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Management and breeding policies for the use of the Booroola F gene for increased flock prolificacy

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ABSTRACT

The Booroola F gene gives sheep breeders a unique method of rapidly increasing the prolificacy of their flocks. Research data indicate that on average, every ewe carrying the F gene will produce about 1 extra lamb at each lambing. Breed type need not be changed from those currently favoured as the F gene can be transmitted to any breed, firstly by a series of controlled backcrosses and then by identifying carrier sheep of the desired breed type. Management systems to cope with large increases in lamb drop need to be developed along with breeding programmes to predict more accurately the genotype of individual sheep. These management systems and breeding programmes must also incorporate a strong emphasis on the ability to rear triplet born lambs to a marketable size.

Keywords Booroola F gene; genotype; prolificacy; management

PROLIFICACY OF F GENE FLOCKS

Three main factors influence the prolificacy of an F gene carrying flock.

Gene Frequency

At present most Booroola flocks contain both F gene carrier and non carrier ewes. It has been reported (Davis *et al.*, 1982; Piper and Bindon, 1982) that each ewe having the Booroola F gene will have on average about 1 extra lamb at each lambing. This enables the overall flock prolificacy (lamb born/ewe lambing) to be manipulated by controlling the gene frequency within the flock.

Prolificacy of base ewes

The F gene has been introduced into most dual purpose breed types in New Zealand and this together with the within breed variation means that ewes with base prolificacy of around 100% up to base levels approaching 200% have been infused with the Booroola gene. Research results have shown that the effect of the gene on ovulation rate is the same over a wide range of prolificacy (Piper *et al.*, 1984).

Live weight of ewes

Environment and management systems as well as breed type have a big influence on the live weights of breeding ewes. The F gene has been incorporated into sheep covering a broad spectrum of live weight—ranging from 40 to 50 kg hill and high country ewes to heavy (>60 kg) intensively farmed ewes.

These live-weight differences have a major influence on lambing percentage. A complicating factor has been the small size of the medium non-Peppin Merino from which the F gene has been taken and hence many F gene carriers retaining 25 to 50% of Merino type have been smaller sheep than their non Booroola contemporaries.

These factors mean that flocks with some ewes carrying the F gene range in performance from litter sizes of around 1.4 up to 3.0 or more. The management input required will obviously vary considerably within this wide range.

FLOCK PERFORMANCE

Low Prolificacy Flocks

In flocks with a low live weight and a lambing percentage in the 80 to 100% range an F gene frequency of 25 to 50% has given very worthwhile improvements in lambing percentage—in the order of 20 to 40%. This has kept the flocks within the range of easy care minimum shepherding inputs typical of hill and high country flocks. The number of triplets born has not been great because of the low base prolificacy. For triplets that are born in these flocks the survival of all 3 lambs is low.

Moderate Prolificacy Flocks

Moderate prolificacy flocks up to 130% comprise a big proportion of the New Zealand flock and it is these flocks that have had the biggest F gene input. These flocks also have a range of breed types, ewe live weights and management systems. Superimposed on top of this has been a range of frequencies of the F gene.

Some farmers from within this group now have groups of sheep within their flock which have a lambing percentage capability of around 200%. This is a large increase over the performance of the base breed ewes and has led to a search for new systems of identification, feeding and management. Typical of these flocks are the Moir Farm Booroola Coopworths, the performance of some of which is shown in Table 1.

The small flock of F1 Booroola Coopworths weighed only 46 kg and this may have influenced their litter size. The B1 Booroola Coopworth although having a lower gene frequency than the F1 ewes are heavier and have a very similar litter size to the F1 sheep. This litter size compares favourably to the 2.33 predicted from the gene frequency. Their rearing performance is however much better and reflects the better mothering ability and milking ability of the three-quarter Coopworth ewe. This is also shown in weaning weights at 12 weeks of age. These results were obtained under adverse lambing conditions after a particularly hard winter. However it is recognised that a large performance potential is not being realised through high lamb mortality and it is anticipated that achieving better lamb birth weights through higher ewe body weights and better ewe nutrition will help overcome this problem.

50% will carry the Booroola gene and generally these rams are sold in groups to ensure that some gene carriers are present. Because embryonic mortality has a large effect on eventual litter size, ovulation rate is a much better indicator of ewe genotype. Hence the use of laparoscopy is important in assisting identification of ewe genotype. Until recently, laparoscopy has only been available as a research tool and those flocks using the technique have been part of field trial research work. A commercial laparoscopy service is now available and provided numbers are sufficient the cost will be about $3 to $5 per ewe, provided the farmer can supply sufficient labour—usually 2 to 3 people. The main use to which this service has been put at present is to test groups of daughters from single sire matings so as to obtain a progeny test on Booroola sires to identify their genotype.

