

# Reproduction rate as a factor in meat production

A.W. Lishman

Department of Animal Science, University of Natal

A.G. Paterson

Production Division, Stockowners Co-op Ltd

S.M. Beghin

Cedara College of Agriculture and Research Station

The need to optimize rather than maximize rates of reproduction has been demonstrated for various production situations. In a highly intensive system, incorporating the use of artificial insemination, increasing the calving rate from 75 to 85% did not yield more saleable beef. Under ranching conditions, gross margins increased parallel with calving rate, but the margin per cow did not always follow this trend. In Sourveld areas it will probably not be profitable to improve calving rates by additional short-term feeding during winter. The negative effect on reproduction rate of over-emphasis on growth rate to weaning has been reviewed and the efficiency of various genotypes was evaluated for different environments.

*S. Afr. J. Anim. Sci.* 1984, 14: 164–168

Die behoefte om optimum eerder as maksimum reproduksie te verkry, is vir verskillende produksietoestande gedemonstreer. In 'n hoogsintensiewe stelsel wat die gebruik van kunsmatige inseminasie insluit, het 'n verhoging in die kalfpersentasie vanaf 75 na 85% nie 'n groter hoeveelheid verhandelbare vleis opgelewer nie. Onder ekstensiewe omstandighede het die bruto marge vermeerder met 'n verhoging in die kalfpersentasie, alhoewel die marge per koei nie deurgaans hierdie neiging gevolg het nie. In suurvelddele sal dit waarskynlik nie lonend wees om die kalfpersentasie te verbeter deur middel van bykomstige korttermynvoeding gedurende die winter nie. Die negatiewe invloed van 'n oorbeklemtoning van groeitempo tot speenouderdom op reproduksie en die doeltreffendheid van verskillende genotipes vir verskillende omgewings is bespreek.

*S. Afr. Tydskr. Veek.* 1984, 14: 164–168

**Keywords:** Reproduction, meat production

Presented at the Symposium on 'Intensive Red Meat Production' held during the 23rd Annual Congress of the South African Society of Animal Production, Ermelo, 11–13 April, 1984

**A.W. Lishman\***

Department of Animal Science, University of Natal, P.O. Box 375, Pietermaritzburg, 3200 Republic of South Africa

**A.G. Paterson**

Production Division, Stockowners Co-op Ltd, P.O. Box 260, Howick, 3290 Republic of South Africa

**S.M. Beghin**

Cedara College of Agriculture and Research Station, Private Bag X9050, Pietermaritzburg, 3200 Republic of South Africa

\*To whom correspondence should be addressed

## Introduction

For many years advisers to the animal industry have taken great pains to impress on producers the importance of reproductive rate. Many people have been convinced that the profitability of meat production is strongly dependent on the number of offspring raised to weaning as a proportion of the number of breeding units.

Minish & Fox (1982) have shown that the monetary return from the calves weaned per unit of improvement is twice as much as that from growth rate and 20 times that from carcass merit. Consequently, they believe, and so do many others, that female selection should lay great emphasis on reproductive efficiency. There are many ways of measuring the efficiency of an animal production system and some of these, as will be shown in this article, can be misleading.

The disturbing fact about reproductive rates is that as long ago as 1935 it was stated that in the prime ranching areas of the Northern Transvaal bushveld the calving percentage was between 35 and 50 (Le Roux, 1951). In spite of what farmers would like people to believe, the figure of 50–55% calving rate still appears to be far too common (Ronchietto, 1984; personal communication).

The foregoing begs the question 'Why do producers not find it to their advantage to maximize reproductive rates?' It could be because:

- (i) They are not aware of the need to do so. This seems highly unlikely in view of the considerable emphasis placed upon reproductive rates both in the press and at Farmers' days.
- (ii) It does not prove profitable under existing farming conditions. This must be viewed in the light of overstocking which occurs in many instances.
- (iii) Maximization of reproductive rate is counteracted by selection for some other trait of economic significance.

The second alternative implies that producers know something which the scientists do not. In fact, commonly held beliefs began to be questioned some 7 years ago when Steenkamp (1977) suggested that under extensive ranching conditions it was perhaps not profitable to operate at calving rates much above 50%.

The influence of calving rate and of weaning mass on the mass of beef produced per cow exposed to the bull is often represented as a simple linear response. The slope of the line and its intercept with the Y-axis then increases as the calving rate improves.

The question that needs to be asked is 'whether this situation is applicable when the profitability of the whole

enterprise is considered"? In addition, we need to question whether maximum calving rates and maximum weaning masses are independent?

