CAN HETEROSIS FOR GROWTH BE EXPECTED TO IMPROVE FEED CONVERSION EFFICIENCY ?

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SUMMARY

The purpose of this paper is to model the effects of heterosis on feed conversion efficiency (FCE) of growing animals. This paper utilises the model proposed by Kinghorn (1985) and assumes that crossbreds are 2% longer (6.1% heavier) than purebreds. FCE was calculated as live-weight gained per unit dry matter (DM) consumed. It was found that heterosis for improved feed FCE could vary from -4% to infinitum depending on the method and period of calculation.

INTRODUCTION

Reported effects of heterosis (difference between the mean of the crossbreds and purebreds), on food conversion efficiency (FCE) are variable. Martin (1982) stated that profit in the cattle industry is highly dependent on efficient utilization of feed. Feed consumption and weight gain were recorded over a 22-week period beginning at 225 kg live-weight. Heterosis estimates were 4.3% for daily gain and 2.1% for FCE. He concluded that by producing crossbreds feed and yardage costs could be reduced compared to purebreds, therefore potentially increasing producer profits and lowering costs to consumers.

Gregory et al. (1966) grew out beef steers to a constant age and found that from 200-452 days crossbred steers used only 0.2% less total daily nitrogen to gain the same weight as purebred steers. They concluded that increased feed intake, rather than FCE, was the major factor contributing to heterosis for increased weight gain. Kasser et al. (1986) found that, for rats grown from 4-14 weeks, heterosis improved FCE by only 0.3% and also concluded that increased gain of crossbreds compared to purebreds was due to increased feed consumption rather than increased feed FCE.

Kinghorn (1985) modelled relationships between animal weight and production efficiency by using animal length as the basic measure of size. Experiments, such as those of Nelson et al. (1982) have reported heterosis estimates for height and weight as 2.0 and 6.2%, respectively. Based on the equations of Kinghorn (1985), the purpose of this paper is to show the effects of a 2% increase in length on changes in weight gain, and how experimental results for FCE can vary depending on the method and period of calculation. Much of this is not new, but I believe that by using Kinghorn's (1985) equations, one can account for discrepancies in previous results.

Kinghorn (1985) showed that an animals weight (W) is proportional to its length cubed and that rate of feed intake is a function of weight gain and maintenance requirement which is proportional to length squared. Cumulative, or total, DM intake is the integral of the rate of feed intake with respect to time. The following two equations were used to calculate weight (W) and total DM intake (F) (Kinghorn 1985). Equation 2 includes an adjustment (-7/6) so that at zero age when W is zero, F is also zero, Kinghorn (1985) used -11/6.

$$W = w.L_m^3.[\ 1 - \exp(-65.t.k/L_m)\ ]^3 \qquad (1)$$

$$F = NFCR.W + m.L_m^3/k.[\ t.k/L_m + 3.\exp(-t.k/L_m) - 3/2.\exp(-2.t.k/L_m) - 1/3.\exp(-3.t.k/L_m) - 7/6\ ] \qquad (2)$$

Table 1 Explanation of Abbreviations.

t	= age (days).
W	= weight at age t.
L_m	= mature length (cm) and is taken to be 250 cm for purebreds and 255 cm for crossbreds.
w	= 0.000065 kg/cm^3. This value was chosen subjectively by Kinghorn (1985) and gives A = 65 kg for L_m = 100 cm, ie. $A = w.L_m^3$.
A	= mature (asymptotic) weight (kg). A = 1015.625 kg for purebreds and 1077.791 kg for crossbreds.
P	= percentage of mature weight = W/A.
k	= 0.013. k is characteristic of the rate of decrease in dL/dt and was chosen by Kinghorn (1985) to give the best fit to Taylor's (1980) data (k/L_m is therefore 0.000052 for purebreds and 0.000051 for crossbreds).
F	= cumulative DM intake at age t.
NFCR	= Net Food Conversion Ratio = 2. This means that, in addition to maintenance requirements, 2 kg of DM is required in order to increase live-weight by 1 kg.
m	= 0.00005 $kg/day.cm^2$. This gives a maintenance ration of M = 500 g/day for L_m = 100 cm.
FCE	= Food Conversion Efficiency for a given time period = Change in W / Change in F (kg live-weight / kg DM).

