International Trypanotolerance Centre

Effects of nutrition pre-partum and post-partum on subsequent health and productivity of N'Dama cows infected with *Trypanosoma congolense.*

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SUMMARY

This report covers a single trial conducted as a continuation of the project B0025 which had the overall objective of "improving the productivity of trypanotolerant N'Dama cattle under trypanosomiasis challenge through the development of strategic supplementary feeding practices".

The specific objective of this project (A0461) was to isolate the effects of body condition, long and short-term levels of nutrition and trypanosomiasis infection on the productivity and subsequent reproductive performance of N'Dama cows. Supplementary feeding during gestation, ensured that 55 cows split into two groups of animals had different liveweights and condition scores by calving. Two days post-partum, half the cows from each group were placed on either a basal or supplemented plane of nutrition. In order to assess the effect of trypanosomiasis on milk yield, liveweight, body condition and feed intake, half the animals in each group were then inoculated intradermally four weeks post-partum with at least 1 x 10^4 trypanosomes using the *T.congolense* clone known as ITC 84. The trial continued for a further 9 weeks.

The results demonstrated that body weight loss was greater in animals supplemented post-partum, with a similar trend for animals on the high pre-partum diet. The reduction in feed intake (particularly concentrate and groundnut hay) was greatest in infected animals, supplemented post-partum. The refusal of the better quality components of the diet is contrary to other experiments where infected animals tended to refuse andropogon hay. However, the decline in milk yield was proportionally greater in infected animals on the basal plane of nutrition post-partum. Pre-partum nutrition had no effect on feed intake post-partum.

BACKGROUND

In the majority of tsetse endemic areas the availability of drugs for prophylactic control trypanosomiasis is erratic and their mis-use can lead to resistant strains of the trypanosome. The trypanotolerant breeds of cattle offer an alternative to small holder farmers yet their productivity under disease challenge is variable or low.

There is now clear evidence that improved nutrition increases the ability of cattle to tolerate infection through the control of anaemia, both from on station trials (Little *et al* 1990; Romney *et al* 1993) and field observations (Agyemang *et al* 1990). However, the responses to short term nutritional interventions and infection in trials appear to be dependent, in part, on initial liveweight (or body condition) of animals. Using rate of Packed Cell Volume (PCV) decline as an indicator, Little *et al* (1990) found that the initial acute phase response was more severe in N'Dama bulls in a better body condition.

Field studies with the N'Dama have also investigated the impacts of trypanosomiasis infection on components of cattle productivity, especially milk yield and reproductive performance. Agyemang *et al* (1990) noted marked effects of infection on milk yield. Mael *et al* (1988) concluded that infection reduced milk production because calves suckling parasitaemic cows had impaired pre-weaning growth rates and reduced weaning weights. Agyemang *et al* (1993) found independent and additive effects of infection and weight change *post-partum* on subsequent calving intervals

One of the major constraints to the improvement of reproductive efficiency of N'Dama cows is the duration and variability in the length of the *post-partum* anoestrous period. In temperate *Bos taurus* cattle breeds, while suckling has an inhibitory effect on the return to cyclicity, the dominant factors affecting calving interval are peri-parturiant weight change and body condition which in turn reflect *pre-partum* levels of feeding (Wright *et al* 1992). There is less information for tropical *bos taurus* breeds such as the N'Dama. Agyemang *et al* (1991) provide the only indication of the independent effects of liveweight and liveweight change, suggesting that cows which conceived within 12 months *post-partum* showed either rising or high liveweight in the three months prior to conception. Agyemang *et al* (1993) also found independent effects of infection and weight change in the period 0-4 months *post-partum* on the proportion of cows conceiving within 12 months.

These observations suggest that milk production, reproductive responses, and the control of infection are all associated with both current liveweight and short-term liveweight change. Thus, it may be possible to develop a concept of target liveweights at different seasons, levels of tsetse challenge, and/or physiological status, with required short-term supplementary feeding interventions to promote productivity under trypanosomiasis challenge.

PROJECT PURPOSE

The purpose of this experiment was to isolate the effects of body condition, long and short-term levels of nutrition and trypanosomiasis infection on the productivity and subsequent reproductive performance of N'Dama cows.

