lactations, are being used for the study.

Treatments and measurements

In a 2 x 2 factorial experiment, pregnant cows were stratified, according to previous milk production, number of lactations completed, crossbred type, body weight and previous reproductive efficiency, into four treatment groups (10 animals each):

- non-working, non-supplemented
- non-working, supplemented
- working, non-supplemented
- working, supplemented.

All animals are fed natural pasture hay *ad libitum* providing about 7 MJ of metabolisable energy (ME) per kg dry matter (DM). Supplemented animals are also offered concentrate providing 25% crude protein and 11 MJ ME/kg DM. Working animals spend four hours a day, four days a week pulling sleds with a draft force of 350–450 N at a speed of 0.4–0.6 m/s.

Work starts two weeks after parturition; each cow is worked 100 days a year, in two periods of 50 days each, separated by a three-month rest period. The daily working schedule is three hours work, followed by one hour rest then one hour work.

Cows are individually fed in a stanchion barn at 0700, 1200 and 1700 hours, and are milked twice a day at 0500 and 1530 hours. For each cow, the total experiment will cover two consecutive lactations or four working periods over two years.

The measurements taken during the trials include:

- walking speed, distance and force during work
- heart rate, respiration rate and body temperature before, during and after work
- body weight and condition score
- milk yield and composition
- feed quality, feed intake and utilisation
- onset of oestrus, days open, conception rate and calving interval
- plasma progesterone.

Results

Preliminary results reported here concern intake of feed dry matter (DM), milk production, and body weight change over one year after parturition, including two complete working periods of 50 days. Average results are reported for the different working and resting periods.

Daily hay DM intake was greater for working cows during working periods and rest between work periods (Table 1). Total intake (hay + concentrate) of working cows, as well as for supplemented cows was also greater than non-working and non-supplemented cows, respectively (Table 2). Total hay intake was greater for working cows than non-working cows (3118 *vs* 2777 kg). Supplemented

Table 1: Effects of draft work and diet supplementation on average daily hay dry matter intake of crossbred dairy cows during work and rest periods over one year after parturition

		Average daily hay dry matter intake (kg)				
	Days after calving	*0–14*	*15–89*	*90–179*	*180–269*	*270–359*
Treatment		*Rest*	*Work*	*Rest*	*Work*	*Rest*
Non-working	Non-supplemented	7.8	7.9	6.5	6.5	6.3
	Supplemented	8.5	8.5	8.5	7.5	7.5
Working	Non-supplemented	9.0	9.4	7.2	7.6	7.5
	Supplemented	8.3	8.5	7.7	7.3	7.1
Standard error		0.4	0.5	0.3	0.5	0.6
Friesian x Boran		8.3	8.5	7.7	7.3	7.1
Simmenthal x Boran		8.6	9.0	8.0	7.8	7.8
Standard error		0.2	0.4	0.2	0.4	0.5
F-test probabilities	Work	NS	$P < 0.05$	$P < 0.05$	$P < 0.05$	NS
	Supplement	NS	NS	$P < 0.001$	$P < 0.05$	NS

Table 2: Effects of draft work and diet supplementation on average daily total dry matter intake of crossbred dairy cows during work and rest periods over one year after parturition

		Average daily total matter intake (kg)				
	Days after calving	*0–14*	*15–89*	*90–179*	*180–269*	*270–359*
Treatment		*Rest*	*Work*	*Rest*	*Work*	*Rest*
Non-working	Non-supplemented	7.8	7.9	6.5	6.5	6.3
	Supplemented	10.6	11.1	11.0	9.6	9.2
Working	Non-supplemented	9.0	9.4	7.2	7.6	7.5
	Supplemented	10.4	11.8	11.9	11.4	10.3
Standard error		0.3	0.5	0.3	0.5	0.7
Boran x Friesian		9.4	9.8	9.0	8.5	8.0
Boran x Simmenthal		9.6	10.3	9.3	9.0	8.8
Standard error		0.2	0.4	0.2	0.4	0.5
F-test probabilities	Work	NS	P < 0.05	P < 0.05	P < 0.05	NS
	Supplement	P < 0.001	P < 0.001	P < 0.001	P < 0.001	P < 0.001

cows consumed more than non-supplemented cows (3082 *vs* 2813 kg) (Table 3). Total intake (DM) followed a similar pattern: 3179 *vs* 3585 kg for non-working and working cows and 2813 *vs* 3950 kg for non-supplemented and supplemented cows, respectively. The effect of work on average daily milk yield was not significant even though milk yield was affected by work during the first working period (90 days) (Table 4). Daily milk yield was greater for supplemented cows during both working and rest periods. Total milk production in one year postpartum was similar for working and non-working cows (1288 *vs* 1321 kg) (Table 5). However, supplemented cows produced significantly more milk than non-supplemented cows (1781 *vs* 828 kg). In addition, Friesian x Boran cows

