

## Growth pattern for body weight of straightbred and crossbred Kedah-Kelantan cattle

(Corak pertumbuhan berat badan lembu Kedah-Kelantan tulen dan kacukannya)

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Key words: growth, body weight, Kedah-Kelantan, beef cattle

### Abstrak

Data berat badan 1 018 ekor lembu Kedah-Kelantan (KK) tulen dan kacukannya Hereford-KK (HK), Brahman-KK (BK) dan Friesian-KK (FK) daripada umur 12 bulan hingga dewasa telah digunakan untuk menilai perbezaan berat badan sebelum matang, berat matang dan kadar kematangan antara jenis baka. Perbezaan yang besar dikesan pada berat badan baka-baka tersebut pada umur 12 bulan, 24–48 bulan dan peringkat matang. Kacukan KK lebih berat daripada KK tulen pada semua berat badan yang dikaji. Berat matang HK, BK, FK dan KK tulen masing-masing 333.3, 316.5, 320.9 dan 227.8 kg. KK tulen dan kacukan BK lebih cepat matang (0.0428 hingga 0.0523) daripada kacukan HK dan FK (0.0366 hingga 0.0376). Dirumuskan bahawa jenis baka yang mencapai berat matang yang lebih tinggi didapati matang lebih perlahan daripada yang mempunyai berat matang yang lebih rendah.

### Abstract

Body weight data from 12 months of age to maturity of 1 018 straightbred Kedah-Kelantan (KK) cattle and Hereford-KK (HK), Brahman-KK (BK) and Friesian-KK (FK) crosses were utilised to examine breedtype differences in weight at immature ages, mature weight and rate of maturing. Large differences in body weight at yearling, 24–48 months and at maturity were detected among the breedtypes. Crossbreds were significantly heavier than straightbred KK in all body weights studied. Mature weight for HK, BK, FK crosses and KK cattle were 333.3, 316.5, 320.9 and 227.8 kg respectively. KK cattle and BK crosses were faster maturing (0.0428 to 0.0523) than HK and FK crosses (0.0366 to 0.0376). It was concluded that breedtypes which had higher weights at maturity tended to be slower maturing than those with lower mature weights.

### Introduction

Attempting to fit the appropriate genotypes to specific nutritional environments would seem to be a reasonable pursuit to follow in any production environment. In the tropics, the interaction of nutritional limitation and

breedtype incompatibility is perhaps the most important obstacle restricting an efficient beef production. Of particular interest in breedtype differences in the primary traits for beef production is the variability in mature size for body weight

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because of its direct relationship with rate of maturing, body size at immature ages, growth rate and energy requirements for maintenance and growth (Cartwright 1979). Cost of maintaining adult cows is especially important since it forms a major proportion of the total cost of production in any beef operation. Thus, mature weight is an important indicator of the extent of growth rate potential among breeds and it also relates to the potential maintenance upkeep of the beef herds.

There is a dearth of information on breedtype differences in mature size and maturing pattern of tropical breeds of cattle raised in the hot and humid region. Many of the reports on mature weights of beef cattle breeds have been confined to temperate and Zebu-type cattle managed in temperate or semi-tropical environments. Brown et al. (1976) and Smith et al. (1976) reported on maturing patterns of temperate breeds such as Hereford and Angus cattle, and concluded that breeds which grew to heavier mature weight tended to be slower maturing than breeds of lighter mature weight. Therefore, it is the objective of this paper to describe the growth pattern and mature size for body weight of straightbred KK cattle and KK crosses raised in a humid environment of the tropics.

## Materials and methods

### Data

Body weight records of 1 018 straightbred Kedah-Kelantan (KK) and  $F_1$  crossbred KK females were obtained from a beef cattle crossbreeding project conducted at Livestock Research Centre, MARDI Kluang, Johor. Two 90-day restricted breeding seasons were practised for each year of mating from 1978 to 1983. Straightbred KK cattle were produced from the natural mating of KK bulls to KK cows. For each year of mating, approximately 100 KK cows were used to produce straightbred KK calves. Four KK bulls were utilised in two consecutive breeding seasons for each year of mating in the KK herd after which the