RESEARCH ACTIVITIES

In mid-November 1994 the oestrous cycles of over 120 breeding N'Dama cows were synchronised using norgestomet and oestradiol valerate (Intervet UK Ltd), they were then artificially inseminated with Jersey or Holstein semen imported from New Zealand. In February 1995, in the mid-dry season 55 pregnant cows (including nine heifers) were selected from the original group for the trial. Twenty nine cows received supplementary feed for a six month period of the dry season to maintain weight and body condition whilst the other group of twenty seven received supplements in the final two months of gestation. Both groups had access to poor quality natural grazing. This ensured that two groups of animals had different liveweights and condition scores by calving in late August/early September 1995, early in the rainy season. The animals continued to graze until calving.

Two days post-partum, half the cows from each group were placed on either a basal or supplemented plane of nutrition. In order to assess the effect of trypanosomiasis on milk yield, half the animals in each group were then inoculated intradermally four weeks post-partum with at least 1 x 10^4 trypanosomes using the *T.congolense* clone known as ITC 84. The trial continued for a further 9 weeks.

As calving was spread over 4 weeks the experimental animals were allocated to 2 blocks to ensure each animal was subjected to the treatments similar stage of their lactation. The trial was divided into 4 separate periods with each block following the same sequence:

Period
1 = 4 weeks pre-infection
2 = pre-patent; wks 1,2 post-infection
3 = post-infection wks 3 - 7
4 = post-infection wks 8-10

The following is a summary of the main treatments and the numbers of animals in each sub-class at the start of the trial (Period1):

Pre-partum feeding	**Post-partum feeding**	**Infection (4 weeks post-partum)**	
Hi (29)	Basal (15)	Infected (7)	Control (8)
	Suppl (14)	Infected (7)	Control (7)
Lo(23)	Basal (12)	Infected (5)	Control (7)
	Suppl (11)	Infected (5)	Control (6)

In traditional Gambian cattle herds, milk is extracted for human consumption in addition to the calf suckling the dam. A similar practice was adopted in this trial. The cows were milked once a day at 08.00hrs, after overnight separation from their calves. The calves suckled twice a day, once to stimulate let down prior to milking and after milking, and again at 15.00hrs. The herdsmen were allowed to use their experience as to the amount of milk extracted from each animal. If the yield was deemed inadequate, by the herdsmen, all the milk was left for the calf.

Diets and feeding

Pre-partum: Between February and June (3 - 7 months post-conception) all animals grazed natural grasslands and aftermath's on a stretch of salt flats and rice fields, savannah woodland, and large areas of cultivated and fallow croplands. The supplemented group (**Hi**) were individually fed 0.94kg dry matter (DM) per day of concentrate containing groundnut (*Arachis hypogea*) cake and rice bran in the ratio of 1:4 and 0.93kg DM/d of groundnut hay. The feeds were offered in the morning before the animals were released for grazing. The non-supplemented group (**Lo**) had access only to grazing. In the final two months of pregnancy (July and August) the cattle were moved to ITC headquarters on the coast where the grazing consisted predominantly of croplands and short-term bush fallows. To compensate for the lack of fodder at the end of the dry season, the Hi group received 4.7kg DM/d of the concentrate whilst the Lo group received 1.4kg DM/d.

Post-partum: All animals were individually stall fed. The ratios of feeds offered to cows in the basal (Basal) and supplemented (Suppl) groups were the same, only the quantity differed. In periods 1,2 and 3 groundnut hay and andropogon hay were offered in addition to a concentrate consisting of equal parts (1:1) groundnut cake and rice bran. In period 4 fresh cut green andropogon was substituted for groundnut hay and andropogon collected in the proceeding dry season. The shortage of fodder was caused by rain contaminating the hay stacks (heavy duty plastic sheeting becomes brittle in the tropics). Table 1 summarises the quantities offered on a dry matter basis in Periods 1,2 and 3. In the morning during milking the cows were first given the concentrate followed by the groundnut hay and then the andropogon. The refusals of the andropogon were collected at 16.00hrs.

