# Characterization of beef cattle breeds by virtue of their performances in the National Beef Cattle Performance and Progeny Testing Scheme

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Average growth and body weight data, which comprised 745 400 weaning records and 14 990 Phase C growth records of young bulls of 16 breeds were obtained from the National Beef Cattle Performance and Progeny Testing Scheme and used in this re-analysis to characterize breeds for a variety of important traits. Phenotypically, mature breed size ($X$) was found to be significantly related to birth weight ($Y = 2.85 + 0.066X$), weaning weight ($Y = 25.8 + 0.369X$) and growth rate ($Y = 320 + 2.28X$). Nevertheless, some breeds deviate considerably from their predicted values. Productive efficiency was, however, unrelated to mature breed size and dual-purpose breeds tended to be the most efficient. They were also the breeds showing the highest degree of sexual dimorphism.

Gemiddelde groei- en liggaamsgewigdata, wat 745 400 speenrekords en 14 990 Fase C groeirekords van jong bulle ingesluit het, is van 16 rasse van die Nasionale Vleisbeesprestasie- en Nageslagstoetsskema verkry en herontleed ten einde die rasse vir 'n verskeidenheid van belangrike eienskappe te karakteriseer. Daar is aangedui dat geboortegewig ($Y = 2.85 + 0.066X$), speengewig ($Y = 25.8 + 0.369X$) en groeitempo ($Y = 320 + 2.28X$) fenotipies betekenisvol met ras volwasse gewig verband hou. Tog wyk 'n aantal rasse aansienlik van hulle voorspelde waardes af. Produksiedoeltreffendheid is egter onafhanklik van ras volwasse grootte en dubbeldoel rasse het geneig om die doeltreffendste te wees. Dit was ook die rasse wat die hoogste mate van geslagtelike dimorfisme getoon het.

**Keywords:** Beef cattle, breeds, characterization, growth, productive efficiency

## Introduction

There is a large variety of beef cattle breeds in South Africa (*circa* 30). They vary considerably for a variety of traits, e.g. fertility, growth rate, milk production and size.

Changes in some traits can be brought about more effectively by selection between breeds than by within-breed selection. Breed characterization is therefore essential for selection among breeds for their effective use in either straight breeding or crossbreeding programmes. Considerable effort has already been devoted to breed characterization in other countries, especially in the United States (Laster *et al.*, 1976; Smith *et al.*, 1976).

There are basically two methods of characterization of breeds. One is by directly comparing several breeds under the same but varying environmental conditions (Thiessen *et al.*, 1984; Hetzel, 1988; Schoeman, 1989; Morris *et al.*, 1993; Jenkins & Ferrell, 1994). However, this is very costly and not always possible. The other is through crossbreeding and the estimation of crossbreeding parameters (viz. direct, maternal en heterotic effects) under different environmental conditions (Alenda *et al.*, 1980; Dillard *et al.*, 1980; Robison *et al.*, 1981; Schoeman *et al.*, 1993). By doing this, breeds can *inter alia* also be characterized as sire or dam lines for specific environments.

The purpose of this report is to rank the most numerous beef cattle breeds which took part in the National Beef Cattle Performance and Progeny Testing Scheme for individual growth traits and some productivity and efficiency indices. Data from Progress Reports of the Scheme were re-analysed for this investigation. Some authors (Brown & Dinkel, 1982; McMorris & Wilton, 1986) hold the belief that differences between breeds are strongly related to differences in mature breed size and that almost no differences in biological efficiency exist between breeds. Although the data of the scheme are subjected to criticism, the scheme nevertheless provides a useful source of information for breed comparison purposes. One point of criticism is that it does not take into account the effect of differences in production environments and management levels. In South Africa, however, lack of funds prohibits expensive breed comparison on a variety of production environments, thus leaving us with the data of the National Beef Cattle Performance and Progeny Scheme as the only data source for breed characterization purposes. It is furthermore believed that herds in all breeds are to a large degree subjected to differences in production environments and management levels, consequently cancelling some breed biases owing to environment. It is therefore assumed that breed averages reflect to a large degree true breed effects.

