MULTIPLE SHORT EGG PRODUCTION CYCLES

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SUMMARY

During an extended laying period terminating at 120 weeks of age birds of two strains were subjected to short production pauses at 20-week intervals, each pause being induced by feeding uncrushed barley for either five or eight days, Performance was compared with that of birds subjected to two long pauses induced by feeding barley for 21 days at 70 and 104 weeks or for 28 days at 65 and 104 weeks. A fifth (control) group was paused once only at 104 weeks by feeding barley for 21 days.

Total egg number of the five-day pause birds was similar to that of the control birds at 60 and 80 weeks of age and similar to that of the long pause birds at 100 and 120 weeks. Total egg number of the control group at 100 or 120 weeks was lower than that of any other group, and total egg number of the eight-day pause group at 60 or 80 weeks was lower than that of any other group. The short pause birds produced more large eggs than the controls in each 20-week cycle from 60 to 120 weeks. Substantial improvements in egg specific gravity and Haugh unit score immediately following each pause were lost within 28 weeks unless the birds were paused again during that time. The length of the pause inducement period had little effect on liveweight loss (10-17%) during the pause.

INTRODUCTION

Although laying flocks are generally kept for a single production cycle of 50-60 weeks duration, under some economic conditions it is profitable to retain the flock for a second cycle of 30-40 weeks (Emmans 1974). This is most satisfactorily achieved by a rejuvenation process in which the birds are induced to moult, discard a substantial proportion of body weight and remain out of lay for up to six weeks (Baker et al. 1981). As compared to the single cycle strategy, the general effects of the double cycle include lower bird depreciation and increased egg size, but considerably fewer eggs of marketable quality. In Australia the double cycle tends to be used impulsively as a management tool to manipulate total flock size, or speculatively to take advantage of anticipated changes in the supply and demand for large grade eggs. From this point of view, however, the conventional double cycle programme lacks sufficient flexibility, since the times of commencing and ending the second phase are dictated by flock age and performance rather than by market conditions. This drawback would largely disappear if a technique could be devised for employing cycles of short or variable duration commencing at any desired age.

Given a particular cost/price structure, the age at which a laying flock ceases to be viable depends largely upon the rate of decline in egg output and the rate of increase in the proportion of second quality eggs. A problem of particular concern in Australia is the steep early decline in egg quality (shell strength and albumen thickness) which may be related to climate and genetic factors. It is well known that egg quality parameters are much improved after inducing a production pause, and remain superior to those of unpaused birds for some time (Decuypere et al. 1987). However, by the time a conventional pause is implemented at 65-70 weeks of age, the deterioration in egg quality will already have had a considerable economic impact. If it is feasible to begin a new production cycle at 40-55 weeks of age, much of this damage might be avoided. A series of short production cycles would have the effect of maintaining a relatively high level of quality.

While the concept of recycling might be considered to be advantageous from a welfare point of view because the life of the bird is greatly extended, a disadvantage of the conventional pausing technique is that it uses harsh measures to achieve the desired results. Short pauses using less traumatic techniques are evidently satisfactory provided that the subsequent production phase is also short (Creger and Scott 1980; Karunajeewa et al.

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1989). There is also a possibility that multiple short cycles may permit a greater extension of productive life than conventional rehabilitation techniques.

The scientific literature appears to be devoid of reports on multiple short production cycles. A small trial (still in progress) was therefore set up to investigate the potential of these strategies as compared with those which use a single long pause followed by a long second cycle. However, since the trial extended well beyond the normal age of disposal of conventionally managed flocks, the long-cycle birds were paused a second time at 104 weeks of age and the control birds were also paused at the same time.