Table 1 Composition of the diets offered in periods 1,2 and 3 post-partum

	Feeds offered g DM/day		
	Groundnut Hay	Andropogon Hay	Concentrate*
SUPPL	2418	1860	2326
BASAL	1953	1488	1860

*concentrate contains 1:1 ratio of groundnut cake and rice bran

The diets were devised so that the amount offered to the basal group was estimated to be proportional to 1.10 of the daily Metabolizable energy (ME) requirement for maintenance and lactation based on a 230 kg animal producing 2.5 litres of milk per day (records from ITC indicate that the average daily milk yield in the first 100 days of lactation is 2.3 l/d). Cows on the supplemented plane were offered proportionally 1.38 of the daily ME requirement for maintenance and lactation. The crude protein content of both diets was approximately 12%. Each cow received 12g of local sea salt per day in the concentrate. Water was offered at 11.00 hrs and 15.00 hrs.

Management and Health.

Post-partum, the cows were orally dosed with a broad-spectrum anthelmintic, 10% fenbendazole (Panacur, Hoechst) @ 7.5ml per 100 kg liveweight; and every two weeks, to the end of the trial, 1% flumethrin pour-on (Bayticol; Bayer) was used to eliminate tick infection and minimise the chances of a possible natural trypanosome infection by tsetse flies. One control animal was recorded as positive for trypanosomiasis and withdrawn from the trial. As two of the calves voided *Toxocara vitulorum* immediately after birth, all calves were dosed with 10% fenbendazole at birth and at three weeks of age.

All infected cows were treated with 7.0 mg/kg bodyweight diminazene aceturate (Berenil, Hoechst) when withdrawn from the trial or 9 weeks post-infection. Cows were

withdrawn if their packed cell volume (PCV) fell below 15% or if recumbent for more than two days.

Measurements and observations

Feed intake and refusals: Voluntary DMI was recorded daily by weighing feed offered and feed refusals. Sub-samples from the feed offered and refused were taken daily, pooled over a 7 day period, dried in an oven at 60^{o}C until constant weight, ground through 1mm screen and stored for analysis. Water intake was recorded daily.

Analysis of feed samples: The following determinations were made on the weekly pooled samples of feed offered and refused: dry matter (DM); organic matter; total nitrogen (N) using the Kjeldal method; neutral detergent fibre (NDF), and acid detergent fibre (ADF) using the methods of Van Soest (1982).

Haematological measurements: Blood samples were collected weekly with EDTA-coated vacutainers. The samples were examined by the buffy-coat dark- ground/phase parasitological technique to detect presence of trypanosomes and quantify the intensity of infection as a parasitaemia score (Murray *et al* 1977) and to measure PCV. The plasma was separated and stored for subsequent progesterone analysis.

Liveweight and condition score: Weekly records were maintained of cow body weights to the nearest kg and their condition score to the nearest half. The calves were also weighed on a weekly basis to the nearest half kg.

The condition scores were based on a five point scale adapted for N'Damas using scales devised by Pullen (1978) and Richards, Spitzer and Warner (1986) as defined in Appendix 1.

Milk yield and composition: Milk yields were measured each day, the percentage of milk fat and protein analysed twice weekly using the Gerber test.

Reproduction component: The resumption of ovarian activity was monitored using progesterone profiles in plasma.

Statistical analysis

The data were analysed using the general linear models (GLM) procedure of the Statistical Analysis Systems Institute (1987) whereby:

$Y_{ijklmn} = Period_i + Block_j + Diet\ pre\text{-}partum_k + Diet\ post\text{-}partum_l + Health\ status_m + animal(block*diet\ pre*diet\ post*health\ status)_{njklm} + e_{ijklmn}$

The interactions between experimental period, diet and health status were tested. The means presented are least squares.

RESULTS

A) LIVE WEIGHT

Table 2. Effects of diet pre and post-partum and *T.congolense* infection on the liveweight (kg) of cows in period 1 (pre-infection) and period 3 (post-infection).

