# INTAKE, DIGESTIBILITY AND GROWTH BY TROPICAL BREEDS OF CATTLE CONSUMING TROPICAL GRASSES SUPPLEMENTED WITH MILL RUN

W.R.J. Gwaiseuk* and J.H.G. Holmes†

## ABSTRACT

*When ten steers were fed a diet of 75% or more mill run plus Hamil grass (*Panicum maximum *Jacq. var. Hamil) chaff, intake was highly variable between and within animals over 6 weeks. Dry matter digestibility ranged from 16% to 58% and two steers developed severe diarrhoea.*

*The effect of supplementing grazing steers with mill run was evaluated in an 18 week feeding experiment in a 4(genotype) × 4(diets) factorial design. The steers were (a) 2 year old 5/8 Brahman × British crossbred, (b) yearling 5/8 Brahman × British crossbred, (c) 2 year old "Javanese Zebu" (JZ), 2 in each group and (d) 2 year old purebred Brahman, 1 per group. Diets were (i) grazing Buffel grass (*Cenchrus ciliaris *L.) (ii) grazing Buffel grass + 4 hours/day fed mill run* ad libitum *in pens (iii) grazing Buffel grass + 20 hours/day fed mill run* ad libitum *in pens (iv) pen fed* ad libitum *30% Hamil grass chaff and 70% mill run. Feed (ii) gave fastest growth rates for all breeds, while treatment (iv) gave slowest growth. Treatment (iii) was better than (i) for crossbreds, but worse for JZ and Brahman. Intakes of supplementary mill run, (ii) and (iii) and of complete diet (iv) were greater by crossbreds than JZ or Brahman. Digestibility of organic matter was 60.6% for diet (iv). Yearling crossbred steers (b) were not slaughtered. In the other groups, at slaughter, fat cover was greatest with diet (ii), least for diet (iv), but "finish" of all carcasses was adequate. Thus all breeds of steers were able to fatten on four hours of supplementary feeding/day, consuming about 1 kg mill run pellets/100 kg liveweight, growing about 1 kg/day and fattening from store condition in 18 weeks. On more intensive feeding, the Brahman and JZ did not consume as much or grow as fast as Brahman crossbreds.*

## INTRODUCTION

Mill run, a by-product of flour milling, equivalent to about 25% of grain, has 11.6% digestible crude protein and total digestible nutrients of 81 for cattle (Crampton and Harris, 1969), indicating that it might be a satisfactory major component of cattle feeding rations. Where food-processing systems are well advanced, rations are formulated from many ingredients. In Papua New Guinea (PNG) the sources of the few food-processing by-products available are separated by distances which may preclude the use of compounded rations. Each ingredient must be evaluated as the major component in simple diets, which will accentuate any deleterious characteristics such as the laxative effect of wheat bran in mill run. The first experiment examined the effect on digestion of feeding high levels of mill run in a full feeding situation. The second experiment assessed the usefulness of

* Animal Production Officer, Beef Cattle Research Centre, Erap, Papua New Guinea.

† Formerly Senior Veterinary Officer, (Cattle), Erap. Present address: School of Agriculture and Forestry, University of Melbourne, Parkville, Vic. 3052, Australia.

mill run fed at lower levels as a supplement to grazing for fattening steers.

## MATERIALS AND METHODS

The experiments were conducted at the Beef Cattle Research Centre, Erap, altitude 90 m, in the Markham Valley, Morobe Province, P.N.G. Climate is humid equatorial; mean annual rainfall is 1260 mm with two peak periods; temperatures range from 17°C to 36°C with little seasonal variation. Soils are recently deposited alluvial silt and sandy loams supporting vigorous stands of Buffel grass (*Cenchrus ciliaris* L.).

### Feeds

Mill run was pelleted with 1.0% added calcium as crushed limestone, 1.0% salt and a trace element premix (*Table 1*).

Hamil grass was cut by hand, after seed ripening in Experiment 1 and during active growth in Experiment 2. It was dried with a warm forced air drier and chaffed into 1-5 cm lengths.

A well established stand (10 ha) of Nunbank Buffel grass was used for grazing.

