# RESPONSE BY CALVES GRAZING KIKUYU GRASS PASTURES TO GRAIN AND MINERAL SUPPLEMENTS

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## ABSTRACT

*Calves grazing nitrogen fertilized kikuyu grass for a 32 week period from weaning were fed crushed maize and/or mineral supplements. The mineral supplement supplied Na, Ca and P and was fed* ad lib.

*Mineral supplementation increased liveweight gain by 27% and carcase weight by 16%, illustrating the presence of mineral deficiencies in calves grazing these pastures. Although crushed maize supplementation did not increase liveweight gain, it did increase carcase weight. However, this increase did not cover the cost of the grain. Lower bone Na levels were observed in calves fed the grain supplement.*

*Factors contributing to the poor response to the grain supplement were discussed. In view of the response to the mineral supplement, a significant research input in this area is warranted.*

## INTRODUCTION

Previous studies at Wollongbar have shown the growth rates of calves grazing nitrogen fertilized kikuyu grass (*Pennisetum clandestinum*) pastures to be inferior to those reported for calves grazing temperate pasture species (Kaiser and O'Neill 1975). Poorer animal production from cattle grazing tropical pastures, when compared with temperate pastures, is well documented and could be due in part to the lower digestibility and intake of digestible energy on these pastures (Minson and McLeod 1970; Stobbs 1971).

Although sodium (Na) and calcium (Ca) deficiencies have not been previously reported in cattle grazing improved tropical pastures, chemical analyses on kikuyu grass samples from Wollongbar indicate that low intakes of these elements, and to a lesser extent phosphorus (P), may be limiting calf growth. Mean Na, Ca and P levels recorded in pasture pluck samples taken from nitrogen fertilized swards were 0.03, 0.35 and 0.33% respectively (Mears 1973; Colman and Kaiser 1974). When the requirements of the young growing calf for these minerals are considered (Agricultural Research Council 1965), it is unlikely that sufficient quantities could be ingested from these pastures to support rapid liveweight gain.

The purpose of this study was to determine if liveweight gain by calves grazing kikuyu grass pastures could be improved by supplementation with grain and/or a mineral supplement containing Na, Ca and P.

## MATERIALS AND METHODS

The experiment was conducted during the period November 1972 to July 1973 at the Agricultural Research Centre at Wollongbar, which is located in a humid sub-tropical environment on the north coast of New South Wales, on a red basaltic soil. Five treatments were compared over a 32 week period in a completely randomized design with two replicates:

A. Kikuyu grass only (control)
B. Kikuyu grass + mineral supplement
C. Kikuyu grass + mineral supplement + 0.91 kg maize per calf per day
D. Kikuyu grass + 1.81 kg maize per calf per day
E. Kikuyu grass + mineral supplement + 1.81 kg maize per calf per day.

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Forty Hereford cross calves (20 male and 20 female), of dairy origin, which had been bucket reared on whole milk to weaning (between 10 and 12 weeks of age), were randomly divided into ten equal groups. Two groups were randomly allocated to each treatment. One calf which had gained little weight during the pre-weaning period was removed from the experiment (treatment A) at this stage and the paddock size was reduced accordingly so that a uniform stocking rate was maintained.

*Supplementary feeding*

The mineral supplement (Wollongbar supplement CM-1) contained 48% bone flour, 44% tricalcium phosphate and 8% fine salt, and where fed, it was offered *ad lib* in open troughs. Calves receiving the crushed maize supplement were group fed from open troughs in their respective paddocks daily. The chemical compositions (on a dry matter basis) of the various dietary components were:

| Nutrient | Mineral supplement | Maize | Kikuyu grass |
|---|---|---|---|
| Crude protein, % | — | 9.44 | 15.09 |
| Na, % | 6.20 | 0.004 | 0.03 |
| Ca, % | 26.24 | 0.038 | 0.35 |
| P, % | 14.03 | 0.23 | 0.31 |
| Mg., % | 0.22 | 0.11 | 0.40 |
| K, % | 0.70 | 0.29 | 3.66 |
| Cu, p.p.m. | 21.50 | 2.68 | 12.55 |

The values for kikuyu grass are the mean of 19 total green (leaf + stem) samples taken at regular intervals throughout the experiment.

*Management of animals and pastures*

Calves continuously grazed nitrogen fertilized kikuyu grass pastures at a stocking rate of 9.9 calves $ha^{-1}$. Nitrogen fertilizer (as ammomium nitrate) was applied in late October (114 kg N $ha^{-1}$) and during January (114 kg N $ha^{-1}$) and superphosphate was applied in late October (251 kg $ha^{-1}$).

Calves were treated at four weekly intervals with anthelmintic* and male calves were emasculated (using "Burdizzo emasculators") at the commencement of the experiment. Liveweights were recorded every four weeks and paunch girth measurements were taken at the point of greatest circumference of the abdomen (Hodgson and Cottrell 1973) at 16 weeks.