Period 1, pre-infection (wks 1-4) mean LW kg

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
us				
Control	227 ± 1.0	209 ± 0.9	225 ± 1.0	211 ± 0.9
Infected	219 ± 0.8	207 ± 0.9	216 ± 0.9	211 ± 0.9

Period 3, post-infection (wks 7-10) mean LW kg

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	226 ± 0.8	210 ± 0.7	227 ± 0.7	209 ± 0.7
Infected	211 ± 0.6	204 ± 0.7	210 ± 0.7	206 ± 0.7

Change in liveweight (kg) between periods 1 and 3

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
us				
Control	-1	1	2	-2
Infected	-8	-3	-6	-5

Pre-partum nutrition had a significant ($P<0.001$) effect on liveweight throughout the experimental period. Post-partum nutrition had a significant ($P<0.001$) effect on liveweight. Infection had a significant ($P<0.001$) effect by period 3. There was no interaction between pre-partum nutrition and infection (but a trend) for animals on the high plane of nutrition pre-partum to lose relatively more weight. The was a significant interaction ($P<0.01$) between post-partum nutrition and infection with a proportionally larger weight loss in the supplemented infected animals compared to basal infected

B) CONDITION SCORE

Table 3. Effects of diet pre and post-partum and *T.congolense* infection on the condition score of cows in period 1 (pre-infection) and period 3 (post-infection).

Period 1, pre-infection (wks 1-4) mean C.S

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	2.3 ± 0.07	1.7 ± 0.06	2.2 ± 0.07	1.8 ± 0.07
Infected	2.3 ± 0.06	1.7 ± 0.07	2.2 ± 0.06	1.7 ± 0.06

Period 3 , post-infection (wks 7-10) mean C.S

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
us				
Control	2.5 ± 0.05	1.9 ± 0.05	2.3 ± 0.1	2.0 ± 0.05
Infected	2.0 ± 0.04	1.6 ± 0.05	1.9 ± 0.1	1.6 ± 0.05

Change in C.S between periods 1 and 3

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	0.2	0.2	0.1	0.2
Infected	-0.3	-0.1	-0.3	-0.1

Pre-partum nutrition had a significant ($P<0.001$) effect the condition score of the animals throughout the trial. Post-partum nutrition also significant ($P<0.001$) effect, as did infection ($P<0.001$). There were no significant interactions period, diet, and infection. The effects were additive and independent.

C) DAILY MILK OFF TAKE

Table 4. Effects of diet pre and post-partum and *T.congolense* infection on the mean daily milk offtake (ml) of cows in period 1 (pre-infection) and period 3 (post-infection).

Period 1, pre-infection (wks 1-4) mean daily milk offtake (ml)

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	819 ± 29	609 ± 27	868 ± 28	559 ± 28
Infected	701 ± 23	663 ± 26	699 ± 25	666 ± 24

Period 3 , post-infection (wks 7-10) mean daily milk offtake (ml)

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	579 ± 21	332 ± 19	566 ± 20	345 ± 20
Infected	232 ± 17	208 ± 20	265 ± 19	174 ± 19

Change in mean daily milk offtake between periods 1 and 3

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	-240	-277	-302	-214
Infected	-469	-455	-434	-492

Pre-partum nutrition had a significant ($P<0.001$) effect on the subsequent mean daily milk offtake (ml) during the trial. Post-partum nutrition had a significant ($P<0.001$) effect on mean daily milk offtake (ml) whilst infection significantly reduced average daily milk offtake ($P<0.001$).

There was no interaction between pre and post-partum nutrition on milk offtake nor was there an interaction between pre-partum nutrition, infection and milk offtake. However, there was a significant interaction ($P<0.01$) between post-partum nutrition and infection. The reduction in milk off take was proportionally larger in the basal infected cows

D) FEED INTAKE

Table 5. Effects of diet pre and post-partum and *T.congolense* infection on the mean daily dry matter intake (g DM/head/day) of cows in period 1 (pre-infection) and period 3 (post-infection).