## Materials and Methods

Breed average values were obtained from the 1980 to 1985 and 1986 to 1993 reports of the National Beef Cattle Performance and Progeny Testing Scheme, respectively. These two averages per breed were then pooled by calculating weighted averages per breed for a number of traits. These included 745400 weaning records and 14990 Phase C records of young growing bulls of the 16 most prominent breeds taking part in the Scheme. The first were recorded on the cow herd by breeders on the farm, while the latter were derived from central testing centre data. For the Phase C, only those evaluated over the 140-day period were included in the analysis.

The operation of the National Beef Cattle Performance and Progeny Testing Scheme will not be discussed here. For more detail, Anon (1986) or Bergh (1990) could be consulted. Simple correlation and regression procedures were calculated for a variety of traits. Since only breed averages could be estimated, valid tests for statistical significance between breeds were not possible.

## Results and Discussion

### Birth weight

Average between-breed birth weight was 35.9 kg and it varied from 27 kg for the Nguni to 41 kg for the Charolais and South Devon (Table 1). Breed average birth weights are highly correlated with average breed mature size, as estimated by dam weight at weaning (Figure 1).

Points-of-breed-means above the line indicate breeds with higher relative birth weights, while points below the line indicate breeds with lower relative birth weights. The South Devon produced calves which weighed 6.3% more than their predicted value, while the Sussex produced calves which weighed 8.4% less than their predicted value.

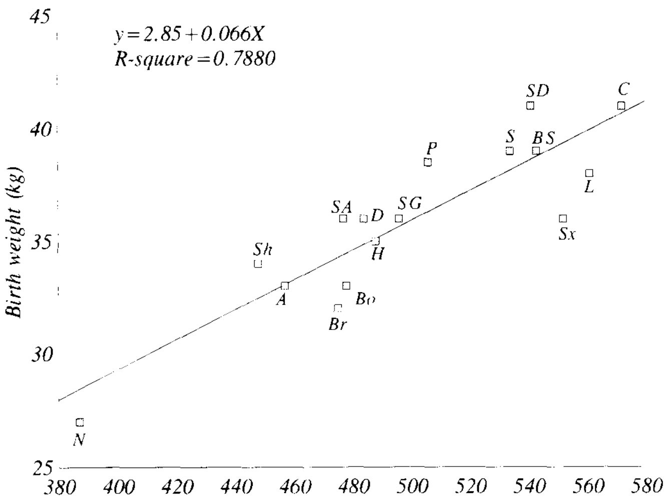


**Figure 1** Regression of breed birth weight on dam weight at weaning (breed mature weight). For breed abbreviations, see Table 1.

The lower than predicted value of the Brahman (6.8%) may be due to a negative maternal effect which restricts birth weight (Cartwright, 1973; Roberson *et al.*, 1986; Comerford *et al.*, 1987; Tawonezvi *et al.*, 1988). A more favourable birth to weaning weight ratio for Simmentaler calves compared to higher ratios for Charolais and Hereford sires, led Paterson *et al.* (1980) to believe that it might be possible to select sire breeds to produce fast-growing calves with low birth weights. This 'favourable ratio' is more likely the result of a high weaning weight in Simmentalers owing to their high milk production, than to a restricted birth weight. One would expect those breeds with birth weights higher than their respective predicted values to be inclined to more dystocia problems compared to those with birth weights lower than their predicted values.

### Weaning weight and pre-weaning growth rate

Breed average weaning weight varied from 161 kg for the Nguni to 235 kg for the Charolais and Simmentaler (Table 1). The Angus, Hereford and Sussex produced calves which weighed 8.4%, 5.3% and 6.8% less, while the Santa Gertrudis and Simmentaler produced calves which weighed 6.3% and 5.9% respectively more than their predicted weaning weights (Figure 2). This may be the result of between-breed differences in milk production. It is known that the Hereford is a low milk producing breed (Reyneke & Bonsma, 1964; Jenkins & Ferrell, 1992). All dual-purpose breeds, except the South Devon, produced calves heavier than their respective predicted weaning weights.