bulls were removed from the herd. Brahman-KK (BK) calves were produced through the natural mating of approximately 120 KK cows to 11 Brahman bulls. The Brahman bulls were derived from a straightbred Brahman herd originated from an initial importation of 14 cows and five bulls from the southern part of United States in 1972. Both the Hereford-KK (HK) and Friesian-KK (FK) calves were produced by artificial insemination method using frozen semen. Semen from a total of eight Hereford bulls and 10 Friesian bulls purchased from the United States were used to produce the HK and FK calves over the 1978 to 1983 mating periods. The calves were born from 1979 to 1984. Number of records per breedtype were 104 for HK, 293 for BK, 100 for FK and 521 for KK. Body weight measurement was taken at 3-month intervals following birth. All calves were born in the grazing paddocks and were herded into the yard within 24 h of birth for assignment of identification number, tattooing, navel treatment and measurement of body weight at birth. Calves were weaned from their dams when they reached 7 months of age. Weaned calves were separated by sex and raised in different paddocks away from their dams. Only body weight data of females were included in this study since the females were kept longer in the herd than males. Fluctuation in body weight due to gestation and calving was deemed to have averaged out among the cows in the herd across all the years considered in this study.

The animals were raised on improved pasture of *Setaria kazangula* and *Brachiaria decumbens* grasses fertilized annually with 100 kg nitrogen, 80 kg phosphorus and 80 kg potassium in two instalments. Concentrate feed supplement namely palm kernel cake (gross energy 17.3 MJ/kg and crude protein 16%), was provided to cows at approximately 1 kg/head daily for 1 month prior to the breeding season. Mineral supplements in the form of mineral salt blocks were made available to the animals throughout the year. Shade was provided in

the open pasture by shade trees. Water was made available from natural streams.

### Growth function

Size and age relationship was represented by the general form of Richards function (Richards 1959) which describes the change in size  $Y_t$  with the change in age,  $t$ :  $Y_t = A(1 - Be^{-kt})^m$  where  $A$  is the asymptotic value for size as  $t$  approaches infinity (mature size),  $B$  is a constant of integration which is established by the initial values of  $Y_0$  and  $t_0$ ,  $k$  is a function of the ratio of growth rate to mature size, commonly referred to as a maturing rate and  $m$  is the inflection parameter which establishes the degree of maturity at the point of inflection. In this study, size was represented by body weight. Brown et al. (1976) concluded that for describing the weight-age relationship at ages after the point of inflection, Brody's equation (Brody 1945) gave as good a fit as Richards' equation and furthermore it has the advantage of easier computation of the estimates of the parameters. In this study, the parameters of  $A$  and  $k$  were the important variables examined and they are based on estimates from Brody's growth function.

### Statistical analysis

Least squares analyses of body weight data for unequal sub-class numbers were performed using the GLM procedure of SAS (SAS Institute Inc. 1982). A general model used to analyse the body weight data was

$$Y_{ijk} = u + B_i + T_j + (BT)_{ij} + E_{ijk}$$

where  $Y_{ijk}$  = observation of the  $k$ th individual born in the  $j$ th year of the  $i$ th breed type

$B_i$  = fixed effect of the  $i$ th breed type

$i$  = 1, ..., 4

$T_j$  = fixed effect of the  $j$ th year of birth

$j$  = '79, ..., '84

$(BT)_{ij}$  = interaction effect

$E_{ijk}$  = random errors, assumed to be NID (0,  $\sigma^2e$ )

Estimates of rate of maturing ( $k$ ) and mature weight ( $A$ ) were obtained by fitting Brody's growth function of  $Y_t = A(1 - Be^{-kt})$  using the method of Marquandt of the non-linear regression procedure of SAS (SAS Institute Inc. 1982). The growth model was adequately tested by examining the asymptotic correlation matrix of the parameters of  $k$  and  $A$ . For all breed types, the correlation coefficients of  $k$  and  $A$  were within an acceptable range ( $-0.83$  to  $-0.71$ ) and conformed to the practical interpretation of the relationship of the two parameters (Brown et al. 1976).

### Results

Results from the analyses of variance, degree of freedom, residual mean squares, coefficient of determination and tests of significance for body weight are presented in *Table 1*. Breed type was significant for all body weights. Year of birth was significant for body weight from 12 to 48 months of age.

