SOME ASPECTS OF NITROGEN METABOLISM OF BRITISH AND ZEBU-TYPE CATTLE

J. E. VERCOE*

Summary

An experiment is reported in which the gross nitrogen metabolism of a group of Brahman x Hereford cattle was compared with a group of Hereford cattle on a diet of hammermilled, high quality lucerne hay, at three levels of food intake.

Significantly higher digestibilities for dry matter and nitrogen were found in Brahman x Hereford animals. The nitrogen balances and efficiencies of utilization of apparent digestible nitrogen were also higher for the Brahman x Hereford animals although these differences were not statistically significant.

I. INTRODUCTION

Differences in the growth rate of various breeds of cattle have been observed under grazing conditions at the National Cattle Breeding Station, "Belmont", Rockhampton, and the nutritional reasons for this are being investigated as part of the overall research programme described by Kennedy and Turner (1959).

The present paper reports some of the results obtained from an experiment designed to investigate differences in gross nitrogen metabolism between a group of Brahman x Hereford and a group of Hereford animals fed at three levels of intake of a high quality diet.

II. EXPERIMENTAL

(a) Animals and diet

Six Hereford and six Brahman x Hereford F1 cross steers, approximately 16 months old, were used. The mean body weights of the two breeds were 243 kg and 273 kg for the Hereford and Brahman x Hereford respectively. All animals were given a subcutaneous injection of "Neguvon" at the start of the experiment to control possible internal parasites.

The diet was a hammermilled, high quality lucerne hay containing 3.63 % nitrogen (N) on a dry matter (DM) basis.

(b) Methods

Three levels of intake were used in an extra-period Latin-Square design as described by Lucas (1957). Each period was 21 days and consisted of an 11 day preliminary feeding and a 10 day collection period. During the preliminary feeding period the animals were housed in individual feeding stalls and

* Division of Animal Genetics, C.S.I.R.O., Cattle Research Laboratory, Rockhampton, Queensland.

during the collection period they were confined in metabolism cages. In any period there were two animals of each breed on each level of feeding.

The daily ration for each animal was offered in two equal feeds at 8 a.m. and 5 p.m. each day. Nitrogen was determined in duplicate fresh samples of food, faeces and urine using a macro-kjeldahl digestion and a modified Technicon Autoanalyzer procedure.

The results were analyzed over four periods as described by Lucas (1957). This design is powerful for estimating residual effects but is not satisfactory for estimating breed or animal effects. This is because the appropriate error for testing breed effects is animal within square variation which in the extra-period design also contains effects due to level of feeding. In the absence of residual effects and to effectively demonstrate breed effects, the results were analyzed as a Latin-Square using periods 1, 2 and 4. Period 3, which was the same as period 4, was omitted because one animal in this period did not eat its whole ration.

II I. RESULTS

The Latin-Square analyses of variance for faecal DM, total faecal nitrogen (TFN) , urinary nitrogen (UN) and nitrogen balance (NB) are shown in Table 1. There were significant differences in faecal DM and TFN within and between breeds, for periods and for level of feeding. The significant effect of periods can be attributed to slight variations in the dry matter intake (DMI) and nitrogen intake (NI) between periods. The Brahman x Hereford animals produced significantly less faecal DM and TFN than the Hereford animals at the same levels of DMI and NI. The only significant source of variation in both UN and NB was that produced by the level of intake. For NB, breed differences approached significance at $P < 0.05$. Table 2 shows the means for DMI, faecal DM, NI. TFN, UN, apparent digestible nitrogen (ADN) and NB, for each breed and level of intake.

TABLE 1

Analysis of variance for Latin-Square, using periods I, 2 and 4 for faecal DM, total faecal nitrogen (TFN), urinary nitrogen (UN), and nitrogen balance (NB)

		Mean Squares			
	d.f.	Faecal DM kg/day	TFN g/day	UN g/day	NB g/day
Breeds	1	0.034225**	71.7127*	5.7203	117.9758
Squares in Breeds	2	0.003895	8.1018	4.9088	14.5230
Periods in Squares	8	0.009929**	4.3967**	74.5441	71.3711
Animals in Squares	8	0.002072*	9.7361**	75.6295	54.0792
Levels of Feed	2	4.671809**	3376.1890**	8335.1825**	3910.9305**
Level x Breed	2	0.001983	0.4688	28.3765	34.4498
Error	12	0.000685	0.9260	50.4129	49.9711

*$P<0.05$; **$P<0.01$.

