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**SAMPLING SCHEME TO GIVE AN ACCURATE
ESTIMATE OF BODY-WEIGHTS OF PULLETS AND
LAYING HENS**

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SUMMARY

Bulk and individual weighing procedures gave similar estimates of mean and variance of a hen population. Sample sizes to give an estimate of the population mean of a required accuracy for a large proportion of future samples are calculated. Recommendations are given for the size and frequency of sampling for body-weight during the rearing and laying period on commercial properties.

I. INTRODUCTION

Restricted feeding programmes for pullets can save feed costs and improve later egg production. However, severe restriction, particularly during the rearing period, can reduce life-long production. Hence, it is important to monitor the weight of birds during the rearing period, either to check on their natural weight pattern, or to ensure that their growth is not retarded by the restricted feeding.

In general, conditions on commercial properties preclude individual weighing of birds and bulk weighing in groups of 4 to 10 is all that is possible. Since it is impracticable to weigh all birds in a flock, problems of how many birds to weigh, and how frequently, must be considered. The sampling scheme needs to provide an estimate of the population mean accurate within prescribed limits. Weighings should be frequent enough to provide a reliable pattern of weight increase.

The experiment described in this paper compares the means and variances from bulk and individual weighing and develops recommendations for the size and frequency of sampling for body-weight on commercial properties.

II. MATERIALS AND METHODS

COMPARISON OF BULK AND INDIVIDUAL WEIGHINGS. At the Husbandry Research Farm, Rocklea, pullets were caged as 42 groups of 18 birds each. When the birds were 9 weeks old, they were weighed in two separate ways. Each group was arbitrarily split into two sub-groups of nine birds, each of which was bulk weighed. All birds were individually weighed so that their individual weights could be identified with the bulk weighing for each sub-group.

Analysis of variance was used to partition the total variation in body-weight for each weighing method. Variation between sub-groups gave an estimate of population variance for the bulk weighing, whereas variation between individuals was used for the other method. The F-ratio provided a test for differences between these two estimates. Differences in mean body-weight between bulk weighing and individual weighing over the 84 sub-groups were tested using Student's t-test for paired comparisons.

ESTIMATION OF SAMPLE SIZE. A sample from two commercial flocks each of 3 000 birds was weighed at weekly intervals from 8 weeks to 35 weeks of age. During the rearing period, birds were run into a constraining area from which they were weighed, initially as groups of 10 and later as groups of five. This procedure was repeated in four different parts of the shed with equal numbers of birds being weighed in each part. In the laying shed, cages to be sampled were selected from a table of random numbers and were marked with coloured tape for future reference. Birds were bulk weighed by cages so that the total weight only of groups of three to seven birds was available. The number of birds sampled at each weighing is given in tables 1 and 2.

The mean and variance of the weights were calculated for each sampling. These were used to predict the sample size to give an estimate of the population mean of required accuracy a large proportion of the time. The accuracy level was set at 0.025 of the estimated mean, and the 0.95 probability level was used so that this accuracy would fail to be achieved in less than 5% of future samples. Cochran (1963) gives the formula for the first approximation to the sample size, n , as:

$$n = \frac{t^2 s^2}{d^2}$$

where t = 5% point of Student's t-distribution with degrees of freedom corresponding to that for s^2

s^2 = estimate of population variance

d = required accuracy, here chosen as 0.025 of the estimated mean

He concludes that this first approximation is adequate unless the estimated sample size exceeds 10% of the population, when finite population correction need be applied.

III. RESULTS

COMPARISON OF BULK AND INDIVIDUAL WEIGHINGS. The population variance estimated from bulk weighing was 0.007 3 with 42 degrees of freedom. In comparison, the individual weighings gave a variance estimate of 0.006 2 with 672 degrees of freedom. These two estimates do not differ significantly ($P > 0.40$) which indicates that bulk weighing can provide a reliable estimate of population variance.

The bulk and individual weighing procedures gave estimates of the population mean of 0.710 and 0.711 kg respectively. These were not significantly different ($P > 0.50$), so the bulk weighing procedure gives an unbiased estimate of the population mean.