In some recorded flocks many F gene carrier ewes are identified and this gives the opportunity for selective management of carrier ewes. However in unrecorded flocks this possibility does not exist and hence 2 distinctly different populations of ewes are managed in the same way.

TABLE 1 1983 Lambing performance of Moir Farm Coopworth and Booroola Coopworth ewes born 1980.

	Elite Coopworth	F1 Booroola Coopworth	B1 Booroola Coopworth
Number	100	25	91
F gene frequency %	0	approx 75	approx 60
Coopworth breed type %	100	50	75
Live weight at mating kg	60	46	51
Lambs born/ewe lambing %	173	228	229
Lambs reared/ewe lambing %	146	156	184
Average weaning weight kg	23.6	21.9	22.9

High Prolificacy Flocks

The F gene has been used in Coopworth flocks which have lambing percentages close to 200%. The resultant progeny have a lamb drop of around 300%, however it is unlikely that this performance level will be sought by many New Zealand farmers in the forseeable future.

IDENTIFICATION OF F GENE CARRIER EWES

By using homozygous rams a farmer can be sure that all the progeny are heterozygous and hence give the performance expected of F gene carrier ewes. This offers many advantages and is likely to be one of the most attractive alternatives for the adoption of the F gene in commercial flocks. However very few of these rams are available at present and most so far identified are of Merino breed type. To date most rams used in New Zealand have either been guaranteed heterozygous progeny of homozygous rams or the progeny of heterozygous ewes or rams. In this latter group only

MANAGEMENT

Within a flock F gene carrier ewes should have different feeding priorities than non carrier ewes. High ovulation rates can be obtained from moderate live weight (45 to 50 kg) ewes carrying the F gene but as live weight has a big influence on lamb survival at birth it appears that mating live weight of F gene carriers is still an important consideration. As ovulation rate is responsive to nutrition in F gene carriers (Bray *et al.*, 1980) heavier ewes will produce more large litters which will create further demands in their management.

Pre lamb feeding of litter-bearing ewes is important from the ewe health point of view as well as having some effect on birth weight and milk production. Metabolic disorders have been a problem with some sheep carrying litters and it appears in most cases insufficient feed can be ingested to give the total nutrients required for the ewe in the last weeks of pregnancy. In Britain it has been found (Robinson, 1983) that protein requirements are particularly high in the last 3 weeks of pregnancy and although it may not be possible to meet the total energy requirements, a high protein supplement will allow protein requirements to be met.

Post lambing feeding of the ewe has the major influence on milk production and hence lamb growth rates to weaning. These feeding levels can be manipulated under intensive systems by segregating singles, twins and triplets post lambing. This practice is likely to become more common as management of F gene carriers intensifies. A high protein concentrate will increase milk production (Robinson, 1983) and should be evaluated under our pastoral conditions, especially where ewes are rearing triplets.

At present the farmer may or may not know the genotype of individual ewes, is unlikely to know the ovulation rate of individual ewes unless they have been laparoscoped for research or progeny test purposes and will not have an accurate assessment of the number of lambs being carried prior to lambing. This makes preferential feeding of litter carrying ewes difficult. An accurate, quick and relatively cheap means of indentifying ewes carrying 3 or more lambs would help accurate preferential management under intensive production systems.

BREEDING PROGRAMMES

In ram breeding flocks Booroola breeding programmes are now aimed at producing homozygous nucleus flocks of sheep of the breed type desired for that particular type of property. This breed type can be completely independent of the Merino background of the original Booroola sheep. However any breed incorporating the F gene must be able to successfully rear the increased number of lambs born so selection for productive traits such as milking ability and growth rate must be included in any breeding programme. High prolificacy allowing high culling levels increases the selection pressure which can be applied to these traits.

At present some heterozygous sheep approaching the desired breed type have been developed through a series of controlled back crosses and inter-breeding programmes commenced to breed homozygous nucleus flocks. An extensive progeny testing and laparoscopy programme is a necessary part of the programme to identify these homozygous sheep.

The immediate demand from ram buyers is for guaranteed heterozygous rams which will give the F gene to 50% of their daughters. For heterozygous rams to be available in increased numbers it is imperative that some homozygous sheep of the desired breed type be developed and identified. In the longer term the market demand will almost certainly swing to homozygous rams which will give a guaranteed performance boost to all their female progeny and hence help to overcome the genotype identification problems discussed earlier.

The use of meat breed terminal sires is likely to increase in flocks with a high lambing percentage. Increased birth weight of 0.5 kg can be expected from large terminal sire breeds (G. N. Hinch, pers. comm.) with associated improvement in survival rates of multiple born lambs. Also improved growth rates both pre and post weaning will give a better return on progeny from ewes not needed to breed replacement stock.

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