TABLE 2

Breed means for dry matter intake (DMZ) kg/day, faecal dry matter (FDM), (kg/day), nitrogen intake (NZ) (g/day), total faecal nitrogen (TFN) (g/day), urinary nitrogen (UN) (g/day), and nitrogen balance (NB) (g/day).

Breed	Level	DMI	FDM	NI	TFN	UN	ADN	NB
Hereford	Low	2.523	0.935	91.56	23.16	72.56	68.40	—4.16
	Medium	4.205	1.532	152.60	38.31	101.07	114.29	13.22
	High	5.887	2.202	213.64	57.01	126.74	156.63	29.89
Brahman x Hereford	Low	2.523	0.882	91.56	20.79	74.80	70.77	—4.03
	Medium	4.205	1.490	152.60	35.34	97.17	117.26	20.09
	High	5.887	2.111	213.64	53.89	126.01	159.75	33.74
	s.e.		±0.008		±0.278	±2.05		±2.04
	s.e. of a difference		±0.011		±0.393	±2.90		±2.88

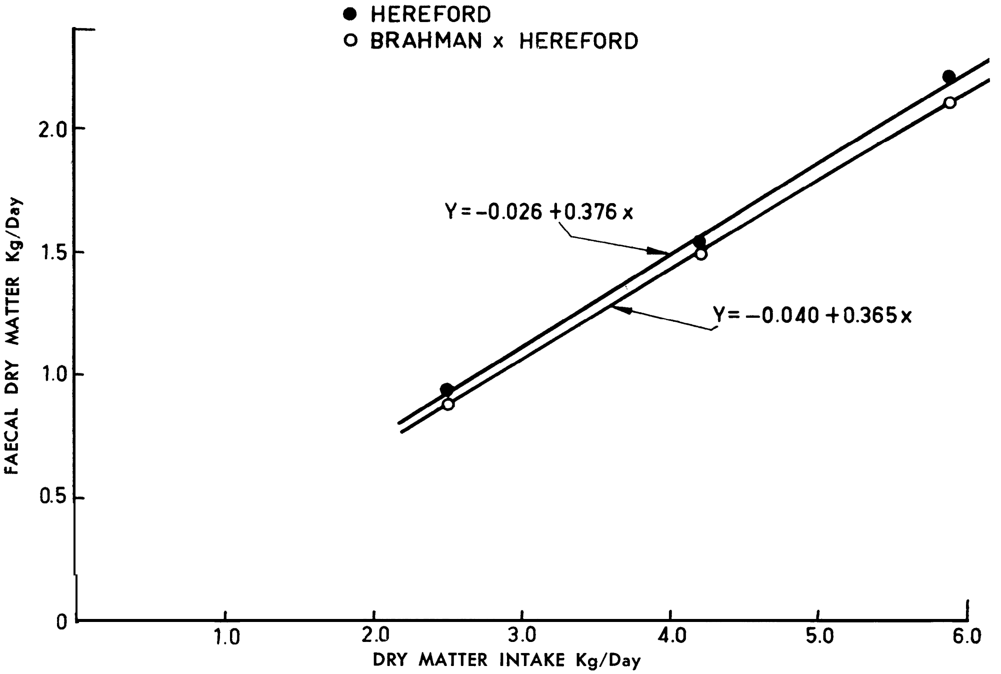

Fig. 1.The relation between faecal dry matter and dry matter intake for each breed.

The relations for each breed, which are significantly different, for faecal DM and DMI, and TFN and NI, are shown in Figure 1 and Figure 2 respectively. Linear regressions are shown because there was no statistical justification for fitting curvilinear regressions. However, curvilinear regressions produce intercepts which are physiologically more meaningful. The significant difference between the linear regressions shown in Figure 1 and also for the regressions in Figure 2 cannot be ascribed to either a difference in slopes or a difference in intercepts. The intercepts are not significantly different from zero and if the regressions are fitted through zero the slopes become significantly different. On the other hand, if the slopes are made identical by covariance, then the intercepts become significantly different.

