Observations on Non-Nutritional Factors Affecting Fertility in Sheep

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INTRODUCTION:

FERTILITY has a peculiar fascination for both scientist and farmer, which is not entirely due to its undeniably predominant role in any livestock industry. As a result, many and varied have been the approaches towards a complete understanding of the physiology of reproduction, and the methods and factors capable of affecting fertility. Some have already been discussed this morning.

At this stage it is not proposed to introduce any new material approach to the many aspects of this problem, but rather to focus attention on three which have been already reported. The data presented relating to these aspects has been collected and analysed in the course of a general examination of factors affecting female fertility which is at present being carried out at Lincoln College. It is proposed to discuss these aspects under the following headings:—

1. The Relationship of the ewe's physiological fertility peak to her economic life.
2. The significance of breed fertility level.
3. The effect of photoperiodicity on fertility.

Material and Methods.

The College stud flocks of Romney, Southdown, Corriedale, Border Leicester and English Leicester sheep provided a wealth of suitable material for this survey. It will be appreciated that accurate flock records are essential if any conclusions are to be drawn. Fortunately such records had been kept in the ordinary routine of stud breeding and are available at the College. These cover many lambing seasons and this has allowed a preliminary study to be made of over three thousand breeding records during five successive seasons.

It is considered that comparisons between age groups in any one breed, and between breeds, are valid, as conditions for feeding and management have been substantially the same in any one year for all ages and breeds during that breeding season, and throughout pregnancy. Obviously, tupping has required the separation of the ewes on (a) a breed basis and (b) a sire basis, but as the sheep have been retained always on the College property and their distribution has been a random one, this factor could hardly be regarded as likely to be of a significant nature. From the cessation of tupping, both management and feeding have been the same for all breeds and ages.

Assessment of fertility has been made on the basis of each individual ewe having been "run with a fertile ram" during the mating season, and at the subsequent lambing, production of a full-time lamb either alive or dead.

Degrees of fertility have been determined by the number of multiple births which occurred.

The figures used to express percentage fertility for ewes in Auckland and Otago-Southland districts have been derived from lambing statistics over a period of four years, as published by the New Zealand Meat Producers' Board.

The yearly Light curve has been constructed from Sunrise and Sunset tables for Auckland and Dunedin, as shown in the Nautical Almanack, 1952. It must be noted that these figures have not been corrected for civil twilight factor, which would more clearly accentuate a difference already clearly apparent.

RESULTS AND DISCUSSION.

1. Physiological Fertility Level.

Fig. 1 is merely a summary of data in Table 1 and contains the records of the ewes of all ages in the four breeds—Romney, Corriedale, Southdown and Border Leicester.

The number of lambs per ewe mated has been plotted against the age of the dam at lambing. It would appear obvious that further records are necessary before any definite statement could be made as to the peak of fertility. But it is abundantly clear that there is an increase in fertility of a significant amount from the 2-year ewe to the 4-year ewe. In other words, the fertility level of 50 4-year-old ewes is 15 lambs higher than that of the same number of 2-year-old ewes, and the fertility level is still rising. Now it is common practice in other than stud flocks in New Zealand to cull the 5-year-old ewe from the flock. So here we have the anomalous situation of removing from the flock the most fertile ewes in order to replace with ewes at their lowest fertility level.

Naturally there are many considerations other than fertility which come into the picture at this point, such as teeth, udders, wool, "livability" and resale value, to mention a few. But it is suggested that these "other factors" may not add up to quite the same high total as we have been wont to imagine.

