THE EFFECTS OF SEASON, SUPPLEMENTATION AND PELLETING ON INTAKE AND UTILISATION OF SOME SUB-TROPICAL PASTURES

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Summary

Two experiments were carried out with Hereford heifers to compare two tropical grass hays and to delineate seasonal changes in a grass-clover pasture.

There was no difference in voluntary intake between Rhodes grass and ***Setaria sphacelata.*** Intake of long hay was 3.2 kg dry matter/head/day. Chaffing or pelleting increased intake of both grasses by 14% and 47% respectively but supplementation with sorghum grain or soybean meal did not affect intake.

A paspalum-white clover pasture was cut for hay in November, February and June (early and mid-wet season, and early dry season), and fed as chaff, as pellets, and as chaff supplemented with soluble carbohydrate or casein. Intakes of chaff were: November hay 4.5 kg, February 4.1 kg and June 2.7 kg dry matter/head/ day. Effects of supplementation were inconsistent; pelleting increased intake of the two later hays.

In both experiments weight changes (-0.2 to 1.04 kg/day) were closely related to digestible dry matter intakes on all feeds. Differences in volatile fatty acid proportions showed no relation to the nutritive value of the feeds.

I. INTRODUCTION

Setaria sphacelata and Rhodes grass (*Chloris gayana)* are being compared at the C.S.I.R.O. Field Station, Samford, in a field experiment by Jones (1964). Hay conserved during the experiment produced poor growth when fed back to grazing steers during the winter, and the nutritive value of the hays has been studied using penned cattle.

In various grazing studies, calf growth during the wet season from calving (October-November) to weaning (May) has been satisfactory but growth of yearlings from January to May, and of weaners from May onwards, has been poor (Davies, personal communication). A *Paspalum dilatatum*—Ladino clover pasture was, therefore, cut in November, February and June and fed as hay to cattle in pens.

In both these experiments the hays were fed ***ad libitum*** and the effects of pelleting and of supplementation with grain or protein meal were studied.

II. EXPERIMENT 1

(*a*) *Materials and Methods*

(i) Animals

The Hereford heifers used were 15 months old and weighed 160-190 kg at the start of the experiment.

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TABLE 1

Voluntary intakes of Setaria and Rhodes grass kg/day (air/dry)

	Setaria			Rhodes grass		
	No supplement	+ Sorghum	+ Soybean	No supplement	+ Sorghum	+ Soybean
Hay	3.63	3.45	3.13	3.31	3.72	3.68
Chaff	3.90	4.04	3.86	3.95	3.86	4.31
Pellets	5.40	5.13	5.13	5.04	4.45	5.40

(ii) Feedstuffs

In December 1963, hay was cut from grazed permanent pastures of *Setaria sphacelata* (C.P.I. 28709) and Samford Rhodes grass, (*Chloris gayana,* C.P.I. 16144) treated annually with 2 cwt superphosphate, 2 cwt potassium chloride and 6 cwt urea. Grazing was continuous throughout the growing and hay-making period at either 2 or 1.5 steers/acre. Crude protein (N x 6.25) was 9.6% in Setaria and 10.6% in Rhodes grass hay, and dry matter digestibility of each hay was estimated at 53 % (Milford, personal communication). The supplements used were soybean meal of 41% crude protein and grain sorghum, hammer-milled, using a $\frac{3}{8}$ in. screen. The dry matter digestibilty of soybean meal was assumed to be 77.9% and of sorghum grain, 72.6% (Morrison 1945).

(iii) Experimental

The design was 2 (species) x 3 (methods of preparation-hay, chaff or pellets) x 3 (supplementation—none, sorghum, soybean meal) with two heifers per treatment. The heifers were fed individually for a 14-day preliminary period and a 28-day experimental period. One kilogram of supplement was fed at 8 a.m., and then hay, chaff or pellets were available ***ad libitum.*** Intakes were recorded daily, and live weights were measured weekly after a 16-hour fast off food and water. During the last week, rumen samples were collected by stomach tube for volatile fatty acid (VFA) analysis at 2, 4, 6 and 8 hours after feeding.

