Strategies to Improve Moulting Practice and Reduce Reliance on Beak Trimming

A report for the Australian Egg Corporation Limited

by Peter Cransberg and Greg Parkinson

July 2005

AECL Project No VAG-1A

ISSN 1448-1316

Title of publication
Project No VAG-1A

Researcher Contact Details

Name:	[Mr Peter Cransberg]
Address:	[Primary Industries Research Victoria, 475 Mickleham Rd, Attwood 3049]
Phone:	[(03) 9217 4200
Fax:	[(03) 9217 4299]
Email:	[peter.cransberg@dpi.vic.gov.au]

In submitting this report, the researcher has agreed to AECL publishing this material in its edited form.

AECLContact Details:
Australian Egg Corporation Limited
A.B.N: 6610 2859 585
Suite 4.02, Level 4
107 Mount Street
North Sydney NSW 2060

Phone:	02 9409 6999
Fax:	02 9954 3133
Email:	irene@aecl.org
Website:	http://www.aecl.org

Published in July 2005
Published only on the web

Foreword

This report focuses on three issues confronting the Australian Egg Industry; the use of moulting as a means of extending the laying period of commercial egg layers, establishing best practice flock body weight distributions, and reducing the reliance on beak trimming as a means of controlling cannibalism. Each are important issues for the Australian egg industry but for different reasons.

Moulting has the potential to lower the high cost base of the Australian egg industry primarily by reducing pullet depreciation. Other advantages of moulting come from increased flexibility in capturing sudden changes in egg supply and improvements in cash flow management. As a long-term strategy, the Australian egg industry should be assessing options such as moulting to lower the cost base for egg products. There are also strong arguments for some fundamental research to examine the questions of flock longevity, from both a welfare and resource allocation standpoint. The moulting work has 3 primary objectives. The first is to provide egg producers with a simple economic model which will allow producers to assess the financial implications of keeping birds for a second cycle. Obviously if producers are to adopt moulting as a regular part of their replacement program then it must be financially viable. The second objective is to develop a commercial moulting program that demonstrates financially viable post-moult egg production and the third is to provide a recommendation to industry on improved management strategies for moulting that addresses welfare issues and is considered humane practice.

The issue of body weight management has been researched by PIRVic for a number of years. Research undertaken on flocks with different average body weights has clearly demonstrated that the incidence of cloacal haemorrhage is markedly increased in birds with low body weights (EGG 99-06, EGG01-10). Despite the lack of definitive causal linkages, there is a high probability that significantly under weight birds in multiple bird cages will experience a high incidence of cloacal haemorrhage, and that secondary beak trauma to the cloacal haemorrhage will result in cessation of egg production and mortality. There is a strong argument therefore to undertake studies of flock body weight distributions amongst the elite high technology farms for both cage and barn systems, to identify management and technology that can be used to influence the proportion of under weight birds. Producers will be encouraged to develop strategies to lower the incidence of under weight birds, and the correlations between the proportion of under weight birds with overall mortality will be calculated. By targeting the best producers with the latest technology and the best body weight management strategies, it may be possible to identify models achieving hen housed egg production of 320-330 eggs, and 2-3% annual mortality with no reliance on routine beak trimming.

This project was funded from industry revenue which is matched by funds provided by the Federal Government.

This report is an addition to AECL’s range of research publications and forms part of our R&D program, which aims to support improved efficiency, sustainability, product quality, education and technology transfer in the Australian egg industry.

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Irene Gorman
Research Manager

Acknowledgments

The authors would like to acknowledge the AECL and the Victorian Department of Primary Industries for their financial support of this project. The support of all producers who allowed us access to their farms and provided information as required is also gratefully acknowledged. Finally the managerial assistance of Mr Ryan Peacock, Longerenong Poultry Facilities Manager, is gratefully acknowledged.

About the Authors

Dr Greg Parkinson has been with the Primary Industries Research Victoria for the past 17 years after completing a PhD at Latrobe University. Greg has been the Senior Industry Officer for poultry for the past 13 years. Peter Cransberg has completed an Agricultural Science degree at the University of Western Australia in 1988 and a Master of Behavioural Science Degree at Latrobe University in 1996. Peter started work with Dr Parkinson at Primary Industries Research Victoria in 1996.

Greg and Peter have been continually supported by the AECL (formerly EIRDC) for the last 10 years and have also received financial support from the CMRDC and other private companies. Research has covered a wide range of issues including osteoporosis in laying hens, body weight management of pullets and laying hens, calcium and vitamin D nutrition, moulting and beak trimming. Research aside, Greg is called upon to provide policy direction in issues affecting the egg and chicken meat industries both in Victoria and nationally. Additionally Greg is the Victorian president of the WPSA while Peter is the secretary.