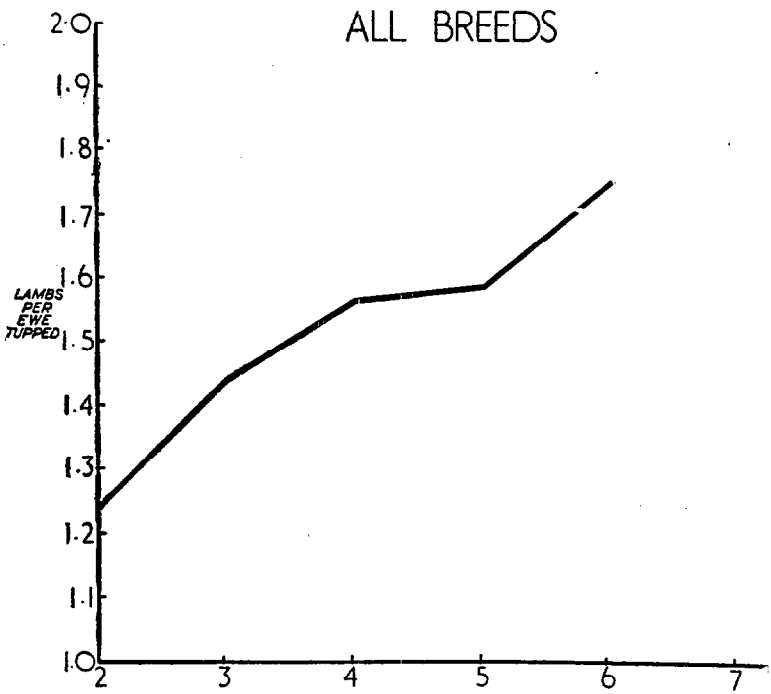

FIG. I.

A considerable amount of re-education might be necessary in order to adapt ourselves to the idea of retaining the 5-year-old ewe for one, or possibly two more years, if possible, in the flock. From the fertility level aspect, the approach might well be, how to keep the annual replacement of unprofitable two-tooths to the lowest possible minimum, thereby automatically raising the general fertility level of the flock.

Fig. 2 shows the fertility curves for the individual breeds and it is interesting to note here that the Romney fertility curve shows no sign of flattening, even at the seven-year mark. In spite of apparently quickly climbing to a near maximum fertility they have the capacity of maintaining this towards their peak, which is well beyond their present economic life. Table II.

The Corriedale breed gives evidence of its slower rate of maturity, it having the lowest 2-tooth level, but at the same time its potential fertility peak apparently approximates to that of he Romney. See Table III.

The Southdown certainly conforms to the general trend in reaching the peak of the fertility curve about the "full mouth" stage, yet it would appear to have a tendency to level off at least a year before the other breeds, doubtless due to its earlier maturity and shorter span of life. Table IV.

It would appear that the Border Lecister breed, Table V. also, like the Southdown, reaches its peak of fertility within the limits of its economic life. That peak likewise is correlated to its known slightly slower rate of maturity and is one year later than in the Southdown, although the subsequent decline may be more rapid.

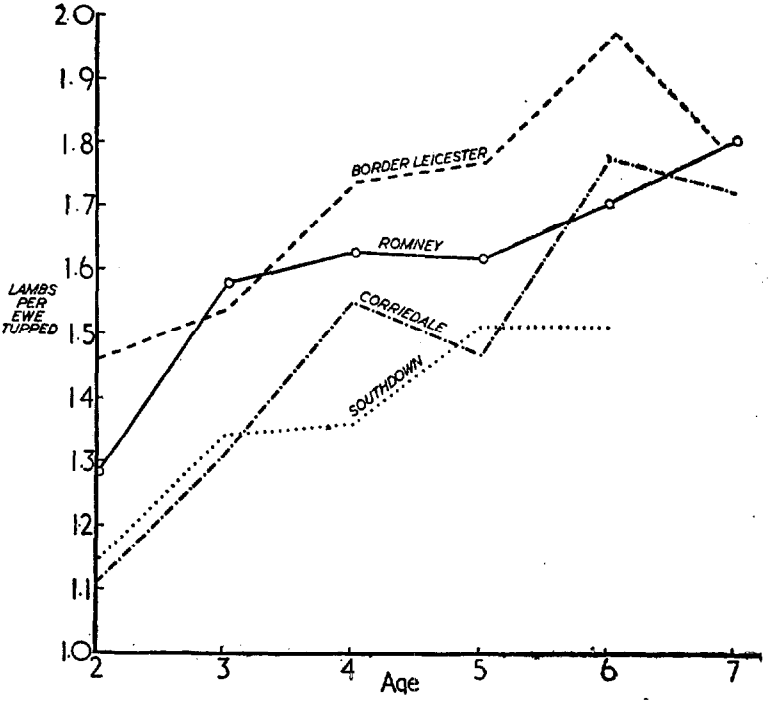

FIG. II.

2. The Significance of Breed Fertility Level.

That there exists a genetic variation between breeds as to fertility levels is shown by Fig 2, the Border Leicester being significantly higher than the other breeds, Romney, Corriedale and Southdown in that order.

An example of the application of this fact may be quoted: a North Canterbury farmer has for the last four years purchased nothing but twin Corriedale Rams from the College flock above. These have been mated to a mixed half-bred ewe flock and all female progeny continually bred back to the Corriedale rams from that point. The result is that he has raised the fertility level of his flock so that he tails 130 per cent, or over, regularly. In 1951 season 71 per cent of 2-tooths lambs were twins, compared with 52 per cent of the remainder of the ewe flock, thus depicting the gradual increase in concentration of the Corriedale higher fertility in the young sheep, which had been further raised by continual selection of **twin** rams.

