

INCREASES IN THE REPRODUCTIVE PERFORMANCE OF SHEEP FLOCKS IN WESTERN AUSTRALIA FROM 1960/61 TO 1987/88

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SUMMARY

The period from 1960/61 to 1987/88 has seen lamb marking percentages range from 59% to 75% in the Western Australian sheep flock, with the period from 1984/85 to 1987/88 having above average values (73-75%). The data were tested for the correlations between variation in annual lamb marking percentage and changes in season, stocking rate, proportion of wethers and year, using multiple regression analyses. The results indicate that there has been an annual increase in lamb marking percentage of 0.35 lambs per 100 ewes mated ($P<0.001$) over the 28 years. The analyses also indicated that there was a positive association of lambing performance with changes in stocking rate ($P<0.001$) and rainfall in the year of lambing ($P=0.03$). Overall, 52% of the variation of the State's lambing performance between years was attributable to these three significant factors. On-farm studies indicate that these changes are likely to have resulted from improved conception rates and higher live weight of the ewes at joining.

INTRODUCTION

The period from 1960/61 to 1987/88 has seen lamb marking percentages range from 59% to 75% in the Western Australian (W.A.) sheep flock, with the period from 1984/85 to 1987/88 having above average lamb marking percentages (73-75%), source: publications of the Australian Bureau of Statistics (ABS)). This 28 year period has not only seen substantial changes in the areas in which sheep are farmed and the size of the W.A. sheep population, but also over the last 20 years there has been considerable improvement in the information on how to improve the reproductive performance of sheep. The value of feeding lupins about the time of joining to increase the lambing performance (Knight *et al.* 1975; Lightfoot *et al.* 1976) and use of teasers to improve mating performance of ewe flocks (Oldham 1980) are two examples of recent strategies designed to improve reproduction in commercial sheep flocks. To test if the changes in the performance of the W.A. sheep flock have been due to variation in seasonal conditions or management changes, the annual lamb marking percentages for W.A. over the period 1960/61 to 1987/88 were tested for their association with annual conditions (as measured by annual rainfall), stocking rate per hectare of pasture, proportion of wethers (one year of age and over) and time (year). The proportion of wethers was included to reflect changes in emphasis towards wool production, and therefore possible attention by farmers to factors unrelated to the reproductive performance of a flock. In addition, results from on-farm studies into the reproductive performance of sheep flocks in the early 1970s (Knight *et al.* 1975) and those from work in the mid-late 1980s (Crocker, K.P. and Kelly, R.W., unpubl. data) were compared in an attempt to explain some of the causes of these changes,

MATERIALS AND METHODS

Collation of data

State data Data were collated from the ABS publications covering the period 1960/61 to 1987/88 for lamb marking percentage, number of sheep, area of pastures and number of wethers one year of age and over. From these data stocking rate of sheep per hectare of 'pasture and proportion of wethers in the W.A. flock were calculated.

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The basis for calculating the area of pasture production and definition of an agricultural enterprise has changed over the period of study. The most significant change occurred in 1981/82 when the area used for more than one purpose was changed from counting only once to counting separately for each enterprise. Consequently the values from and including 1981/82 onwards have all been adjusted by multiplying by 0.875, the proportional change in area of pastures between 1980/81 and 1981/82.

To measure the annual conditions on a State basis, six sites in W.A. (Nabawa, Wongan Hills, Lake Grace, Narrogin, Xojonup and Esperance Downs) were chosen to represent the major areas in which sheep are run. Using the average annual rainfall for each site for the period 1959-1988, each year's rainfall was calculated as a proportion of the average for the site. From these proportional values the overall rainfall index for the State was calculated as the mean of the six sites. Hence, changes in conditions for the State as reflected by changes in annual rainfall over the period of study could be examined for their effect on lambing percentage.

The linking of rainfall indices with sheep performance values is complicated by the fact that the rainfall statistics are recorded for a calendar year, but the values for lamb production are recorded for the year ending March 31. As the majority of ewes lamb in late autumn-early winter (Kelly and Lindsay 1987), it was appropriate to test the effects of annual conditions over two years - the year when the majority of ewes lamb and the year before this production year which could affect performance at joining (November-February).

On-farm research data On-farm studies in the early 1970s by researchers from the University of Western Australia (Knight et al. 1975), and in the last four years by W.A. Department of Agriculture workers (K.P. Croker and R.W. Kelly, unpubl. data), have enabled individual flock data to be examined for changes in live weight at joining and reproductive performance between the early 1970s and mid-late 1980s. This comparison between the two periods of study is undoubtedly influenced by "sampling error", since different farmers were involved in the work. Nevertheless the farmers who participated were chosen on the basis of their willingness to co-operate, rather than any criteria based on the history of the lambing performance of their flocks. Therefore it has been assumed that there is no significant bias in reproductive performance between the two studies,

Statistical treatment of the State data

All independent variables were included in a multiple regression analysis to examine their association with the between year variation in lamb marking percentage. Independent variables explaining the least amount of variation in lambing percentage were then removed until only those with $P < 0.05$ remained. For the on-farm work, the performances of flocks in the two studies were compared using unpaired t-tests.

