FACTORS TO CONSIDER IN A MODEL FOR FERTILITY OF BEEF FEMALES IN NORTHERN AUSTRALIA

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SUMMARY

A study of the fertility of beef cattle from a dry tropical environment was undertaken using data from the National Cattle Breeding Station, "Belmont". Data were collected from 1974 to 1990 from Hereford-Shorthorns (HS), interbred Brahman x HS (BX) and low (BL) and high (BH) grade Brahmans. The dependent variable, pregnancy success and the fixed effects of environmental category, genotype and the combined effects of cow age and lactational status (ALS) were analysed using a least-squares analysis of variance. Environmental categories of good, average and poor years were based on pregnancy rate. Pregnancy rates of 3 yr old maidens and 5+ yr old non-lactating cows were consistently high and similar across all genotypes and environmental categories. Lowest pregnancy rates occurred in the lactating cows but in particular, lactating BH cows. Factors that need to be considered in constructing genetic prediction models of fertility in northern Australia are discussed.

Keywords: Female fertility, *Bos indicus,* cow age, lactational status.

INTRODUCTION

Compared to southern Australia, the environment in northern Australia is characterised by relatively high and more variable levels of stresses. Brahman and Brahman derived genotypes predominate in this region because of their high levels of resistance to these stresses (Frisch 1987). Compared to *Bos taurus* these genotypes possess relatively low levels of production potential, especially fertility (Chenoweth 1994). The combination of environment and genotype results in sub-optimal reproductive rates in this region.

One option that may be available to northern beef producers is BREEDPLAN's estimated breeding values for the number of days to calving to improve a herd's fertility (Schneeberger *et al.* 1991). However, world wide, genetic evaluation techniques were generally derived in temperate environments and based on *Bos taurus* genotypes and do not consider either extreme environmental variability of the tropics, or the proportion of *Bos indicus* or the effects of lactation. Genetic prediction models for female fertility in the tropics should be modified in order to better reflect northern environment and genotypes. The present study aimed to highlight factors to consider in such models.

MATERIALS AND METHODS

Data were collected from 1974 to 1990 at the National Cattle Breeding Station, "Belmont", located 26 km north of Rockhampton, Queensland, Australia. Harvey's PC version of Mixed Model Least Squares and Maximum Likelihood, (Harvey 1987) was used to estimate fixed effects and first order interactions. Pregnancy success was chosen as the index for fertility. Environmental category based on pregnancy rate was used as a fixed effect. Years where pregnancy rates were ≥ 78% were defined as good years, rates between 78% and 68% as average years and rates ≤ 68% were defined as poor years. The number of years in each category were approximately equal. Respective genotypes and their number of records were; Hereford-Shorthorns (HS), 1682; interbred Brahman x HS (BX), 1750; and low (BL = >5/8<15/16), 402 and high grade Brahman (BH = ≥15/16),766. Age of cow and lactational status, at the time of joining, were combined into a single fixed effect (ALS). For convenience the following classes of ALS are presented; 3 yr maiden, 4 yr lactating, 5 + yr lactating, 4 yr non-lactating and 5 + yr non-lactating. A detailed description of the environment, dataset and analysis can be found in O'Neill (1995).

RESULTS

Genotype significantly (P<0.001) affected overall mean pregnancy rate (HS 74.5±1.3%, BX 69.0±1.2%, BL 74.2±3.1%, BH 58.8±1.8%). ALS also had a highly significant effect on pregnancy rate (P<0.001). Highest values were found in 3 yr old maidens (81.5±1.6%) and 5+ yr old non-lactating cows (80.7±1.9%). Within lactating cows there was a significant (P<0.01) range in pregnancy rate from 48.6±2.3% for 4 yr old cows to 69.8±1.9% for 7 to 9 yr old cows.