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Executive Summary

Moulting Research

The first component of this research report evaluates several aspects of the maintenance of commercial egg layers for a second egg production cycle and compares this management strategy to the traditional single cycle commonly practised in the Australian egg industry. The first, and most important issue, was to thoroughly investigate the economic merits of second cycle production relative to financial return achieved for single cycle strategies. Secondly, if we can show that under the right circumstances that moulting can be financially viable, then it is important to assess different methods of humanely moulting hens in an attempt to optimise financial returns.

The main incentive for the commercial egg industry to extend the productive life of flocks is to reduce the costs associated with bird depreciation. The cost of day old chicks and point of lay pullets is extremely high in Australia in comparison to the rest of the world, and accounts for approximately 25% of the costs of egg production. Despite these economic opportunities there is significant resistance to moulting in the Australian egg industry, mainly because brown egg layers are reputed to perform at a lower and unacceptable rate in the post moult phase compared to the standards clearly evident in the Unites States for White Leghorns.

The first part of this project was a desktop study which was aimed at producing a user friendly Excel spreadsheet whereby producers could compare the financial returns from a single cycle flock in comparison to keeping birds for a second laying cycle. In consultation with a number of egg producers, the major variables affecting the financial return to egg producers were determined. The 4 most important variables in determining whether it was financially viable to keep birds for a second cycle were the price of eggs, the production levels in the second cycle, the cost of the 16 week old pullet and the cost of feed. The modelling data indicated that in a significant proportion of circumstances, especially where producers are purchasing 16-week-old pullets, keeping birds for a second cycle can be financially viable. The economic equilibrium is very sensitive to post-moult/second cycle egg production performance and egg prices. In the future egg prices to producers are likely to decline and it seems highly likely that post-moult egg production can be significantly improved with more precise management.

Having shown that moulting can be financially viable, the next step in this research program was to assess different moulting regimes in an attempt to guide producers towards programs that will optimise second cycle returns. A number of papers have been written about moulting, the majority of which have been conducted in the United States and use White Leghorns as the experimental bird. It is important therefore to increase our knowledge of the capabilities of the brown egg strains during the second cycle. A variety of different moulting programs are used by commercial producers worldwide and are influenced by factors such as welfare guidelines, available feed ingredients and managerial experience. The variables generally assessed in moulting research include; duration of the moult period, type of moult diet the birds receive, what is the target weight at the end of the moult period or alternatively what is the percentage body weight the birds need to lose during the moult period. Some researchers suggest that birds need to be taken down to a set weight while others argue that a percentage of body weight needs to be stripped from the bird during the moult process. The first of two experiments addresses this question with regard to the current brown egg laying strains housed under Australian conditions, with the moulting programs designed to minimise mortality.

Two experiments were completed using brown egg layers in a commercial situation. The first experiment is reported in Chapter 2 and describes an experiment using 580 Hyline brown birds where birds were separated into two groups, high and low egg production, based on records taken prior to the moult period. Each of the two groups was then further separated into two treatments; birds that were moulted back to a set weight (in this case 1800 grams) versus those birds moulted back to 75% of their pre moult body weight. There was no significant difference in egg production between those birds moulted back to 1800 grams compared to those birds moulted back to 75% of their starting weight in either the high or the low production groups. There was however a significant difference between the high and the low production groups. Second cycle egg production in the better performing birds prior to the moult was superior to those birds in the low production group. This result suggests that the egg production and management of the birds during the first cycle will have a strong positive correlation with second cycle performance. As performance of the birds during the first cycle is dependant on the rearing of the birds, moulting should be seen as a whole of flock strategy and not in isolation. It is highly unlikely that a poor first cycle flock will produce at a high level in the second lay period.

The second commercial experiment conducted analysed a flock of just over 3700 sixty-nine week old Hisex birds, with 80 of those birds housed individually. Individual housing of birds provided the researchers with the opportunity to closely assess the relationship between body weight and egg production. At the end of the experiment the birds that performed poorly during the second cycle were post mortemed to ascertain why their production performance was below other birds in the flock. All individually housed birds were weighed prior to moult period and it was again apparent that the lighter birds prior to the moult were the light birds during the second laying cycle. Results from the individually housed birds showed a clear correlation between body weight and production in the second cycle, with the lighter birds generally producing at lower rates.

