A Note on the Uniformity of Lambing Probability in Ewes

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Lambing data from five flocks of fine wool Merino ewes were examined to see if the distribution of numbers of ewes lambing or failing to lamb in each year was random. A random distribution implies that all ewes in a flock have the same chance of lambing in any one year.

Each flock was joined for mating for four successive years and details of lambing percentages in each year are shown in Table I.

The lambing performance of each ewe, whether it lambed or failed to lamb each year? irrespective of whether the lamb was reared or not, was examined. Two approaches were followed in analysing the data.

In the first approach the homogeneity of lambing probability for individual ewes in each flock was tested. For this purpose the binomial form of distribution of lambing was assumed. Each ewe lambed on a proportion (p) of the four occasions on which it was joined for mating. A X^2 test of homogeneity was applied to the p values for each flock. In only Flock B did this test reveal evidence of non-uniformity. When the second year's record for this flock was omitted the remaining three years showed no departure from homogeneity. Consequently it was concluded that the discrepancy in Flock B was confined to the second year, in which the lambing percentage was low.

The second approach was to compare the observed numbers of ewes which lambed on 4, 3, 2, 1 and 0 occasions with those expected when uniform chance of lambing within a year, and independence of lambing probability from year to year, are assumed.

Where the lambing percentage is assumed to remain constant as well, the results should follow the binomial distribution,

$$(p + q)^4 \qquad (1)$$

where p is the mean proportion of ewes lambing for the four years, and $q = 1 - p$.

The expected numbers so calculated were in very close agreement with those observed in Flock A (Table II) but did not agree so closely in other flocks.

To make allowance for the lower lambing percentage in the maiden year in Flocks C-E, frequencies were calculated from the expansion of the expression,

$$(p_m + q_m)(p_1 + q_1)^3 \qquad (2)$$

instead of the simple binomial expression,

$$(p + q)^4$$

where p_m is the proportion lambing as maidens, $q_m = 1 - p_m$,
p_1 is the mean proportion lambing subsequently, and
$q_1 = 1 - p_1$.

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TABLE I.

Percentage of Ewes which Lambed Each Year.

Flock	No. of Ewes	Age at 1st Lambing Period	Percentage of Ewes Lambed							Mean % Ewes Lambed over 4 Years
			1948	1949	1950	1951	1952	1953	1954	
A	478	3	92.5	94.6	85.6	73.0				86.4
B	219	2	80.4	67.6	90.4	84.9				80.8
C	120	2			46.7	74.2	97.5	91.7		77.5
D	166	3				66.3	98.8	95.8	96.4	89.3
E	179	2				69.3	98.3	96.6	95.5	89.9

TABLE II.

Number of Ewes Lambed 4, 3, 2, 1 and 0 Times in Four Matings.

Flock	Total No. of Ewes		No. of Times Ewes Lambed				
			4	3	2	1	0
A	478	Observed Nos.	270	163	40	3	2
		Calculated Nos.	266.4	167.7	39.6	4.1	0.2
B	219	Observed Nos.	102	79	27	9	2
		Calculated Nos.	93.5	88.7	31.5	5.0	0.3
C	120	Observed Nos.	38	60	19	2	1
		Calculated Nos.	38.4	59.1	19.9	2.5	0.1
D	166	Observed Nos.	101	59	6	0	0
		Calculated Nos.	100	60.8	5.1	0.3	0.002
E	179	Observed Nos.	112	63	3	1	0
		Calculated Nos.	112.6	61.0	5.3	0.2	0.0

The observed frequencies in Flocks C, D and E agreed very closely with the expected frequencies calculated in this latter manner (Table II).

When four years' data were included, Flock B did not give a close agreement with any modification of expression 2, and the closest agreement was with expected frequencies calculated from the simple binomial. These latter are quoted in Table II. Even this agreement was not satisfactory. However, when the results with Flock B in the second year are excluded, the agreement between observed and expected frequencies calculated from the binomial expression for the other three years' records is close (Table III).

TABLE III.

Flock B-Number of Ewes Lambed 3, 2, 1 and 0 Times in Three Matings.

Flock	Total No. of Ewes		No. of Times Ewes Lambed			
			3	2	1	0
B	219	Observed Nos.	139	65	13	2
		Calculated Nos.	135.6	70.5	12.2	0.7

Because the assumptions on which the expected figures were calculated include that of independence from year to year as well as that of uniformity among the ewes, the close agreement between observed and calculated numbers indicates that in four of the five flocks examined the chance of lambing in any year is not sufficiently affected by success or failure in preceding years to cause a significant departure from a random distribution for the whole flock.

It is concluded that in general no marked increase in the percentage of ewes lambing would be achieved by culling ewes which fail to lamb.