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THE RELATIONSHIP BETWEEN BODY MASS AND FERTILITY OF BEEF COWS OF DIFFERENT AGES

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OPSOMMING: DIE VERWANTSKAP TUSSEN LIGGAAMSMASSA EN VRUGBAARHEID BY VLEISBEESKOEIE VAN VERSKILLENDE OUDERDOMME

Liggaamsmassa — en reproduksiedata van 920 Sussex-tipe koeie, wat gewissel het in ouderdom van 1 jaar oud tot volwasse koeie (5 jaar en ouer), is ontleed vir verwantskappe tussen liggaamsmassa (X) en herkonsepsie (Y). Die gegewens is oor 'n 6-jaar periode ingesamel en het die volgende ingesluit: Liggaamsmassa aan die begin en aan die einde van die teelseisoen, persentasie massatoename oor die teelseisoen, liggaamsmassa aan die begin en aan die einde van die winter en persentasie massatoename of verlies oor die winterperiode. Betekenisvolle verwantskappe tussen liggaamsmassa aan die begin van die teelseisoen en herkonsepsie is by alle ouderdomsgroepe gevind, met die uitsondering van 2-jaar-oud diere wat vir die eerste keer gepaar is. Geen verwantskap is waargeneem tussen konsepsie en gemiddelde liggaamsmassa aan die begin van die winter, einde van die winter, persentasie massatoename of verlies gedurende die winter en persentasie massatoename oor die teelseisoen nie.

SUMMARY:

Records on body mass and reproductive performance of 920 Sussex type cows, ranging in age from yearlings to adults (5 years and older) were examined for relationships between body mass (X) and conception (Y). The data was obtained over a 6-year period and included: body mass at the start and at the end of the breeding season, percentage gain in mass over the mating season, body mass at the start and at the end of the winter and percentage gain or loss over the winter. Significant relationships were recorded for body mass at the start of the mating season and conception for nearly all the age groups with the exception of the 2-year-old animals mated for the first time. No relationship could be established for conception rate and mean body mass at the start of the winter, end of the winter, percentage gain or loss over the winter and percentage gain over the breeding season.

A considerable amount of research has been devoted to the effects of undernutrition on the reproductive performance of beef cows. Review articles by Lamond (1970), McClure (1970), Terblanche (1974) and Topps (1977) and additional information edited by Cunha, Warnick & Koger (1967) and Preston & Willis (1974) have dealt with this topic rather extensively. Throughout these reports there has been the inference that adequate nutrition, both *pre* and *post partum*, is of vital importance in order to sustain good reproductive performance in beef females.

Preston & Willis (1974) maintain that a rising plane of nutrition during the breeding season is the most important requirement to secure high calf crops. This contention is supported by McClure (1965), who supplemented cows with hay from calving until three weeks after service and recorded a 62% conception rate to first service, compared with 13% for unsupplemented animals. The data of Wiltbank, Rowden, Ingalls & Zimmerman (1964) and Dunn, Wiltbank, Zimmerman & Ingalls (1964) provide further evidence to support the belief that breeding cows should be improving in condition during the mating period.

Parker, Waldrip & Marion (1966) did not observe an effect of nutrition on calving performance and concluded that the failure to demonstrate a response was due to the overall fertility of the cows being very high. Meaker (1974) recorded a conception rate of only 25% among Africander cows that had gained 10 kg in body mass from 14 days *post partum* until the end of the mating season, whereas the conception rate was 87,5% when cows had lost 54 kg in body mass over the same period. The results achieved by Meaker (1974) are therefore at variance with the belief that a breeding animal must be gaining in mass in order to conceive. The results also suggested that body mass

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at the end of the breeding season influenced the rate of conception. It was found that as this body mass decreased from 435 kg to 378 kg, reconception decreased linearly from 87,5% to 25% (Meaker, 1974).