Period 1, pre-infection (wks 1-4) mean daily DM intake (g/head/day)

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	5565 ± 105	5521 ± 95	6035 ± 102	5052 ± 98
Infected	5609 ± 85	5526 ± 95	6016 ± 91	5119 ± 88

Period 3 , post-infection (wks 7-10)) mean daily DM intake (g/head/day)

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	5771 ± 78	5684 ± 69	6257 ± 74	5198 ± 72
Infected	4796 ± 63	4849 ± 74	4816 ± 70	4828 ± 68

Change in mean daily DM intake (g/head/day) between periods 1 and 3

	Pre-partum		Post-partum	
Dietary plane	High	Low	Suppl	Basal
Health Status				
Control	206	163	222	146
Infected	-813	-677	-1200	-291

As planned, there was a significant ($P<0.001$) difference in the daily total Dry Matter Intake (DMI) between the two post-partum diets, the overall average daily intake of the supplemented group throughout the trial was 5877 gDM/head/day compared to 5088 gDM/head/day for the Basal group. Pre-partum nutrition had no significant effect on total DMI or on any of the components of the diet. Infection caused a significant ($P<0.001$) reduction in total DMI .

There was a significant interaction ($P<0.001$) between diet post-partum, infection and change in dry matter intake with a proportionally larger decline in supplemented infected animals. There was no interaction between diet post-partum, infection and andropogon intake. The reduction in andropogon intake was similar in both the basal and supplemented groups. The decline in concentrate and groundnut hay intake was significantly ($P<0.001$) greater in the supplemented infected groups.

PRELIMINARY CONCLUSIONS

Body weight loss was greater in animals supplemented post-partum, with a similar trend for animals on the high pre-partum diet. The reduction in feed intake (particularly concentrate and groundnut hay) was greatest in infected animals, supplemented post-partum. The refusal of the better quality components of the diet is contrary to other experiments where infected animals tended to refuse andropogon hay a feed low in protein and high in fibre..

Infection has a highly significant adverse effect on milk yield. However, the decline in milk yield was proportionally greater in infected animals on the basal plane of nutrition post-partum suggesting the animals on the supplemented diets tried to maintain milk yield at the expense of liveweight.

Pre-partum nutrition had no effect on feed intake post-partum.

REFERENCES

Richards M.W., Spitzer J.C. and Warner M.B. (1986) Effect of varying levels of postpartum nutrition and body condition at calving on subsequent reproductive performance in beef cattle. *Journal of Animal Science* 62:300-306

Murray C.M., Murray M., Murray P.K., Morrison W.I., Payne C. and McIntyre W.I.M. (1977) Diagnosis of African trypanosomiasis in cattle. Improved parasitological and serological techniques. *In: 15th Meeting of the International Scientific Council for Trypanosomiasis Research and Control. Publ. No. 116* OAU/STRC, The Gambia pp 247-254

Paris J., Murray M. and McOdimba F. (1982) A comparative evaluation of the parasitological techniques currently available for the diagnosis of African trypanosomiasis in cattle. *Acta Tropica* 39:307-316

Pullen N.B. (1978) Condition scoring of White Fulani cattle. *Tropical Animal Health and Production* 10(2): 118-120

Van Soest P.J. (1982) *Nutritional ecology of the ruminant.* O and B Books, Corvallis, Oregon.

Appendix 1. Body condition scores definitions for N'Dama cattle.

1 = Emaciated
- all skeletal processes are visible and sharp, no eye muscle on the lumbar vertebrae
- animal looks totally emaciated
- ribs project prominently
- gluteal muscle on hindquarter concave

2= Lean
- processes of lumbar vertebrae clearly visible, but some tissue cover
- ribs visible but not as sharp as above
- gluteal muscle on hindquarter straight

3= Good condition
- good overall appearance
- processes on lumbar vertebrae can be identified but covered by rounded muscle and some fat
- ribs just visible
- muscle on hindquarter convex

4 = Fat
- cow appears fleshy and carries some considerable fat over ribs and tail head
- spinous processes well covered and not visible
- convex shape to gluteal muscle
- fat "rings" appear on flank if cow bends head round to scratch

5= Obese (rare in The Gambia)
- spinal processes invisible
- tail head and hips buried in fatty tissue
- bone structures no longer visible
- cow has fat deposits over ribs, around tail head, below vulva, and between back legs

The scale was adapted for N'Damas using scales devised by Pullen (1978) and Richards, Spitzer and Warner (1986)