(b) Results

(i) Intake

The average daily intakes are shown in Table 1. There was no difference in intake between the two species, and no effect of supplementation. Chaffing increased the intake by 14% and pelleting by 47%. Two of the 12 animals offered soybean meal did not eat it even when offered nothing else and had to be replaced.

(ii) Weight gain

There were no significant differences in growth rate over the four week period between cattle fed the two species (Table 2). Gain on unsupplemented hay averaged 0.086 kg/day, and pelleting increased gains by 0.33 kg/day. Supplementation with grain sorghum increased gains by 0.15 kg/day and with protein by 0.40 kg/day. The best diet, pelleted hay plus soybean meal, produced a gain of 0.74 kg/day which is low for ***ad libitum*** feeding of a ration containing 15.2% crude protein.

TABLE 2

Weight gain, kg/day

	Setaria			Rhodes grass		
	No supplement	+ Sorghum	+ Soybean	No supplement	+ Sorghum	+ Soybean
Hay	0.005	0.12	0.37	0.16	0.15	0.45
Chaff	0.12	0.45	0.54	0.12	0.29	0.70
Pellets	0.49	0.54	0.76	0.22	0.50	0.72

(iii) Volatile fatty acid precentages

Since there were minor but inconsistent trends throughout the day, the results for all times were pooled to give a mean level (Table 3).

There were small non-significant differences between the two grasses, *Setaria* consistently giving higher total titres and high propionic acid percentages. Pelleting caused a reduction in acetic acid and an increase in butyric acid. Protein or carbohydrate supplementation of hay resulted in reduced acetic acid and increased butyric acid proportion. There was no consistent relationship between total titre or proportions of any acid, and either intake or weight gains.

(iv) Intake of digestible dry matter

The approximate total digestible dry matter (DDM) intake of each animal was calculated from the estimated digestibility of the hays and supplements, assuming that there had been no associative effects. The weight gains and DDM intakes were well correlated ($r = 0.78$) but it was clearly not permissible to make any comparison among the feeds.

III. EXPERIMENT 2

(a) Material and Methods

(i) Animals

Hereford steers, nine months old, 136-1 82 kg live weight, and selected from the Samford grade herd, were allocated to treatments at random and fed in individual pens. All animals received 10^6 i.u. Vitamin A by injection.

(ii) Feedstuffs

The hay was made from a permanent pasture cut on November 22, 1963, February 5, 1964 and June 17, 1964. The November hay was clover-dominant, the February hay intermediate and the June hay, cut after frosting, paspalum-dominant and dormant. The results of chemical analysis and digestibilty trials with sheep (Milford, personal communication) are presented in Table 4.

TABLE 4

Composition and digestibilities of three cuts of hay (% dry matter basis)

Hay	Protein (Nx6.25)	Soluble Carbo-hydrate	In Vivo % Digestibility		Dry Matter Percentage
			Dry Matter	Protein	
November	18.9	3.7	68.2	69.0	87.3
February	10.7	3.0	57.0	48.5	91.3
June	8.3	3.0	47.1	42.3	89.6

TABLE 3

***Volatile fatty acid proportions in** rumen contents (%)*

	Setaria						Rhodes Grass					
	Hay			Pellets			Hay			Pellets		
	Acetic	Propionic	Butyric	Acetic	Propionic	Butyric	Acetic	Propionic	Butyric	Acetic	Propionic	Butyric
Alone	72.8	19.4	7.8	70.0	19.3	10.7	75.5	15.5	9.0	70.0	16.9	13.1
+ Sorghum	69.7	18.5	11.8	69.2	18.4	12.4	70.5	18.9	10.6	69.4	18.0	12.6
+ Soybean	69.0	19.9	11.1	70.3	19.6	10.1	71.4	19.0	9.6	69.5	17.3	13.2

S.E. for Acetic acid—2.07%.
Propionic acid—1.14%.
Butyric acid—1.15%.

TABLE 5

*Voluntary intake **of feeds, kg/day** (Oven-dry)*

	November	February	June
Chaff	4.50	4.09	2.68
Chaff + sugar	4.36	4.36	2.95
Chaff + casein	5.72	3.99	2.93
Pellets	3.90	5.43	3.99

(*iii*) ***Experimental***

The design was 3 (times of cutting) x 4 (methods of preparation), with a 14-day preliminary period and a 42-day experimental period. The hay was fed:

-Chaffed.