### Experiment 1

*Animals*

Ten 5/8 Brahman × British steers, 10-12 months old, weighing 161 ± 12 kg were penned individually and introduced to a diet of 1/3 chaff and 2/3 mill run, over a two-week period. They were then allotted at random to one of five diets, containing 75%, 80%, 85%, 90% and 95% mill run pellets with chaff making up the rest of the diet.

*Procedure*

Rations were fed at 0800 h after the previous day's refusals had been removed, weighed and sampled for analysis. Quantities offered were adjusted daily to maintain refusals at about 10% of intake. After a preliminary period of 14 days daily intake was measured for 14 days.

In week 4 feed offered was reduced to 95% of that consumed; a gelatin capsule containing one g chromium sesquioxide ("chromic oxide") was administered with a balling gun to each steer at 0700 h and 1600 h. After 5 days, samples were collected from all faeces voided in the pens, during the next five days, to estimate faecal output.

Feed, feed residue and faecal samples were dried at 105°C for 24 hours and analysed for:

(i) ash, by combustion in a muffle furnace at 600°C for 4 hours.
(ii) energy by adiabatic calorimeter.
(iii) chromic oxide by the method of Christian and Coup (1954).
(iv) nitrogen by macro-Kjeldahl method.
(v) acid detergent fibre (ADF) by the method of Van Soest (1963).

### Experiment 2

*Animals*

Five groups of seven steers were assembled, each containing: (a) two 5/8 Brahman crossbreds (age 16-24 months), (b) two "yearling" 5/8 Brahman crossbreds (age 10-20 months), (c) two Javanese Zebu (JZ) (Holmes 1977) (age 20-24 months), (d) one 2 year old purebred (15/16 or higher) Brahman; they were assigned by stratified random allocation on a body weight basis within breeds. One group was slaughtered at the start of the experiment, the others were allotted to one of four feeding regimes.

*Procedure*

After an introductory period of 14 days, the experiment continued for 18 weeks, from 24/10/78 to 20/2/79. Feeding regimes used were:

(i) Grazing Buffel grass.

(ii) Twenty hours/day grazing Buffel grass; 4 hours/day (0800 h to 1200 h) in individual pens, fed mill run pellets *ad libitum*.

(iii) Four hours/day (0800 h to 1200 h) grazing Buffel grass, 20 hours/day in individual pens, fed mill run pellets *ad libitum*.

(iv) Full hand feeding; individually penned, continuously fed 70% mill run pellets and 30% Hamil grass chaff, *ad libitum*.

Shade, water and salt were available at all times. Groups (i), (ii) and (iii) grazed the same paddocks to eliminate differences in quality of feed available. The area of pasture was 10 ha, but no conventional stocking rate can be calculated. They were weighed fortnightly after an overnight fast, without water. Feed offered in the pens was adjusted to maintain refusals at about 10%.

After 116 days of the experiment, the daily intake by the steers on full feeding (Group (iv)) was reduced to 85% of that consumed previously and digestibility was measured as described in experiment 1.

### *Slaughter*

After 18 weeks, all large crossbred (a), JZ (c) and Brahman steers (d) were slaughtered in a commercial abattoir. Carcass weight and backfat thickness were recorded.

### *Statistical Analysis*

Data were analysed as a 4 (diets) × 3 (genotypes) factorial, with two animals per group (Sokal and Rohlf, 1969). The purebred Brahmans could not be included in statistical analyses due to lack of computation facilities. Differences among means were tested by Duncan's Multiple Range Test.

## RESULTS

### Experiment 1

Although the chaff used was low in nitrogen and high in fibre, all rations contained nitrogen adequate for rapid growth and none contained in excess of 20% ADF (*Table 1*).

During the first two weeks of feeding the experimental rations, animals appeared to adapt to the feed with little digestive upset. Intake of Dry Matter (DM) increased during weeks 3 and 4 (*Table 2*) as shown by the positive regressions of intake on time. There was no relation between roughage level and intake due to extreme variation between animals. Mean intakes differed widely between animals on the same diet, and for individual animals, day to day variation in intake was often large, as shown by the standard errors of the regression coefficients. Faeces became more fluid, and two animals (No. 616 and 801) developed severe diarrhoea for several days. The data shows the association between observed diarrhoea and low and erratic intake.

