MARDI Res. Bull. 3, 2: (68 – 86)

STUDIES ON KEDAH-KELANTAN CATTLE

I. EFFECT OF IMPROVED NUTRITION ON GROWTH

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Accepted for publication on 22 July, 1975

RINGKASAN

Kertas pertama ini melapurkan kesan memperbaiki mutu pemakanan ke atas pertunjukkan sifat-sifat dalam rancangan penyelidikan bagi menentukan kemampuan produksi lembu Kedah-Kelantan tempatan. Tiga puluh lima ekor anak lembu betina Kedah-Kelantan berumur 6 hingga 8 bulan telah diperuntukan bagi lima treatment. Treatmentnya berasaskan makanan jirim kering dari rumput Napier *(Peninsetum purpureum)* diberi *ad libitum* dengan tambahan atau tidak ada tambahan makanan lengkap bagi mencukupi selera tiap-tiap seekor mengikut nisbah rumput:makanan pekat; 100:0. 75:25, 50:50, 25:75, 0:100. Penyelidikan ini berlangsong selama 518 hari. Untuk dibandingkan dengan mutu rumput Napier, maka rumput Guinea *(Panicum maximum)* telah diberi kepada sekumpulan 6 ekor anak lembu betina selama 427 hari. Pertukaran ukuran badan, kenaikan berat badan, dan kecekapan menggunakan makanan telah dicatitkan.

Perbezaan di dalam kenaikan berat badan dan kecekapan penggunaan makanan didapati penting dalam kiraan statistik ($P<0.01$ di antara treatment. Kenaikan berat badan tertinggi sebanyak 339 g. dan kecekapan penggunaan makanan yang terbaik didapati bagi treatment 50:50 nisbah rumput:makanan pekat. Treatment ini juga yang menunjukkan banyak bilangan piantan biang (heat) yang nyata dilihat. Bagi nisbah 75:25 rumput:makanan pekat tidak ada perbezaan di antara rumput Napier dan rumput Guinea. Pertalian yang significant ($P<0.01$) didapati bagi ukuran bulatan dada, tinggi dibahu, panjang badan dan jarak tulang pinggang dengan berat badan.

Kenaikan berat badan yang maksima dicapai semasa umur 8 bulan. Di dalam pertalian pembesaran tisu dan daging, berat badan penyembelehan lembu-lembu ini nampaknya boleh dilakukan pada 220 kg. dalam umur 20 bulan. Kematangan badan dan piantan biang yang pertama nampaknya dicapai dalam umur 10 hingga 12 bulan. Semua keputusan ini jika dibandingkan dengan data-data yang lalu dapat menunjukkan perbaikan sebanyak 80.3% dalam berat badan di umur 24 bulan, 133.8% dalam kenaikan badan harian dari umur 6 hingga 24 bulan dan 94.4% dalam umur untuk dikahwinkan.

Pentingnya pemakanan yang baik ke atas pertunjukkan sifat-sifat, dan kemungkinan menambahkan pengeluaran daging dari lembu Kedah-Kelantan dan nilainya bagi mencapai kecukupan negara kita ditegaskan.

INTRODUCTION

Limited information exists about the growth performance of the indigenous Kedah-Kelantan or Kedah-Thai cattle of Malaysia. Recently however, a detailed study was presented concerning their origin, breed description and what is known about their performance in Malaysia (DEVENDRA *et al.*, 1973). It was quite clear from this report that much more critical knowledge was needed about the productive potential and capacity of this breed, which as it concerns cattle in Malaysia has never really been examined in any detail (DEVENDRA, 1975).

In order to assess the productive ceilings that this breed was capable of, and more particularly, to provide definitive information on performance, a programme of research was

initiated. This programme represents one aspect of fundamental studies on the ruminant resources and their individual capacities in Malaysia. Part I in this series on studies on Kedah-Kelantan cattle reports growth performance. Subsequent parts will deal with effect of tapioca *(Manihot utilissima* Pohl) feeding, and carcase characteristics.

EXPERIMENTAL PROCEDURE

(a) Animals

Thirty five 6 to 8 months old Kedah-Kelantan heifer calves were selected from about 120 animals in Kelantan. The basis of selection was brown colour, body conformation, size, dentition for age, number of teats and the condition of the animals. On arrival in Serdang, they were drenched, sprayed for ectoparasites and adapted to grass and some concentrate feeding for one month. Thirty of these animals were allocated to 5 treatments with 6 replications in each treatment in a completely randomised design. The experiment commenced in March 1973 and ended 18 months later when the heifers were about 2 years old in August 1974, giving an experimental duration of 518 days.

The animals were allocated by weight to the 5 treatments to give uniform initial live weight. One animal from treatment 2 died 4 months later because of constipation and another from treatment 5 was removed 3 weeks after it was off-feed.

(b) Treatments

Treatments were designed to provide varying proportions of roughage to concentrate ratios in the dry matter to satisfy appetite. This was based on a 3% daily dry matter intake (DMI) which was confirmed in measurements in these cattle during the one month of adaptation. The DMI increased with age and the quantities required were increased based on the previous week's intake, maintaining nevertheless the proportion of roughage to concentrate in the diet. Approximately 10% residues were left behind each day. The treatments were as follows:-

	Treatments	
1.	(100G*, OC**)	100% Napier grass *(Peninsetum purpureum)*
2.	(75G, 25C)	75% Napier grass + 25% concentrates
3.	(50G, 50C)	50% Napier grass + 50% concentrates
4.	(25G, 75C)	25% Napier grass + 75% concentrates
5.	(0G, 100C)	100% concentrates

* grass ** concentrate

In addition to these treatments, and approximately three months after the start of the trial, a parallel observation was made in June 1973 on five heifers having the same origin, age, and approximately live weight as the other animals in a sixth treatment. This involved Guinea grass *(Panicum maximum)* cut at about four weeks of age having approximately the same chemical composition. The choice of Guinea grass was to confirm the role of the fibre component of the diet on treatment 2, which tended to promote good response when this main observation began in March 1973, 91 days after the start of the trial using Napier grass. The management of the experimental animals and the parameters measured were identical to that of the main trial. This parallel observation on Guinea grass lasted for 427 days, ending when the heifers were about 24 months of age also in August 1974.