Pasture availability — dry matter yield of green material on offer (kg $ha^{-1}$) — was measured at the commencement of the experiment (November) and in January, February, May, June and at the end of the experiment (July). The method used was generally similar to that developed by Campbell and Arnold (1973), with two standard and six randomly thrown quadrats (0.5 m x 0.5 m) per plot. Two observers were used.

*Carcase measurements*

At the completion of the experiment two calves from each plot were slaughtered after a 24 h fasting period. Carcases were dressed by normal commercial methods with kidney knob and channel fat being left in place. Hot carcase weight was recorded, as was cold carcase weight after a 24 h chilling period. Dressing percentages, based on cold carcase weight and fasted liveweight, were calculated for each calf. Carcase measurements — length, eye muscle area between the tenth and eleventh ribs and fat depth over the eye muscle — used in the Australian Beef Carcase Appraisal Scheme (Australian Meat Board 1971) were taken.

The tenth rib from the right side of each carcase, and a liver sample were taken from each animal for chemical analysis. Blood samples were also taken at slaughter.

* "Nilverm" (injection) registered trade name; manufactured by I.C.I. Australia, Ltd.

*Chemical analyses*

Bone Ca, P and Na levels were experessed on a volumetric basis as % (by weight) per ml of air dry bone. Bone P levels were determined by the vanado-molybdate yellow colorimetric technique with readings being taken on a Unicam SP1800 spectrophotometer using a wavelength of 470 nm. Blood P levels were determined using the molybdenum blue method with stannous chloride as a reducing agent. Bone and blood Ca and Na levels, and liver Cu levels, were determined by atomic absorption spectrophotometry (Varian Tectron AA5).

*Statistical analyses*

All data were subjected to an analysis of variance. Treatment sums of squares were partitioned into four single degree of freedom comparisons — maize effect (A, B *vs* D, E); mineral effect (A, D *vs* B, E); grain x mineral interaction (A, E *vs* B, D); linear response to maize in the presence of minerals (B, C, E). Paunch girth data was adjusted by covariance for liveweight at 16 weeks.

## RESULTS

One calf in the control treatment died from encephalitis and was replaced to maintain the stocking rate.

Calves receiving the crushed maize supplement were unable to consume their daily ration early in the experiment. However, calves receiving 0.91 kg crushed maize daily were consuming their full ration by the third week and those receiving 1.81 kg by the eighth week. Average daily intakes per calf over the full experimental period were 0.90, 1.75 and 1.78 kg maize for calves in treatments C, D and E respectively.

Intake of the mineral supplement by calves in treatments B, C and E varied considerably during the experiment. Total intakes during the experiment were 8.50, 12.90 and 12.10 kg per calf for treatments B, C and E respectively.

*Pasture availability*

The correlations (mean of 0.76 over all samplings) between estimated and actual green D.M. yields in standard quadrats were not sufficiently accurate to allow reliable predictions of actual yields in the randomly thrown quadrats. Consequently a comparison of treatment effects on pasture availability could not be made. The inability to obtain higher correlations (accurate regressions) was attributed to the restricted range of green D.M. yields at each sampling.

Ample pasture was available during the first half of the experiment with all plots having > 6,000 kg green D.M. $ha^{-1}$ in January. Pasture availability declined during the second half of the experiment and was < 4,000 kg green D.M. $ha^{-1}$ in all plots by the end of the experiment.

*Liveweight gain*

Analyses on these data were divided into two growth stages — 0 to 12 weeks and 12 to 32 weeks. Similar percentage liveweight gain responses (Table 1) to mineral supplementation were recorded in both periods ($P<0.05$), with an overall response (0 to 32 weeks) of 27% ($P<0.01$). Liveweight gain was unaffected by supplementation with crushed maize.

Empty body weights taken at the completion of the experiment were significantly increased by both mineral supplementation ($P < 0.01$) and supplementation with 1.81 kg crushed maize ($P < 0.05$). Those calves fed the maize supplement lost less weight during the fasting period (Table 1).

*Paunch girth*

Paunch girth at 16 weeks, adjusted for liveweight at 16 weeks, was significantly ($P < 0.01$) reduced by supplementation with maize, there being a linear decline ($P <$

0.05) in paunch girth as the level of maize fed was increased. Paunch girth was also reduced (P < 0.05) as a result of mineral supplementation.