The relations between UN and N intake for each breed are shown in Figure 3. There were no significant breed differences in this relation.

The relations between NB and ADN for each breed are shown in Figure 4. The regressions are not significantly different.

IV. DISCUSSION

The Brahman x Hereford animals were significantly better than the Hereford animals in digesting DM and N. It can be calculated from the equations in Table 3 that at a DMI of 6kg/day and a NI of 150 g/day, the Brahman x Herefords would have mean digestibilities of 74.2% and 76.0% for DM and N respectively, whereas the Herefords would have mean digestibilities of 72.5% and 74.2% for DM and N respectively.

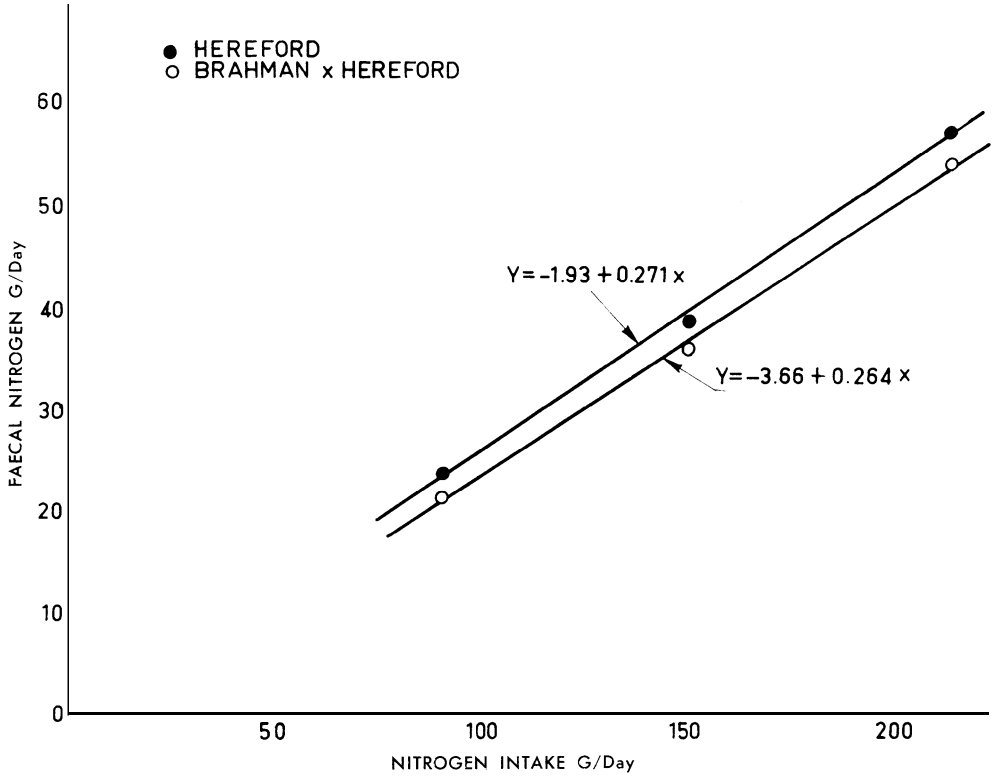

Fig. 2.—The relation between total faecal nitrogen and nitrogen intake for each breed.

The regressions for each breed shown in Figure 1 for faecal DM on DMI and in Figure 2 for TFN on NI are significantly different but the difference cannot be positively attributed to either a difference in slope or a difference in intercept. It is a matter of two things which, considered alone, are not significantly different making a significant difference when considered together.

In physiological terms, a difference in intercepts would indicate a difference in endogenous excretions and a difference in slopes would indicate either a difference in true digestibility or a difference in some part of the endogenous excretion which varied with level of intake. For DM, where metabolic excretions are small in comparison with undigested food residues, a difference in true digestibility of food DM (i.e. slope) could be suspected of causing the difference between breeds. For N, however, although endogenous excretions may form a substantial part of the TFN, the results of this experiment give no indication as to whether the breed difference resides in endogenous excretions or digestive efficiency.