(c) **Diets**

Table 1 gives the chemical composition of Napier and Guinea grass, both cut at about 4 weeks of growth. The grass was chopped and lacerated by a forage harvester and delivered for feeding every morning.

TABLE 1. CHEMICAL COMPOSITION OF NAPIER AND GUINEA GRASS
(on dry matter basis)

	Napier Grass *(Pennisetum purpureum)*	Guinea Grass *(Panicum maximum)*
Dry matter	18.4 %	20.0 %
Crude protein	13.9 %	13.3 %
Crude fibre	23.4 %	25.7 %
Ether extract	2.8 %	2.7 %
Ash	9.4 %	8.9 %
Nitrogen-free extract	50.5 %	49.4 %
P	0.37%	0.25%
Ca	0.25%	0.91%
Mg	0.13%	0.44%

Table 2 gives details of composition of the concentrate diet used.

TABLE 2. TYPE AND COMPOSITION OF THE CONCENTRATE DIET

Ingredient	% of diet
Molasses	33.0
Tapioca chips	30.0
Copra cake	30.0
Urea	3.0
Salt	2.0
Tricalcium phosphate special*	2.0
Total	100.0

*Declared contents: 38.7% PO_4, 1.1% CO_3, 1.5% flourine, 0.2% SO_4, 46.2% Ca, 0.2% Mg, 2.4% Fe, 5.8% Al, 120 ppm K, 92 ppm Mn, 55 ppm Cu, 410 ppm Zn, 0.5 ppm Co and 0.9 ppm Mo.

Chemical composition (on dry matter basis)

Crude protein	15.0%
Crude fibre	6.2%
Ether extract	2.8%
Ash	9.4%
Nitrogen-free extract	66.6%
P	0.58%
Ca	0.88%
Mg	0.34%
ME (Kcal/kg.)	2985.9

The concentrate diet was mixed each morning. The urea was first dissolved in the molasses before the rest of the ingredients were added and thoroughly mixed. The grass was offered first at about 09.00 hours and the concentrates at 10.30 hours; once a day feeding was practised. All the animals had access to mineral bricks and water.

(d) Parameters measured

The animals were weighed weekly and monthly, body measurements on heart girth, body length, height at withers and hip width were recorded. Daily records of grass and concentrate intake and residue were kept for dry matter determination. The daily samples for a week were then bulked for proximate analyses.

Records were also maintained on signs of heat, regularity of these and the general health of the experimental animals. The results were analysed according to the analysis of variance, and the comparisons of treatments were made by the method of least significant differences.

RESULTS

(1) Body measurements

Table 3 presents results of the effect of treatments on body measurements. There were significant effects ($P<0.05$) on body length, with the 50:50 grass:concentrate ratio (treatment 3) giving the highest response, followed by treatments 2, 4, 1 and 5. No treatment effects were recorded for heart girth, height at withers and hip width. Nevertheless it is of interest to note that treatment 3 also gave the highest response for heart girth, height at withers and hip width measurements (Plates 1, 2, 3 and 4).

Individual body measurements were correlated for each month with the corresponding live weight of each animal within individual treatments. In every instance, highly statistically significant differences ($P<0.01$) were noted *(Table 4)*.

(2) Live weight gain and food conversion

Treatments exerted considerable effects on the response of the cattle. The pattern of this response followed that noted for body measurements of the cattle, with treatment 3 being notably the best *(Table 5)*. The relationship between live weight (Y) and time in weeks (X) for each treatment is illustrated in *Figure I* and described by the equations:-

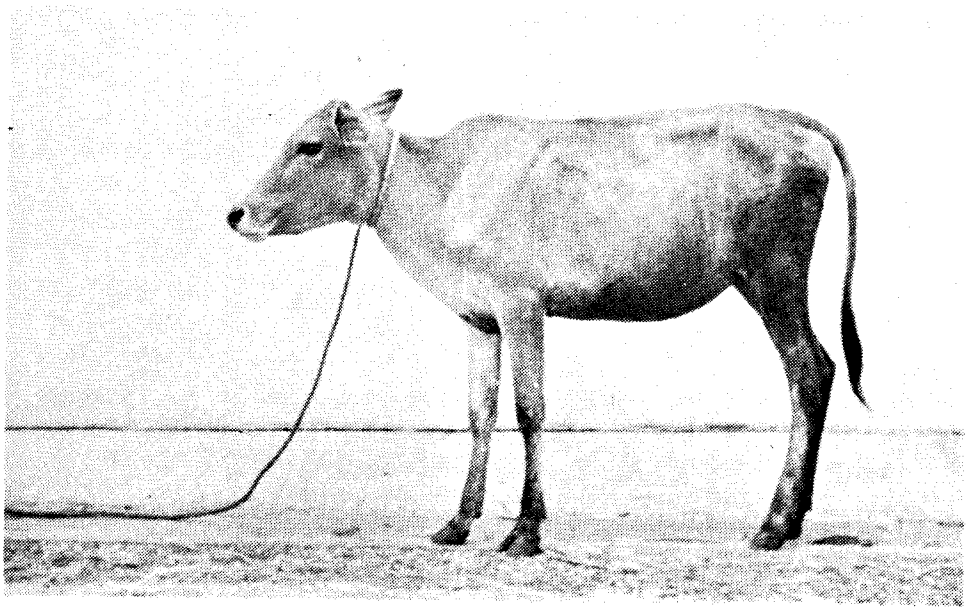

Plate 1. A Kedah-Kelantan heifer calf at about 6 months age. Mean live weight is 72kg.