A small pilot experiment using 34 individually housed White Leghorns provided detailed insights into the response of individual birds to the moulting process. Some 6% of the flock responded poorly to moulting with a reduction in production in the post-moult phase. These birds were lighter than average prior to the moult and appeared to recover body weight more slowly following refeeding. On the other hand some 90% of the flock responded well to moulting with the maintenance of high levels of production or significant improvements in production. Interestingly if the 6% of light birds that produced poorly were removed from the analysis, then the second cycle production performance of the remaining birds was equivalent to the first cycle performance. Clearly this small pilot experiment using White Leghorns validates the observations from the two commercial experiments that provide evidence of the problems induced by a population of light birds prior to and following the moulting process.

One of the most promising results to arise out of both of the commercial experiments was the level of production achieved by the birds in the second cycle. The best treatment in the first experiment achieved a peak of 87% and produced at an average of 76% from the time the birds were refed at 71 weeks through to 97 weeks. Flocks with high first cycle performance had superior production in the second cycle. In the second commercial experiment the whole flock averaged 75.1% from the time that the birds were refed at 72 weeks until week 90. The heavier birds (>2000 grams pre moult) produced at an average above 75% for the duration of the second cycle whilst the light birds (<1950 grams pre moult) produced at an average of less than 70%. The lighter birds represented approximately 12% of the flock and if these birds were excluded from the analysis then the overall average post-moult production performance is increased by 4% to 79%. This finding highlights the significance of the residual effect of lightweight birds to the moulting process.

Studies of Cannibalism and flock body weights

In the second component of the research undertaken in these studies, clear evidence was obtained to illustrate that pullet factors such as body weight and/or acquired behaviour in pullets are likely to be a major variable(s) in the induction of cannibalism in barn egg production systems. Beak trimming practice, light intensity, stocking density and nutrition are not the only significant variables influencing cannibalism. It seems probable that low pullet body weights (in comparison to the breed standard) increases the incidence of cloacal haemorrhage, and that this tissue haemorrhage can act as a significant predisposing factor in the induction of cannibalism. In addition, these studies indicated that cannibalism and vent trauma appear strongly correlated with the incidence of oviduct impaction, egg peritonitis and salpingitis. Mortality due to these oviduct dysfunctions combined with cannibalism explains up to 90% of mortality in the barn egg laying flocks examined in these studies. At this stage it appears that average pullet weight and flock uniformity are likely to be critical factors in influencing the predisposition of flocks to cannibalism, but there may also be interactions between body weight with acquired cannibalism behaviour in pullets that could be contributing. In other words, uneven and under weight pullets flocks may be predisposed to both cloacal haemorrhage and picking behaviours patterns that are reflected in low body weights during the rearing period. Irrespective of the precise explanation, there are very important carry over effects of pullet management that are major contributors to cannibalism. The severity or frequency of the beak trimming is only part of the answer to achieving effective control over cannibalism.

The studies of flock uniformity are probably the most significant component of the research undertaken on this project. The compliance with flock uniformity standards and the proportion of lightweight birds are probably the key determinants of post moult egg production performance and current flock mortalities. Improving compliance with body weight standards and eliminating light birds offers additional strategies to improve control over cannibalism. Furthermore, the modelling of flock uniformity brings into question the sensitivity of the objective standards that are currently used by the industry to set uniformity benchmarks, and illustrate the large variation in current industry practice. There is the potential for significant industry improvement in overall uniformity and to eliminate the estimated 10% of lightweight birds in the national flock.

These studies illustrate a total variance in flock live weights of some 430 grams on an average live weight of 1440 grams at 16 weeks of age as a “best practice bench mark”. This standard observed in Australia needs to be validated by international breeding companies as the maximum biological potential for flock uniformity in brown egg layers. Assuming that this standard is at world’s best practice, additional effort should be made by the industry to benchmark the range of pullet rearing practices and improve compliance with these standards. The other critical factor that needs improved definition is the threshold mature body weight below which the incidence of cloacal haemorrhage is increased and production reduced. At this stage we only have a limited analysis that indicates marked reductions in egg production potential and increased cloacal haemorrhage at a threshold of 1650 grams. Defining the nature of these relationships over the weight range of 1650 to 2000 grams will be vitally important for future industry improvement and quantifies the range of body weights required to achieve “true genetic potential”.

In summary, there seems to be significant potential to improve post–moult egg production performance to those standards achieved in the first cycle by focussing on the elimination of light birds from flock populations. These strategies should concurrently produce incremental reductions in flock mortality and significantly improve control over vent trauma, cannibalism and oviduct dysfunction. The net economic benefits could be a 5-10% reduction in pullet depreciation costs with high second cycle production, a reduction in mortality from 8 to 5% in both first and second cycles combined, and increase hen housed egg production of some 20 eggs in the first and second cycles. The scientific evidence suggests that brown egg layers can be successfully recycled and that there is no reason to expect brown egg layers or White Leghorns to differ in this respect. Successful moulting performance is more likely to be influenced by factors such as body weight and flock uniformity rather than inherent physiological capacity.