Simmentaler and Charolais produced the fastest growing calves. Breeds which rank high for mature size, are also high ranking for pre-weaning growth rate ($Y$ = 97.5 + 1.510$X$; $r^2$ =

**Table 1** Breed group means for body weight at birth (BW), weaning (WW), dam weight at weaning (CW), actual growth rates and relative growth rates (RGR)

| Breed | Breed abbreviation | $n$* | BW (kg) | WW (kg) | Pre-weaning ADG[1] (g) | ADA[2] of heifers 365d (g) | ADA[2] of heifers 540d(g) | CW (kg) | Pre-weaning RGR[3]x100 | Post-weaning RGR[3] x 100 | Pre-weaning RGR/ Post-weaning RGR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Afrikaner | A | 38391 | 33 | 178 | 707 | 478 | 458 | 457 | 0.95 | 0.0985 | 9.6 |
| Bonsmara | Bo | 397477 | 36 | 206 | 832 | 565 | 518 | 477 | 0.99 | 0.0895 | 11.1 |
| Brahman | Br | 57722 | 32 | 205 | 840 | 620 | 549 | 475 | 1.05 | 0.1104 | 9.5 |
| Brown Swiss | BS | 1496 | 39 | 230 | 921 | 661 | 606 | 543 | 1.00 | 0.1045 | 9.6 |
| Charolais | C | 4412 | 41 | 236 | 957 | 743 | 671 | 572 | 0.99 | 0.1284 | 7.7 |
| Drakens berger | D | 56976 | 36 | 204 | 825 | 542 | 507 | 484 | 0.98 | 0.0866 | 11.3 |
| Hereford | H | 25295 | 35 | 195 | 784 | 606 | 534 | 488 | 0.97 | 0.2985 | 3.2 |
| Limousin | L | 1143 | 38 | 225 | 914 | 720 | 651 | 561 | 1.01 | 0.1313 | 7.7 |
| Nguni | N | 16609 | 27 | 161 | 648 | 414 | 401 | 387 | 1.01 | 0.0895 | 9.7 |
| Pinzgauer | P | 5373 | 38 | 219 | 882 | 608 | 531 | 506 | 0.98 | 0.0806 | 10.5 |
| Angus | SA | 20082 | 33 | 206 | 845 | 627 | 570 | 478 | 1.04 | 0.1194 | 7.4 |
| Santa Gertrudis | SG | 32337 | 36 | 222 | 913 | 682 | 611 | 496 | 1.03 | 0.1194 | 6.8 |
| Shorthorn | Sh | 5861 | 34 | 203 | 830 | 573 | 513 | 448 | 1.01 | 0.0925 | 9.4 |
| Simmentaler | S | 53788 | 39 | 236 | 965 | 709 | 616 | 534 | 1.02 | 0.1045 | 7.9 |
| South Devon | SD | 9159 | 41 | 224 | 902 | 645 | 601 | 541 | 0.96 | 0.1104 | 7.7 |
| Sussex | Sx | 19279 | 36 | 214 | 875 | 643 | 591 | 552 | 1.01 | 0.1194 | 7.4 |
| Total/Average | | 745400 | 35.9 | 210 | 853 | 615 | 558 | 500 | | | |

*Number of weaning records; [1]ADG (205d age adjusted weight – birth weight)/205; [2]ADA = (Age adjusted weight – birth weight)/age; [3]RGR = lnW2 - lnW1/ t2-t1 (Fitzhugh & Taylor, 1971)

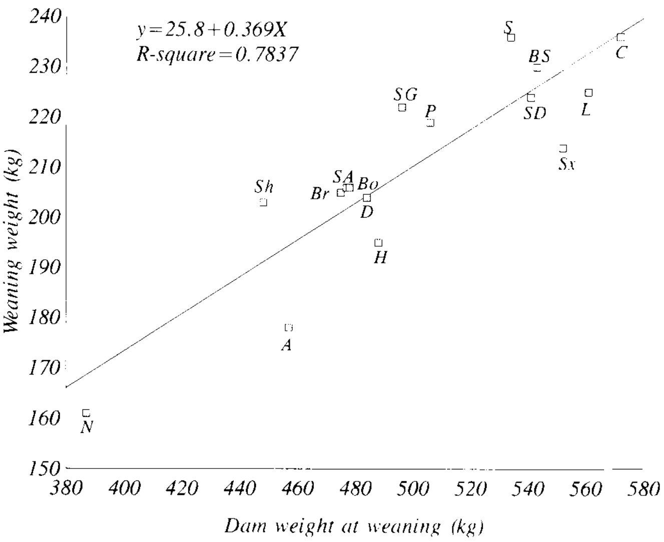


**Figure 2** Regression of breed weaning weight on breed mature weight.

0.746). Pre-weaning efficiency on the other hand, which was defined as pre-weaning ADG/$CW^{0.75}$, was unaffected by mature size (Figure 3). The Shorthorn, Santa Gertrudis and Simmentaler had the highest efficiences, while the Afrikaner, Nguni, Hereford and Sussex were the least efficient breeds.