MATERIALS AND METHODS

Pullets of two strains, A and B, (SIR0 CB and Tegel Super Tint respectively) were reared to 22 weeks of age using a restricted feeding programme from six weeks onwards. At 18 weeks of age 288 pullets of each strain were distributed into the experimental accommodation which comprised six blocks of twelve layer cage units, each unit consisting of four adjacent two-bird cages served by a common feed trough. Within each block six units were allocated to strain A and six to strain B; four husbandry treatments were allocated to four units in each set of six and a fifth (control) treatment was allocated to the other two units. The five treatments are described below:

C	Control. Birds were not paused until 104 weeks of age, when a 21-day barley feeding period was used to induce a pause
L21	Long cycles using a 21-day barley feeding period to induce a pause at 70 weeks of age and again at 104 weeks
L28	Long cycles using a 28-day barley feeding period to induce a pause at 65 weeks of age and again at 104 weeks
MS5	Multiple short cycles using a 5-day barley feeding period to induce a pause at 40, 60, 80 and 100 weeks of age
MS8	Multiple short cycles using an 8-day barley feeding period to induce a pause at 40, 60, 80 and 100 weeks of age.

Except during pause inducement periods, all birds received a high quality layer diet throughout the trial. Production pauses were achieved by replacing the layer diet by uncrushed barley only (treatments MS5 and MS8) or by uncrushed barley and granulated limestone (treatments L21 and L28) for the specified length of time. Water was available from nipple drinkers at all times.

From 20 to 120 weeks of age egg production, feed intake and mortality were recorded continuously and appropriate observations were made of live weight, egg mass, egg specific gravity and albumen quality (Haugh unit score), Production, feed intake and egg mass data were analysed by analysis of variance for five successive 20-week periods from 20 to 120 weeks of age (hereafter referred to as periods 1-5) corresponding to the five production phases of the multiple short cycle birds. Much of the available egg specific gravity and Haugh unit data were analysed by analysis of variance at suitable intervals and trend lines were fitted to data within each 20-week period.

RESULTS

Overall performance in each short cycle

Egg number per bird, feed intake per bird and mean egg size in each of the five 20-week production phases (periods 1-5) and the cumulative egg number and feed intake to the end of each period are shown in Table 1.

Mortality rates did not differ significantly between husbandry treatments at any stage of the experiment. Mean mortality rates from 20 to 80 and 120 weeks of age were respectively 7.3% and 14.2%. In period 1, when all birds were treated identically, as might be expected the husbandry treatments did not differ significantly in respect of total egg number per bird, total feed intake per bird, mean egg mass, mean specific gravity of eggs, mean Haugh unit score of eggs, mean live weight gain or mortality. However the two strains of bird were significantly different in all these respects and, except for mortality rates which were similar in both strains after period 1, these differences tended to remain throughout the length of the trial.

TABLE 1 Treatment mean egg production, feed intake and egg mass in each 20 week period preceding inducement of a production pause in the birds subjected to multiple short pauses

