Anim. Prod. Aust. 2002 Vol. 24: 209-212

THE EFFECT OF DIFFERENT CONCENTRATE: FORAGE RATIOS ON BEEF CATTLE GROWTH AND ECONOMICS IN SOUTHERN CHINA

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SUMMARY

Six crossbred bulls (Simmental x Chinese yellow cattle) were used to study the effect of diets consisting of different ratios of concentrate to forage on their growth rate and the economics of feeding. During a growth trial lasting 58 d, the average daily live-weight gain of bulls given freshly cut green forage *ad libitum* supplemented with 25% concentrate did not differ significantly from that of bulls given the same forage supplemented with 43% concentrate. The mean growth rate for both groups over 58 days of feeding was 935 ± 20 g/d. The results emphasise the important potential role for fresh forages in that the feeding cost per kg live-weight gain was 18 % lower for the bulls given the higher forage diet.

Keywords: beef cattle, forage, concentrate:forage ratio, growth, economics

INTRODUCTION

The red-soils region south of the Yangtze river in southern China, an area the size of Western Australia (2.6 million km^2), represents only 25% of the total area of China but holds nearly half its population. The region has 0.58 million km^2 of grassland and 1.06 million km^2 of hilly or mountainous land. A joint study undertaken more than 10 years ago by the Australian Centre for International Agricultural Research (ACIAR), Winrock International and the Chinese Academy of Agricultural Sciences (CAAS) recommended priority be given to establishing forage-based beef production in this region. Although the efficiency of the relatively new cattle industry in this region has been improving, it is still influenced by traditional habits and productivity is relatively low. There is an urgent need for relevant cattle production research and rapid extension of the research findings.

An ACIAR-China project has been established to undertake research and extension in support of the developing cattle industry and to determine the most efficient way to make use of forages and agricultural by-products (straws) and reduce the conflict between population and arable land. A viable cattle industry will enhance national food and protein supply by utilizing untapped resources (the hilly grasslands) and agricultural by-products and will improve the living conditions of people throughout the red-soils region. At present, beef cattle in the region are often under-fed and this leads to poor feed conversion efficiency. Low productivity results in poor economic returns to potential producers, and this in turn has severely hindered the development of a viable beef cattle industry in the red-soils region.

The aim of this study was to determine the nutritional value of locally available forages in Jiangxi province such as dwarf Napier grass and to obtain economic information needed for the development of cattle feeding and management systems appropriate to Jiangxi as well as other provinces in the red-soils region of southern China.

MATERIALS AND METHODS

Experimental animals, design and diets

The study was undertaken at the Jiangxi Agricultural University in southern China. Six clinically healthy bulls (Simmental x Chinese yellow cattle; 187 ± 1.7 kg) were randomly allotted from 3 weight strata to 2 groups, each of 3 animals on 14 August 2001. The bulls were housed individually in the same animal house in pens with a concrete floor.

There was a 15-day pre-experimental period from 14 August to 29 August 2001 when *ad libitum* intakes of dwarf Napier grass (*Pennisetum purpureum*) were determined. The main growth experiment was

started on 30 August and ran to 26 October 2001 (i.e. 58 d). In this period the two groups of bulls were offered diets that consisted of cut-and-carry forage *ad libitum* and concentrate at 25% or 43% of total dry matter (DM) intake. Fresh forages were cut daily under contract and delivered to the Animal House. They consisted of dwarf Napier (referred to locally as 'elephant') grass (*Pennisetum purpureum*), sweet potato vine (*Ipomoea batatas*) and, later in the experiment, Dallis grass (*Paspalum dilatatum*). Table 1 gives details of the dietary components, and Table 2 gives the predicted ME and crude protein concentrations of the resulting diets offered to the bulls.

Table 1. Components of the diets of fresh forage and concentrates offered to the bulls during a 58-day growth period expressed as dry matter offered per day (and fresh forage material per day in parentheses)

Treatment	Period	Concentrates				Forages		
		Maize	CSM	RSM	Premix	DNG	SPV	DG
Diet 1	Phase 1	0.57	0.45	0.09	0.05	4.58 (22)		
	Phase 2	0.71	0.56	0.12	0.07		3.92 (28)	1.48 (5)
Diet 2	Phase 1	1.13	0.54	0.18	0.10	3.54 (17)		
	Phase 2	2.78	0.69	0.23	0.13		3.50 (25)	1.18 (4)

CSM-cottonseed meal; RSM-rapeseed meal; DNG-dwarf Napier grass; SPV-sweet potato vine; DG-Dallis grass