RESULTS

State flock

Over the period from 1960/61 to 1987/88 lamb marking percentages ranged from 59.1% (1977/78) to 74.9% (1985/86), with an average of 67.5%. During the first 11 years of this period the State flock increased from 17.2M to 34.7M, and it has fluctuated since then from 29.5M to 34.8M. The proportion of wethers in the State flock has generally fallen over the 28 years, from 0.30 in 1960/61 to 0.21 (1982-84), with slight increases to 0.24 in the last year. The area in pasture has increased from 3.1M hectares in 1960/61 to be 7.6M in 1987/88. After allowing for changes in the recording of pasture area in 1981/82, the stocking rate has generally fallen from 5.5 sheep per hectare of pasture

(1960/61) to 4.0 (1978/79), and then increased to 5.1 (1987/88).

The results of the multiple regression analyses showed that the rainfall in the year of lambing ($P = 0.03$), stocking rate ($P < 0.001$) and year ($P < 0.001$) were all significantly correlated with lamb marking percentage. Over the 28 years lamb marking percentages increased by 0.35 lambs per 100 ewes mated per annum. The model with these three independent variables explained 52% ($P < 0.001$) of the variation between years in W.A.'s lamb marking percentage.

On-farm studies

The results covered a total of 34 two-tooth flocks and 76 flocks of older (adult) ewes. For two tooth ewes, the 16 flocks studied in the 1980s were heavier at joining (45.7 kg v 40.6 kg, $P < 0.01$), had greater fertility (ewes lambing per ewe joined, 85.5% v 70.6%, $P < 0.001$) and higher fecundity (lambs born per ewe lambing, 108% v 101%, $P < 0.001$) than the 18 flocks studied in the 1970s. Similar increases in performances were noted between studies for the flocks of adult ewes. The 39 flocks examined in the 1980s were heavier (54.7 kg v 45.0 kg, $P < 0.001$), had higher fertility (92.8% v 72.0%, $P < 0.001$) and fecundity (122% v 108%, $P < 0.001$) than the 37 flocks studied in the 1970s.

DISCUSSION

The analyses show that an annual increase of 0.35 lambs per 100 ewes mated per annum in W.A.'s lambing performance has been achieved over the 28 years between 1960/61 and 1987/88. The model used explained a significant proportion (52%) of the variation between years in lambing performance. It is likely that it could be improved if more sites were used to determine annual conditions for the State, and monthly rather than annual rainfall was used to model pasture growth and climatic conditions about lambing. Nevertheless, it is unlikely that such changes will affect the conclusion that sheep farmers in W.A. have adopted management strategies which have improved the reproductive performance of their flocks.

The results also indicate that higher lambing percentages were recorded in the years of higher rainfall. The most probable explanation is that conditions at lambing influence lamb birth weight and survival and are the overriding determinants of lamb marking percentage. Nevertheless, it was surprising to find that the conditions in the year of joining had no significant correlation with the lambing performance of the State's flock, since it was reasonable to expect an association through the effect that it will have on pasture production, ewe live weight at joining and so lamb drop.

The comparison of the on-farm data between the early 1970s and mid-late 1980s indicates that there have been substantial improvements in conception rates of breeding flocks. It is reasonable to expect that this is attributable, at least in part, to the higher live weights of the flocks, the now widespread use of teaser rams, an increase in the resistance of ewes to clover disease (Crocker et al. 1989), and to improved preparation of rams prior to joining and use of the appropriate joining percentages. The sowing of subterranean clovers with a low oestrogen content will have also contributed to these improvements.

The improvement in the fecundity of the sheep flocks studied in the 1980s is probably due, to the higher live weight of the ewes at joining. There was a change of seven lambs born per 100 ewes lambing for the two tooth flocks, which differed in mean weight by 5.1 kg, and 14 lambs born per 100 ewes lambing for the adult ewes which differed in mean weight by 9.7 kg. These differences are consistent with the between flock relationships for increases in fecundity per kilogram increase in live weight at joining of about 1% (two-tooths) and 1.5-2% (adults) that are commonly recorded in W.A. (Crocker, K.P. and Kelly, R.W. unpubl. data).

In summary, the results support the conclusion that better management of the breeding flock over the last 28 years has led to annual increases of about 0.5% per annum in lamb production. Nevertheless, while these increases in performance have been of value to the State, the over two-fold range that exists between farms in lambing performance (Kelly 1986) indicates that marked inefficiencies still exist in maximizing either per head or per hectare production on many farms.

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