Period	Treatment[1]	Number of eggs/hen[2]		Feed intake/hen[2]		Mean egg mass[2] (g/egg)
		in period	total	in period (g/day)	total (kg)	
1 20-40 weeks	C	94.4	-	108.7	15.22	56.07
	L21	96.2	-	106.2	14.87	56.42
	L28	96.2	-	106.7	14.94	55.93
	MS5	96.7	-	108.7	15.22	56.65
	MS8	94.8	-	106.7	14.93	56.12
2 40-60 weeks	C	114.4^{b}	208.8^{b}	120.0^{ab}	32.02^{ab}	59.81^{a}
	L21	117.2^{c}	213.4^{b}	121.0^{ab}	31.80^{ab}	60.51^{a}
	L28	118.0^{c}	214.2^{b}	121.4^{ab}	31.93^{ab}	59.56^{a}
	MS5	112.6^{b}	209.3^{b}	123.1^{b}	32.45^{b}	61.96^{b}
	MS8	107.5^{a}	202.3^{a}	115.7^{a}	31.12^{a}	60.69^{a}
3 60-80 weeks	C	97.4^{b}	306.2^{ab}	119.7^{b}	48.78^{b}	62.58^{a}
	L21	88.3^{a}	301.7^{ab}	113.2^{a}	47.64^{ab}	62.67^{ab}
	L28	88.0^{a}	302.2^{ab}	113.7^{a}	47.86^{ab}	61.44^{a}
	MS5	99.9^{b}	309.2^{b}	120.8^{b}	49.37^{b}	64.28^{c}
	MS8	96.3^{b}	298.6^{a}	116.4^{ab}	47.42^{a}	63.80^{bc}
4 80-100 weeks	C	71.4^{a}	377.6^{a}	105.4^{a}	63.54^{ab}	64.17
	L21	90.9^{b}	392.6^{ab}	114.2^{b}	63.64^{ab}	64.73
	L28	90.1^{b}	392.3^{ab}	111.7^{bc}	63.50^{ab}	63.86
	MS5	86.1^{b}	395.3^{b}	110.9^{abc}	64.89^{b}	63.90
	MS8	83.6^{b}	382.2^{ab}	107.1^{c}	62.40^{a}	64.48
5 100-120 weeks	C	48.0^{a}	425.6^{a}	105.9	78.37^{ab}	66.77
	L21	63.1^{b}	455.7^{b}	110.7	79.14^{bc}	67.85
	L28	61.9^{b}	454.2^{b}	108.5	78.70^{ab}	66.49
	MS5	66.7^{b}	462.0^{b}	109.8	80.27^{c}	67.23
	MS8	64.5^{b}	446.7^{ab}	106.7	77.34^{a}	67.49

[1] Treatments: C - control (21-day pause inducement at 104 weeks), L21 - 21-day pause inducement at 70 and 104 weeks, L28 - 28-day pause inducement at 65 and 104 weeks, MS5 and MS8 - 5 and 8-day pause inducement at 40, 60, 80 and 100 weeks

[2] Values within columns and periods having a common superscript are not significantly different ($P<0.05$)

In period 2 the number of eggs laid by treatment MS8 birds was lower ($P<0.01$) than that of treatments which had not so far been paused, resulting in a lower ($P<0.05$) total number of eggs to 60 weeks than for two of these treatments (L21 and L28). Although egg production of the MS5 birds was lower ($P<0.05$) than that of treatments L21 and L28 in period 2, the production of the MS5 birds for periods 1 and 2 combined was not significantly different from that of any other treatment. Mean egg mass for treatment MS5 was higher ($P<0.05$) in period 2 than that of any other treatment. Mean feed intake of the MS8 birds in this period was lower ($P<0.05$) than that of any other treatment.

In period 3 the L21 and L28 birds, which were paused during this period, laid fewer ($P<0.001$) eggs than the other groups and consumed less ($P<0.05$) feed than the C and MS5 birds. At the end of this period the total egg number of the MS5 birds was higher while that of the MS8 birds was lower than that of the other treatments (non-significant). Mean egg mass in period 3 was higher ($P<0.05$) for treatments MS5 and MS8 than for treatments C and L28, and higher ($P<0.05$) for treatment MS5 than for treatment L21.

In periods 4 and 5 the rate of lay of the control group (C) was lower ($P<0.01$ to $P<0.001$) than that of any other group. At the end of period 4 the total production of treatment MS5 was higher ($P<0.05$) than that of treatment C, although the difference was greater (20.8 eggs) for strain A than for strain B (14.6 eggs). At the end of period 5 these differences had increased to 46.7 and 26.0 eggs respectively and at this stage treatments L21 and L28 were also significantly ($P<0.05$) ahead of treatment C with strain A again being more advantaged by the pause treatments. There were no overall differences between husbandry treatments in egg size during these periods, although birds of strain B on treatment L28 laid smaller ($P<0.05$) eggs than those on the other treatments. In period 4 the L21 and L28 birds consumed more ($P<0.05$) feed than the C birds. Cumulative feed intake up to the end of period 5 was lower ($P<0.05$) for the MS8 birds than for the L28 or MS5 birds, and higher ($P<0.05$) for the MS5 birds than for the C or L28 birds.