Table 2. Calculated* metabolisable energy (ME, MJ/kg DM) and crude protein (CP, g/kg DM) concentrations in diets offered to bulls during a growth trial lasting 58 d

Treatment	Period	Concentrate		Forages	
		ME	CP	ME	CP
Diet 1	Phase 1	12.0	235	7.9	100
	Phase 2	12.0	233	9.8	171
Diet 2	Phase 1	11.9	330	7.9	100
	Phase 2	12.1	165	9.8	103

*Analyses taken from Devendra (1979)

After green forages were delivered to the animal house, they were chopped to lengths of about 30 cm before being placed in the feed troughs. The concentrate was offered first on each occasion and when it was completely consumed (usually less than 20 min), the forage was offered. Fresh forage feed was offered twice daily at 08:00 h and 17:00 h and water was always available. Feed (concentrate and forage) offered and forage refusals of each bull were recorded daily.

The bulls were weighed before the morning feeding on 14 August, 30 August (start and end of Phase 1) and on 30 September and 27 October 2001 (start and end of Phase 2).

Statistical analysis

Feed intake, live-weight gain, feed conversion efficiency and feed cost per kg live-weight gain were determined. Statistical analyses were performed using one-way ANOVA (Excel spreadsheet, Microsoft Corporation).

RESULTS

During the 16-day pre-experimental period when the bulls were offered freshly cut dwarf Napier grass, those in Group 1 (later given Diet 1) had a voluntary intake of 2.99 ± 0.15 kg DM/d and gained 379 g/d, whereas those in Group 2 ingested 2.41 ± 0.06 kg DM/d and lost 10 g/d because one bull had ingested sub-optimal amounts of dwarf Napier grass. Thus on 30 August the range of live weights of bulls in the group to be given Diet 2 (187±8.8 kg) in the experimental period was greater than that for Diet 1 (193±2.3 kg), although the mean live weights of both groups did not differ significantly ($P>0.05$).

During the 58-day experimental period, the bulls ingested all of the concentrates and 91-94% of the forages offered each day. The intakes of forages and concentrates, ME intakes and live-weight gains of the bulls over 58 d are given in Table 3.

Table 3. Intake of forage and concentrate DM, calculated ME intake and live-weight (LW) gain of the bulls given forage diets with 25% (Diet 1) or 43% (Diet 2) of concentrates over 58 d. Values are means (± standard errors)

Diet	Forage intake (kg DM /d)	Concentrates (% of total DM intake)	Total DM intake (kg/d)	Total intake (kg DM/100 kg LW)	Total ME intake (MJ/d)	Mean LW gain (g/d)
1	4.27[a]	24.8[a]	5.68[a]	2.58[a]	53.9[a]	950[a]
	(0.106)	(0.47)	(0.106)	(0.059)	(0.84)	(29)
2	3.49[b]	42.8[b]	6.10[a]	2.87[b]	58.1[b]	920[a]
	(0.118)	(0.68)	(0.135)	(0.061)	(1.05)	(57)

Values with different superscripts within a column differ significantly (P<0.05)

The bulls given more concentrates (Diet 2) ingested (P<0.05) less forage but their total DM intakes tended (P=0.07) to be higher than those given less concentrates and these bulls also had higher (P<0.05) ME intakes.

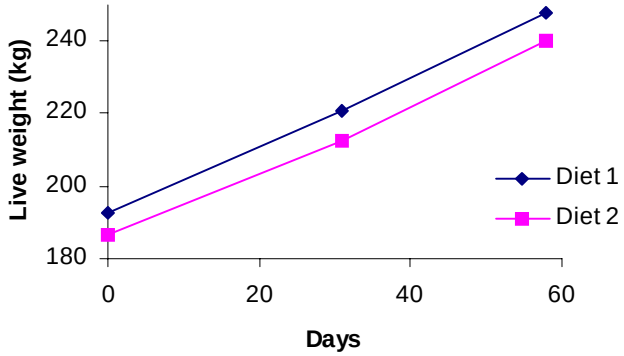

Figure 1. Live weights of bulls on forage-concentrate diets with 25% concentrate (Diet 1) or 43 % concentrate (Diet 2) during Phase 1 (31 d) and Phase 2 (27 d) of the experiment

The mean live weights of bulls during the 58 d growth period are given in Fig. 1. The live weight of the bulls offered the two dietary treatments did not differ (P>0.05) on Day 0 of Phase 1 of the growth trial, although the mean weight of the group given Diet 2 tended to be lower than of those offered Diet 1 as noted earlier. Over the 58 d, the average daily live-weight gain of bulls was higher in Phase 2 (mean 1012 g/d) than in Phase 1 (mean 872 g/d). However, the gains of bulls given Diet 1 or Diet 2 and the corresponding FCR over 58 d (950±29 and 920 ±57 g/d; 6.0 and 6.7 g feed DM/g LW gain) did not differ significantly (P>0.05). (The growth rates of both groups appear identical if the smallest bull at the start of Phase 1 (in Group 2) is treated as an outlier and its data are removed from the data analysis.)