This relationship supports the contention that a critical or target mass must be attained before conception is likely to occur (Lamond, 1970). In more practical terms it means that the reproductive ability of cows will probably decline concurrently with a decrease in body mass below the target mass. Conversely, as body mass increases above the target mass, cows will tend to become subfertile due to excessive deposition of fat. Richardson, Oliver & Clarke (1975) examined the influence of body mass at the beginning and end of the mating season on conception rates. They concluded that the greater the loss in body mass over this period, the lower the subsequent calving rate. The hypothesis, as formulated by Lamond (1970), is supported by the findings of Ward (1968), Trail, Sacker & Fisher (1971), Meaker (1975), Steenkamp, van der Horst & Andrew (1975) and Buck, Light, Rutherford, Miller, Rennie, Pratchett, Capper & Trail (1976).

According to Broster (1973), a positive relationship between live mass and fertility in the cow has not been consistently demonstrated. Munro (1970, unpublished) analysed a large number of data and failed to produce a conclusive result regarding the relationship between fertility and live mass change for cattle (Broster, 1973). Similarly, Whitman, Remmenga & Wiltbank (1975) found that when they fed Aberdeen Angus and Hereford cows, aged 2-11 years, various levels of energy, before and after calving, the cows gaining in mass before calving had a greater likelihood of oestrus 50 days *post partum* than those which lost mass before calving. However, neither body mass change before breeding nor body condition at first breeding affected the incidence of pregnancy. Although numerous reports have demonstrated a positive relationship between body mass and fertility, much controversy still exists regarding the target mass concept. For instance, what is the target mass for a specific breed and age of cow? The objective of this study was therefore to determine whether body mass at the start and/or at the end of the mating season were related to conception in Sussex type cows.

Procedure

Records on the reproductive performances of 920 Sussex type cows, ranging in age from yearlings to adults (5 years and older), were examined. The data was obtained over a 6-year period. The animals were maintained on the Dundee Research Station where controlled summer mating seasons were used viz. 45 days for heifers and 65 days for all other females. Only Sussex bulls were used.

Body mass at the start and at the end of the breeding season was recorded for all the animals. Percentage gain in mass over the mating season, body mass at the start and end of the winter and percentage gain or loss over the winter were also recorded for cows 5 years and older.

In order to examine the relationships between body mass and fertility, the animals were divided into the following age groups (numbers in brackets refer to number of animals used in the calculations):

Age group:

1 Heifers 1-year-old and mated for the first time (132)

2 Heifers 2-years-old and mated for the first time (87)

3 Cows 2-years-old and mated for the second time (47)

4 Cows 3-years-old and mated for the second time (38)

5 Cows 3-years-old and mated for the third time (36)

6 Cows 4-years-old, irrespective of the number of calves produced (98)

7 Cows 5-years and older, irrespective of the number of calves produced (482)

Within each age group, the cows were divided into equally spaced categories of body mass (X) and the percentage conception (Y) was calculated for each category. In all cases regression analyses were carried out using weighted means for Y. When animal numbers were limited (e.g. Groups 4 and 5), only a few categories of body mass were possible and only linear regressions could be fitted to the data. On the other hand, when numbers were not limiting (e.g. Groups 6 and 7), the animals were divided into a greater number of body mass categories and quadratic functions were fitted by least squares analysis.

Discussion of results

Yearlings

On average, when the mean body mass of the heifers at the start of the breeding season was 212 kg, 43% of them conceived whereas those with a mass of 337 kg exhibited a conception rate of 78% ($P < 0,10$). Thus, the conception rate rose at the rate of 3,0% for every 10 kg increase in body mass. However, when the mean body mass of the heifers exceeded 278 kg, the percentage conception tended to decrease, perhaps due to the heifers becoming too fat. Arnett, Holland & Totusek (1971) recorded a decrease in conception rate when cows became overfat. From this relationship it appears that the optimum mass at mating i.e. the target

Table 1

Relationship between body mass (X) at the start and at the end of the mating season and reconception (Y) for Sussex type cows of different ages