### Procedure

An exercise to investigate how 2 400 weaners could be produced in the highly intensive system operating on the Johannesburg City Council Farms yielded some thought-provoking information.

The required number of calves could be produced in at least two ways, namely

System 1: 85% Conception-rate from AI followed by clean-up bulls.

Breeding cows = 2 400  
Replacement heifers = 424 (15% of 2 824)  
Total breeding females = 2 824

System 2: 75% Conception rate with AI only.

Breeding cows = 2 400  
Replacement heifers = 800 (25% of 3 200)  
Total breeding females = 3 200

The apparent reduction in number of breeding units and consequent saving in feed inputs with the higher calving rate does in fact not hold. The cow-herd size would be the same for both systems and there would be no saving in feed because the replacement heifers are drawn from the 1 200 heifers on the farm which have to be fed in any case. Because there is no saving in feed, there appears to be no benefit arising from the increased conception rate.

The additional implications of breeding 800 instead of 424 heifers are:

- (i) The average age of the breeding herd would be reduced with 68% of the breeding females, being less than sixth calvers in System 1 (85% conception) whereas in System 2, 87% occur in the same category. Obviously, the latter system favours early maturing types which are suited to a young average cow-age situation (Paterson, Venter & Harwin, 1980). With the younger average age of the herd having a conception rate of 75% it could be expected that their maintenance costs would be lower than where a greater proportion of mature cows occurred.
- (ii) With the large percentage of heifers in System 2 one would expect a lowered production of beef. The reduced weaning mass of calves from first-calvers (Table 1) is more than compensated for by the increased mass of cull cows slaughtered, relative to heifers (Table 2).

Therefore, there is a loss of 3 600 kg of live mass,

equivalent to a loss of 1 800 kg carcass mass at weaning, owing to a larger number of heifers bred.

The important point in this exercise is that it does not matter how many heifers are bred since the whole crop of 1 200 is fed in any case. Even though there would be no additional feed input it is still not economical to increase the conception rate above 75%.

If all surplus heifers were sold at weaning the comparison could have produced a different result. However, this practice is generally not encouraged because of the low profitability.

The hypothesis that has been tested here is supported by Klosterman (1981). He in fact suggested that heifers should be used to solve the reproductive problem in many beef herds. Such a procedure would be likely to reduce the costs of production for beef through a combination of reproduction with the growth of immature females.

The alternative of selling all excess progeny at the weaner stage, where no extra feed inputs are involved, was tested for an extensive ranching situation in the Zululand area of Natal.

A computer program has been developed to describe the production system and to evaluate the effect of changes in the system. In this operation the effect of varying the calving rate and of replacing *all* non-pregnant breeding units with heifers was evaluated (Table 3). For this exercise the calving rate refers to the breeding herd as a whole. It is assumed that the conception rate of heifers is the same as that of the herd as a whole. The replacement rate is taken to be the culling rate plus 5% to allow for deaths of mature cows and some small measure of culling on the basis of productive level (i.e.

**Table 1** Expected production at weaning from breeding herds containing 800 or 424 heifers and with 75 or 85% conception rates

|               | System 1 (424 heifers)    |          | System 2 (800 heifers)    |          | Total weaning mass (kg) |         |
|---------------|---------------------------|----------|---------------------------|----------|-------------------------|---------|
|               | Average weaning mass (kg) | <i>n</i> | Average weaning mass (kg) | <i>n</i> |                         |         |
| Heifer calves | 190                       | 360      | 68 400                    | 190      | 600                     | 114 000 |
| Cow calves    | 205                       | 2 040    | 418 200                   | 205      | 1 800                   | 369 000 |
| Total         | —                         | —        | 486 600                   | —        | —                       | 483 000 |

**Table 2** The advantage of selling heavier cull females in a system of 75% conception rate (CR) (System 1) versus 85% conception rate (System 2)

| Category            | System 1 (85% CR)         |                   |                         | System 2 (75% CR)         |                   |                         |
|---------------------|---------------------------|-------------------|-------------------------|---------------------------|-------------------|-------------------------|
|                     | Cull females ( <i>n</i> ) | Carcass mass (kg) | Total carcass mass (kg) | Cull females ( <i>n</i> ) | Carcass mass (kg) | Total carcass mass (kg) |
| Not-in-calf heifers | 64                        | 200               | 12 800                  | 200                       | 200               | 40 000                  |
| Not-in-calf cows    | 360                       | 250               | 90 000                  | 600                       | 250               | 150 000                 |
| Heifers not bred    | 776                       | 200               | 155 000                 | 400                       | 200               | 80 000                  |
| Total               | 1 200                     | —                 | 258 000                 | 1 200                     | —                 | 270 000                 |