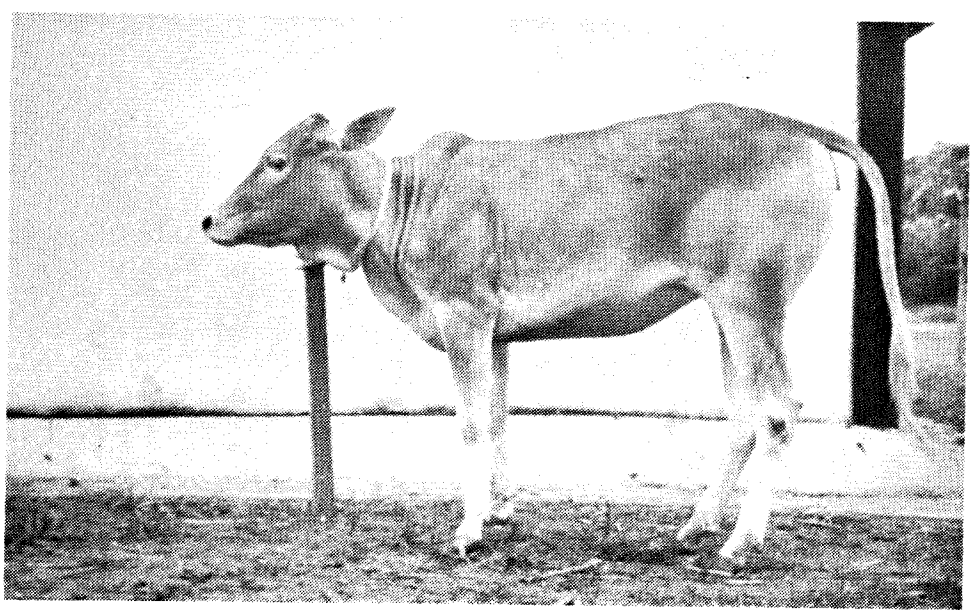

Plate 2. The heifer at 12 months age with a mean live weight of 150kg.

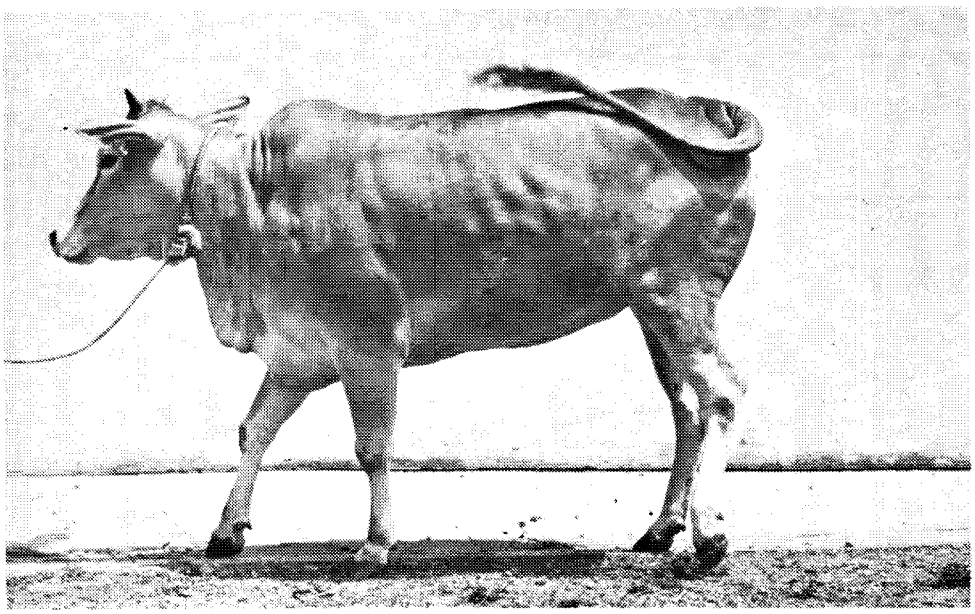

Plate 3. The heifer at 18 months age with a mean live weight of about 200kg.

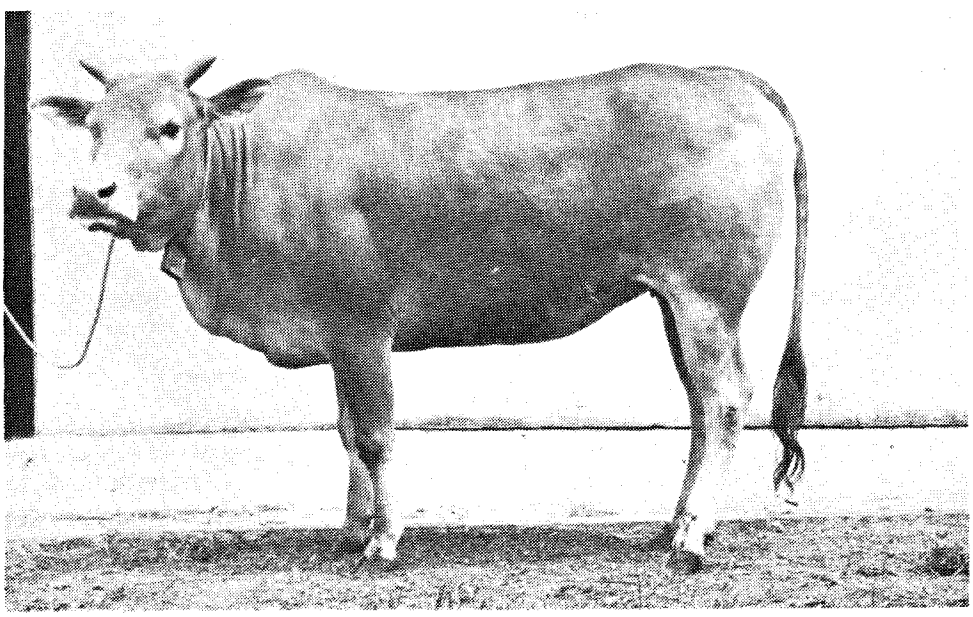

Plate 4. The heifer well grown on a diet containing 75:25 grass: concentrate in the total dry matter intake at 24 months age. The mean live weight is about 241kg.