-Chaff mixed with sugar to give 15% soluble carbohydrate.

-Chaff mixed with 6 kg commercial casein per 100 kg.

-Pelleted in a Christy and Norris "Pressfeed 10" pelleter.

Rumen liquor for VFA analysis was collected by stomach tube two hours after feeding on two days during the second and fifth weeks of the experimental period. In calculating DDM intake, the digestible dry matter content of sugar was taken as 100% and that of casein as 86%.

(b) Results

(i) Intake

The mean daily intake per animal over the experimental period is shown in Table 5. Intake of November hay fed as chaff was not significantly greater than intake of February hay ($0.2 > P > 0.1$) but both were greater than intake of June hay ($0.01 > P > 0.001$ and $0.05 > P > 0.01$). The addition of soluble carbohydrate did not affect intake of any hay but the addition of protein increased intake of November-cut hay ($0.05 > P > 0.01$) . Pelleting did not significantly decrease intake of November hay ($0.2 > P > 0.1$) but did increase intake of the other two ($0.01 > P > 0.001$).

(ii) Weight gains

These are set out in Table 6. Gain on November hay was greater than on February hay ($0.01 > P > 0.001$) and on February hay was greater than on June hay ($0.05 > P > 0.01$) . The addition of sugar or casein did not alter rate of gain and pelleting significantly increased rate of gain on February hay only (***0.05*** $> P > 0.01$).

TABLE 6

Mean weight changes, kg/day

	November	February	June
Chaff	0.77*	0.31†	—0.02‡
Chaff + sugar	0.72*	0.44†	—0.03‡
Chaff + casein	1.05*	0.34†	0.04‡
Pellets	0.84*	0.70*	0.12‡

All results with the same superscript are not significantly different.

TABLE 7

Proportions of volatile fatty acids in rumen-contents (%)

	November			February			June		
	Acetic	Propionic	Butyric	Acetic	Propionic	Butyric	Acetic	Propionic	Butyric
Chaff	76.8	18.5	4.7	74.0	19.2	6.9	70.8	20.2	9.0
Chaff + sugar	64.5	17.6	17.9	69.8	14.6	15.6	65.8	18.1	16.2
Chaff + casein	73.1	17.1	9.8	78.3	13.2	8.5	69.4	16.2	14.4
Pellets	75.2	19.8	5.0	75.1	16.2	8.7	75.2	16.0	8.8

(iii) Volatile fatty acid percentages

Pooled results for two samplings are presented in Table 7. In the groups receiving chaff only, there was a small drop in acetic acid and a rise in propionic and butyric acids from November to June. There was a marked rise in butyric acid and concomitant falls in acetic and propionic acids when sugar was added to the diet, and a drop in propionic acid and a rise in butyric acid when casein was added. No consistent effect of pelleting was observed, and there was no consistent relationship between proportions of any acid and either intake or rate of gain of any ration.

(iv) Intake of digestible dry matter

The total intake of DDM was calculated for each animal. The correlation of weight gain with intake of DDM was 0.94 ($P < 0.001$), and the regression equation of gain (y) on intake (x), both in kg/week, was

$$y = 0.462x - 4.83 \quad \text{(Figure 1)}$$

The maintenance requirement of a 163 kg beast was estimated to be 1.5 kg DDM/day.

IV. DISCUSSION

(a) Experiment 1

In the grazing experiment, *Setaria* gave better animal production than Rhodes grass (Jones 1964), whereas in the pen trial no difference was observed. This may perhaps be attributed to the observation (Jones, personal communication) that cattle grazing *Setaria* selected the leaf and rejected the stem but those grazing Rhodes grass showed little selectivity. *Setaria* hay harvested as surplus from a grazed pasture, unlike Rhodes hay, would thus be of poorer quality than the herbage grazed. Heifers fed *Setaria* as hay in this experiment did tend to eat less and grow less rapidly than those fed on Rhodes grass hay.