## Post-weaning growth rate

Average daily gain (ADG) of young bulls in the feedlot (Table 2) was also correlated with mature cow size (Figure 4). Afrikaner (-12.2%), Brahman (-14.5%) and Limousin (-7.0%) performed more poorly than predicted values. The Angus (15.5%) and Simmentaler (13.8%) on the other hand were, compared to their predicted values, the best performing breeds.

Breed group rankings were fairly similar for 540 days ADA of heifers and ADG of bulls in the feedlot ($r$ = 0.728). The correlation between ADG of bulls under feedlot conditions and mature cow weight was 0.686. The same applied to the correlation between pre-weaning ADG and post-weaning ADG of heifers ($r$ = 0.732). In the case of the first, there are a few noteworthy exceptions. The Limousin ranked 2nd for 540-d ADA, but 12th for ADG, while the Pinzgauer ranked 11th for 540-d ADA but 5th for ADG and the Sussex 7th for 540-d ADA and 11th for ADG. Theron *et al.* (1994) indicated the possibility that ADG of bulls under feedlot conditions is probably genetically independent of the same trait in heifers/cows under pasture conditions, where 540-d ADA and cow weight were recorded. That would mean that those breeds of which the bulls grow rapidly under feedlot conditions, but whose heifers grow more slowly under pasture conditions, would most likely be those to select for as

**Table 2** Breed group means for body weight, growth rate (ADG) and feed conversion efficiency (FCE) of young bulls

| Breed | n | Final weight (kg) | ADG g/day | FCE g/kg feed |
|---|---|---|---|---|
| Afrikaner | 489 | 396 | 1196 | 132 |
| Bonsmara | 4988 | 483 | 1534 | 145 |
| Brahman | 1070 | 431 | 1200 | 142 |
| Brown Swiss | 76 | 541 | 1674 | 141 |
| Charolais | 210 | 561 | 1815 | 154 |
| Drakensberger | 520 | 464 | 1435 | 138 |
| Hereford | 928 | 481 | 1554 | 148 |
| Limousin | 113 | 481 | 1450 | 142 |
| Nguni | 344 | 353 | 1167 | 141 |
| Pinzgauer | 535 | 534 | 1637 | 143 |
| Angus | 852 | 482 | 1629 | 145 |
| Santa Gertrudis | 1142 | 506 | 1626 | 148 |
| Shorthorn | 200 | 470 | 1538 | 139 |
| Simmentaler | 2387 | 553 | 1751 | 146 |
| South Devon | 526 | 550 | 1733 | 151 |
| Sussex | 610 | 466 | 1521 | 147 |
| Total/Average | 14990 | 485 | 1529 | 144 |