TABLE 3. EFFECT OF TREATMENTS ON BODY MEASUREMENTS

Parameter (cm)	Treatments				
	1 (100G,0C)	2 (75G,25C)	3 (50G,50C)	4 25G,75C)	5 (0G,100C)
1. Heart Girth					
Initial	99.5	102.0	101.2	101.7	97.8
Final	150.3	153.3	159.3	152.1	148.8
Increase	50.8	51.3	58.1	50.4	51.0
2. Height at withers					
Initial	83.3	82.5	84.3	84.4	84.6
Final	110.8	111.3	113.2	110.2	109.6
Increase	27.5	28.8	28.9	25.8	25.0
3. Body length					
Initial	108.8	113.7	109.6	111.2	111.2
Final	149.6	155.0	156.0	152.4	148.2
Increase	40.8^{a}	41.3^{b}	46.4^{b}	41.2^{b}	37.0^{a}
4. Hip width					
Initial	21.9	22.3	22.2	21.5	22.2
Final	40.7	43.0	44.0	41.7	42.2
Increase	18.8	21.0	22.0	19.7	20.2

a–b : Means with different superscripts differ significantly ($P<0.05$)

TABLE 4. CORRELATIONS BETWEEN BODY MEASUREMENTS AND MONTHLY LIVE WEIGHTS

Live weight with	Treatments				
	1 (100G,0C)	2 (75G,25C)	3 (50G,50C)	4 (25G,75C)	5 (0G,100C)
Heart girth	0.99	0.91	0.99	0.97	0.99
Height at withers	0.98	0.98	0.99	0.96	0.99
Body length	0.99	0.97	0.99	0.87	0.99
Hip width	0.99	0.99	0.99	0.97	0.99

TABLE 5. EFFECT OF IMPROVED NUTRITION ON GROWTH AND EFFICIENCY OF FEED CONVERSION

Parameter	Treatments				
	1 (100G,0C)	2 (75G,25C)	3 (50G,50C)	4 (25G,75C)	5 (0G,100C)
Number of animals	6	5	6	6	5
Initial live weight (kg.)	72.5	75.2	72.3	74.2	73.5
Final live weight (kg.)	214.7	240.6	248.0	232.8	214.3
Gain in weight (kg.)	142.2	165.4	175.7	158.6	140.8
Daily DMI from grass (kg.)	3.79	2.85	1.94	0.99	–
Daily DMI from concentrate (kg.)	–	1.11	1.90	2.10	2.19
Daily total DMI (kg.)	3.79	3.96	3.84	3.09	2.19
DMI as % of live weight	3.23	2.90	2.64	1.89	1.57
Average daily gain (g.)	274.7^{a}	$318.7^{a,b}$	339.1^{b}	$306.5^{a,b}$	271.5^{a}
Efficiency of feed conversion (Kg. DM/Kg. live weight gain)	13.86^{c}	12.49^{d}	11.44^{e}	10.20^{f}	8.11^{g}

a–b : Means with different superscripts differ significantly ($P<0.05$)
c–g : Means with different superscripts differ significantly ($P<0.01$)

$$T_1\ Y = 76.94 + 2.76X - 0.0116X^2$$
$$T_2\ Y = 82.28 + 3.23X - 0.0146X^2$$
$$T_3\ Y = 79.90 + 3.19X - 0.0124X^2$$
$$T_4\ Y = 77.38 + 3.17X - 0.0148X^2$$
$$T_5\ Y = 69.27 + 2.39X - 0.0076X^2$$

Treatments had no significant effects on total live weight gain, but was significant for daily live weight gain and efficiency of feed conversion (EFC). In respect of daily gain in weight, no differences were found between treatments 2, 3 and 4, but treatment 3 significantly differed ($P<0.05$) from treatments 1 and 5. Statistically significant differences ($P<0.01$) were also noted for EFC. The EFC data showed that this improved with increased intake of concentrate in DMI *(Figure 2)*.

Table 6 presents performance data comparing Napier and Guinea grass fed on 75:25 grass:concentrate ratio.

It was found that there were no statistically significant differences in the parameters measured. Type of grass fed apparently had no significance, although there was a tendency for better results on Napier grass. The live weight gain and the body measurements: heart girth, height at withers, hip width and body length were all comparable.