TABLE 1

AGE, ACTUAL SAMPLE SIZE, MEAN, VARIANCE AND ESTIMATED SAMPLE SIZE FOR FLOCK 1
(HATCHED 27-8-73)

Age (days)	Actual Sample Size	Mean (kg)	Variance	Estimated Sample Size
88	250	0.77	0.016 6	180
102	250	0.83	0.022 1	208
116	250	1.08	0.026 0	144
129	250	1.22	0.047 2	205
144	250	1.36	0.046 4	162
161	199	1.62	0.021 7	55
165	191	1.65	0.050 4	123
172	134	1.69	0.024 4	58
182	175	1.68	0.063 7	150
189	178	1.71	0.031 1	71
203	146	1.69	0.034 3	81
217	137	1.74	0.042 1	94
232	123	1.79	0.052 7	113
245	124	1.75	0.076 2	169
260	148	1.83	0.054 8	110

TABLE 2

AGE, ACTUAL SAMPLE SIZE, MEAN, VARIANCE AND ESTIMATED SAMPLE SIZE FOR FLOCK 2
(HATCHED 24-9-73)

Age (days)	Actual Sample Size	Mean (kg)	Variance	Estimated Sample Size
60	250	0.39	0.004 6	198
67	245	0.38	0.026 8	1 180
74	250	0.44	0.001 7	58
84	250	0.58	0.014 3	274
88	250	0.62	0.011 6	195
95	250	0.70	0.014 3	189
101	250	0.78	0.014 2	153
109	250	0.83	0.023 2	220
116	250	0.93	0.025 4	189
133	250	1.09	0.016 7	92
137	245	1.11	0.033 9	179
144	250	1.25	0.067 7	279
154	149	1.53	0.137 5	388
161	246	1.54	0.062 2	171
168	234	1.58	0.062 7	163
175	214	1.63	0.054 0	133
182	215	1.71	0.035 4	79
189	212	1.71	0.047 5	106
196	211	1.76	0.045 4	95
204	202	1.78	0.031 3	65
217	190	1.78	0.045 7	94
232	196	1.83	0.048 3	95

ESTIMATION OF SAMPLE SIZE. Tables 1 and 2 present sample size, mean and variance summarizing the weights observed at intervals of 1 and 2 weeks for the two flocks. Estimated sample sizes are also tabulated for each weighing. Since these estimated sample sizes represent less than 10% of the population for all but two weighings, finite population corrections have not been applied.

The weights increase steadily during the rearing period up to sexual maturity. After this they increase more slowly. Variability tends to be higher during the onset of sexual maturity within the flock at between 16 and 26 weeks of age.

IV. DISCUSSION

The accuracy level for the estimated population mean was chosen as 0·025 of the expected mean for the present investigation. Other values could be appropriate in different circumstances with sample sizes estimated from the same formula but using different values for *d*. The accuracy could also be specified as a definite value, 50 g, for example. With the birds increasing in weight rather rapidly during the rearing period, a fixed proportion of the expected mean rather than a definite value was considered as the most appropriate way to specify accuracy.

Although the mean weight followed a regular pattern with the age of the birds, variance fluctuated irregularly from week to week. The estimated number of birds to be sampled demonstrated similar fluctuation. This irregularity cannot be readily explained but should be recognized as normal, especially for a commercial property.

From an overall assessment of these results the sampling schemes recommended for future work involving body-weights is as follows—

1. weigh 200 to 250 birds every 2 weeks from the start of the investigation at about 8 weeks of age up to 16 weeks.
2. weigh 200 to 250 birds every week from 16 weeks to 26 weeks.
3. weigh 150 to 200 birds every 4 to 6 weeks after 26 weeks of age.

The recommended number of birds to sample is slightly higher than given in tables 1 and 2. This number is not affected by the size of the flock, unless it has fewer than 2 500 birds. Weekly weighing over the period of sexual maturity allows body-weight changes to be followed more closely. The decrease in frequency of weighing after peak production is warranted because of the much slower increase in weight.

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REFERENCES

COCHRAN, W. G. (1963).—“Sampling Techniques”. (2nd ed., Wiley: New York.)

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