**Table 3** Income (R) from a fixed area of 2 790 ha with different calving rates, ages and avenues of sale of stock from a ranch in Zululand

| Calving % | Cow herd size | 2,5-year-olds sold at:    |         |        |                           |         |        |                           |         |        |
|-----------|---------------|---------------------------|---------|--------|---------------------------|---------|--------|---------------------------|---------|--------|
|           |               | Weaners                   |         |        | Auction                   |         |        | Abattoir                  |         |        |
|           |               | Gross <sup>a</sup> margin | Per cow | Per FU | Gross <sup>a</sup> margin | Per cow | Per FU | Gross <sup>a</sup> margin | Per cow | Per FU |
| 75        | 425           | 67 515                    | 159     | 85     | 81 498                    | 256     | 102    | 64 223                    | 202     | 81     |
| 80        | 450           | 69 820                    | 155     | 88     | 85 612                    | 274     | 107    | 68 530                    | 219     | 86     |
| 90        | 512           | 74 213                    | 145     | 93     | 93 302                    | 308     | 117    | 76 614                    | 253     | 96     |

<sup>a</sup>Gross margins do not include cost of grazing, labour costs, fuel costs, interest on capital invested and managerial fees.

weaning mass). Only two options for age of sale were considered, namely weaners and 2,5 years of age (Table 3). For the latter, sale via country auction or through the abattoir were compared.

When the farm size is kept constant and the calving rate rises above 75%, then regardless of the stage or avenue of sale, the gross margin does in fact improve. The percentage improvement can be gauged from the change in gross margin per fodder unit (one fodder unit (FU) = a cow of 464 kg). Where weaners are sold the gross margin per cow produces misleading results and illustrates the limitations of this measure of efficiency.

Calving rates below 75% have not been included since below this figure insufficient heifer replacements become available to replace non-pregnant cows.

Both the example based on the Johannesburg City Council Farms and that for the Zululand ranch have one important characteristic in common, namely that there is no additional feed cost associated with the improved reproductive rate. Such changes are simply the result of improvements in one or more aspects of management. In ranching areas, improved feeding could however result from more effective veld management.

In contrast to these two situations, it is generally believed that reproductive rates in sheep and cattle reflect the level of management to which the animals are exposed. The principal component of this management is believed to be the feeding conditions that operate. In particular, the deficiencies or inadequacies that may occur at certain critical times such as during late gestation (commonly late winter) or early lactation (spring/early summer) have been shown to be important in cattle. This is supported by Whitehead & Beghin (1984) who maintain that where overhead costs cannot be reduced, the beef farmer will increase profitability only by improving feeding and veterinary management.

For those producers who operate under more intensive conditions than in the ranching areas and who wish to correct inadequacies in the nutritional regime, the solution appears to be fairly simple. It merely involves better provision for times of scarcity. However, producers maintain that the improvement of calving rates by better feeding, particularly during winter, is not reflected in improved profitability. This contention is supported by the findings of Van Niekerk (1982). He measured the amount of feed and time required to improve the condition scores of beef cows after having weaned their calves. If the cost of this extra feed is related to the expected increase in calving rate, and thus the additional number of saleable weaners (Table 4), then it is clear that the expected return does not justify the expenditure. The expected returns (Table 4) incorporate the cost of producing

**Table 4** Expected feed costs and returns from sale of weaners when additional feeding is used to improve the condition score after weaning

| Initial condition score | Final condition score | Additional feed cost/100 cow herd (R) | Additional calves expected | Improved <sup>a</sup> income when sold as weaners (R) |
|-------------------------|-----------------------|---------------------------------------|----------------------------|---|
| 1,5                     | 2,5                   | 3 200                                 | 56                         | 2 352   |
| 2,0                     | 3,0                   | 5 000                                 | 35                         | 1 470   |
| 2,5                     | 3,0                   | 2 000                                 | 14                         | 588   |

<sup>a</sup>220 kg weaner valued at 110 c/kg live mass with a cost of production of R200.

a weaner which is over R200 for a typical Natal Midlands farm operating at a calving rate of 75%.

Because of the generally recognized poor returns from the weaner operation the profitability could be markedly improved by delaying the age of sale. A computer program is being developed for a typical Highland Sourveld farm and this will allow the various alternatives to be compared for this area. These results support the belief that when costs are incurred (in the beef operation) in the form of increased winter feeding which is designed to eliminate losses in condition that occurred during summer, then this practice is unlikely to be economic.