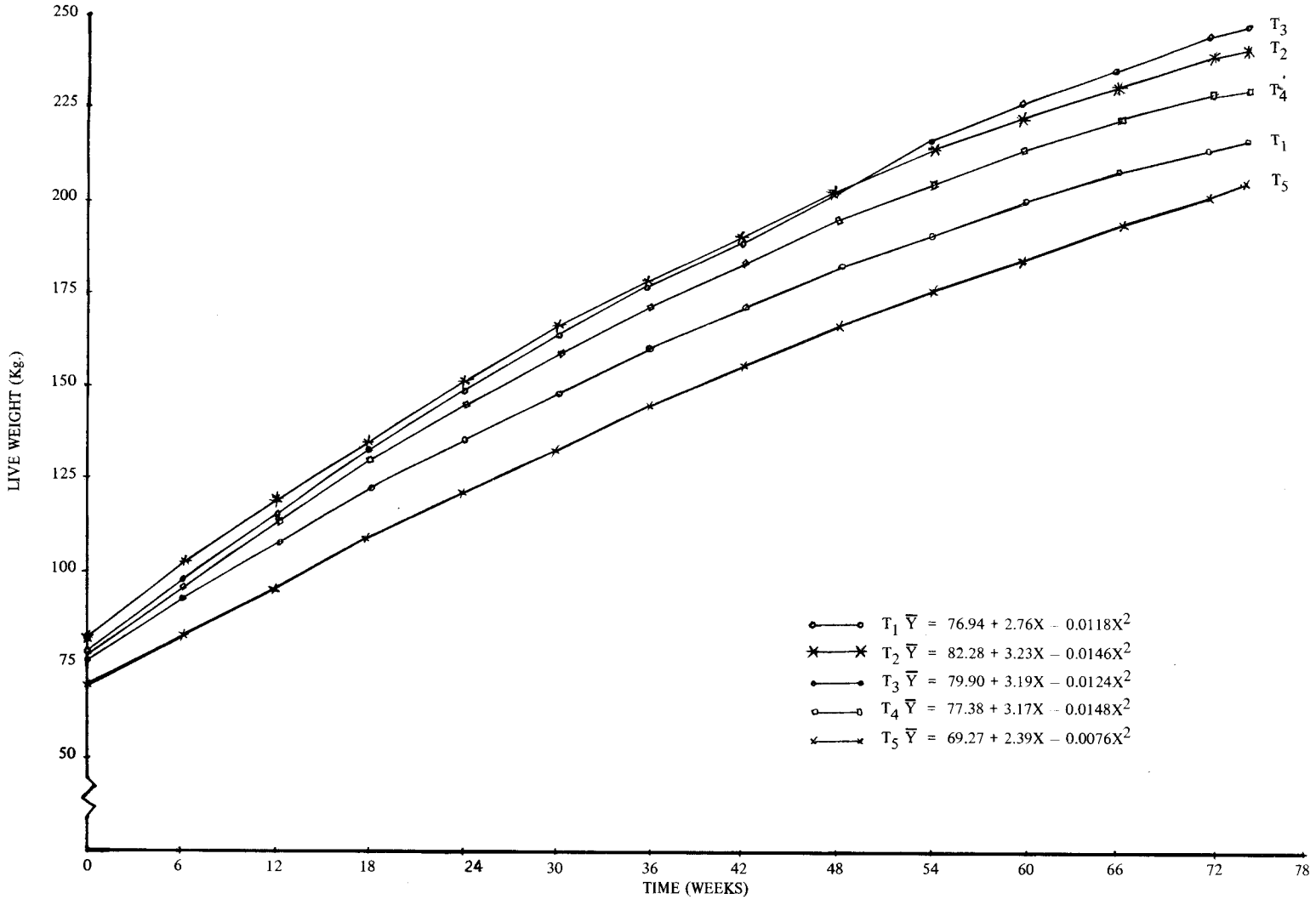

Figure 1. Effect of treatments on live weight response in Kedah-Kelantan heifers

TABLE 5. EFFECT OF IMPROVED NUTRITION ON GROWTH AND EFFICIENCY OF FEED CONVERSION

Parameter	Treatments				
	1 (100G,0C)	2 (75G,25C)	3 (50G,50C)	4 (25G,75C)	5 (0G,100C)
Number of animals	6	5	6	6	5
Initial live weight (kg.)	72.5	75.2	72.3	74.2	73.5
Final live weight (kg.)	214.7	240.6	248.0	232.8	214.3
Gain in weight (kg.)	142.2	165.4	175.7	158.6	140.8
Daily DMI from grass (kg.)	3.79	2.85	1.94	0.99	–
Daily DMI from concentrate (kg.)	–	1.11	1.90	2.10	2.19
Daily total DMI (kg.)	3.79	3.96	3.84	3.09	2.19
DMI as % of live weight	3.23	2.90	2.64	1.89	1.57
Average daily gain (g.)	274.7^{a}	$318.7^{a,b}$	339.1^{b}	$306.5^{a,b}$	271.5^{a}
Efficiency of feed conversion (Kg. DM/Kg. live weight gain)	13.86^{c}	12.49^{d}	11.44^{e}	10.20^{f}	8.11^{g}

a–b : Means with different superscripts differ significantly ($P<0.05$)
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$$T_1\ Y = 76.94 + 2.76X - 0.0116X^2$$
$$T_2\ Y = 82.28 + 3.23X - 0.0146X^2$$
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Treatments had no significant effects on total live weight gain, but was significant for daily live weight gain and efficiency of feed conversion (EFC). In respect of daily gain in weight, no differences were found between treatments 2, 3 and 4, but treatment 3 significantly differed ($P<0.05$) from treatments 1 and 5. Statistically significant differences ($P<0.01$) were also noted for EFC. The EFC data showed that this improved with increased intake of concentrate in DMI *(Figure 2)*.

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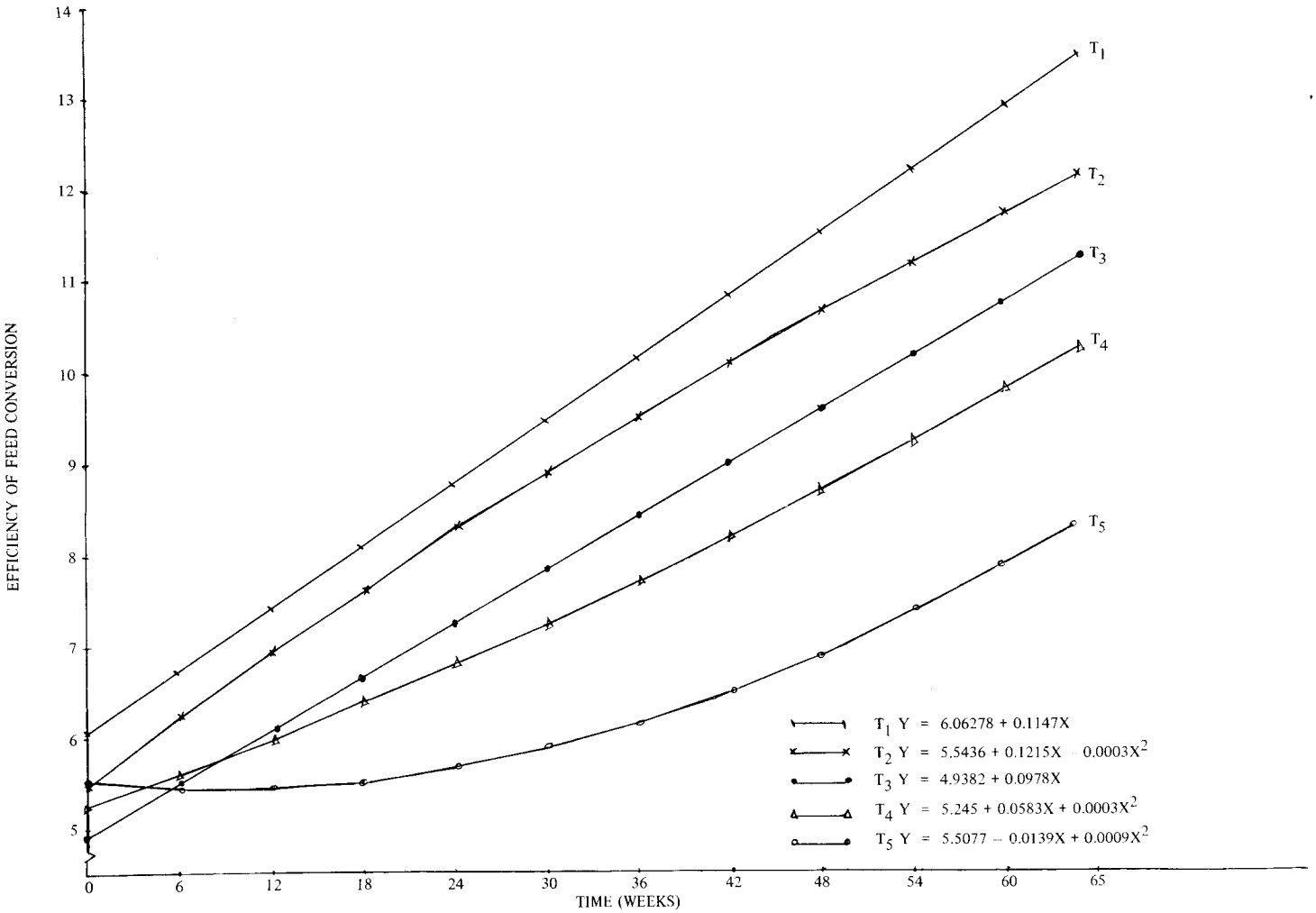