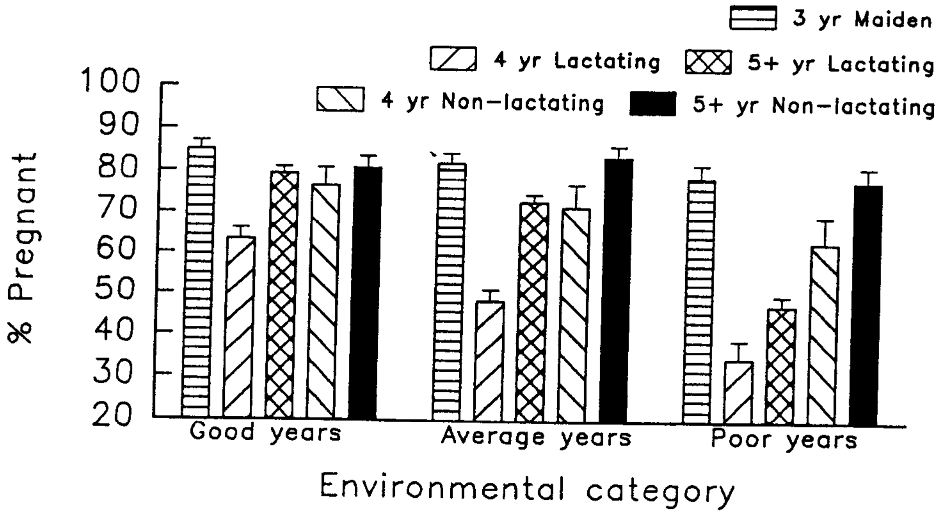

Figure 1. Interaction of ALS by environmental category.

The response of the different classes of ALS to the different environmental categories (Figure 1) and the response of the different genotypes to the different classes of ALS (Figure 2) were highly significant (P<0.001). Three yr old maidens and 5+ yr old non-lactating cows achieved relatively high and similar pregnancy rates in all three environmental categories (Figure 1). Lactating classes experienced the greatest decline in pregnancy in the poor years. The 4 yr old lactating cows had significantly lower pregnancy rates than both maidens and 5+ yr old non-lactating cows in good ($P<0.05$), average ($P\leq0.01$) and poor ($P<0.001$) years. Pregnancy rates of 3 yr old maidens were consistently high and similar across all genotypes (Figure 2). Pregnancy rates of the two non-lactating classes of ALS were also similar to each other and consistently high for all genotypes except BH. The pregnancy rates of 4 and 5+ yr old lactating HS cows were similar, unlike the corresponding pregnancy rates in the other three genotypes. For lactating BH cows, the pregnancy rate was the lowest and the difference in pregnancy rate between 4 and 5+ yr old cows was greatest.

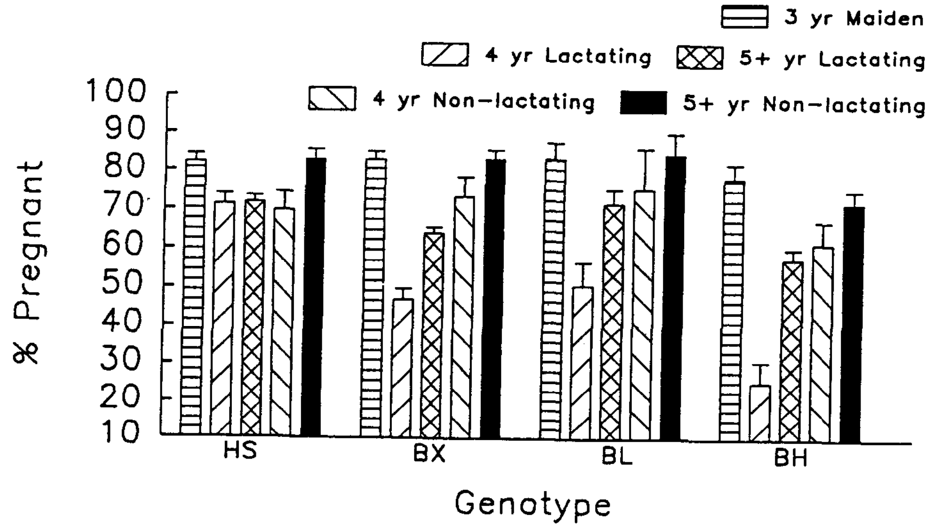

Figure 2. Interaction of ALS by genotype.