Temporary effects of pause inducement

A summary of the short-term effects of pause inducement in relation to age at commencement of pause, type of pause and rate of lay prior to pause inducement appears in Table 2. Mean daily barley intake increased with increasing length of the pause inducement period (PIP) and appeared to be unrelated to the age of the birds at start of the pause. Live weight loss due to a long PIP (21-28 days) was only slightly greater than for a short PIP (5-8 days). The birds recovered 50-70% of this loss during the three days after ending a short PIP or during the six days after ending a long PIP. The minimum rate of lay achieved during the PIP appeared to be unrelated to the pause treatment, although there was more variation when short pauses were used. Both strain of bird and length of pause contributed to this variation, but not in a consistent way. All pauses except MS5 and MS8 at 100 weeks of age resulted in generally higher rates of lay than those immediately prior to pause inducement. Treatment MS5 and MS8 birds reached a peak rate of lay approximately 25 days after terminating the PIP, while the L21 and L28 birds took approximately 29 days. Pause inducement was invariably accompanied by considerable feather loss, followed by regrowth, but no comparisons of plumage condition were made.

Effects of Pause inducement on egg quality

Linear regressions of egg specific gravity (SG) and Haugh unit score (HU) against age of bird are graphed in Figs. 1 and 2. As there were generally no significant differences between treatments MS5 and MS8 for either of these parameters, data from these treatments have been pooled. SG of control eggs declined from 1.089 at 24 weeks of age to 1.075 at 100 weeks and HU declined from 89.9 to 73.5 over the same period. Following each short pause, SG of MS5 and MS8 eggs was 0.0035 to 0.0052 higher ($P<0.05$ to $P<0.01$) than the control values, while HU was 3.0 to 7.3 points higher ($P<0.05$ to $P<0.01$), the latter margin increasing with each successive pause. However the rate of SG decline of eggs from short-paused birds within each period was greater than that of the control eggs, so that the difference at the end of the period was only 0.0010 to 0.0020; a similar though less pronounced trend was observed for HU. Following a long pause at 65 or 70 weeks (treatments L21 and L28), SG was 0.0056 to 0.0062 higher ($P<0.001$) than the control values, while HU was 7.8 points higher ($P<0.001$). These margins diminished greatly with age, all values except for L21 HU being similar to the control values by 100 weeks of age. The effects on SG and HU due to pausing at 104 weeks (treatments C, L21 and L28) were apparently uninfluenced by the previous history of the birds.

TABLE 2 Temporary effects of pause inducement as affected by age and length of pause

Treatment	C	L21		L28		MS5 and MS8			
Age at start of PIP[*] (wks)	104	70	104	65	104	40	60	80	100
Duration of PIP (d)	21	21	21	28	28	5-8	5-8	5-8	5-8
Rate of lay before PIP (%)	38.5	76.1	54.5	79.4	54.5	89.4	79.9	73.0	60.2
Barley intake (g/bird/day)	62	50	61	69	67	19	25	14	17
Min. rate of lay in PIP (%)	3-6	4-5	3-8	9-10	3-5	0-12	3-10	0-7	0-14
Livewt. loss during PIP (%)	14	13-17	11-14	13-16	11-13	11-15	10-14	13-15	10-13
Days from start of PIP to return to:									
50% rate of lay	52	33	36	40	39	18	20	21	22
peak rate of lay	59	53	52	51	56	28	35	35	27
Post-pause peak rate of lay (%)	51-54	82-84	59-70	77-84	63-67	89-95	83-89	73-81	54-66