Age and number of times mated	n	Relationship at start/end of mating season	r	Sign
1 year — mated 1st time	132	Start Y = —16,29 + 0,28X End Y = —354,56 + 2,61X — 0,004X²	0,6930 0,9652	P<0,10 P<0,05
2 years — mated 1st time	87	Start no significant relationship End no significant relationship		
2 years — mated 2nd time	47	Start Y = —51,97 + 0,37X End no significant relationship	0,8892	P<0,05
3 years — mated 2nd time	38	Start Y = 30,86 + 0,16X End no significant relationship	0,8722	P<0,05
3 years — mated 3rd time	36	Start Y = 42,55 + 0,12X End no significant relationship	0,9912	P<0,01
4 years — irrespective of matings	98	Start Y = —1 060,98 + 5,05X — 0,006X² End Y = —1 103,04 + 5,07X — 0,005X²	0,8992 0,8912	P < 0,05 P < 0,05
Adult cows — irrespective of matings	482	Start Y = —415,58 + 1,94X — 0,002X² End Y = —630,77 + 2,70X — 0,003X²	0,9483 0,9838	P < 0,01 P < 0,01

mass for yearling heifers, of Sussex type, is approximately 280 kg. In confirmation of this tendency, percentage conception and mean body mass of yearling heifers at the end of the mating season were significantly ($P < 0,05$) correlated (Table 1). Similar relationships have been recorded by Ellis (1974), Carter & Cox (1973), Young (1974) and Axelsen & Morley (1976).

Two-year-old

No significant relationship was observed between percentage conception and mean body mass at the start or at the end of the breeding season of 2-year-old heifers mated for the first time. Percentage conception did not vary greatly (85,7% — 100%) when the mean body mass of the heifers varied between 285 kg and 385 kg at the start of the mating season. These results tend to substantiate the findings of Broster (1973), with the exception that the present findings refer to a specific age group, while Broster studied dairy cows that received moderate to generous planes of nutrition. Harwin, Lamb & Bisschop (1967) found that mass at mating affected the reproductive rate of 2-year-old Africander heifers. They recorded a calving rate of 100% when the mass at mating exceeded 318 kg and only 60% when the mass was 250 kg and less. It can be concluded therefore that the mean body mass of the 2-year-old heifers used in this study was well above the minimum joining mass required for maximum conception. Although no definite joining mass for 2-year-old heifers mated for the first time was established, it would appear that the optimum for Sussex type beef heifers ranges between 320 kg and 340 kg.

A significant ($P < 0,05$) linear relationship was noted between conception and mean body mass at the start of the mating season of 2-year-old cows mated for the second time (Table 1). Although no decrease in conception was recorded above the maximum at 385 kg, it seemed pointless to feed these animals so as to exceed this mass as no extra benefit in conception could be expected. From the relationship demonstrated, it appears that approximately 390 kg would be the target mass for maximum conception to occur. No significant relationship was recorded at the end of the mating season, but it was evident that a tendency existed for conception to occur more readily as the body mass increased.

Three-year-old

Although animal numbers were limited for the 3-year-old cows mated for the second time, a significant ($P < 0,05$) linear relationship was recorded between conception and mean body mass at the start of the mating season. No relationship was noted for the same animals at the end of the mating season (Table 1). The

results indicated that high conception rates were attained irrespective of whether the mean body mass at the start of the mating season was 350 kg (83%) or 450 kg (100%). From the results it would appear that the optimum mass at mating was approximately 410 kg.

The results of only 36 cows that were 3-years-old and had been mated for the third time were available. A significant ($P < 0,05$) relationship was obtained between conception and mean body mass at the start of the breeding season (Table 1). It is obvious from previous discussions that with the greater animal numbers available these relationships tended to exhibit curvilinear responses. It can therefore be expected that, had there been more animals the same curvilinear relationship would apply for the group of 3-year-olds. However, the relationship recorded was of the order of only a 1,4% increase in conception for every 10 kg increase in body mass at the start of the mating season. Furthermore, according to the relationship it appeared that maximum conception occurred when the mean body mass at mating was approximately 440 kg.