Figure 2. Effect of treatments on efficiency of food conversion in Kedah-Kelantan heifers

TABLE 6. A COMPARISON BETWEEN THE EFFECTS OF FEEDING NAPIER GRASS AND GUINEA GRASS WITH CONCENTRATE IN THE RATIO 75:25 IN THE DAILY DRY MATTER INTAKE

Parameter	Concentrates plus	
	Napier grass	Guinea grass
Number of animals	6	5
Initial weight (kg.)	121.2	108.9
Final weight (kg.)	240.6	232.2
Total gain in weight (kg.)	119.4	123.3
Average daily gain (g.)	317.8	286.0
Daily DMI from grass (kg.)	3.00	3.69
Daily DMI from concentrates (kg.)	1.18	0.84
Daily total DMI (kg.)	4.18	4.53
DMI as % live weight (%)	2.60	2.28
Efficiency of feed conversion (kg. DM/Kg. live weight gain)	12.5	15.8
Heart girth (cm.)	153.3	152.4
Height at withers (cm.)	111.3	109.6
Hip width (cm.)	43.0	42.2
Body length (cm.)	155.0	153.2

An analysis of the highest live weight gain data due to treatment 3 to assess the natu and change of the live weight gain reached is given in *Table 7.*

Table 7 demonstrates that peak live weight gain occurred at about 101 kg. when the cattle were 8 months of age. Relative to the maximum live weight gain at seven months of age, the decrease commenced at nine months age, and by 24 months age, this decrease was about 34%.

(3) Heat cycles

It was of interest to assess the effect of improved feeding management and an increasing plane of nutrition on the occurance of heat cycles in the treatment cattle. In several instances there were distinct periods during which some of these cattle, irrespective of treatments, showed no apparent manisfestation of heat symptoms. This was noted in long intervals between some heat cycles, which theoretically, should not have occurred in the face of the fact that they should display regular heat cycles. The first heat symptoms were observed in July 1973, approximately four months after the start of the experiment. It is feasible therefore to mate these heifers at about 10 to 12 months of age.

Nevertheless, the mean total number of heat cycles observed by treatments that were recorded are presented in *Table 8.* Treatment 2 recorded the most number of heat cycles. No statistically significant differences were found between treatments.

TABLE 7. RATE OF LIVE WEIGHT GAIN WITH TIME IN CATTLE FED A DIET CONTAINING 50:50 GRASS:CONCENTRATE IN THE DMI

Age (months)	Live weight (kg.)	Live weight increase/day (g.)	% change in daily live weight increase
6*	72.3	–	–
7	87.0	474	–
8	101.6	527	+10.1
9	114.9	513	– 2.7
10	128.6	499	– 5.3
12	150.3	463	–12.1
14	168.2	427	–19.0
16	184.9	404	–23.3
18	200.4	381	–26.2
20	218.8	377	–28.5
22	231.7	354	–31.8
24	240.6	350	–33.6

*Age at weaning.

TABLE 8. EFFECT OF TREATMENTS ON TOTAL NUMBER OF HEAT CYCLES RECORDED OVER THE EXPERIMENTAL PERIOD

Parameter	Treatments				
	1 (100G,0C)	2 (75G,25C)	3 (50G,50C)	4 (25G,75C)	5 (0G,100C)
Total number of heat cycles	8.0	13.2	10.8	7.8	7.4

DISCUSSION

The ingredients in the concentrate diet in this trial were of local origin and their use is of considerable local significance and especially in the context of increasing the utilisation of such feeding-stuffs and agricultural by-products. Tapioca chips, copra cake and molasses were roughly used in the ratio 1:1:1 with additional nitrogen from urea and mineral supplements. The choice of a 33% level of molasses in the diet is based on the fact that the net energy value of molasses is reduced considerably beyond 30% of diet dry matter as demonstrated in steers and milk cows (LOFGREEN, 1965; LOFGREEN and OTAGAKI, 1960).