Chapter 1

Economic Impact of Moulting Laying Hens

1.1 Introduction

Moulting is a process by which laying hens are rested from egg production as a means of extending their productive life by restoring egg production rate and shell quality. The technique is widely practised in many parts of the world and has the primary objective of reducing pullet depreciation costs. Other economic advantages to the producer come from increased flexibility in capturing sudden changes in egg supply, improvements in cash flow management and, in the situation where new facilities are being built, a reduction in the number of rearing places required for a set number of laying hens. Pullet depreciation is the second highest cost after feed in producing eggs and, in Australia, our cost of pullets is extremely high in comparison to the rest of the world. A comparative study of 45 countries published in World Poultry (Volume 21, number 1, 2005) illustrated that Australia has the sixth highest 16-week-old pullet cost and the most expensive day old chick cost in the countries studied. These figures add support to the authors' assertion that moulting, or other methods of extending flock life, should be more widely adopted in Australia. Current modelling of the national flock indicates that approximately 24% of birds are moulted annually, but the proportion of farms moulting is higher at about 30% (Rowly Horne, personal communication). Cage farms over 100,000 birds do not generally practice moulting.

There have been a number of papers in the literature that have addressed the financial impact of moulting (McClelland *et al*, 1989, Bell, 1996, 2000). As Bell (2000) states "… one can find as many supporters as opponents of induced moulting from an economic viewpoint". The financial viability of moulting will depend on the economics of the time as well as the technique used to evaluate moulting (Bell, 2000). Obviously it will be important to evaluate all contributing factors in an attempt to produce a replacement program that will maximise returns to the producer.

The use of moulting needs to be planned well in advance and structured into the replacement schedule used on a particular farm. It is important therefore that an egg producer is able to accurately assess the financial benefits or otherwise of taking birds through a second cycle in comparison to the more traditional single cycle replacement programs generally practised in Australia. If there is going to be a change in the often negative attitude of Australian egg producers to moulting then it will be important to provide sound economic evidence that, under certain circumstances, moulting can be profitable.

The aim of this part of the research program is to produce simple economic modelling for egg producers that will allow them to determine the financial impact of keeping birds for a second cycle. It will allow producers to compare different strategies over a set time period using a simple Excel spreadsheet. It should be noted that each particular farm will have its own unique set of inputs that will determine the viability of moulting.

1.2 Methods

The work undertaken in this part of the project was a desktop study which evaluated the range of factors involved in determining financial returns to the producer of keeping birds for a second cycle. A Microsoft Excel worksheet was created and the productivity determining variables ascertained. A copy of the Excel spreadsheet is available from the accompanying compact disk. The variables used in the modelling spreadsheet were as follows:

Feed cost
First and second cycle egg production
Mortality during moult and during first and second cycle production
Average egg price
Average feed consumption
Spent hen price
16 week-old pullet cost
Packaging and transport costs
Length of moult period

Costs such as electricity, labour, insurance and depreciation were not included in the modelling as these costs were determined to be relatively constant regardless of the replacement strategy adopted.

1.3 Results

Due to the large number of variables used in this modelling there is no simple prescriptive solution that can give a definitive answer on whether or not moulting is economically viable. Whether moulting is viable or not is dependent on a number of interacting variables. There are however some variables that have a greater impact on profitability than others. Table 1 provides an illustration of the financial impact of a change in 4 of the major variables on the viability of keeping birds for a second cycle. It should be noted that Table 1 should not be taken in isolation as there will be many other variables that will effect the profitability of keeping birds for a second cycle.

Table 1: Financial impact of a change in the 4 major variables on final profit margin for a 20000 bird flock moulted at 66 weeks and taken through to 100 weeks compared to a flock kept to 72 weeks then replaced. A positive result in the profit/loss column indicates that moulting is financially superior. ***A number of assumptions need to be made for the following analysis. These assumptions were based on industry data and can be found at the foot of Table 1.**

Variable				
Feed cost (per ton)	**16-wk pullet cost ($)**	**Ave. egg price ($ per dozen)**	**Average 2nd cycle production (hen day)**	**Profit/loss per year ($)**
270	6.00	1.20	73	3968
320	6.00	1.20	73	2214
370	6.00	1.20	73	-460
420	6.00	1.20	73	-1293
470	6.00	1.20	73	-3046
330	**5.2**	1.20	73	-1372
330	**6.0**	1.20	73	1863
330	**7.0**	1.20	73	5908
330	**7.5**	1.20	73	7930
330	**8.0**	1.20	73	9952
330	6.0	**0.80**	73	6477
330	6.0	**1.10**	73	3017
330	6.0	**1.30**	73	710
330	6.0	**1.60**	73	-2750
330	6.0	**1.80**	73	-5056
330	6.0	1.20	**68**	-6359
330	6.0	1.20	**70**	-3070
330	6.0	1.20	**72**	219
330	6.0	1.20	**74**	3508
330	6.0	1.20	**76**	6797