TABLE 1

*Growth response by calves grazing kikuyu grass pastures to maize and mineral supplements*

| Treatment | Liveweight 0-12 weeks | gain 12-32 weeks | 0-32 weeks | Final live-weight | Final empty body-weight | Paunch† girth at 16 weeks |
|---|---|---|---|---|---|---|
| | | kg day$^{-1}$ | | kg | kg | cm |
| A. Kikuyu control | 0.46 | 0.41 | 0.43 | 173 | 159 | 158.6 |
| B. Kikuyu + mineral supplement | 0.64 | 0.50 | 0.55 | 198 | 183 | 155.7 |
| C. Kikuyu + 0.91 kg maize + mineral supplement‡ | 0.62 | 0.57 | 0.59 | 199 | 187 | 152.3 |
| D. Kikuyu + 1.81 kg maize | 0.51 | 0.43 | 0.46 | 180 | 172 | 152.2 |
| E. Kikuyu + 1.81 kg maize + mineral supplement | 0.60 | 0.57 | 0.58 | 203 | 192 | 146.4 |
| *Level of significance* | | | | | | |
| Maize effect A,B *vs* D,E | n.s. | n.s. | n.s. | n.s. | * | ** |
| Mineral effect A,D *vs* B,E | * | * | ** | ** | ** | * |
| Maize x mineral interaction A,E *vs* B,D | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| Linear maize B,C,E | n.s. | n.s. | n.s. | n.s. | n.s. | * |
| Standard error of mean | ±0.04 | ±0.04 | ±0.02 | ±3 | ±3 | ± 0.9 |

*, ** are P<0.05 and P<0.01 respectively.
† Adjusted for liveweight at 16 weeks.
‡ Mineral supplement fed *ad lib* and maize level expressed on per calf per day basis.

*Carcase measurements*

Cold carcase weight (Table 2) was significantly increased as a result of mineral (P < 0.01) and maize supplementation (P < 0.01). There was a linear increase in cold carcase weight as the level of maize fed was increased from 0 to 0.91 to 1.81 kg (P < 0.05) when these calves were also fed the mineral supplement. A similar effect on dressing percentage was observed ($P < 0.05$). Carcase length was significantly increased by mineral supplementation ($P < 0.01$). Differences in eye muscle area and fat depth over the eye muscle were not significant.

TABLE 2

*Effect of maize and mineral supplementation of calves grazing kikuyu grass pastures on various carcase measurements and bone composition*

| Treatment | Cold carcase weight | Dressing percent-age | Carcase length | Eye muscle area | Fat depth † | Ca | Bone Na | P |
|---|---|---|---|---|---|---|---|---|
| | kg | % | cm | $cm^2$ | mm | | % per ml air dry bone | |
| A. Kikuyu Control | 76 | 47.7 | 80.0 | 38.71 | 1.4 | 34.90 | 0.91 | 17.15 |
| B. Kikuyu + mineral supplement | 92 | 48.1 | 84.8 | 36.71 | 2.9 | 35.93 | 0.96 | 17.86 |
| C. Kikuyu + 0.91 kg maize + mineral supplement‡ | 94 | 52.1 | 83.5 | 44.00 | 3.0 | 34.75 | 0.88 | 17.18 |
| D. Kikuyu + 1.81 kg maize | 90 | 51.0 | 81.8 | 40.35 | 3.9 | 32.74 | 0.85 | 16.49 |
| E. Kikuyu + 1.81 kg maize + mineral supplement | 101 | 53.2 | 85.0 | 45.35 | 3.9 | 34.46 | 0.88 | 17.10 |
| *Level of significance :* | | | | | | | | |
| Maize effect A,B *vs* D,E | ** | ** | n.s. | n.s. | n.s. | n.s. | * | n.s. |
| Mineral effect A,D *vs* B,E | ** | n.s. | ** | n.s. | n.s. | n.s. | n.s. | n.s. |
| Maize x mineral interaction A,E *vs* B,D | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| Linear maize B,C,E | * | * | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. |
| Standard error of mean | ±2 | ±0.4 | ±0.6 | ±2.06 | ±0.4 | ±0.58 | ± 0.02 | ±0.27 |

*, ** are $P < 0.05$ and $P < 0.01$ respectively.

† Measured over eye muscle at tenth rib (Australian Meat Board 1971).

‡ Mineral supplement fed *ad lib* and maize level expressed on per calf per day basis.

*Chemical composition*

Bone Na levels were significantly ($P < 0.05$) reduced by supplementation with 1.81 kg maize daily (Table 2) but bone Ca and P and blood Na, Ca and P levels were not affected by treatments. Mean blood Na, Ca and P levels were 3,007 p.p.m., 7.48 mg per 100 ml and 6.66 mg per 100 ml respectively. A mean liver Cu level of 70 p.p.m. was observed, there being no significant treatment differences.