The pattern of voluntary DMI of these cattle from an all grass, various grass:concentrate ratios to an all concentrate diet is of interest *(Table 4)*. The DMI was found to decrease with increasing availability of concentrates and therefore nutritive value of the diet. With grass, it is well known that voluntary DMI is determined by rate of passage of digesta from the rumen (BLAXTER, WAINMAN and WILSON, 1961; CAMPLING, FREER and BALCH, 1961), and by factors such as fat depots which limit distention of that organ (TAYLER, 1959). With increased nutrient concentration in the diet, feeding to appetite and satiety are thermostatic or chemostatic (MONTGOMERY and BAUMGARDT, 1965; CONRAD, 1966; WALDO, 1967).

A decrease in intake with increasing energy concentration in the diet is apparent in the DMI (percentage of live weight) decreasing with increased concentrate intake, being lowest for the all concentrate diet (1.4%). For the 50:50 grass:concentrate ratio which gave the best live weight gain response, a similar result has also been reported for Hariana cattle in India in comparison to a 50:50 ratio (RANJHAN and DANIEL, 1972). On the all grass diet, the figure of 3.2% DMI as a percentage of live weight is comparable to values of 3.0 to 3.7% reported for Zebu x Holstein dairy cattle grazing Pangola grass *(Digitaria decumbens,* Stent) under wet and dry season conditions in Trinidad (BUTTERWORTH, GROOM and WILSON, 1961), 3% for European and Zebu dairy cows grazing pasture in Kenya (PHILLIPS and LAMPKIN, 1964), but higher to values of 2.2% for Holstein bulls and 2.1% for waterbuffalo cows in the Philippines (JOHNSON, HARDISON and ORDOVEZA, 1968) and 2.3% for indigenous goats in Malaysia (DEVENDRA, 1967).

One important measure of the magnitude of the improvement that can be brought about in Kedah-Kelantan cattle through improved nutritional management, is a comparison with what is known about the performance of these cattle previously. With specific reference to live weight gain from birth to 24 months age, it was previously reported from recorded data over 17 years that this was 164.5 g. for females. Based on this data and a comparison with the present results, the degree of improvement that can result suggest quite remarkable capacity by these cattle *(Table 9)*.

This degree of improvement in live weight, quite feasible in this breed suggests that at 6, 12, 18 and 24 months age, this improvement was 31.0, 69.4, 87.3 and 80.3% respectively. The results represent an improvement of quite spectacular dimensions.

The live weight performance data clearly demonstrated that these cattle at their peak were capable of about 527 g. increase per day. Bearing in mind that this response is from heifers, the live weight gain in steers of the some breed will be about 15% more or 606 g., which makes this cattle about half as good as exotic beef breeds.

The live weight increase data *(Table 7)* suggests that since maximum increase was achieved at about 101 kg. live weight when the cattle were about 8 months age, this weight represents that of maximum tissue (muscle) growth. However it is not profitable to market at this weight, age and body composition since some "finish" in the carcase is desirable because of increased marbling and succulence of the meat, despite a decrease rate of growth due mainly to fat deposition. The best part of a year's further growth is necessary which then renders these cattle marketable at about 220 kg. and 20 months age. The period of fattening however will largely be determined by economic considerations. The important point is that in terms of muscle tissue growth, the optimal weight of Kedah-Kelantan cattle appears to be about 115 kg. with a corresponding age of about 8 months, which appears also to be the point of maturity. This age is contrary to the suggestion made previously (DEVENDRA *et al.*, 1973) that maturity in these cattle was between 3 to 4 [illegible] age.

TABLE 9. MAGNITUDE OF IMPROVEMENT IN LIVE WEIGHT AT THE SAME AGE OF KEDAH-KELANTAN CATTLE DUE TO IMPROVED NUTRITION ON GROWTH

Age (months)	Previous data (kg.)	Present data (kg.)	% improvement
6*	55.2	72.3	31.0
12	87.9	148.9	69.4
18	109.3	204.5	87.1
24	133.5	240.7	80.3

*Age at weaning.

The highest live weight gain of 339 g. up to approximately 24 months of age is higher than that of 227 g. recorded for Mashona cattle in Rhodesia (OLIVER, 1966) and similar to the gain 329 g. per day for Brahman x Kedah-Kelantan crossbred cattle on inferior nutritional management (DEVENDRA *et al.*, 1973), and 240 g. for Bali cattle in Malaysia (DEVENDRA, LEE KOK CHOO and PATHMASINGAM, 1973).

An improvement of about 80% in live weight performance through feeding and management suggests that, there might be further room for improvement through genetic manipulation. Two aspects are in this respect, worthy of mention. Firstly, these cattle have never been selected for breed quality and high performance so that together with improved feeding and mangement, the degree of response might well be higher. Secondly, even more spectacular results can be achieved by crossbreeding. Brahman x Kedah-Kelantan crossbreds have in fact been shown to have as much as an 84% improvement in live weight gain and about 12% in dressing percentage (DEVENDRA *et al.*, 1973). Similar results have also been reported by FLINT (1971) for other exotic crossbreds in Malaysia.

The EFC responses to the best grass:concentrate ratios of 75:25 and 50:50 of 12.49 and 11.44 kg. DM per kg. live weight gain are however, poorer than the value of 10.5 to 11.9 reported by RICHARDSON *et al.*, (1961); 10.1 (75:25 ratio) by WOODS and SCHOOL (1962) and 10.2 to 10.4 by CLANTON and WOODS (1966). On the other hand the EFC of 13.86 on straight grass feeding was better than the values reported by WOODS and SCHOOL (1962) and CLANTON and WOODS (1966). On exclusive concentrate feeding, the EFC of 8.11 was higher than the value of 6.5 reported by LAMMING, SWAN and CLARKE (1966) for maize-barley straw diets.

It was consistently found in the trial reported here that a 50:50 grass:concentrate ratio, followed by a 75:25 ratio in the daily DMI gave the best results in terms of live weight gain and EFC response. Concerning the latter ratio, this was also confirmed for Guinea grass of approximately similar chemical composition. Since there were no statistically significant differences between these treatments, and also during a half-way analysis of the results (DEVENDRA, 1974), the results suggest further that for maximum response in these cattle, the optimal grass:concentrate ratio was between 75:25 and 50:50. The lowest live weight gain response on the all concentrate diet confirms similar observations in various *Bos taurus* and *Bos indicus* breeds in India (KATIYAR *et al.*, 1972). On the other hand, feeding exclusively on concentrates have been shown to have given the best live weight gain in cattle (TAYLER and

WILKINSON, 1972); however, the crude fibre content in this diet was much higher than that used in the trial reported here.