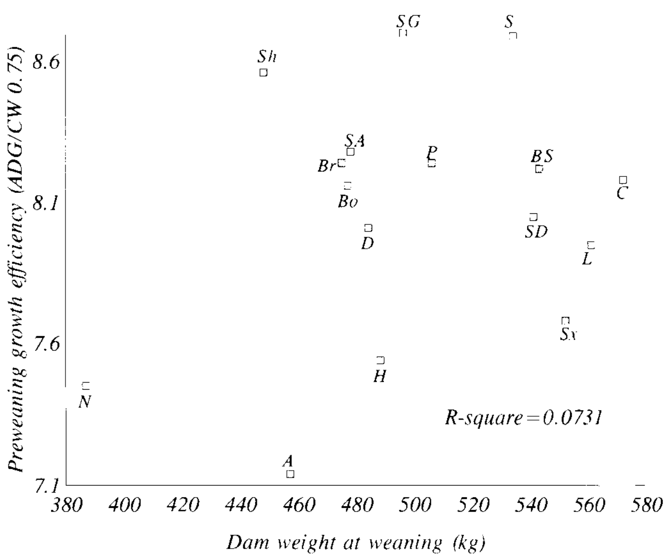


**Figure 3** Relationship between breed mature weight and breed pre-weaning growth efficiency.

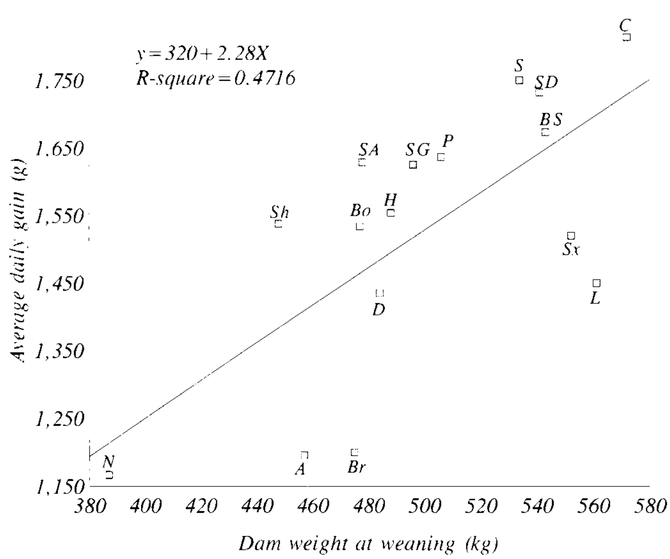


**Figure 4** Regression of Phase C average daily gain (ADG) on breed mature weight of cows.

sire lines for the production of feedlot calves, despite the mature size of the breed.

Although the rankings of breeds were fairly similar for actual growth rate between the pre- and post-weaning phases, it was not the case for relative growth rate (RGR) ($r = -0.166$). Laster *et al.* (1976) reported that breeds which ranked high for pre-weaning RGR, but low for post-weaning RGR, tended to reach puberty earlier. The ratios of pre-weaning RGR/post-weaning RGR were estimated (Table 1) and varied from 3.2 for the Hereford to 11.3 for the Drakensberger. If the finding of Laster *et al.* is true, it would mean that the Hereford is sexually very early maturing and that the Drakensberger is the latest maturing breed. This ratio was, however, not significantly correlated ($r = 0.346$) to age at first calving.

## Productive efficiency

Cow productive efficiency was defined as (Calf WW/$CW^{0.75}$) × Calving rate. Across breeds the average of this index was 1.68. The Afrikaner has the lowest and the Shorthorn the highest efficiencies. Efficiency was furthermore independent of breed mature size (Figure 5). The Shorthorn, Angus and Simmentaler were the most efficient breeds, while the Afrikaner was the least efficient breed. Calving rate, which is an important part of the productive efficiency index, varied from 0.76 (Afrikaner) to 0.88 (Angus). Contrary to what was found by Roux & Scholtz (1984), calving rate was related neither to cow mature weight ($r = -0.145$), nor to weight of bulls at the end of the Phase C test ($r = -0.096$).

Ratios of calf weight to cow weight (CW) or to cow metabolic weight ($CW^{0.75}$) have often been used as estimators of efficiency. Dinkel & Brown (1978) were of the opinion that this tends to bias these ratios in favour of smaller cows. In this study, efficiency was independent of breed mature size. Smaller breeds were not more efficient than larger breeds. This is also contrary to what was found at the Omatjenne Research Station, where the Nguni was found to be the most efficient (Schoeman, 1989).

Roux (1992) illustrated the importance of sexual dimorphism as far as herd efficiency is concerned and calculated fairly large differences in sexual dimorphism between breeds. In this study, sexual dimorphism was calculated as the end of Phase C test body weight (approx. 430 days of age) of bulls/mature body weight of cows at weaning of their calves. Sexual dimorphism values then varied from 0.86 to 1.06, a difference of 23.3%. Breed productive efficiency was significantly ($p \leq 0.01$) influenced by breed sexual dimorphism (Figure 6). It is interesting that the dual-purpose breeds, *viz.* the Simmentaler, Shorthorn and Pinzgauer ranked higher for both efficiency and sexual dimorphism. This may be the result of both a high direct effect (growth rate) and a high maternal effect (milk production) of dams of these breeds.

## General

The profitability of a beef enterprise depends on two major components, *viz.* a productivity (growth) and a maternal component (reproduction and milk production). These data also demonstrated that there are important differences in individual traits and efficiency among breeds. Ranking of breeds may be totally different for different traits.