## DISCUSSION

The 27% liveweight gain response to the mineral supplement in this study has shown that mineral deficiencies are limiting the growth of young calves on kikuyu grass pastures in this environment. The growth rate of unsupplemented calves (0.43 kg $day^{-1}$) was 32% below a mean recorded for calves grazing temperate pastures and similar to previous estimates for kikuyu grass pastures (Kaiser and O'Neill 1975). In this experiment mineral supplementation reduced this deficit to 14%. When one compares the mineral requirements for growth (Agricultural Research Council 1965) with the levels in kikuyu grass, it appears that the mineral response in this experiment may have been a combined Na and Ca response. However, from my data it is not possible to partition the mineral response. Further research is required to define those factors contributing to responses to mineral supplementation.

Although the P nutrition of grazing cattle in the sub-tropical and tropical areas of Australia has been extensively researched, and some emphasis is being placed on S nutrition (Rees, Minson and Smith 1974) there have been few studies on the requirements for other mineral elements. Sodium deficiency has been confirmed in some areas where responses to Na supplementation (Murphy and Plasto 1973) and low salivary Na levels (Gartner and Murphy 1974) have been recorded. Low Na levels in tropical grasses have been observed by other workers with levels varying considerably between species and soil types (Playne 1970). Few values have been reported for kikuyu grass; Said (1971) observed lower Na levels (mean 0.007%, Kenya) than have been observed at Wollongbar but Joyce (1974) has recently reported considerably higher levels (mean 0.41%, New Zealand).

The Ca levels in kikuyu grass are lower than those observed in temperate grasses (Whitehead 1966). The mean Ca (0.35%) and P (0.31%) levels observed in this study fall within the ranges (Ca, 0.22-0.46%; P, 0.18-0.36%) observed in other studies (Sherrod and Ishizaki 1967; Gomide *et al* 1969; Said 1971) with this species.

Although grain supplementation increased carcase weight, the 12 kg increase in treatments D and E was too small to cover the cost of grain, which is currently retailing for approximately 10 cents $kg^{-1}$. Consequently, there appears to be little scope for feeding grain in this type of grazing enterprise. However, one advantage of supplementary grain feeding which was not measured in this experiment is the increased stocking rate which can be maintained in such a system (Hodgson and Tayler 1972).

The poor response to grain supplementation in this study is in agreement with similar observations by other workers (e.g. Slade 1972). In general, large responses to grain feeding have only been observed at high stocking rates or grazing pressures, where the quantity of pasture available is limiting liveweight gain (Conway 1968). Where stocking rates are low and pasture availability is non-limiting, the grain tends to become a substitute rather than a supplement (Tayler and Wilkinson 1972). These observations have been made on temperate pastures, there being no comparative data for young growing cattle grazing tropical pasture species.

Although the availability of non-limiting quantities of pasture during the greater part of this experiment indicates that a response to grain would have been unlikely, the lower intake of digestible energy by cattle tropical pastures (Minson and McLeod 1970; Stobbs 1971) could be expected to partially override this effect. A larger response to grain in this experiment was therefore expected. It is possible that the calves supplemented with maize were protein deficient, especially during the early post-weaning period, as substitution of maize for pasture would lower the crude protein percentage of the whole diet. This contention is supported by the data of Slade (1972) who observed no response by grazing calves to a barley supplement but a mean response of 14% to a barley/protein (3:1) supplement. In Slade's study, which was conducted over three years, a "plentiful supply of leafy grass" was available throughout each experiment.

The paunch girth of calves in the control treatment was observed to be greater than those in other treatments, this observation being confirmed when measurements were taken at 16 weeks. Hodgson and Cottrell (1973) have shown that it is possible to accurately estimate the volume of abdominal organs from paunch girth measurements. In my study, therefore, the reduced paunch girth at a given liveweight, which resulted from feeding both supplements, is a reflection of a reduced volume of abdominal organs in these calves.

Apart from lower bone Na levels in calves supplemented with 1.81 kg maize, chemical composition of blood and bone were unaffected by treatments. As the maize contained less Na than kikuyu grass, the total Na intake by supplemented calves would be expected to be reduced, this leading to less deposition of Na in bone. The absence of a change in the chemical composition of bone following mineral supplementation is not surprising, as calves in this growth phase would be depositing more skeletal tissue rather than increasing the concentration of the various minerals in the existing skeleton.

The large response to mineral supplementation in this experiment has an important bearing on future research in this, and perhaps other environments. In the past, studies of the nutrition of cattle grazing improved tropical grasslands in higher rainfall areas has mainly been orientated towards the problems of low digestibility and intake, while mineral nutrition has been generally neglected. Finally, the scope for improving per calf liveweight gain by grain supplementation appears limited.

## ACKNOWLEDGEMENTS

I would like to thank Dr. C.E. Lewis for chemical analyses, Mr. G.H. O'Neill for statistical analyses, and Mr. R. Bryant for technical assistance. Financial support was provided from the Australian Extension Services Grant.

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(Accepted for publication June 28, 1975)