The statistically significant correlations that were found between live weight and parameters such as heart girth, length of body and width of hips confirm similar reports for Zebu and crossbred cattle (GILL, *et al.*, 1971); Kedah-Kelantan cattle (DEVENDRA *et al.*, 1973); Bali cattle (DEVENDRA, LEE KOK CHOO and PATHMASINGAM, 1973), goats (TANDOM, 1966) and more recently in sheep (DEVENDRA, 1975). The very high statistically significant correlation coefficients between live weight and these body measurements suggest as was concluded before for Kedah-Kelantan and Bali cattle (see for example DEVENDRA *et al.*, 1973), and that it is feasible to predict live weight fairly accurately.

It was clear from this study that puberty or sexual maturity was reached in Kedah-Kelantan cattle as early as 10 months age. The effect of an improved plane of nutrition is implicated and supports a similar report by WILTBANK *et al.*, (1966), and also the demonstration that restricted feeding delayed the onset of oestrus (REID, 1953; JOUBERT, 1954a; 1954b; WILTBANK *et al.*, 1957 and SORENSON *et al.*, 1959). Although puberty is reached around 10 months age, delayed mating is desirable to ensure complete growth of the heifer so that there would be no competition with foetal growth. Weight rather than age is probably a more practical guide for this, and in relation to the relatively small size of the mature cow, mating at 200 kg. live weight at 18 months age is suggested. This age of first service is much lower than the value of 35 months reported previously (DEVENDRA, et al., 1973). In Cuba, it is of interest to note that a policy of hand mating heavier Criollo heifers at the first observed heat after 250 kg. is used (WILLIS and PRESTON, 1969).

The fact that improved feeding and management hastened the manifestation of heat is of considerable practical significance. It means that, in addition to earlier first service at 18 months, the reproductive efficiency will be high because of increased calvings. The significance of a high plane of feeding becomes more clear when it is remembered that heat symptoms in Zebu breeds are not completely distinctive, and may manifest at times when supervision is least, namely late evening through to morning, as was also noted in this study.

Summarising the magnitude of the improvement that can be brought about by better feeding and management, it has been forcibly demonstrated here that three main parameters can be substantially improved: live weight, live weight gain and age at first service. The magnitude of this improvement in relation to the previous data (DEVENDRA, *et al.*, 1973) is demonstrated in *Table 10.*

The demonstration that Kedah-Kelantan cattle can produce about 80% improvement in live weight response has implications of national significance in the face of expanded beef production and the drive towards self sufficiency. In 1972 the total number of oxen slaughtered was 59,256 (Statistical Digest, 1974). Assuming that 80% of these were of the Kedah-Kelantan breed, and a slaughter weight of about 220 kg. and a 50% dressing percentage, this amounts to 5,214 tonnes of beef. An 80% increase in performance would increase this production to 9,385 tonnes which is extremely significant. The role of nutritional management cannot therefore be over emphasised. The task for the future is to elevate the contribution from these cattle and probably also other domestic ruminants in Malaysia from apparent sub-standard nutrition and also through selection pressure, to one of productive adequacy in the quest to exploit fully the underestimated value of Kedah-Kelantan cattle.

TABLE 10. MAGNITUDE OF IMPROVEMENT IN KEDAH-KELANTAN CATTLE IN THREE IMPORTANT PARAMETERS DUE TO IMPROVED NUTRITION

Parameter	Previous data	Present data	% improvement
Live weight at 24 months (Kg.)	133.5	240.7	80.3
Daily live weight gain from 6 to 24 months (g.)	145.0	339.1	133.9
Age at first service (months)	35.0	18.0	94.4

ACKNOWLEDGEMENTS

The authors are grateful to Messers. Abdullah bin Abu Bakar, Husin bin Jalaludin, V. Pullikutty and T. Sweetman for technical assistance, and Mr. Low Wan Loy for the statistical analyses. We are also grateful to the Director, Dr. Anuwar bin Mahmud for his special interest in this project.

SUMMARY

Paper 1 reports the effect of improved nutrition on performance, in a programme of research on the productive capacity in the indigenous Kedah-Kelantan cattle. Thirty Kedah-Kelantan heifers about 6 to 8 months of age were allocated by weight to five treatments based on dry matter intake from Napier grass *(Pennisetum purpureum)* fed *ad libitum* with or without concentrates fed to appetite individually in the following grass:concentrate ratios: 100:0, 75:25, 50:50, 25:75, 0:100. This trial lasted for 518 days. In addition, Guinea grass *(Panicum maximum)* was compared with Napier grass in an additional treatment on 5 group-fed heifers for 427 days. Changes in body measurements, live weight gain, efficiency in feed conversion (EFC) were measured.

There were statistically significant ($P<0.01$) differences between treatments in daily live weight gain and EFC. The highest live weight gain of 339 g. and best EFC were recorded on the 50:50 grass:concentrate ratio. However, treatments had no significant effects on total live weight gain. On the 75:25 ratio the most number of visible heat cycles were observed and there were no differences in feeding Napier or Guinea grass. Heart girth, height at withers, body length and hip width were significantly correlated ($P<0.01$) with live weight.

Maximum live weight gain was achieved at about 8 months age. In relation to tissue growth and carcase finish however, the weight and age of slaughter of these cattle appears to be about 220 kg. and 20 months. Physical maturity and first oestrus appears to be reached around 10 to 12 months age. The results together, when compared to previous data demonstrated an improvement of 80.3% in live weight at 24 months age, 133.8% in daily live weight gain from 6 to 24 months age and 94.4% in age at first service. The importance of improved nutrition on performance, and possibilities of increasing national beef production from Kedah-Kelantan by as much 80% and its significance of self-sufficiency are emphasised.

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