Cumulative DM intake (2) increases with time and weight (1), which also increases with time. Weight is plotted against cumulative DM intake in Figure 1. The curve is from birth to 2000 days of age with points every 100 days. Results for various periods of growth and various methods and periods of calculation of FCE are presented in Table 2.

Figure 1. Graph of weight (W) against total DM intake (F)

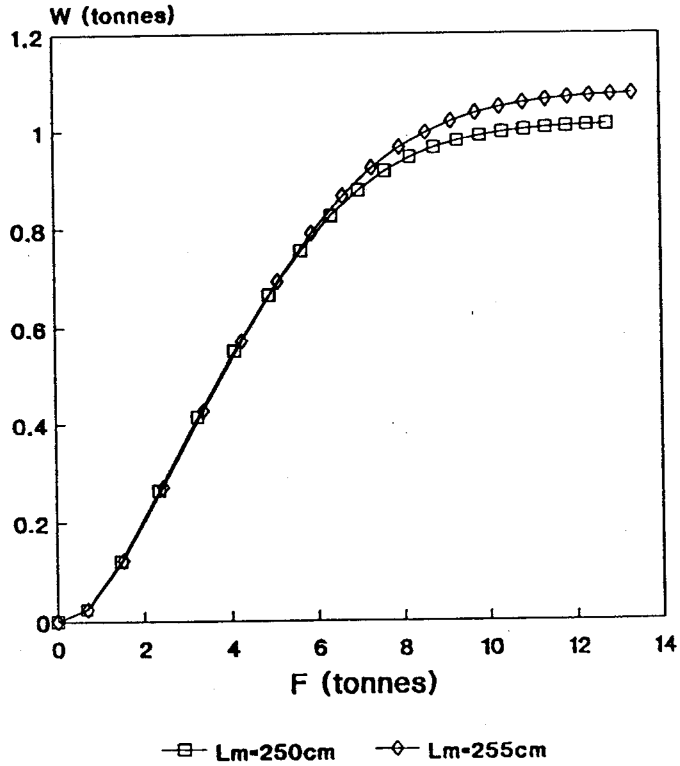

Table 2. Values for various methods and periods of calculation of FCE.

	Time taken (days)		Change in F (kg)		Change in W (kg)		FCE (kg/kg)	
	L_m=250	L_m=255	L_m=250	L_m=255	L_m=250	L_m=255	L_m=250	L_m=255
20%-60% maturity	289	295	2510	2665	406.8	432.0	.1621	.1621
200-600 days	400	400	3438	3588	544.6	570.3	.1584	.1589
200-600 kg	283	267	2463	2436	400.0	400.0	.1624	.1642
600-1000 days	400	400	2708	2845	250.3	271.5	.0924	.0954
600-1000 kg	1017	595	6201	4214	400.0	400.0	.0645	.0949

DISCUSSION

It can be seen from figure 1, that up until 700 days or when approximately 6 tonnes of feed has been consumed, there is no significant difference in weight at a given amount of DM eaten between the two sizes. Subsequently, however, for a given amount of DM eaten the crossbred will be heavier, or at a given weight the crossbred will have eaten less DM than the purebred. When the animal reaches maturity, a 2% increase in length will result in a 6.1% increase in weight according to Kinghorn's (1985) equations.

Heterosis for FCE from 20-60% maturity was zero. According to the model used in this paper, increasing the mature length (or size) of the animal will not improve FCE if animals grow from one level of maturity to another. This is why Kinghorn (1985) concluded that genotype size is not expected to affect overall production efficiency except through any effect on reproductive efficiency.

In the first day heterosis for FCE for one days growth was -4%. Heterosis for FCE from 200-600 days of age was negligible (0.3%) whereas from 600-1000 days it was 3.2%. Heterosis for FCE from 200-600 kg was 1.1% and from 600-1000 kg it was 47.1%. At 10000 days of age (a very old steer!), heterosis rose to 100%; ie. on the same amount of feed the crossbred gained twice as much weight in a day as the purebred. According to the model in this study this would keep on increasing, although the absolute differences are insignificant.

The results are based on the assumption that heterosis does not change the relationship of W and F with L_m, ie. that heterosis does not change body composition proportions at a given level of maturity. These results show how differences in FCE estimates between purebreds and crossbreds may be obtained depending on whether animals are grown from one weight to another, one age to another or one level of maturity to another and also on the time period examined.

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