During the digestibility trial, diarrhoea was not observed while feed was offered at 95% of previous *ad libitum* intake. Digestibilities (*Table 2*) showed that considerable digestive disturbances were still occurring in three animals, including No. 616 and 801, which recorded digestibilities below 35%. The validity of these estimates is doubtful due to the occurrence of diarrhoea.

### Experiment 2

The Hamil grass chaff, harvested at an early stage of growth, contained more nitrogen and less ADF (*Table 1*) than that used in Experiment 1.

Steers fed mill run adapted with some digestive upsets. Occasionally, loose faeces were voided by three steers on

*Table 1.* —**Composition of mill run, pelleted with added calcium carbonate, and Hamil grass chaff, expressed on dry matter basis**

| | Mill run | Hamil grass chaff | |
|---|---|---|---|
| | | Experiment 1 | Experiment 2 |
| Ash (mg/g) | 83 | 117 | 123 |
| N (mg/g) | 29.2 | 5.4 | 11.2 |
| Energy (MJ/g) | 18.19 | 16.35 | 16.47 |
| Acid detergent fibre (mg/g) | 110 | 462 | 420 |

*Table 2.* —**Intake of dry matter (D.M.) by steers fed diets of mill run pellets with low levels of roughage (Hamil grass chaff) during a two week period**

| | Level of roughage fed | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5% | | 10% | | 15% | | 20% | | 25% | |
| Steer number | 616 | 755 | 615 | 693 | 801 | 875 | 681 | 919 | 763 | 898 |
| Daily intake kg of D.M. | 3.53 | 4.12 | 3.72 | 5.68 | 2.89 | 5.30 | 5.25 | 4.41 | 3.59 | 4.76 |
| Change of intake g/day | 22 | 118 | 198 | 83 | 70 | 98 | 50 | 29 | 28 | 80 |
| S.E. of regression g/day | 74 | 18 | 39 | 29 | 76 | 46 | 40 | 37 | 28 | 24 |
| Intake g D.M./$kg^{0.75}$ | 77.4 | 91.2 | 79.0 | 116.5 | 64.5 | 112.9 | 108.7 | 108.9 | 83.0 | 111 |
| Organic matter digestibility % | 24.2 | 50.8 | 50.3 | 55.2 | 19.0 | 52.2 | 53.0 | 59.1 | 33.0 | 52.1 |

*Table 3.* —**Intake of mill run pellets (feeds (ii) and (iii)) and pellets plus Hamil grass chaff (feed (iv)) by steers of different breeds and ages (two animals/group except for purebred Brahman, 1/group)**

| Treatment | Steer type | Mean L.W. kg | D.M. Intake kg/day | Intake g/kg 0.75 L.W. |
|---|---|---|---|---|
| Four hours pen feeding | Brahman | 389 | 3.73 | 43.1 |
| | J.Z. | 310 | 3.15 | $42.6^{a}$ |
| | 20 month old crossbred | 325 | 3.88 | $50.7^{a}$ |
| | Yearling crossbred | 254 | 2.80 | $44.0^{a}$ |
| 20 hours pen feeding | Brahman | 383 | 3.43 | 62.9 |
| | J.Z. | 277 | 4.69 | $69.6^{b}$ |
| | 20 month old crossbred | 313 | 5.88 | $79.0^{b}$ |
| | Yearling crossbred | 241 | 4.75 | $77.6^{b}$ |
| Full feeding | Brahman | 399 | 7.21 | 80.8 |
| | J.Z. | 261 | 6.22 | $95.4^{c}$ |
| | 20 month old crossbred | 317 | 8.23 | $109.5^{d}$ |
| | Yearling crossbred | 250 | 7.58 | $120.8^{d}$ |

Means with different superscripts are significantly different ($p < 0.05$, L.S.D. = 12.8).

treatment (iii) and four steers on treatment (iv). Depressions in intake and growth rate occurred during two periods of extremely hot, windless weather. Mean dry matter intakes of supplement (treatment (ii) and (iii) and total ration (treatment (iv)) differed greatly ($p<0.001$) (*Table 3*). Intake differed between genotypes, especially with "full feeding", JZ consuming less feed than the crossbred animals ($p<0.025$); purebred Brahman steers ate even less than JZ but these animals were excluded from statistical analysis. Within crossbred groups, yearlings ate less than 20 month steers on diet (ii) and more on diet (iv) ($p<0.025$). Digestibilities of the ration fed in treatment (iv) were DM 55.1% ± 2.8, OM 60.6% ± 1.6, ADF 28.5% ± 4.8, and N 78.0% (mean ± S.E.M.), with no consistent breed differences. Steers which had developed diarrhoea previously had reduced digestibilities ($p<0.1$).