Body weight at any stage as well as weight gain is strongly related to breed mature size as estimated by dam weight at weaning. There are exceptions, however. The Charolais is the fastest growing breed with the highest mature size. However, it ranked just above average for pre-weaning growth efficiency and on average for productive efficiency. The Afrikaner ranked lowest for almost all traits. The Simmentaler, on the other hand, is amongst the highest ranking breeds for all traits. It makes this breed a logical choice as a terminal sire line but most likely also as a dam line under very favourable conditions. Choice of breeds for any production system (e.g. crossbreeding) within a specific environment should therefore be considered with great caution.

Initially evidence was provided by several researchers (Klosterman & Parker, 1976; Brown & Dinkel, 1982; McMorris & Wilton, 1986) suggesting that breeds are very similar in biological efficiency. Evidence suggesting the contrary was, however, provided later on by Ferrell & Jenkins, 1984; Green *et al.*, 1991; Jenkins *et al.*, 1991; Brown *et al.*, 1993; Morris *et al.*, 1993 and Jenkins & Ferrell, 1994. These results provided evidence of changing breed group rankings in different environments. This probably explains the conflicting results in this regard. This genotype × environmental interaction gives effect to the perception

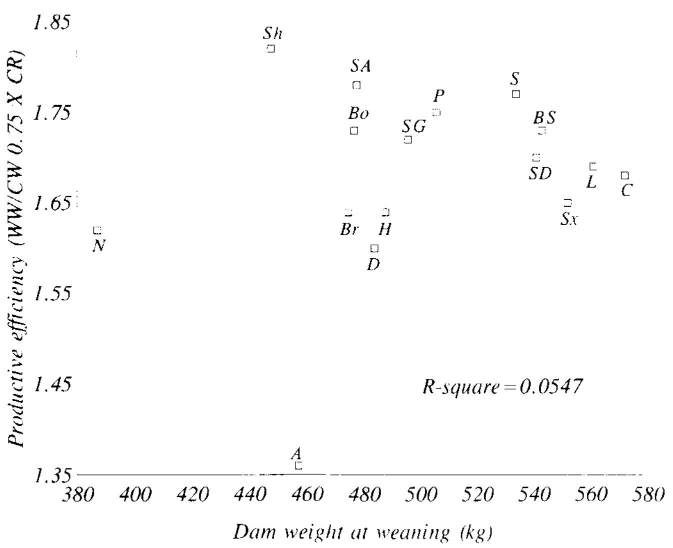


**Figure 5** Relationship between breed mature weight and breed productive efficiency.

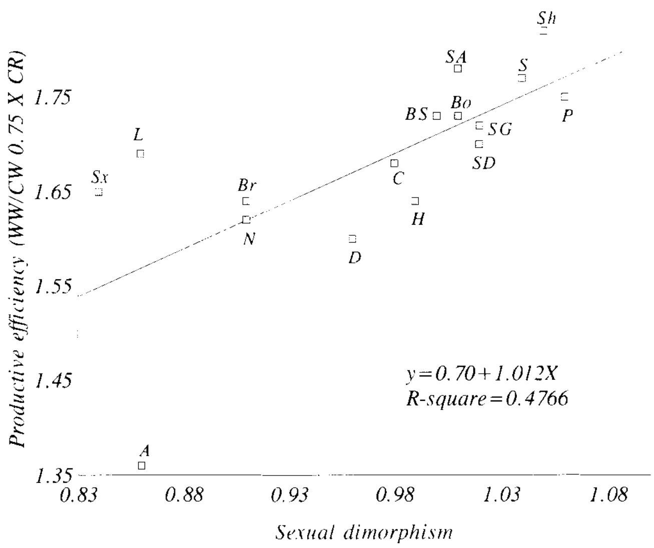


**Figure 6** Regression of breed productive efficiency on degree of sexual dimorphism.

that there is no single 'best breed' for all environments. Large European type breeds (e.g. Simmentaler and Charolais) normally tend to have reduced performances under less favourable conditions such as reduced dry matter intakes. In this study, breeds were expected to produce under a large variety of environmental conditions. One may, however, accept that in most cases management levels were fairly favourable.

## Acknowledgement

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