Table 3: Effect of work and diet supplement on total dry matter intake of crossbred dairy cows in one year after parturition

		Dry matter intake	
Treatment		*Hay (kg)*	*Total (kg)*
Non-working	Non-supplemented	2598.8	2598.8
	Supplemented	2955.0	3756.5
Working	Non-supplemented	3027.2	3027.2
	Supplemented	3209.2	4142.4
Standard error		132.4	140.7
Friesian x Boran		2867.7	3310.0
Simmenthal x Boran x		3027.4	3453.6
Standard error		93.6	99.5
F-test probabilities	Work	P < 0.01	P < 0.01
	Supplement	P < 0.05	P < 0.001

Table 4: Effect of draft work and diet supplementation on average daily milk production of crossbred dairy cows during work and rest periods over one year after parturition

		Average daily milk production (kg)				
	Days after calving	*0–14*	*15–89*	*90–179*	*180–269*	*270–359*
Treatment		*Rest*	*Work*	*Rest*	*Work*	*Rest*
Non-working	Non-supplemented	6.1	3.5	1.8	1.7	1.7
	Supplemented	8.1	6.1	5.3	4.5	4.8
Working	Non-supplemented	6.6	3.2	1.5	1.1	0.7
	Supplemented	8.3	4.9	5.0	4.3	3.8
Standard error		0.7	0.4	0.4	0.4	0.6
Friesian x Boran		8.2	4.9	3.4	3.3	3.0
Simmenthal x Boran		6.4	4.0	3.4	2.5	2.6
Standard error		0.5	0.4	0.3	0.3	0.4
F-test probabilities	Work	NS	NS	NS	NS	NS
	Supplement	P < 0.05	P < 0.001	P < 0.001	P < 0.001	P < 0.001
	Breed	P < 0.05	NS	NS	P < 0.1	NS

Table 5: Effect of work and diet supplementation on total milk production of crossbred dairy cows in one year after parturition

Treatment		*Total milk yield (kg)*
Non-working	Non-supplemented	848.8
	Supplemented	1792.6
Working	Non-supplemented	806.7
	Supplemented	1769.9
Standard error		152.2
Boran x Friesian		1458.5
Boran x Simmenthal		1150.5
Standard error		107.6
F-test probabilities	Work	NS
	Supplement	P < 0.001
	Breed	P < 0.05

produced more milk (P < 0.1) than Simmenthal x Boran cows.

Non-supplemented cows lost body weight throughout the year, while supplemented cows, except for working cows during the first working period (90 days), maintained or gained body weight (Table 6). Total body weight losses were similar for working and non-working cows (–14.6 *vs* –19.5 kg). Total body weight change in non-supplemented cows was significantly different (P < 0.001) from that of supplemented cows (–60.6 *vs* 26.4 kg). Rate of body weight change during work and rest periods for Boran x Friesian crosses tended to be greater than for Boran x Simmenthal. This was also the case for total body weight loss over two working periods.

Within the timeframe adopted (360 days postpartum for all cows), reproduction parameters could be summarised as follows:

- all supplemented non-working cows were bred and pregnant
- all supplemented working cows were bred but 90% were pregnant
- 60% of non-supplemented non-working cows were bred and pregnant
- 20% of non-supplemented working cows were bred and pregnant.

Work delayed onset of oestrus by 108 days in supplemented cows, indicating that there was an effect of work on reproduction even when nutrition was adequate. However, diet supplementation had a much greater effect on onset of oestrus than work.

Discussion

Results indicate that the greater feed (DM) intake of working, compared to non-working, cows was utilised partly to sustain milk production and/or support energy expenditure for work. Assuming that average daily energy expenditure for work was 31.8 MJ metabolisable energy (ME) (work = 4 hours, work rate = 250 watts, body weight = 450 kg), the increase in hay intake to meet that energy demand should have been 4 kg per working day. Low hay digestibility limited intake and at 90 days postpartum, the increase in hay intake was only 1.6 kg/day for working non-supplemented cows (equivalent to 12 MJ ME). This was associated with a body weight loss of 0.39 kg/day (equivalent to 14.4 MJ ME). Energy equivalents of hay intake and body weight loss would account for a total of 26.4 MJ ME per day of extra energy supply for work and milk production.