Two aspects are important:

- (i) Overgrazing of the veld should be strongly avoided so as to prevent a rapid decline in veld composition and in order to prevent cows entering the winter in poor condition (Van Niekerk, Hardy, Mappedoram & Lesch, 1984).
- (ii) The animal management should be such as to utilize the available grazing to the best advantage without detriment to the condition of the breeding cows.

#### Limitations imposed by over-emphasis of growth rate

Let us now consider the third possibility offered as an explanation of why reproductive rates are not maximized in practice. In calculating the beef produced per cow in the herd, when both the calving rate and weaning mass are varied, we are assuming that these two traits are at least independent. However, it is every producer's hope that they will be positively correlated. Unfortunately, this is not the case and in fact over-emphasis of growth rate up to the age of weaning can be to the detriment of reproductive efficiency and therefore overall efficiency of the farming enterprise. In considering measures of efficiency, Baker, Smith & Cartwright (1983) suggested that the biological efficiency of a herd could be

defined either as the ratio of the total mass sold to the total mass of digestible nutrients consumed (WT/TDN), or the total mass sold to the total number of breeding cows (WT/C). A simulation model was designed by Baker and co-workers to account for trade-offs amongst the effects of different genetic potentials (early vs. late maturing genotypes) and the production environment. It was found that these effects tended to be compensatory, but not necessarily equally so for the different genotype-environment combinations. Baker, *et al.* (1983) therefore recommended that individual animal-selection goals which are designed to increase net herd off-take should allow for the production/management environment as well as the total herd performance.

This line of thought can be taken a step further by considering the stress imposed on beef cows by different calf-breed groups. The effect of growth potential (calf breed) of the calf on characteristics of the cow such as milk production, reproduction, measures of condition, bodymass and changes in condition and bodymass during lactation was studied by Kress, Doornbos & Anderson (1983). When Hereford cows were mated to either Hereford, Angus, Simmentaler  $\times$  Hereford or Simmentaler sires the calf-breed group had a significant effect on the change in bodymass of the dams during lactation, on cow condition and on pregnancy rate. All the results consistently showed that crossbred calves exerted a greater stress on their mothers than purebred calves. These effects of calf-breed group on production traits of the dams were at least partially mediated via the growth of the calf. This effect was not attributable to any stress at calving that could be assigned to the breed-type of the calf. Shannon & Shrode (1983) extended this argument and evaluated the effect of the sire of the foetus carried by the cow on the performance of the calf being suckled at that time. They found a significant effect on the average daily gain and on the condition score during the first year of life in both polled Hereford and Angus cows. Kress, *et al.* (1983) therefore suggest that the advantages to be gained from crossbreeding should be weighed against the disadvantages. Marlowe & Nadarajah (1983) were also of the opinion that advantages in growth to weaning were largely offset by fewer calves being weaned in Aberdeen Angus cows.

There is currently the suggestion that in spite of the concerted emphasis on improving weaning mass no real improvement in growth rate as such has occurred. In effect, only an increase in birth mass, which in turn is related to mature size, may have materialized. Increased mature mass is unfortunately not significantly related to total calf mass produced per year in the herd (Marshall, Stewart & Mohler, 1983). When the feed requirements of the genotype are brought into consideration then the picture changes even further. Thus, Davis, Rutledge, Cundiff & Hauser (1983) concluded that when Holstein cows were mated to Hereford sires such dams produced progeny with greater slaughter mass, carcass mass and trimmed wholesale cuts, lower pre-weaning feed consumption, and more efficient post-weaning gains. In addition they possessed greater salvage value. However, the Holstein dams were less efficient than Hereford dams mated to Holstein sires because of the greater ME intake of such cows. This finding has been confirmed by Jenkins & Ferrell (1983) who stated that cow ME requirements are a major component of the total ME required in a beef production cycle. Such cow requirements have a substantial impact on efficiency estimates of retail production. Amongst the breeds tested (Angus, Hereford, Charolais and Simmentaler) by Jenkins & Ferrell

(1983) the cows with the smallest mature mass and lowest milk production were most efficient in retail product/ME. Contrary to common belief the cows with the highest milk production were concluded to be the least efficient. Seldin & Notter (1983) also evaluated the importance of maximum daily milk production (PMA) and found that relatively low PMA values (which tended to maximize female reproductive rates) were optimal. When PMA values rose above 27 kg the costs were increased owing to the increased lactational stress and the lower reproductive rates. A similar conclusion can be reached from the results of Jenkins & Ferrell (1983) who measured milk production for 165 days of the pre-weaning period.