Least square means for body weight at immature ages from 12 to 48 months of age are presented in *Table 2*. HK, BK and FK crossbreds were heavier ( $p < 0.05$ ) at yearling and at ages after 24 months of age than purebred KK cattle. The KK crossbreds were heavier than purebred KK by 21.3–70.6% for yearling weight. For body weight at 12 months of age, BK crossbreds were the heaviest and differed ( $p < 0.05$ ) from HK and FK crosses. The trend in the ranking of the breed types for body weight at 24 months of age and older was similar to that for yearling body weight. However, there were smaller differences among the crossbreds for body weight at 24 months of age and older than the differences at yearling.

Differences in mature weight, defined as the asymptotic weight, were present among straightbred KK cattle and crosses of KK with Hereford, Brahman and Friesian (*Table 3*). Crosses of HK, BK and FK were heavier ( $p < 0.05$ ) at maturity than straightbred KK. Mature weight of the KK

Table 1. Analyses of variance for body weight at 12 to 48 months of age

Source	df	Age (months)			
		12	24	36	48
Breed type	3	**	**	**	**
Year of birth	4	*	**	**	**
Breed type x year of birth	12	*	*	**	*
Residual	923				
Residual mean squares		2 163.25	2 000.34	1 823.91	1 522.47
$R^2$		0.75	0.71	0.87	0.87

\*\* $p < 0.01$ \* $p < 0.05$ 

Table 2. Breedtype least square means for body weight at 12–48 months of age for Kedah-Kelantan and their crosses

Breed type	Age (months)			
	12	24	36	48
Kedah-Kelantan (KK)	101.0a ± 5.5	136.2a ± 7.1	175.8a ± 6.3	197.4a ± 6.5
Hereford-KK (HK)	122.6b ± 4.9	161.7b ± 9.2	219.3b ± 10.1	252.2b ± 9.2
Brahman-KK (BK)	172.3c ± 8.7	185.4b ± 5.5	240.8b ± 8.8	261.8c ± 6.2
Friesian-KK (FK)	136.6b ± 8.7	175.3b ± 8.2	235.5b ± 8.7	253.0b ± 6.2

Mean values in each column with different letters are different ( $p < 0.05$ )

Table 3. Mean mature weight and mean rate of maturing for straightbred and crossbred Kedah-Kelantan cows based on Brody's growth function

Breed type	Mature weight (kg)	Rate of maturing
Kedah-Kelantan (KK)	227.8a ± 2.30	0.0523a ± 0.0037
Hereford-KK (HK)	333.3b ± 7.86	0.0366b ± 0.0029
Brahman-KK (BK)	316.5b ± 4.02	0.0428c ± 0.0018
Friesian-KK (FK)	320.9b ± 9.43	0.0376b ± 0.0034

Mean values in each column with different letters are different ( $p < 0.05$ )

crosses was heavier than the straightbred KK and ranged from 38.9% in the BK crosses to 46.3% in the HK crosses. The difference between the straightbred KK and Zebu breedtype-based crosses, namely BK crosses, was smaller compared with the difference between straightbred KK cows and crosses of KK with the temperate breeds or *Bos taurus*-based crosses, such as the HK and FK crosses. However, crosses of KK cattle with Hereford, Brahman and Friesian breeds did not reveal significant differences in mature size for body weight. *Bos taurus* crosses tended to grow to heavier mature weight (320.9 kg for FK and 333.3 kg for

HK) than Zebu crosses (316.5 kg for BK) and purebred KK cattle (227.8 kg).

At 12 months of age, KK and BK calves reached a higher proportion of their mature weights (44% and 54% respectively) than the HK and FK (37% and 42% respectively). A similar trend was observed at 24 months of age and older among the breedtypes studied.

The magnitude of the rate of maturing ranged from 0.0366 in the HK crosses to 0.0523 for straightbred KK cattle (Table 3). Differences among breedtypes were significant ( $p < 0.01$ ) in affecting the variability of maturing rate. KK cattle was

the fastest maturing breedtype among the four genotypes evaluated. HK and FK crosses were the slower maturing genotypes compared with BK and KK cattle. The maturing rates of the three crossbreds were significantly different from that of the KK cattle, whereas among the crossbreds the two *Bos taurus*-KK crosses, namely HK and FK crosses, were slower maturing ( $p < 0.05$ ) than the BK crosses.