3. The Effect of Photoperiodicity on Fertility.

This cannot now be disregarded, Yeates (1949) having induced oestrus in ewes during normal anoestrum by means of light on a decreasing plane. Hart (1950) also obtained similar results using fixed light rhythms, and was able to overcome lactation anoestrum. Hence it is now possible to increase the fertility of the ewe by initiating more than one breeding season a year through the use of suitable light-dark rhythms. That the organ initially stimulated, is the pituitary body seems clear (Clark, McKeown and Zuckerman 1938) and the path is thence to the ovaries. This gonadotrophic stimulation of the pituitary body appears to be due to its contrast-sensitive mechanism being stimulated by light-dark sequences (Hart 1951).

In sheep which are "short day" breeding animals the hypothesis that their pituitary activity varies inversely with the hours of daylight (Robinson 1951) seems well established. Robinson (1951) also points out that there may be a "threshold of pituitary activity" between breeds in this initiation of the onset of oestrus (Fig III). Thus there may well be an individual variation in pituitary activity within a breed, governed by that particular light-dark rhythm environment, in which it is situated. If this hypothesis of a quantitative threshold stimulating effect is accepted, then an interesting situation is shown by Fig IV, where wih the extremes of light and dark being wider apart at Dunedin than Auckland, perhaps a greater "contrast effect" is produced in terms of gonadotrophic stimulation on the pituitary body. The resulting

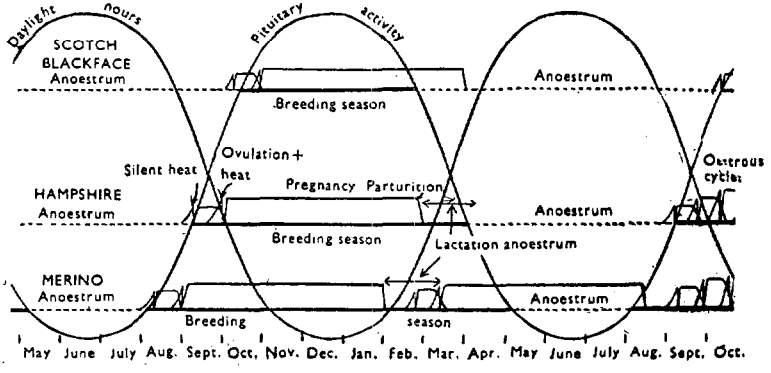

FIG. III.

Showing the differences in threshold of pituitary activity between breeds of sheep in the Northern Hemisphere (After Robinson).

increased pituitary activity may be reflected in the higher fertility level of the ewes in Otago-Southland than the ewes in Auckland. This difference appears to have stabilised itself at the 6 per cent level over a period of years. (Table VI). Expressed in terms of lambs, it means the same number of ewes in the Auckland province could produce over one hundred and ninety thousand more lambs annually if their fertility level were as high as the Otago-Southland group. The latter would suffer a loss of over a quarter of a million lambs annually if their fertility level fell as low as that of Auckland.

It appears therefore that, other factors being equal, the Otago-Southland natural light-dark environment is capable of increasing the fertility level of the ewe to a significant degree.

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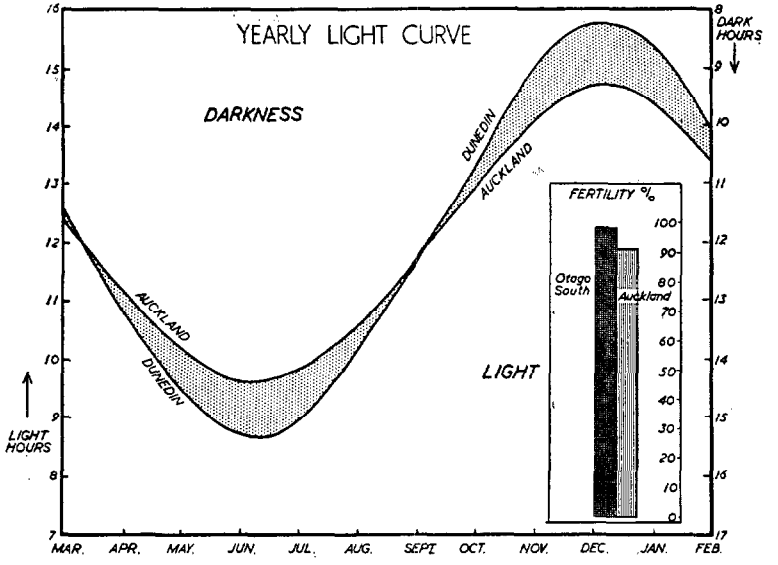

FIGURE IV.