[*] PIP = pause inducement period during which barley was fed

Fig. 1. Effect of treatment and age of bird on egg specific gravity

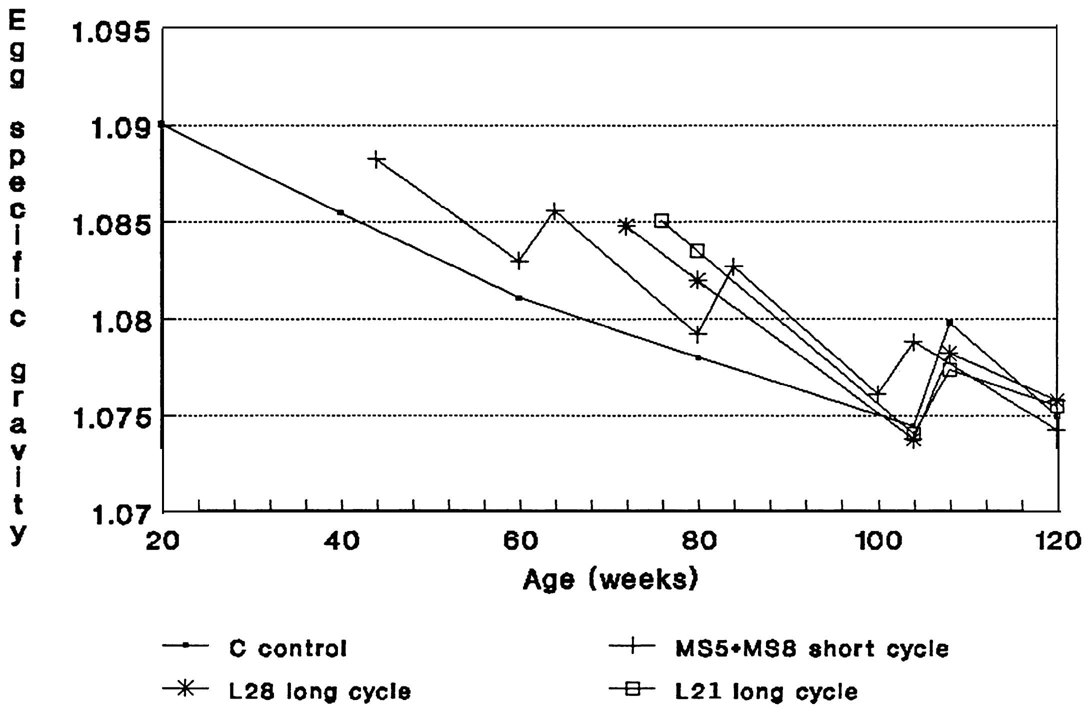
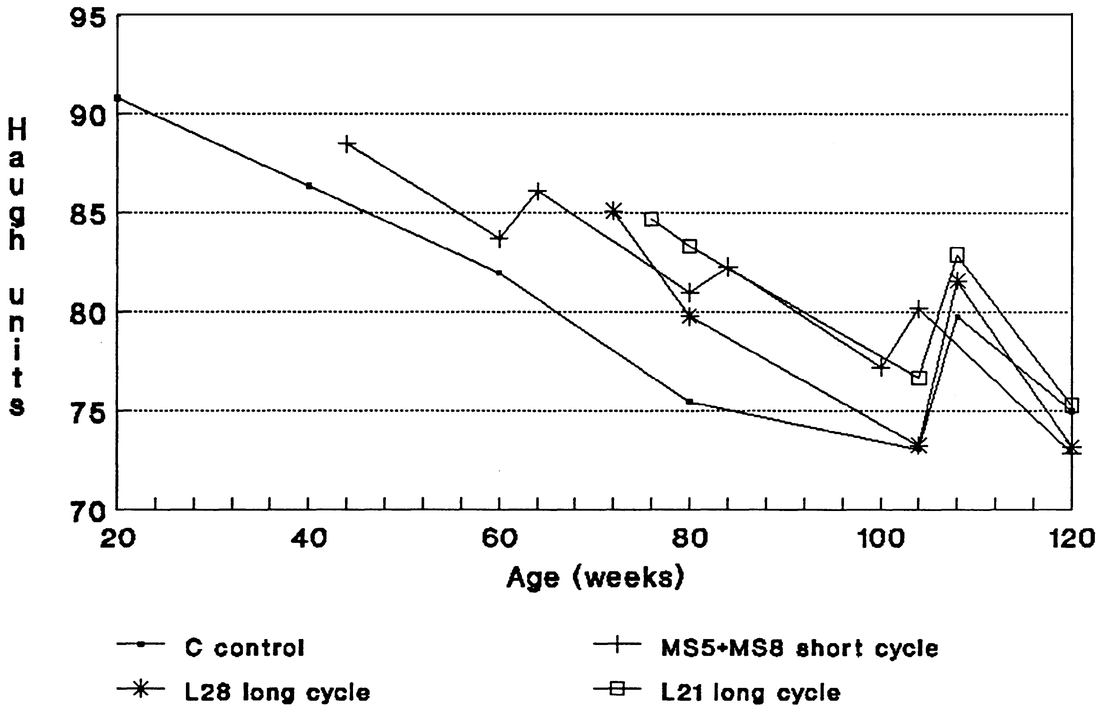