The cost of fresh forages, as supplied, was 0.15 yuan/kg, irrespective of species and water content, and of the different concentrate mixes (see Table 1) was 1.43 yuan/kg (as fed) in Phase 1 and 1.35 yuan/kg in Phase 2. The total cost of feeding for the 58-day feeding period (including the costs of forages that were not eaten by the bulls, but not including labour costs associated with chopping the forages and feeding these to the bulls) was 5.9 yuan/bull.day or 6.2 yuan/kg live-weight gain for bulls on Diet 1 and 7.2 yuan/d or 7.9 yuan/kg live-weight gain for bulls on Diet 2.

DISCUSSION

The development of a cattle industry based on making use of forages could help alleviate rural poverty in the red-soils region of southern China. In Hunan and Jiangxi provinces where research and extension work for the ACIAR project is being undertaken, the annual income of farmers is very low, i.e. less than 2000 yuan (A$ 475) per capita in 1996, and their income is still low even when supplemented by about 70% with income from household businesses (CAY, 1997). Cattle production from forages offers the possibility of increasing the incomes of farmers in this region and may allow better use to be made of the non-arable hilly slopes.

Forages and agricultural by-products (e.g. rice straw) are usually the least expensive options for feeding growing cattle in Jiangxi province where this study was undertaken. However, the quality of pasture grasses in Jiangxi is variable depending on the species (and whether tropical or temperate), stage of growth and prevailing climatic conditions. Fresh mature tropical grasses are often deficient in total N as a sole feed for ruminants. Legumes usually have a higher digestibility than grasses and can improve total N intake but are often not present in the pastures. Energy and nutrient requirements cannot be met fully from a diet consisting only of fresh forage, probably because materials with high water content and low digestibility cause gut distension, and this in turn inhibits intake before the animal can fully satisfy its nutritional requirements. These factors usually lead to sub-optimal growth of pasture-fed beef cattle. In fact, the apparent growth of the bulls given freshly cut dwarf Napier grass in the pre-experimental period exceeded theoretical expectations. The bulls had a voluntary intake of 2.99 ± 0.15 kgDM/d, equivalent to about 24 MJ/d which, after meeting a probable maintenance ME requirement of 20-24 MJ/d (SCA, 1990), left only about 0-4 MJ/d for tissue accretion. Intake of grass was only 1.6% of live weight and was presumably limited by its fibre content. The estimated ratio of crude protein to ME in the grass (and in all diets offered) exceeded 12 g/MJ ME which should have provided adequate N for the rumen fermentation. However, absorbed protein may have been a factor limiting intake on the grass-only diet (Egan, 1965).

Many farmers in Jiangxi province also feed some concentrates to their beef cattle, especially when market prices are high. The ratios of concentrate and forage to be used in the growth experiment were calculated using available analytical information for dwarf Napier grass. We had to substitute other forages for dwarf Napier grass during Phase 2 when the latter became scarce as a result of drought and illegal occupation of the nearby grasslands.

Supplementation with concentrates did not appear to affect the intake of forages and the bulls grew as well on the lower level of concentrate as they did on the higher level. In this context, the question arises as to what is the optimal ratio of concentrate to forage that should be offered. Usually, the highest rates of growth in beef cattle will be obtained by feeding diets with high proportions of concentrate, but because concentrates are expensive, the optimal economic ratio is likely to occur when the diet is made up of a predominance of lower-cost forage. The optimal ratio in any particular case will, therefore, depend on the relative costs of concentrates and forages and their nutritional value, the genetic potential for growth of the cattle being fed, the current market value of the finished cattle, and other factors. In the growth period, estimated ME intakes of the bulls offered the fresh forages plus concentrates were 54 and 58 MJ/d for the 25% and 43% diets, respectively, and the average daily gain was not significantly affected by the level of concentrates. However, the feed cost per kg live-weight gain was 18% lower when the bulls were given the forage diet with 25% concentrate. Whether costs would have been further reduced with even lower concentrate inclusion will be tested in future studies.

ACKNOWLEDGEMENTS

We thank ACIAR, CAAS and the provincial and county governments of Hunan and Jiangxi for facilitating this study and providing financial support. We also thank our ACIAR collaborators from Australia who helped with the preparation of this manuscript.

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