Other workers have investigated breed differences in digestibility. French (1940) was unable to detect significant breed differences in DM digestibility although his results indicate a non-significant difference in N digestibility in favour of Zebu animals. However, only two animals of each breed (Zebu and Grade Ayrshires) were used in any one comparison. Duckworth (1946), from his analyses of data from breeds and diets, estimated that Zebu cattle would have a

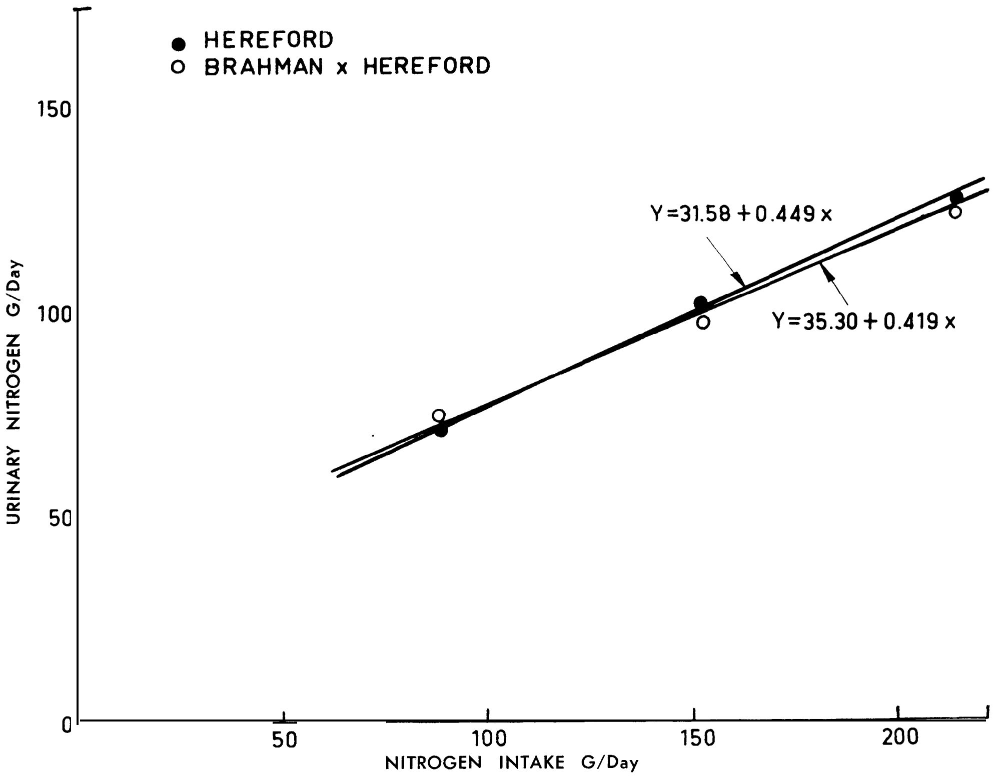

Fig. 3.—The relation between urinary nitrogen and nitrogen intake for each breed.

superior DM digestibility only when the crude fibre of the diet was greater than 38%. Phillips *et al.* (1960) were unable to show significant breed differences although, in their studies too, only a few animals were used. Howes, Hentges and Davis (1963) could not detect significant breed differences in DM digestibility, although the breed means favoured the Brahman cattle, but found significant breed differences in N digestibility. Phillips (1961) found that Zebu steers had higher organic matter digestibilities than Herefords for low quality grass hay, and Ashton (1962) found significant breed differences in both DM and N digestibility in his experiments, the differences in each case except one favouring the Brahman cattle. The exception was the Brahman x Shorthorn cattle which were not significantly better than Herefords in DM digestibility, although they were for N digestibility.

The differences in NB at a given level of NI have been shown to be not significantly different as have the relations between NB and ADN. The breed means indicate that differences in NB, at a fixed level of NI, exist and that the Brahman x Hereford animals have a superior utilization of ADN. The fact that UN varies little between breeds at the three levels of NI, whereas ADN does, suggests that the differences in NB and the utilization of ADN are real and that the variability associated with these makes it difficult to detect small but significant differences.