### Discussion

Body weight or size at maturity can be defined as the body weight attained when lean tissue increment ceases and fat deposition begins to build up. The KK cattle tended to attain their mature size for weight at an earlier age than the KK crosses. The KK cattle is an example of a biological type whose mature weight is among the lowest when compared with other breeds of cattle found in the different geographical regions of the world. Traditional animal husbandry practices adopted by producers of KK cattle have always emphasised on low cost inputs. Thus, the breedtype has to survive on feedstuffs of poor quality and of irregular supply. In the realm of such adversity, a small mature body size would certainly have an advantage in meeting the stresses of physiological and maintenance demands. Indirectly, the KK cattle has been selected for low maintenance requirement with small frame size and lower mature weight.

Previous reports on the mature weights of KK cows were lower than the present report of 220.7 kg. Devendra et al. (1973) reported KK cows reached mature weight of 173.7 kg at 3–4 years of age and Ahmad et al. (1978) reported mature weight of KK cows of 211.5 kg from a different group of KK cows managed on improved pasture. The advantage of a small size cow can be found in complementary crossbreeding in which specialised dam lines of smaller size relative to potential genetic size of progeny reduce maintenance cost per unit of progeny marketed (Cartwright et al. 1975).

Purebred performance is a function of the direct and maternal additive effects. A breedtype such as the Friesian that has been selected in the past for milk yield and size tended to transmit these characteristics of higher milk production and heavier weight at all ages to its crosses as found for body weight of FK crossbreds in this study. The Brahman is one of the larger breeds of cattle developed in the United States by combining the three well known Indian breeds of cattle namely, Guzerat, Gir and Nellore (Sanders 1980). The superiority of the Brahman breedtype for body weight was reflected in the growth pattern of the BK crosses which showed the heaviest weights at weaning and yearling.

The Hereford semen used in this study to produce HK crosses was acquired from the United States. Straightbred Hereford cattle was reported to weigh 481 kg at maturity (Smith et al. 1976). The mature weight of 333.3 kg for the HK crosses was intermediate between the mean values of their two parental breeds. In a study involving the crossing of Holstein Friesian, Brahman and Hereford sires to Hereford and Angus dams, Ariff (1984) reported the ranking of the straightbreds for mature weight was Holstein-Friesian, Brahman and Hereford with estimates of 517.7, 500.2 and 461.6 kg respectively. The ranking of the crossbreds for mature weight resulting from the crossing of these straightbreds followed the ranking for mature weight of their parental sire breeds. However in this study, the ranking of the crossbreds for mature weight was HK, FK and BK followed by the purebred KK. The differences in body size between crossbreds in a similar nutritional environment could possibly be due to the level of hybrid vigour. The magnitude of heterotic expression or hybrid vigour is postulated to be controlled by dominance and non-additive gene interactions and genetic distance between the parental populations making up the crosses. In crosses such as the BK which involved the crossing of two *Bos indicus* breeds, the level

of heterosis would be expected to be lower than those shown by *Bos indicus* x *Bos taurus* crosses as shown by HK and FK. Differences in mature weight among breedtypes could also be attributed to the differences in additive breed effects arising from differences in frequency of genes controlling the expression of body size. Parental breeds of crosses known for their large mature sizes, such as Holstein and possibly Brahman, tended to produce progenies which grew to larger size at maturity.

The straightbred KK and BK crosses were earlier maturing than HK and FK crosses which could be attributed to the magnitude of their mature weight. The breedtypes which grew to heavier weight at maturity tended to be slower maturing than those with lighter mature weight. Taylor and Fitzhugh (1971) concluded that, within a breedtype, animals genetically heavier at maturity tended to be slower maturing. Differences in rate of maturing would also reflect variation in age at puberty (Smith et al. 1976) and the latter trait is important as it determines the life time productivity of a cow.

### Conclusion

Large differences for body weight at immature ages and maturity were detected among KK crosses and straightbred KK cattle in this study. Differences in rate of maturing among the breedtypes studied would indicate the contributory effect of average breed differences and heterosis in reducing maturing rate in crosses between the local KK cattle and exotic breeds and this phenomenon was seen to be better expressed when *Bos taurus* breeds were used as sire breeds on KK cows. Therefore, the contribution of the parental sire breeds in crosses involving the local KK cattle is significant and should be a factor to be considered seriously in combining breeds for efficient beef production in the tropics,

especially when the breeding objective is to improve mature size of the local cattle.

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