Four-year-old

Significant ($P < 0,05$) quadratic relationships were recorded between conception and mean body mass at the start and at the end of the mating season of 4-year-old cows (Table 1). Both relationships followed the same trend, except that the body mass of the cows at the end of the mating season was approximately 11 kg greater than at the start. A marked decrease in conception rate, possibly due to overfatness at the onset of breeding, was observed with the 4-year-olds. When the mean body mass of the cows increased from 460 kg (where maximum conception was recorded) to 510 kg at the start of the mating season, the percentage conception decreased from 93% to 78%.

Adult cows

In accordance with the results obtained for the 4-year-old cows, highly significant ($P < 0,01$) relationships were recorded between weighted percentage conception and mean body mass at the start and at the end of the mating season of adult cows (Fig. 1). From the graphs it is evident that the optimum mass at mating, to achieve maximum conception, was approximately 510 kg. Body masses above this level resulted in no extra gain in conception rate and there was a tendency for conception to decrease with increasing body mass above the target mass. It was also evident that a gain of say 40 kg in body mass favoured conception rate more in thin cows than that it did in well fleshed cows. For instance, there was an increase of 28% and 12% in conception rates when the body mass of cows at the start of the breeding season increased from 320 kg to 360 kg and from 420 kg to 460 kg, respectively (Fig. 1).