DISCUSSION

A number of researchers are concerned that aspects of the new animal breeding technologies do not adequately reflect the genetics of beef production in the tropics (eg. Notter and Hohenboken 1990; Davis 1993). Therefore, the following discussion deals with components of models that the authors felt should be considered for female fertility in the tropics.

Dependent variable. Large yearly variations in pregnancy rate on "Belmont", and other locations in northern Australia (Holroyd *et al.* 1990), may render days to calving, as the target trait, inappropriate for genetic prediction models for tropical environments. In the analysis of days to calving, non-pregnant cows are assigned a value for days to calving (Meyer *et al.* 1990). The very low rates of pregnancy in some years, especially for lactating cows (Figure 1), ensure that for any estimation of breeding value for days to calving a large proportion of cows (i.e. the non-pregnant cows) would be allocated this value. Such an allocation would be expected to reduce the normality of the distribution of the variable. The same conclusion has been reached by Ponzoni and Gifford (1994).

Environmental category. Grouping years into good and poor environmental categories for a semi-arid environment, DeNise and Torabi (1989) found that genetic parameters for growth change in response to the level of environmental stress. The differential response of ALS in the different categories (Figure 1) may mean that the genetic parameters for fertility in the good years are different from the genetic parameters in the poor years.

Genotype. Of the numerous studies of the fertility of 'Brahmans' only a few studies (eg. McCarter *et al.* 1991) considered the influence of Brahman content on fertility. In studies of liveweight data of other breeds the proportion of purebreeding was found to be a significant effect on growth (eg. Graser and Hammond 1985). Evidence from these studies and from Figure 2 suggests that not accounting for various proportions of Brahman breeding would be ignoring important sources of variation.

Age and lactational status of cow. In the dry tropical environment of northern Australia, both age and lactational status of the cow are factors that affect fertility (Figures 1 and 2). The significantly higher reproductive rates of both 3 yr old maidens and non-lactating cows, over lactating cows, confirm previous reports from tropical environments (Frisch *et al.* 1987). Meyer (1992) has shown that ignoring maternal effects can significantly inflate the estimate of h^2 for preweaning growth traits. Ignoring significant ALS effects on reproductive traits could also distort the estimate of h^2 for these traits.

This study indicates that for a model of female fertility to be suitable for northern Austalia the choice of target trait needs careful consideration and that fixed effects should include environmental category, proportion of *Bos indicus* and both age and lactational effects. The influence of these factors on genetic parameters warrants breeders to instigate further investigations into this issue.

REFERENCES

Chenoweth, P.J. (1994) *Aust.Vet.J.* **71**:422.

Davis, G.P. (1993) *Aust.J.Agric.Res.* **44**:179.

DeNise, R.S.K. and Torabi, M. (1989) *J.Anim.Sci.* **67**:2619.

Frisch, J.E. (1987) *J.Agric.Sci.Camb.* **109**:213.

Frisch, J.E., Munro, R.K. and O'Neill, C.J. (1987) *Anim.Reprod.Sci.* **15**:1.

Graser, H-U. and Hammond, K. (1985) *Aust.J.Agric.Res.* **35**:527.

Harvey, W.R. (1987) Unpublished statistical manuscript.

Holroyd, R.G., James, T.A., Doogan, V.J., Fordyce, G., Tyler, R. and O'Rourke, P.K. (1990) *Aust.J.Exp.Agric.* **30**:727.

McCarter, M.N., Buchanan, D.S. and Frahm, R.R. (1991) *J.Anim.Sci.* **69**:2754.

Meyer, K. (1992) *Livest.Prod.Sci.* **31**:179.

Meyer, K., Hammond, K., Parnell, P.F., Mackinnon, M.J. and Sivarajasigam (1990) *Livest. Prod. Sci.* **25**:15.

Notter, D.R. and Hohenboken, W.D. (1990) *Proc.4th.Wld.Cong.Genet.App.Livest.Prod.* **XV**:347.

O'Neill , C.J. (1995) M.App.Sc. Thesis, Central Queensland University.

Ponzoni, R.W. and Gifford, D.R. (1994) *J.Anim.Breed.Genet.* **111**:52.

Schneeberger, M., Tier, B. and Hammond, K. (1991) *Proc.Aust.Assoc.Anim.Breed. Genet.* **9**:194.