Supplementation of these mediocre hays produced no increase in intake of hay; animal performance was improved only by the extra nutrients supplied in the supplement. This result is in accord with the work of Holmes and Jones (1964) who have calculated the equation

$$I = 2.8 - 0.034\ D$$

when I = the increase in total feed intake/lb concentrate fed, and D = digestibiltiy of the organic matter (DOM) of the roughage. When $D = 53\%$, $I = 1$, that is, the increase in intake is due to the concentrate, no increase in

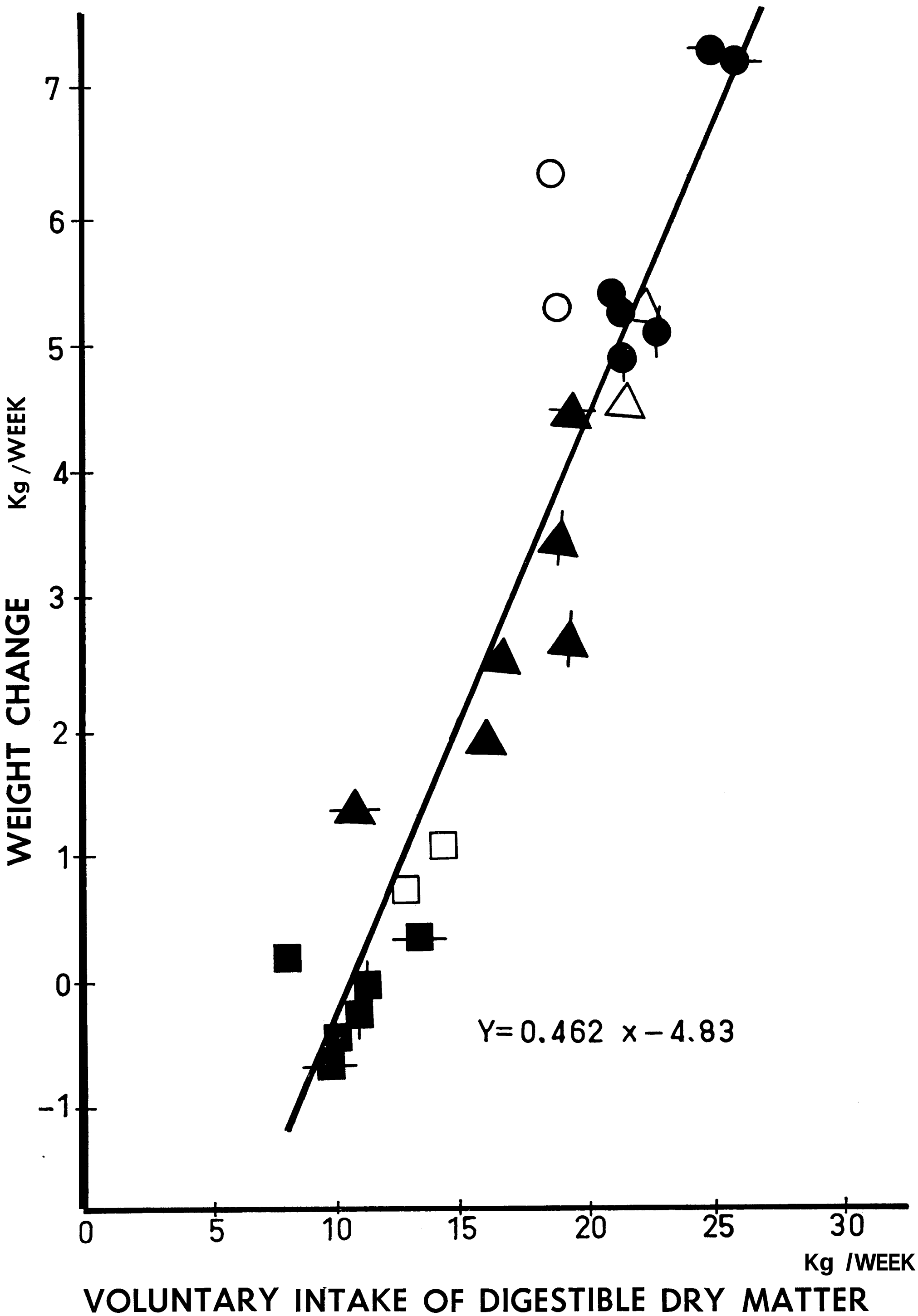


Fig. 1.—Relation between liveweight gain and voluntary intake of digestible dry matter by cattle fed paspalum/white clover hay cut at three times of the year (Expt. 2).

roughage consumption will occur. Above 53% DOM, roughage intake will be depressed although total intake will increase and below 53 % , roughage intake will increase.

