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## Structural characteristics of the sheepbreeding industry and implications for genetic and reproductive technologies

J.B. STEWART AND D.J. GARRICK

Department of Animal Science, Massey University, Palmerston North, New Zealand.

### ABSTRACT

The structure of the sheep breeding industry needs to be understood and documented in order to assess the possible gains resulting from the implementation of genetic and reproductive technologies. This paper reports a structural description of the sheep industry, which apart from census information obtained every 5 years has received little attention since 1948. The proportion of the national flock represented by the minor and 'unspecified' category of the breed census has increased from 1.7% (1979) to 18.4% (1989), suggesting the questionnaire format may be incapable of soliciting reliable responses from farmers utilising crossbreeding or developing composite breeds. The size of the national registered flock has been relatively stable, however there have been major changes in its composition. The Romney, although having sustained a 12.5% decrease in ewe and flock numbers over the last 5 years, is still the most popular registered breed. Somewhat greater reductions in ewe and flock numbers have occurred in the Coopworth, Border Leicester, and Perendale breeds. The Texel has proved to be the most influential of the recently imported exotic breeds and despite a relatively small number of registered ewes (4,745 compared with 130,937 registered Romney ewes), has the third largest number of flocks and second highest number of rams presented for registration. A comprehensive analysis of the Registered Romney breed indicates that only 32 studs (of 624) supply 78% of the sires used by other breeders. Another 31 studs use exclusively homebred sires and sell the remaining rams to unregistered breeders. These results indicate the cost-effective application of technologies for the improvement of genetic gain would be best focused on a subset of the ram breeding flocks. Benefits from the development of new technologies are reliant upon their cost-effective adoption by industry and their implementation by that subset of the sheep breeding industry achieving genetic progress.

Keywords: sheep census; breed composition; heirarchical structure.

### INTRODUCTION

Livestock industries usually include a sire breeding element and an element that utilises these sires in commercial environments. The relative sizes and nature of these elements constitute the structure of the industry from a breeding perspective. The structure of a breeding industry sets limits to the rate of genetic progress which can be achieved. Subsequently, the difference in genetic merit between animals in the sire breeding and commercial elements (genetic lag) can be directly related to structural characteristics (Garrick, 1993). Efficient structures facilitate and expedite the identification and exchange of genes, allowing accelerated rates of genetic progress and reduced genetic lags.

The development and implementation of new technologies is expensive, making it important they be utilised in a productive manner. An important step in ensuring this cost-effectiveness, is the identification of that subsector of the industry for whom these technologies are most beneficial from both genetic and economic points of view. The present study provides a structural description of the sheep breeding industry. Apart from periodic breed censuses, there is little published data since 1948 (Stevens, 1948). This information is a first step towards identifying influential individuals and groups within the breeding element.

The structure of livestock industries vary in complexity from isolated subpopulations through to hierarchical frameworks. The New Zealand sheep breeding industry has evolved a natural division in which a minority of

farmers have specialised in breeding sires while the majority have elected to maintain commercial operations based on sales of produce such as meat and wool. The breeding structure is thus characterised by two tiers: a 'nucleus' of ram-breeders, and a commercial sector reliant upon the breeders in the nucleus for the provision of sires. Traditionally the 'nucleus' in this two-tier model comprises registered animals and has been 'closed' in the sense that only the progeny of registered animals are themselves eligible for registration. The result is a nucleus which although numerically small constitutes the tip of the 'population iceberg' (less than 1% of the national total) and as the main source of industry sires has a significant influence on the rate and direction of genetic change.

Within the nucleus there may be further specialisation into a 'true nucleus' and a group of breeders serving as their multipliers. In this system the nucleus sell a proportion of their rams ('single-entered' in the case of registered societies) to multiplying flocks, which act as satellites and propagate the genes of the sires sourced from the nucleus to produce sons for sale to the commercial sector.

The impact of unregistered breeders, especially members of group breeding schemes has altered the traditional breeding structure within breeds (Meyer, 1979). These relatively independent groups (and individuals) not only produce their own replacement rams but also sell large numbers of rams directly to the commercial sector. In these groups, the nucleus is usually 'open' and commercial animals may be promoted to the nucleus based on certain performance criteria.