* **Assumptions** – average feed consumption is 110 grams/bird/day in first cycle and 116 grams/bird/day in second cycle, spent hen value is 25 cents, transport and packaging costs are 21 cents per dozen, mortality is 0.1% per week during both laying cycles, mortality is 0.5% per week during the moult period, birds are out of lay for 35 days, first cycle egg production is taken from breeder manual, moult diet cost is $155 per ton and birds consume 35 grams/bird/day during the moult period.

The two most influential variables in determining the financial viability of moulting are the cost of the 16-week-old pullet and the performance of the birds in the second cycle. By altering the pullet price in the model, large variations in the profit or loss were experienced. The modelling indicates that in the majority of situations where egg producers are purchasing 16 week old pullets (cost is currently about $8.00 per bird), financial returns favour keep birds for a second cycle. In flocks reared by the egg producer, thus lower pullet costs, moulting can still be economically viable however the margin is reduced.

Similarly to the pullet cost, the performance of the birds in the second cycle is extremely important in determining the financial outcome of keeping birds for a second cycle. One of the problems with moulting in Australia has been the poor second cycle performance of birds. The modelling shown in this report indicates that, using the set of criteria provided in Table 1, if second cycle production averages over 72% then moulting will be economically viable. Using the inputs described in Table 1, for each percentage point above 72, the financial benefits of moulting are increased substantially. In terms of the cost of feed, an increase will generally reduce the benefits of keeping birds for a second cycle. The final variable assessed, the average price of eggs, indicated that the higher the price of eggs then the more likely that a single cycle replacement strategy is financially superior.

The other factors used in the modelling; mortality, feed consumption, first cycle production, spent hen price and packaging and transport costs, all influence the final financial result but not to the same extent as the variables listed in Table 1. Table 2 indicates the strategy favoured by an increase or decrease in these variables.

Table 2: Influence of a variable change on replacement strategy favoured.

Variable	Change	Result Favours
Spent hen price	Price increase	Single cycle
Feed consumption	Consumption increase	Single cycle
Packaging & transport	Cost increase	Second cycle
Mortality	Increased mortality	Single cycle
First cycle production	Increase	Single cycle

1.4 Discussion

This modelling is potentially the first step whereby producers can ascertain the economic benefits or otherwise of keeping birds for a second cycle. If Australia's egg industry is to compete in the world market then they must look at all options to lower the cost base. As can be seen in the result's section, modelling indicates that in a high number of circumstances it is financially beneficial for producers to keep birds for a second cycle. These results show that egg producers should be strongly encouraged to consider keeping birds for a second cycle as a regular part of their replacement program, especially if they buy rather than produce their pullets.

One of the most important factors in the use of the modelling is the accuracy of the inputs. It is imperative that each producer using the model has a sound knowledge of their operation and is able to provide accurate data on costs, productivity variables and returns. **The accuracy of the inputs will determine the accuracy of the output.** Additionally it is important that, since replacement schedules need to be planned well in advance, producers are able to predict with reasonable accuracy the movement of these influencing factors. Producers need to be aware that the economic climate of the egg industry will change according to a number of factors. For example feed prices will be affected by drought and ingredient supply while Australian flock size and per capita consumption will affect egg prices. Providing the producer has a firm grasp of the cost of inputs, the performance of their flocks and is confident in their ability to assess likely changes in the cost of variables then the model will accurately predict the financial impact of moulting.

In addition to the comparison provided between keeping flocks for one or two cycles, the economic modelling can also be used by producers to determine the influence of a variable change on the final profit margin for a single cycle flock. Using only the part of the modelling related to the single cycle flock, producers can alter variables and determine the change on the final profitability of that flock. As an example, a change in feed consumption on a 20000-bird flock from 111 grams/bird/day to 110 grams/bird/day during weeks 16 to 72 will save a producer $2058 over the life of the flock. The financial outcome of making such a minimal change in one variable reinforces the importance of the management skills and the attention to detail of producers in determining final profitability.

Economic trends indicate that the price of eggs is likely to decrease while the price of feed is likely to increase. It is highly likely that there will be significant improvements in post-moult egg production performance that may alter the current economic equilibrium and make moulting more attractive to innovative egg producers.