Growth rates (*Table 4*) were greatest on treatment (ii) for all types of steer ($p<0.001$) and were greatest for two year old crossbreds on all treatments ($p<0.001$). The highly significant interaction ($p<0.01$) is attributed to the relatively poor performance of JZ on treatment (iii) and (iv) and the relatively faster growth of yearling crossbreds on treatment (iv). Brahman and JZ grew faster when grazing without supplement than when intensively fed in treatments (iii) and (iv), while 5/8 Brahman crossbreds grew faster when intensively fed than when grazing.

At the end of the feeding period (*Table 5*), Brahman steers were heaviest; JZ steers from the two more intensive feeding treatments were significantly lighter ($p<0.025$) than on treatments (i) and (ii) and differences between diets were significant ($p<0.05$). Carcass weights of JZ and Brahman crossbreds did not differ on treatments (i) and (ii) but JZ had significantly smaller carcasses in the more intensive treatments (iii) and (iv). Data from the original slaughter group and other unpublished data from this station were used to predict initial carcass weights of the slaughtered animals. Estimated growth of carcass (*Table 5*) followed the same pattern as liveweight growth with crossbreds growing faster than JZ ($p<0.001$) and treatment (ii) supporting the fastest gains ($p<0.001$). However the superiority of the Brahman crossbreds was less marked than with liveweight gains due to the higher dressing percentage of the JZ ($p<0.005$).

JZ appeared fatter but the differences were not significant, partly due to inexpert skinning of the carcass. Two JZ steers had very yellow fat but the differences between breeds were not statistically significant.

## DISCUSSION

The laxative effect of the bran in mill run caused frank diarrhoea and reduced digestibility in all full fed treatments and some steers with only four hours of grazing per day. This must preclude the use of mill run at high levels for fattening cattle. The estimates of digestibility must be considered as inaccurate, due to diarrhoea.

The efficiency of utilization of digestible energy (DE) for growth of all steers receiving diet (iv) was close to predictions from NRC (1970) and the poorer growth of JZ steers was due to low voluntary intake, not inefficient utilization of the ration. This lower intake may be related partly to the rather nervous temperament of JZ when confined. However, Vercoe and Frisch (1977) have shown for Brahman, water buffalo and Banteng that intake is lower than for British and European breeds of cattle. It appears that JZ conform to the performance of some other large tropical domestic ruminants. Nevertheless, JZ steers could be fattened as easily as other breeds with a supplementary feeding system.

The most efficient use of mill run by

*Table 4.* — **Mean growth rate (kg/day) of steers on four feed treatments (values for Brahmans not used in statistical analysis)**

| Treatments | Brahman | JZ | Large Brahman crossbreds | Small Brahman crossbreds |
|---|---|---|---|---|
| (i) Grazing | 0.86 | 0.61[ef] | 0.83[bcd] | 0.67[def] |
| (ii) 4 hours feeding | 1.06 | 0.97[abc] | 1.07[a] | 0.90[bc] |
| (iii) 20 hours feeding | 0.70 | 0.48[fg] | 1.04[ab] | 0.83[bcd] |
| (iv) Full feeding | 0.63 | 0.39[g] | 0.77[cde] | 0.79[cde] |

Values with common superscripts are not significantly different ($p<0.05$, LSD = 0.218).