This study reports the current relative size and trends in the commercial and registered populations and details a classification of registered Romney breeders according to nucleus or multiplier function.

## METHOD

### Data and Analysis

The 1979, 1984 and 1989 breed censuses as carried out by Statistics New Zealand were the primary data source to determine the composition of the national flock. The 1994 census has been delayed and is scheduled for 1996. Available summaries include the number of sheep by age and sex itemised by the predominant breeds, and a category termed 'unspecified'. The unspecified category includes cases where breed has not been specified or where sheep are held on horticultural farms and other small farms not surveyed for that specific year (data estimated).

Breed Society Flockbooks were used to determine the size and nature of individual registered breeds. Flockbooks are updated annually and provide detailed information relating to the history and status of individual flocks. Data for each flock usually includes number of ewes retained from the previous year, two-tooth ewes home-bred, the number of lambs docked and the sires used in that particular season. At the end of the flock summaries a separate section details the rams that have been individually registered ('single-entered'). This includes their flock of origin, birth date, status (twin or single) and pedigree.

Flock returns from Breed Societies for 1989 were examined to provide a comparison of the registered flock with the 1989 census of the national flock. Recent trends were obtained from a comparison of 1989 and 1994 flock books. As most of the Breed Societies do not provide statistical summaries, flocks and their characteristics had to be analysed individually and collated to give overall breed numbers and details.

In order to gain a more comprehensive picture of the size and nature of the multiplier and nucleus sectors, a

detailed analysis of the Registered Romney flocks was also carried out. Each flock was examined according to the number of their own rams in use as well as the number of outside rams used. This involved recording every outside ram used in the 1994 season and tracking it back to the stud in which it was bred. The total numbers of rams contributed from each flock to other registered flocks were obtained, giving total counts that ranged from 0 to over 100 contributed outside rams.

## RESULTS

### The Commercial Population

The national flock has dropped from 70.3 million in 1983 to 49.5 million in 1994 (Statistics New Zealand) and the most recent estimate is 47.9 million (New Zealand Meat and Wool Boards' Economic Service Estimate), the fewest sheep for more than 30 years. Changes in breeds as a percentage of the total population are shown in Table 1. In the most recent breed census (1989) 18.4% of the total population was classified as minor breeds or 'unspecified'. Comparable figures from the previous surveys were 9.8% (1984) and 1.7% (1979). This represents a considerable increase over the 10 year period.

The contribution of dual-purpose breeds has declined from 80.4 to 74.3 and 66.2% between 1979 and 1989. As a proportion of the national flock, the Romney maintains its status as the most popular breed. Between 1984 and 1989 Coopworth and Perendale breeds suffered the largest percentage decreases of all breeds (Coopworth numbers dropped by 44% and Perendales by 55%). In contrast, Merinos showed the greatest relative increase, growing from 2% to 4.1% of the national flock.

### The Registered Population

In 1994 the total registered population stood at around 340,000 ewes, representing less than 1% of the national total. Between 1989 and 1994 the total number of registered animals declined by 8.5%. In comparison, the com-

**TABLE 1:** Numbers of ewes by breed in the national flock in 1979, 1984 and 1989

Breed	1979		1984		1989	
	Numbers (000's)	Proportion (%)	Numbers (000's)	Proportion (%)	Numbers (000's)	Proportion (%)
Romney	28,395	44.7	27,688	39.7	27,708	45.8
Coopworth	11,307	17.8	13,454	19.3	7,572	12.5
Perendale	11,372	17.9	10,641	15.3	4,782	7.9
Corriedale	4,954	7.8	3,844	5.5	2,736	4.5
Halfbred	2,394	3.8	2,459	3.5	2,311	3.8
Merino	1,280	2.0	1,441	2.1	2,481	4.1
Drysdale	589	0.9	571	0.8	547	0.9
Border Leicester	821	1.3	731	1.0	524	0.9
Borderdale	796	1.3	1,386	2.0	516	0.9
Dorset	92	0.1	116	0.2	89	0.1
South Suffolk	94	0.1	155	0.2	72	0.1
Suffolk	54	0.1	118	0.2	63	0.1
South Dorset Down	58	0.1	46	0.1	51	0.1
Southdown	165	0.3	76	0.1	22	0.0
Dorset Down	51	0.1	60	0.1	12	0.0
Minor, crosses & unspecified	1,095	1.7	6,804	9.8	10,935	18.4
TOTAL	63,517	100.0	69,590	100.0	60,421	100.0

Source: Department of Statistics, Census of Agriculture, 1979, 1984, 1989

mercial flock decreased by about 13%. The number of flocks registered for the 1989-1994 time period declined by 3.5% from 2,490 to 2,385, suggesting that in conjunction with the overall decrease in ewe numbers a decrease in the average registered flock size has also occurred.