1.5 References

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Chapter 2

Comparison of Moulting to a Set Weight Versus a Percentage of Pre-moult Body Weight

2.1 Introduction

One of the problems in Australia that has stopped the widespread acceptance of moulting in the commercial industry is the negative perception regarding the suitability of the dominant brown egg layer strains for moulting. There is a general belief in the egg industry that brown egg layers cannot be moulted as effectively as the white birds. There is however no physiological reason why this should be the case. Results of previous studies conducted at Australian farms illustrate that problems include poor post moult performance (10-15% below first cycle), high mortality during the moult phase and egg size being excessive. The potential of moulting programs has been illustrated both experimentally and in the Unites States Egg Industry where moulted White Leghorn flocks have reached up to 93% production in the second cycle following a pre-moult peak of 95% (Donald Bell, personal communication).

There are a number of reasons why moulting should be reassessed and promoted in Australia. Firstly the management skills of producers are continually improving which has lead to a dramatic improvement in body weight management and flock uniformity. With superior body weight management of flocks in the first production cycle, the chances of successfully moulting layers are increased. It is hypothesised that the reason for the high mortalities recorded in some flocks during the moult phase is due to non-uniform body weight distribution of flocks. The mortalities are thought to be the lighter birds with insufficient body reserves to cope with the moult process. Better flock management and flock uniformity should reduce mortality rates during the moult phase. Secondly, new layer genotypes have been recently introduced into Australia with reduced mature body weights and reduced egg size, thus alleviating the problem with excessive egg size.

There are many different techniques that can be used to induce a moult in laying hens. The two most common commercial management practices are to completely remove feed or to severely restrict the quality and amount of feed given. The US has historically used feed removal of up to 14 days to induce a moult. However, due to welfare concerns expressed by significant end users of eggs, the US egg industry is now under pressure to eliminate feed removal as a method of moulting. In Australia it is most common for birds to be fed a low quality ration, such as pure barley or oats (sometimes with the inclusion of a calcium source), to induce moult. Feed withdrawal is not used in Australia as it is stated in our code of practice that "Poultry, other than newly hatched birds, must have access to food at least once in each 24-hour period". Other methods of inducing moult are to remove birds access to water as well as feed (also not permitted under Australia's code of practice), light restriction (used in conjunction with most moult programs), the use of drugs and by altering dietary minerals. The last two methods are not generally used commercially.

One of the many variables widely researched is how much weight loss should be achieved before refeeding to obtain maximal post moult production. The general consensus in the literature is that 25-35% is optimum (Baker *et al* 1983, Brake and Carey, 1983, Ruzler, 1984, 1996). The majority of this research however, has taken place in the US where the dominant birds are White Leghorns. There is limited data in the literature regarding the moulting of brown egg layers and it is important to increase our knowledge in this area to assist Australian egg producers in successfully moulting the brown egg layers.

The aim of this trial is to experimentally compare the post-moult performance of Hyline Brown birds moulted back to a set weight with birds moulted back to a percentage of starting body weight. Birds will be assessed from 66 to 97 weeks of age.

2.2 Methods

Five hundred and seventy seven Hyline brown birds were moulted at 66 weeks of age. As a control treatment, 32 additional birds were allowed to continue laying without moulting. Birds were housed in a controlled environment cage house with a maximum of 4 birds per cage. Prior to moulting, each of the 40 experimental blocks (each block consists of 4 cages) was assessed for egg production at 51, 56 and 61 weeks of age. Based on the average production over the three assessment periods, blocks were ranked from 1 to 40 and the top 20 blocks were designated as the "high production" treatment while the remaining 20 blocks were the "low production" treatment. Additionally each of these 2 treatments was randomly split into two further treatment groups; one treatment moulted back to 1800 grams while the others were moulted back to 75% of their pre-moult body weight. It should be noted that it was originally planned to take the birds average body weight down to 1600 grams however, due to the time taken to reduce the bird's weight down to this level, mortality levels began to increase and therefore 1800 grams was adopted as the target weight. The four treatments and the number of birds in each are shown below. There is a slight disparity in bird numbers between treatments as it was decided not to introduce unfamiliar birds to those cages where mortality had occurred during the first production period.

Control (32 birds) - Continuous laying
Treatment 1 (135 birds) - High production moulted back to 1800 grams.
Treatment 2 (144 birds) - High production moulted back to 75% of pre-moult body weight.
Treatment 3 (148 birds) - Low production moulted to back to 1800 grams.
Treatment 4 (150 birds) - Low production moulted back to 75% of pre-moult body weight.