Table 6: Effect of draft work and diet supplementation on cumulative body weight change (kg) of crossbred dairy cows during work and rest periods over one year after parturition

		Body weight change from parturition (kg)				
	Days after calving	*0–14*	*15–89*	*90–179*	*180–269*	*270–359*
Treatment		*Rest*	*Work*	*Rest*	*Work*	*Rest*
Non-working	Non-supplemented	–3.3	–29.0	–45.8	–41.9	–59.6
	Supplemented	–2.9	4.4	17.8	22.7	20.5
Working	Non-supplemented	–11.3	–34.8	–46.2	–52.9	–61.6
	Supplemented	–12.4	–22.5	15.7	4.9	32.3
Standard error		2.8	4.8	7.9	9.8	13.1
Friesian x Boran		–9.4	25.9	–23.2	–25.9	–22.5
Simmenthal x Boran		–5.6	–15.0	–11.1	–7.7	–11.7
Standard error		2.0	3.4	5.6	7.0	9.1
F-test probabilities	Work	NS	P < 0.01	NS	NS	NS
	Supplement	NS	P < 0.01	P < 0.001	P < 0.001	P < 0.0001

Compared to the calculated requirement of 31.8 MJ ME/day, this indicates a deficit of 5.4 MJ/day, which would affect milk yield and additional body weight loss if work output remained constant (Table 7).

As shown in Table 5, milk yield over a one-year period was similar for working and non-working non-supplemented cows. This suggests that either energy requirements for work were lower, or energy content of hay was greater than estimated.

Feeding concentrate supplied sufficient energy for work with minimal loss of body weight and reduction of milk production. Protein supplementation not only increased total feed intake but also tended to increase hay intake, perhaps by increasing its digestibility. Weight loss of supplemented cows was lower and milk yield was higher compared to non-supplemented working cows. However, concentrate may not be readily available on local markets and its inclusion in the diet may not be feasible throughout the year.

While inadequate feeding may not affect work output, high rates of body weight loss lead to decreased milk production and reproductive ability. Body weight losses greater than 15% have been reported to impair ovarian activity in buffaloes (Teleni et al, 1989). Our results suggest that reducing body weight loss from 0.39 to 0.25 kg/day with supplementary feeding could improve reproductive performance by about 65%. However, work carried out in early lactation delayed onset of oestrus by more than 108 days, indicating that work, partially independent from nutrition, might have an effect on reproduction.

Complete analysis of reproduction parameters will be carried out at the end of two lactations and the two-year working periods. This will allow for a comprehensive evaluation of the efficiency of cows used for draft. Future work would include a more detailed study of reproductive parameters of working cows and testing cow traction technology within the farming system.

In view of these preliminary results, two possible feeding solutions may be recommended where crossbred cows are used for draft.

Production and feeding of improved forages (grasses + legumes, legumes, or other fodder) would increase digestibility of forages and energy intake of cows to levels which would allow them to support milk production, reproduction and work with an acceptable level of physiological body weight loss.

Production and feeding of well-managed natural pasture hays and improved quality crop residues associated with concentrate feeding during early lactation would be appropriate, especially if cows are due to work during that period. Application of new techniques and research findings for better conservation of the natural forage during particular periods of the year needs particular attention.

Table 7: Effect of draft work on energy balance for work of draft crossbred dairy cows fed natural pasture hay *ad libitum*

	90 days postpartum	
Hay dry matter intake (non-working cows)	8.0	kg/day
Hay dry matter intake (working cows)	9.6	kg/day
Hay dry matter intake increase	1.6	kg/day
ME available from extra hay intake	12.0	MJ/day
Body mass loss	0.39	kg/day
ME available from body reserves (after CSIRO, 1990)	14.4	MJ/day
Total ME available for work	26.4	MJ/day
Total ME required for work	31.8	MJ/day
Balance	–5.4	MJ/day

Conclusions

As indicated above, the Ethiopian highlands are increasingly unable to maintain a large cattle population. Therefore it will become more difficult for farmers to maintain the breeding stock required for replacement and draft. Reduction of herd size by using crossbred cows for traction will depend primarily on the available supply of crossbred animals. Increased risk associated with decreased animal numbers needs to be considered. Farmer access to suitable feeds and veterinary services should also be examined. Farmers in peri-urban areas characterised by scarcity of land could find the technology most attractive, given a profitable market for milk and calves. Evidence from this study would suggest that if cows are fed adequately, the effect of draft work on lactation is minimal.

Crossbred cows could play an important role as dual-purpose animals in the highland farming systems. In particular, their preference over oxen could contribute to a better utilisation of already scarce feed resources. Additional research should be carried out on the management and nutritional requirements of the lactating draft cow and possible ways to meet its nutrient needs—especially in early lactation when the high energy demand for lactation is associated with work energy needs.

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