The registered population had similar breed changes to the national flock. Results for a selection of the top breeds are in Table 2. The Romney is still the most popular registered breed despite a reduction of flock and ewe numbers. The largest decreases between 1989 and 1994 have been experienced by the Perendale, Border Leicester, and Coopworth breeds. In accord with the national flock, there has been a significant increase in the number of Merino ewes although the number of Merino flocks has declined.

The Romney still has the highest number of rams being registered and is followed by the Texel with 353 entries in 1994. The number of Suffolk and Dorset Down rams being registered increased by 30% between 1989 and 1994 while Perendale, Coopworth and Border Leicester single-entries have shown significant decreases.

**Analysis of Registered Romney Flocks**

A small proportion of the registered sector is responsible for the supply of stud rams to the remaining members of the Society. This confirms the previous findings that the majority of registered flocks take no active part in the breeding of stud rams (Stevens, 1948). Approximately 15 studs supplied 50% of the sires and around 32 studs supplied 78% of sires used by other registered breeders in 1994. A further 31 studs used only homebred sires and sold essentially all their sires to unregistered breeders. This implies that in relation to the Registered Romney breed the nucleus comprises at the most 63 breeders and that the majority of the 1,267 registered flocks are propagating flocks (multipliers) which supply rams to commercial flocks.

**DISCUSSION**

The sheep breeding industry in New Zealand has undergone a number of changes in size and breed compo-

sition, likely a response to market forces. The dramatic decrease in the size of the commercial flock reflects the rationalisation of sheep farming as a result of decreased profitability relative to other land usage.

Changes in breed composition reflect fluctuations in demand and shifts in consumer preference. Although their proportions may differ, the commercial and registered elements of the sheep breeding industry are clearly related, as evidenced by parallel trends in their size and composition. There is a general paucity of summarised statistical data for both groups, making the task of accumulating information an arduous one.

The analysis of the Registered Romney group indicates that only a small proportion of this breeding group is supplying rams to other group members. Only 63 flocks have the potential to independently influence the genetic merit of commercial flocks of Romney ewes which source rams from the registered sector. The number of studs that are contributing to increased profitability in their clients flocks may be less than 63 because genetic trends in some flocks may be non existent. Sub-optimal (or nil) trends can result from inadequate use of objective measurement techniques or from a failure to use breeding values and other indices derived from these measurements as a basis for selection.

The application and development of reproductive and genetic technologies has incurred considerable investment, historically and currently in New Zealand. The cost effectiveness of these technologies is dependent upon their adoption by that subset of the nucleus sector achieving genetic progress. The purpose of this study being the first essential step in identifying that subset.

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**TABLE 2:** Numbers of registered ewes, flocks and single-entry rams from selected breeds in 1989 and 1994

Registered Breed	Registered Ewes		Registered Flocks		Single-entry Rams	
	1989	1994	1989	1994	1989	1994
Romney	149,426	130,937	717	624	1,513	1,267
Coopworth	46,359	34,668	138	108	482	278
Perendale	25,194	21,510	123	86	233	189
Corriedale	24,443	21,434	124	103	293	224
Merino	18,791	24,848	92	86	246	231
Poll Dorset	18,299	16,556	156	135	163	139
Border Leicester	15,672	11,292	153	96	162	108
Suffolk	14,955	18,718	253	261	152	219
South Suffolk	8,469	9,243	135	110	95	94
Dorset Down	8,334	10,921	105	120	87	124
Lincoln	5,106	2,155	106	47	134	33
Texel	0	4,745	0	198	0	353
Total Other Breeds	32,958	29,847	388	411	283	349
<b>TOTAL ALL BREEDS</b>	<b>368,006</b>	<b>336,874</b>	<b>2,490</b>	<b>2,385</b>	<b>3,843</b>	<b>3,608</b>