Returning finally to the concept of genotype-environmental interactions and the problem of selecting the correct breeding programme for a particular set of circumstances, we need to take cognisance of the results obtained by Paterson, *et al.* (1980). They noted that British (Hereford, Angus and Short-horn) and *Bos indicus* (Afrikaner, Bonsmara and Brahman) cows reached peak production at an earlier age than Charolais, Simmentaler or dual-purpose types (Friesland and Brown Swiss). These findings led to the conclusion that when the average dam-age is low in a herd, the early maturing types (with the lower mature size) could be more productive in terms of calf weaning mass than the later maturing types. If cows are culled at a relatively young age, the later maturing types would have a low level of productivity because they would be eliminated in their potentially prime productive years.

The foregoing inevitably leads to the conclusion that many of our pre-conceived ideas of how efficiency should be measured need to be re-evaluated. At this stage we should very carefully note what inputs are required to increase or maintain herd/flock reproductive rates and then accurately note the returns achieved.

It is in this context that budgeting models such as those described by Whitehead & Beghin (1984) find invaluable application. With a reasonably accurate estimate available of expected product prices, it now becomes possible for the farmer to evaluate the impact on profitability of various marketing and production strategies. Depending on the production circumstances, reproductive rate may be of lower priority than formerly imagined.

## References

- BAKER, J.F., SMITH, G.M. & CARTWRIGHT, T.C., 1983. Effect of altering the shape of the growth curve on biological efficiency of beef cattle production systems. *J. Anim. Sci.* 57, Suppl. 1, 144.
- DAVIS, M.E., RUTLEDGE, J.J., CUNDIFF, L.V. & HAUSER, E.R., 1983. Life cycle efficiency of beef production: Cow efficiency for progeny slaughtered. *J. Anim. Sci.* 57, Suppl. 1, 148.
- JENKINS, T.G. & FERRELL, C.L., 1983. Estimated production efficiencies of crossbred cows. *J. Anim. Sci.* 57, Suppl. 1, 154.
- KLOSTERMAN, E.W., 1981. Measuring beef production in the cow herd. *S. Afr. J. Anim. Sci.* 11, 195.
- KRESS, D.D., DOORNBOS, D.E. & ANDERSON, D.C., 1983. Stresses imposed on beef cows by different calf breed groups. *J. Anim. Sci.* 57, Suppl. 1, 156.
- LE ROUX, J.D., 1951. Maintenance and improvement of fertility in the cattle herds at Mara Research Station. *Fmg. S. Afr.* 26, 73.
- MARLOWE, T.J. & NADARAJAH, K., 1983. Comparative performance of three cow types when mated to two kinds of crossbred bulls. *J. Anim. Sci.* 57, Suppl. 1, 158.
- MARSHALL, T.E., STEWART, T.S. & MOHLER, M.A., 1983. Relationship of lifetime productivity with mature weight and maturation rate in Red Polled cows. *J. Anim. Sci.* 57, Suppl. 1, 158.

- MINISH, G.L. & FOX, D.G., 1982. Beef production and management. Reston, Virginia: Reston Publ. Co.
- PATERSON, A.G., VENTER, H.A.W. & HARWIN, G.O., 1980. The effect of age of dam on weaning mass for five dam breed types in an intensively managed crossbred herd. *S. Afr. J. Anim. Sci.* 10, 135.
- SELDIN, R. & NOTTER, D.R., 1983. Impact of genetic change on the economic efficiency of beef production. *J. Anim. Sci.* 57, Suppl. 1, 166.
- SHANNON, D.A. & SHRODE, R.R., 1983. Effect of sire of foetus carried by a beef cow on performance of her concurrently nursed calf. *J. Anim. Sci.* 57, Suppl. 1, 166.
- STEENKAMP, J.D.G., 1977. Cost of production of a kilogram live weaned calf. *Meat Ind.* 26, 34.
- VAN NIEKERK, A., 1982. The effect of body condition as influenced by winter nutrition, on the reproductive performance of the beef cow. *S. Afr. J. Anim. Sci.* 12, 383.
- VAN NIEKERK, A., HARDY, M.B., MAPPLEDORAM, B. & LESCH, S.F., 1984. Effect of stocking rate and lick supplementation on the performance of lactating beef cows and its impact on Highland Sourveld. *J. Grassl. Soc. S. Afr.* 1, (in press).
- WHITEHEAD, E.N.C. & BEGHIN, S.M., 1984. The economics of grassland beef production. Presented at 19th Ann. Congr. Grassl. Soc. S. Afr., 24-26. Jan., 1984.