*Table 5.* — **Liveweight at slaughter and carcass data from steers of three breeds slaughtered after 18 weeks on four different nutritional regimes**

| Feed treatment | Breed | Liveweight at slaught. (kg) | Cold carcass wt kg | Carcass gain kg/d | Dressing % | Back fat mm |
|---|---|---|---|---|---|---|
| Grazing | Brahman | 456 | 254 | — | 55.7 | 14 |
| | J.Z. | 345[ab] | 192[ab] | .33[cd] | 55.6[abc] | 6 |
| | Brahman X | 358[ab] | 194[ab] | .46[abc] | 54.2[bc] | 4 |
| 4 hours feeding | Brahman | 455 | 267 | — | 58.7 | 12 |
| | J.Z. | 386[a] | 215[a] | .59[a] | 57.4[ab] | 9 |
| | Brahman X | 391[a] | 215[a] | .60[a] | 54.9[bc] | 8 |
| 20 hours feeding | Brahman | 432 | 247 | — | 57.2 | 7 |
| | J.Z. | 308[bc] | 181[ab] | .35[cd] | 58.7[a] | 6 |
| | Brahman X | 378[a] | 201[ab] | .53[ab] | 53.2[c] | 2 |
| Full feeding | Brahman | 438 | 234 | — | 53.4 | 5 |
| | J.Z. | 286[c] | 159[c] | .23[d] | 55.4[abc] | 2 |
| | Brahman X | 366[ab] | 192[ab] | .40[bc] | 53.6[c] | 4 |
| Least significant difference | | 59 | 31 | .14 | 3.4 | 8.3 |

Values with common superscripts are not significantly different.

cattle was as a supplement to grazing with diet (ii), mill run provided about half of the animals' energy requirements (NRC 1970), while it was the main dietary ingredient, with limited grazing to provide roughage, in diet (iii). Total hand feeding was unsuccessful. When mill run was used as a supplement, sustained growth resulted in store steers fattening in 18 weeks, despite a short period of reduced performance due to extreme climatic conditions. The carcasses produced by supplementation with mill run were highly commended by the local meat trade. In PNG it is difficult to fatten cattle on pasture at young ages; there is no lot feeding and most steers with adequate fatness are at least 2½-3 years old. In some areas, fat cattle cannot be produced.

Experiment 2 demonstrates the response of steers on good grazing to supplementation with mill run. At other seasons, cooler weather might permit greater intake of mill run, and cattle on poorer quality grazing might respond more effectively to supplementation. A particularly important case for further study occurs in Central Province, which has the added advantage of a large market for beef and close access to a flour mill (under construction) as a source of mill run. Here, under conditions of variable pasture quality and availability due to a marked wet and dry season each year, an animal which is almost ready for slaughter at the end of the wet season may be little closer to market condition in 6-7 months. Two or three months of supplementation as the pasture deteriorates might enable marketing many months earlier, with an increase in quality, price and turnover. Trials under practical cattle production conditions, perhaps involving the use of self-feeders, are needed in this province.

## ACKNOWLEDGEMENTS

We wish to acknowledge the assistance of Jacob Sano and Masoko Mebarda in caring for the experimental animals; chemical analyses by Faiyo Morahape; and the supply of the mill run pellets by the Lae Feed Mills.

## REFERENCES

CHRISTIAN, K.R. and COUP, M.R. (1954). Measurement of feed by grazing cattle and sheep VI. The determination of chromic oxide in faeces. *New Zealand Journal of Science and Technology*, Sect. A. **36**: 328-330.

CRAMPTON, E.W. and HARRIS, L.E. (1969). *Applied Animal Nutrition*, 2nd Edition. W.H. Freeman and Company, San Francisco.

HOLMES, J.H.G. (1977). South East Asian Cattle in Papua New Guinea. *3rd International Congress of the Society for the Advancement of Breeding Researches in Asia and Oceania*, Canberra, February 1977, i(c): 50-55.

NATIONAL RESEARCH COUNCIL (1970). *Nutrient Requirements of Beef Cattle*. 4th Edition, National Academy of Sciences, Washington.

SOKAL, R.R. and ROHLF, F.J. (1969). *Biometry*. W.H. Freeman and Company, San Francisco.

VAN SOEST, P.J. (1963). A rapid method for the determination of fibre and lignin. *Journal of the Association of Analytical Chemistry*, **46**(5), 829.

VERCOE, J.E. and FRISCH, J.E. (1977). *Third International Congress of the Society for the Advancement of Breeding Research in Asia and Oceania*, Canberra, February 1977, i(c); 42-45.