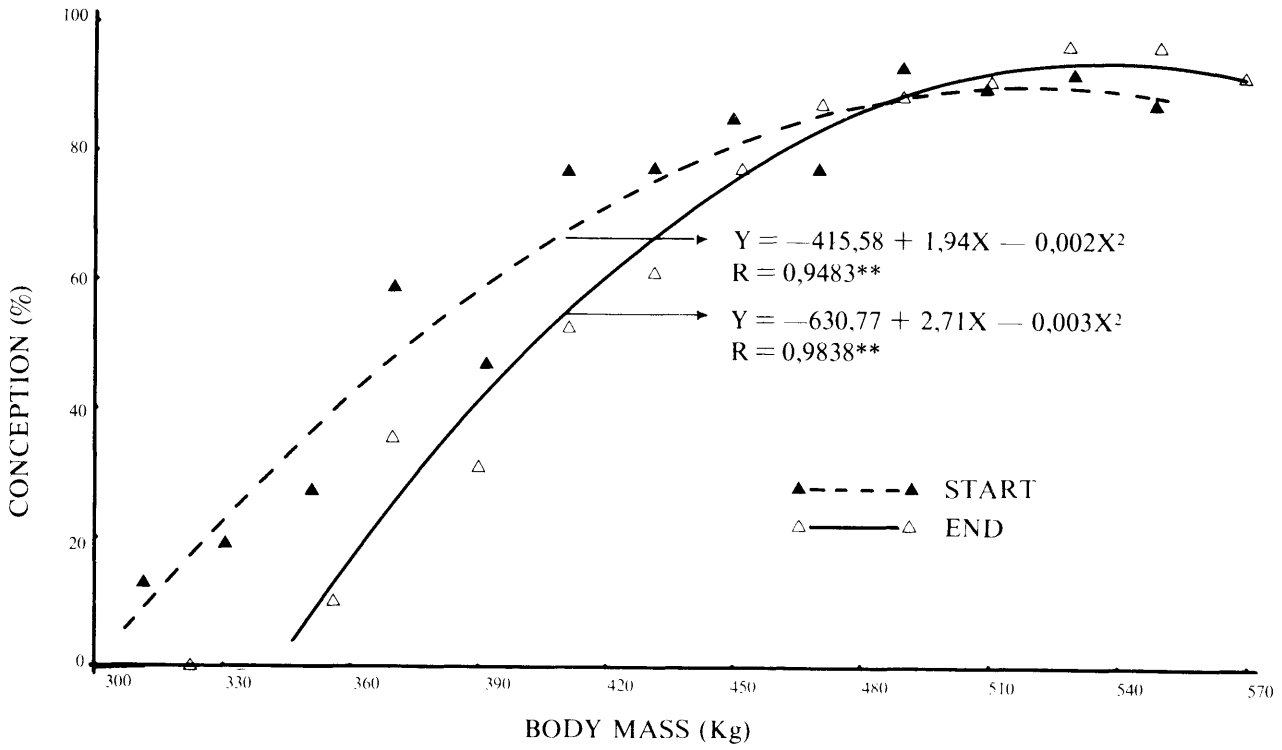

Fig. 1 Relationship between conception and mean body mass at the start and at the end of the mating season of adult cows

The calculated target masses to obtain maximum conception for the different aged animals (Table 2, Fig. 1) were used to establish a relationship between target mass and age of the cow (Fig. 2). This relationship (for cows calving for the first time at 2 years of age) was curvilinear and significant ($P < 0,05$). By using this regression (Fig. 2), the stockman would be able to determine what the target mass for any age of British beef type (Sussex) animals should be to ensure maximum conception. Obviously, the accuracy with which the target mass could be determined depends on the "correctness" of the calculated target masses for each age group.

Table 2

Suggested target masses for British beef type cows at joining to ensure maximum conception rates

Age group	Age and number of times mated	Suggested target mass
1	1 year — mated 1st time	280 kg
2	2 years — mated 1st time	330 kg
3	2 years — mated 2nd time	390 kg
4	3 years — mated 2nd time	410 kg
5	3 years — mated 3rd time	440 kg
6	4 years — irrespective of matings	460 kg
7	Adult — irrespective of matings	510 kg