(b) Experiment 2

Pelleting increased intake of February hay by 34%, compared with an increase of 28 % from chaff to pellets in the previous experiment (Table 1), where hay was of similar digestibility and protein content. The effect of pelleting was proportionately greater in the case of the June hay.

Heaney et *al.* (1963) concluded that pelleting increased ***ad libitum*** digestible energy intake by wether lambs for all forages examined at three stages of maturity, with the effect of pelleting becoming more marked at successive growth stages. With cattle, a similar trend exists (Minson 1963) but the results are more variable. The effect of pelleting *Setaria,* Rhodes and February and June hays, is in line with most other reports of the effect of pelleting roughages, and considerable improvement in utilisation of these hays was achieved as a result of the smaller proportion of intake which was required for maintenance. In two experiments cited by Minson (1963), pelleting depressed intake slightly but resulted in increased weight gains, an effect similar to the result when pelleting November hay. There was some indication that pelleted November hay was utilised more efficiently than the chaff, since less pelleted hay produced more rapid gains (Figure 1) .

The addition of soluble carbohydrate had no effect on intake or gain.

Soluble protein did not increase intake or growth rate on June hay. It has been shown (Annison and Lewis 1959) that casein may be rapidly deaminated and much of the nitrogen lost as ammonia, unless ruminal fermentation is proceeding concurrently at a rapid rate.

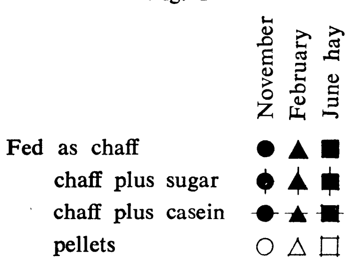
(c) Value of volatile fatty acid measurements

In both experiments the ruminal VFA analyses could not be related to intake or growth rate. Even though supplementation produced consistent changes in VFA patterns, these changes were not associated with differences in feed utilisation which could be measured.

(d) Comments on experimental design

A disadvantage of using only two animals per cell becomes apparent when the cells 'November hay plus casein' and 'February hay plus casein' are studied (Tables 4 and 5).