TABLE I.

ALL BREEDS.

Dam's Age	Lambs	Ewes to Ram	L/E (Tupped)
2	1578	1271	1.241
3	1228	851	1.443
4	1008	644	1.565
5	649	409	1.586
6	345	197	1.751
		3372	

TABLE II.

ROMNEY ANALYSIS.

Dam's age at Lambing.	Lambs Twins	Total Triplets	Lambs Single.	Total Lambs.	Ewes Lambed.	Ewes to Ram.	Barren No.	Ewes. %	L/E (Lambed)	L/E (Tupped)
2	308		145	453	297	352	55	15.62	1.52	1.28
3	308		91	399	240	252	12	4.76	1.66	1.58
4	266		58	324	186	199	13	6.53	1.74	1.63
5	174		30	204	112	126	14	12.5	1.82	1.62
6	106		14	120	64	70	6	9.37	1.87	1.71
7	17		3	20	11	11	0	—	1.81	1.81

TABLE III.

CORRIEDALE ANALYSIS.

2	65		258	388	323	346	23	6.64	1.201	1.121
3	81+1		142	305	223	233	10	4.29	1.367	1.309
4	105		71	281	176	181	5	2.76	1.596	1.552
5	67+1		35	160	102	109	7	6.42	1.568	1.467
6	35+1		25	96	50	54	4	7.40	1.920	1.777
7	25+2		7	59	32	34	2	5.88	1.843	1.735

TABLE IV.

SOUTHDOWN ANALYSIS.

Dam's age at Lambing.	Lambs Twins	Total Triplets	Lambs Single.	Total Lambs.	Ewes Lambed.	Ewes to Ram.	Barren No.	Ewes. %	L/E (Lambed)	L/E (Tupped)
2	63		230	356	293	312	19	6.08	1.215	1.141
3	76		115	267	191	199	8	4.02	1.397	1.341
4	60+1		71	192	131	141	10	7.09	1.465	1.361
5	50		38	138	88	91	3	3.29	1.568	1.516
6	20		10	50	30	33	3	9.09	1.666	1.515

TABLE V.

BORDER LEICESTER ANALYSIS.

2	128	7	118	381	246	261	15	5.47	1.548	1.459
3	86	9	76	257	162	167	5	2.99	1.586	1.538
4	83	13	35	214	118	123	5	4.06	1.813	1.739
5	61	5	20	147	81	83	2	2.40	1.814	1.771
6	30	10	9	79	39	40	1	2.5	2.025	1.975
7	10	1	2	23	12	13	1	7.6	1.916	1.769

TABLE VI.

MEAN OF 4 YEAR PERIOD.

	Ewes Mated	Tailing Percentage	Lambs	
AUCKLAND	3,226,075	99	3,193,814	Theoretical
		93	3,000,249	Actual
			193,565	Theoretical increase
OTAGO	4,730,296	99	4,682,993	Actual
		93	4,399,175	Theoretical
			283,818	Theoretical decrease

Discussion

Dr .WALLACE: Is there any evidence that the extent of the contrast from long to short daylight is more effective than a gradual change in the light/dark radio in inducing the onset of oestrus?

Mr. HART: There is evidence to suggest a slight acceleration of oestrus onset through a complete change-over when compared with the gradual change. The complete change-over, to be effective, needs a dark to light ratio of approximately 2 : 1. It has been found that 8 hours dark and 4 hours light gives the same effect as 16 hours dark and 8 hours light.

Mr. SWAN: What are the effective wave-lengths?

Mr. HART: Within the visible spectrum range. The pituitary appears to be contrast-sensitive to visible light and nothing else.

Mr. CARTER: In considering the increase in fertility with age, there are smaller groups with increasing age. What is the effect of culling policy?

Mr. HART: In culling there was no conscious attempt to select for fertility. There was a slightly higher percentage culled in the 2-tooths but the difference was not significant.

Mr. SWAN: Would an increased culling rate at 5 years account for the drop in fertility at 5 years and the rise in fertility in the 6 and 7 year old ewe? I refer to general culling and not culling specifically for fertility.

Mr. HART: There is no evidence of this.

Dr. WALLACE: What is the level of fertility and oestrus behaviour in the tropics One would expect two seasons and a low level of fertility.

Mr. HART: The difference in behaviour between the blackface and the merino may reflect the fact that one is descended from high latitude stock, but there appears to be little information on the breeding behaviour of sheep in the tropics; what there is suggests a lower fertility level.