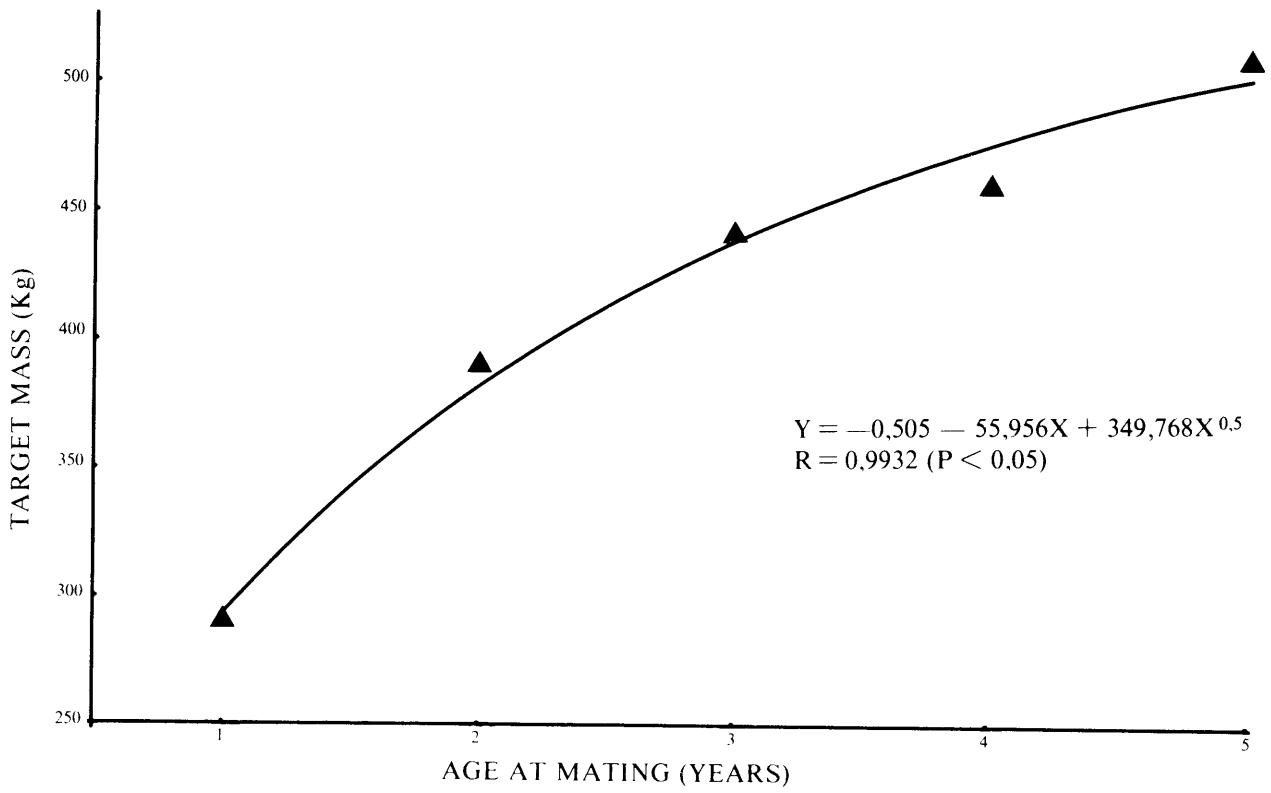

Fig. 2 Relationship between target mass and age at mating of cows calving for the first time at two years of age

No relationship could be determined between conception rate and mean body mass at the start of the winter, end of the winter, percentage gains or loss over the winter and percentage gain over the breeding season. The latter results support the findings of Richardson *et al.* (1975) and Steenkamp *et al.* (1975) who concluded that the ability to conceive is a function of body mass *per se* and not of gain during the post-partum period.

Conclusions

Lamond (1970) maintained that general application of the "target mass" concept was limited by the age and the breed of the beef female. The results of the present study have not only suggested a target mass for Sussex type cattle, but have also permitted the effect of age to be quantitated (Fig. 2). It is thus possible to recommend a target mass at joining for all age categories. There can be little doubt that the mass required to support maximum conception will vary between Zebu, dual-purpose and British beef types of beef cattle. However, the principle suggested by Lamond (1970) is likely to apply to most types. It is important that limits be set for the most common breeds and crosses encountered, since the stockman will then have a predetermined objective goal when selecting and applying feeding regimes. He will then no longer be solely dependant on subjective recommendations viz., that cows must be "well fed" after calving.

Should it become possible to establish a curvilinear relationship for all age-categories, then application of such guides can be expected to have a dramatic impact on the calving rate of the National herd. The producer would know well in advance of the breeding period what the target mass for each beef age group should be in order to maximize the probability of conception occurring.

Generally, at any given time, there is a relatively wide variation in body mass between individuals in a herd, even amongst cows fed similarly and being of similar age and productive status. It is thus necessary, to emphasize that although the target mass may be an absolute figure, because of individual variation the guide must be applied with discretion.

From the data presented it is clear that cows are able to conceive even when their body mass exceeds or is below the indicated target. Consequently, if the body mass of each cow is measured prior to the introduction of breeding bulls, then reference to appropriate figures (e.g. Fig. 1) will indicate just what the chances of conception for each individual are likely to be.

Another important aspect which emerged from the present results was the failure to show relationships between conception rate and body mass for all the age groups under discussion, viz, 2-year-old cows mated for the first time. These results are not unique since Broster (1975) also failed to show relationships between body mass change and fertility for lactating dairy heifers. Broster (1975) suggested that the cows may have been operating within an optimum range. In more simplistic terms, the heifers used in the trials reported here may have been fed on too high a plane of nutrition. This could have resulted in the mean body mass of the heifers being well above the suggested target mass, but not so high that it led to obesity and impaired fertility. The necessity for establishing a target mass for the 2-year-old heifers, mated for the first time, is clearly illustrated. Unnecessarily high planes of nutrition for this group, not only resulted in a wastage of expensive conserved winter feed, but also led to no improvement in the conception rate.

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