Fig. 2. Effect of treatment and age of bird on Haugh unit score



DISCUSSION

While the results of the two long cycle treatments were comparable in most respects at all stages of the trial, the two short cycle treatments appeared to differ in egg output and feed intake, with lower values being associated with the eight-day pause treatment. No clear reason for these differences could be found by'considering the immediate effects of pause inducement: liveweight losses and minimum rates of lay during the pause inducement period were comparable, as were the times taken to resume production. Body weight loss over the pause inducement period was remarkably little affected by the length of the pause, presumably because after the first four to five days barley intake quickly rose to an adequate level for maintenance. The liveweight losses accompanying all the pauses were only about half as great as those formerly considered desirable to achieve an effective pause (Baker et al. 1981).

Up to 100 weeks of age the performance of the five-day short pause birds (at this stage paused three times) was similar to that of the long cycle birds (paused once) and clearly superior to that of the control birds (unpaused). At 120 weeks of age the five-day short pause birds appeared to have the advantage over the long pause birds, but this may have been temporary as the latter birds had the higher rate of lay at this stage.

The absence of a consistent effect of pausing on average egg weight at any given age is in agreement with most other reports (Lee 1982; Christmas et al. 1985). Although there were occasional differences in egg mass favouring some of the pause treatments, in particular MS5, this can probably be ascribed to a greater wastage of large eggs laid by the control birds due to weaker shells (Roland and Bushong 1978). All the production pauses were followed by substantial improvements in shell quality (as indicated by egg specific gravity measurements), although this effect was totally lost within 28 weeks (long cycle birds). A similar pattern was evident for Haugh unit score, but the rate of deterioration was less pronounced; the short cycle birds maintained a substantially higher average Haugh unit score than the control birds until the latter were paused at 104 weeks of age. Since the egg production of the five-day short pause birds was similar to that of the control birds up to 60-80 weeks of age, it would appear that multiple short cycles offer a means of improving egg quality within the normal lifespan of a commercial laying flock. Moreover compared with the conventional single cycle strategy, the multiple short cycles resulted in a much greater number of large eggs towards the end of the normal laying year and a higher proportion of large eggs overall. This suggests a further possible use of multiple short cycles to manipulate the timing of the production phases to match periods of high demand for large eggs.

The relative profitability of multiple short cycle, long double cycle and single cycle strategies cannot be assessed by considering arbitrary production cycle lengths and cut-off points such as those used in the current trial. A model is required to enable optimum cycle length, ages of pausing and total flock life to be determined under various cost/price structures. While the construction of an economic model is essential for the proper evaluation of multiple short cycles, this enterprise is beyond the scope of the present paper, which has sought only to provide physical data for use with such a model.

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