Average body weight was assessed prior to moulting by weighing 16 blocks (4 blocks per treatment). The same birds were then weighed at weekly intervals during the 4-week moult period and then again at 72, 75, 80, 90 and 97 weeks of age.

During the moult phase all birds were fed a pure barley ration at the rate of 40 grams per bird per day supplemented with shell grit at 3 grams/bird/day (which equates to approximately 1.2 grams of calcium/bird/day). Following the attainment of the required body weight, birds were fed a commercial layer ration (2800 kcal/kg) at the rate of 92 grams per bird per day which is 1.5 times the maintenance requirement for a bird of 1.8 kg kept at 21^{o}C as described by Coon (2002). Birds were kept on this restricted diet for 5 days after target body weights were achieved with the aim to start building body reserves but not re-initiate lay. It was also aimed at increasing the bird's appetite when they were refed *ad lib*. All birds were refed the layer diet *ad lib* following this 5-day period. Due to managerial constraints associated with a multi-aged shed it was not possible to reduce day length during the moult period.

Production was measured weekly until 97 weeks of age. An initial measurement of egg weight and specific gravity was done at 65 weeks, with a minimum of 30 eggs per treatment assessed at 65, 75, 80, 90 and 97 weeks of age.

2.3 Results

Body Weight

Average body weight prior to moulting was 2306 grams at 65 weeks of age, 15% above the breed standard of 2000 grams. Because the birds were significantly heavier than the breed standard, the amount of time needed to moult the birds back to the required body weight was increased substantially. Birds were on the moult diet for 26 days and average body weight across the moult period can be seen in Table 1. The target body weight of those birds in the 25% weight loss was 1722 grams.

Post moult body weight continued to increase until week 90 after which it plateau's (Figure 1). Peak body weight occurred between 90-97 weeks and was 2477 g in the High 1800 group, 2490 g in the High 1800 group, 2478 g in the Low 1800 group and 2456 g in the Low 25% group. At 97 weeks birds were, on average, 2474 grams which is 7% above the pre-moult body weight. Control birds had an average weight of 2433 g at the end of the 97th week..

Table 1: Weight loss during the moult period (% weight lost is in parentheses).

Treatment	Average body weight (grams)				
	Pre moult	7 days post moult	14 days post moult	21 days post moult	26 days post moult
High 1800	2309	2003 (13.3)	1938 (16.1)	1828 (20.8)	1742 (24.6)
High 25%	2317	2027 (12.5)	1950 (15.8)	1875 (19.1)	1759 (24.1)
Low 1800	2324	2070 (10.9)	2002 (13.9)	1940 (16.5)	1861 (19.9)
Low 25%	2272	1999 (12.0)	1910 (15.9)	1813 (20.2)	1699 (25.2)

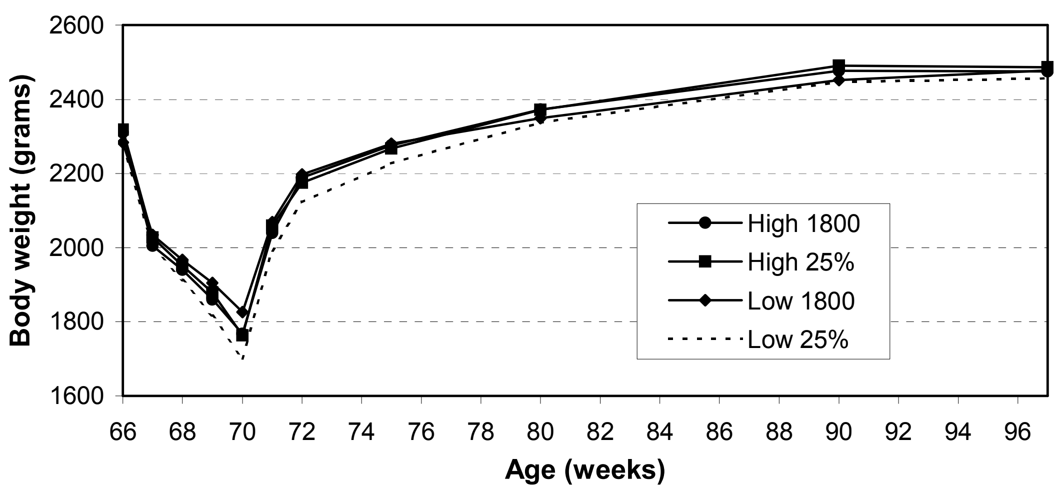

Figure 1: Body weight profile of flock during post moult production period. Treatments are as indicated in the legend.

The average body weight of the combined High production treatments was approximately 50 grams heavier than the combined Low production treatments at the start of the moult period. During the moult period the average body weight of the two groups were not significantly different. After the birds were refed, a similar weight difference to pre moult was observed between the two groups (Figure 2).