Fig. 1



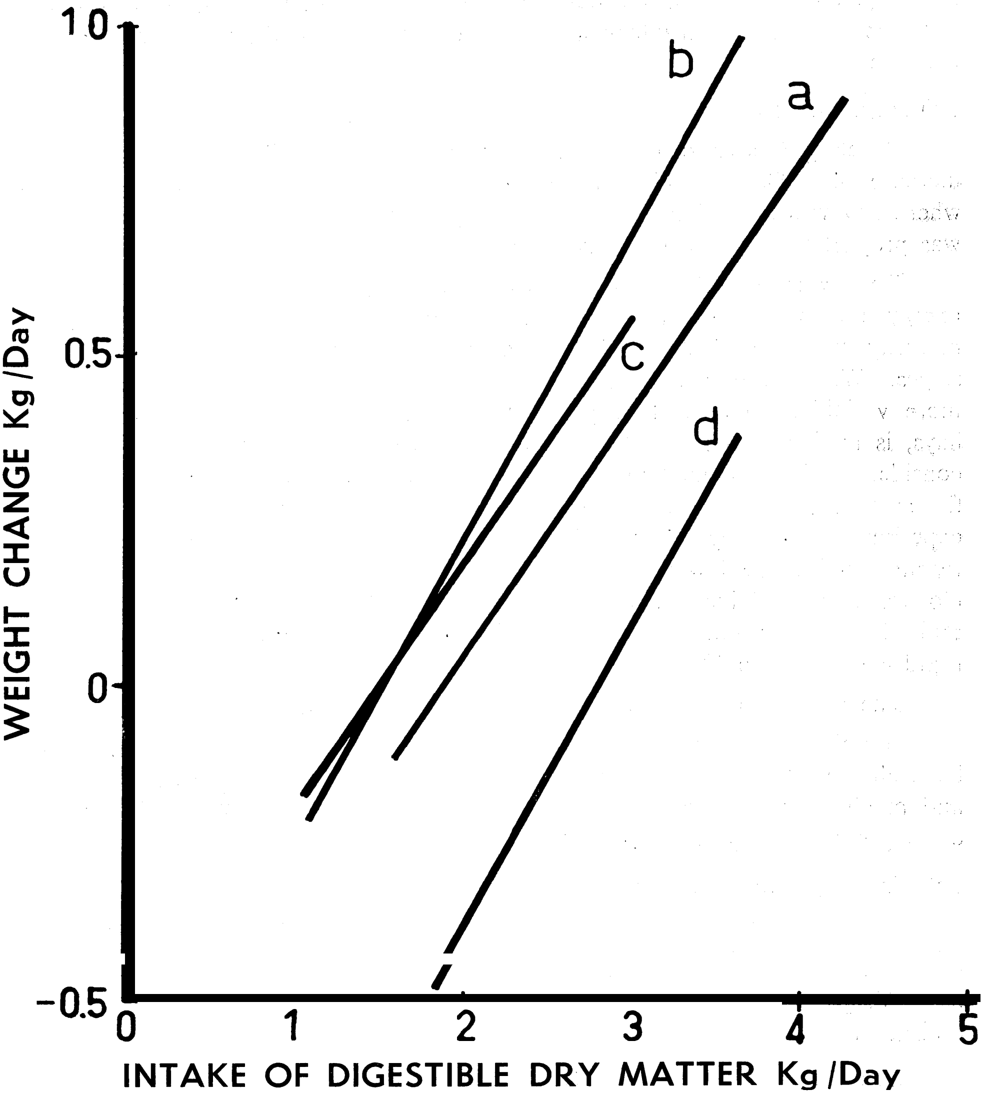


Fig. 2.—Regressions of liveweight gain on digestible dry matter intake for cattle of different weights.

a Expt. 1 Heifers; mean liveweight 195 kg
b Expt. 2 Steers; mean liveweight 163 kg
c Siratro Expt; Heifers; mean liveweight 150 kg
(Unpublished data)
d Peanut meal; Heifers; mean liveweight 268 kg
(Unpublished data)

The two animals selected at random to be fed 'November hay plus casein' happened to be the largest in the experiment, although their calving dates showed them to be no older than the rest of the group. These two are responsible for the apparent increase in intake upon the addition of casein, raising the protein content from 18.9% to 22.7%.

The intake of 'February hay plus casein' is the mean of 5.17 and 3.5 kg/day, and the gain the mean of 0.64 and 0.04 kg/day since one animal 'went off its feed'.

An attempt was made to find a satisfactory way of adjusting the raw intake measurements but no statistically acceptable relation could be shown between intake and, for example, initial liveweight. No adjustment to the simple mean DM intakes shown in Tables 1 and 4 could be justified.

Except in true factorial designs where the estimate of main effects does not depend on the response in single cells, it would appear preferable to use more than two animals per treatment sub-group, and to restrict the randomisation so as to make sub-groups as nearly as possible equal in characteristics likely to influence their response.

(*e*) *Correlation of liveweight gain with intake of DDM*

The linear regressions of liveweight change on intake of DDM have been calculated and similar calculations were made for two further experiments (unpublished data) in which the tropical legume *Phaseolus atropurpureus* (Siratro) or peanut meal was fed in various amounts in combination with low quality hay to cattle in pens.

The individual regressions are shown in Figure 2, and illustrate a considerable degree of uniformity of response over a wide range of animals and feeds. The maintenance requirements appear to be a linear function of liveweight over the range involved, 136 to 272 kg, and, expressed as kg DDM/ 100 kg liveweight, ranged from 0.81 to 0.99. The regression slopes, estimating the liveweight change per unit DDM change in intake, ranged from 0.37 to 0.46.

V. ACKNOWLEDGMENT

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