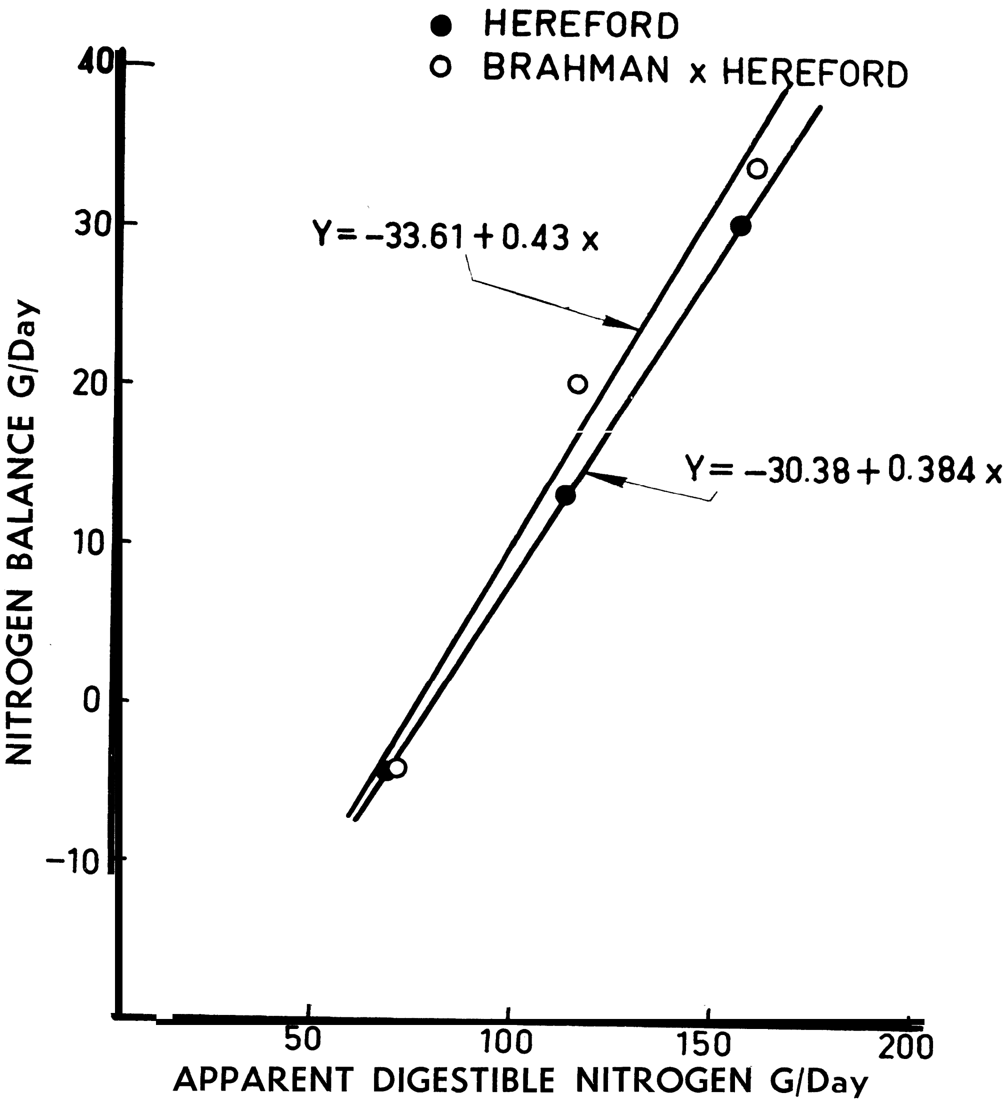

Fig. 4.—The relation between nitrogen balance and apparent digestible nitrogen for each breed.

The findings of this experiment, that Brahman x Hereford animals have a significantly higher digestibility of DM and N and also appear to have a more efficient utilization of ADN than the pure Hereford animals, may explain, at least to some extent, the differences in growth rate between Zebu cross and pure British animals observed under field conditions. The fact that these differences were observed on a high quality diet, whereas hitherto such differences, where they have occurred, have been observd on low quality roughages, suggests that the superior digestive capacity of Zebu cross animals is not limited to conditions of poor feed. However, it should also be noted that this comparison was made between an F1 Brahman x Hereford cross and Herefords. The possibility that the observed phenomena could be partly due to "hybrid vigour" should not be overlooked. Even if this is the case, the results are no less interesting, although the manipulation of these traits at the genetic level would be more limited.

V. ACKNOWLEDGMENTS

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