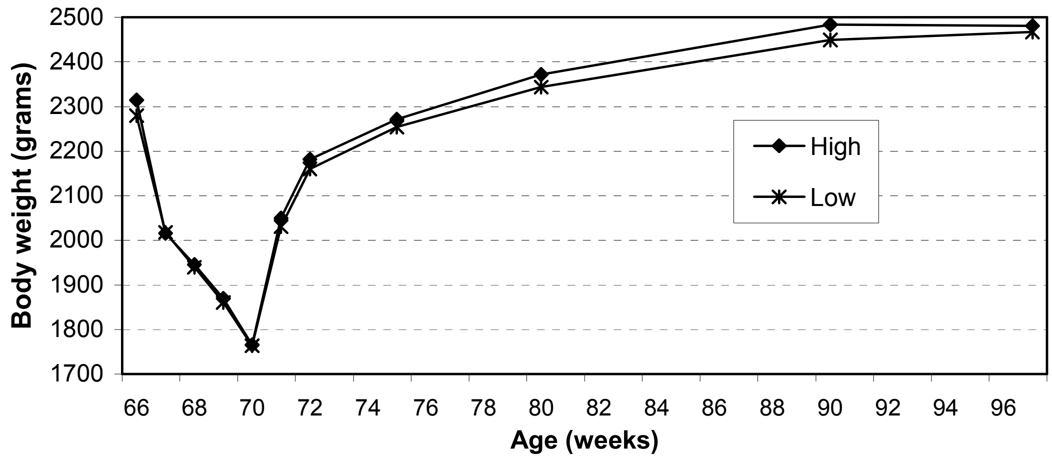

Figure 2: Body weight profile of high pre-moult production birds (average of High 25% and High 1800) in comparison to low pre-moult production birds (average of Low 25% and Low 1800)

Production

First cycle

Egg production peaked at 93.3% in week 24 and averaged above 90% until week 40 (Figure 3). Egg production was approximately 80% at week 66 (Figure 3). The average production (average of measurements taken at 51, 57 and 61 weeks) of the 20 blocks assigned to the high production treatment was 89.5% while birds in the low production treatment had an average production of 83.1%.

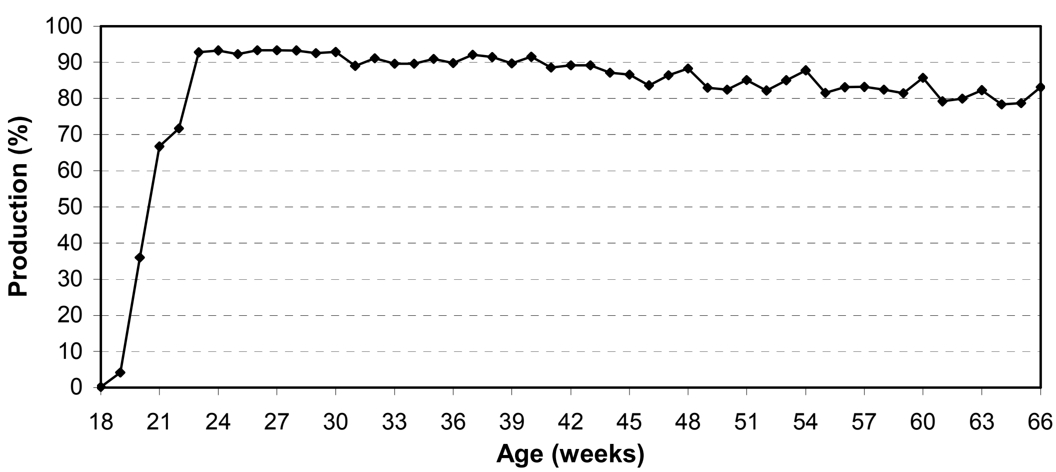

Figure 3: Pre moult egg production.

Post moult

Post moult egg production peaked at 87.8% in the High 25% group, 84.5% in the High 1800 group, 84.4% in the Low 1800 group and 82.1% in the Low 25% group (Figure 4). Average production between the time the birds were refed and 97 weeks was 76.3% in the High 25% group, 73.6% in the High 1800 group, 71.7% in the Low 1800 group and 71.2% in the Low 25% group. Egg production in those birds in the High 25% treatment was significantly greater than from the birds in any other treatment group (P<0.05). Egg production in those birds in the High 1800 treatment is significantly greater than from the birds in the Low 25% or the Low 1800 treatment group (P<0.05). There was no significant difference between the two Low production groups. Average production of the two combined High production treatments is significantly higher than the two combined Low production treatments (Figure 5).

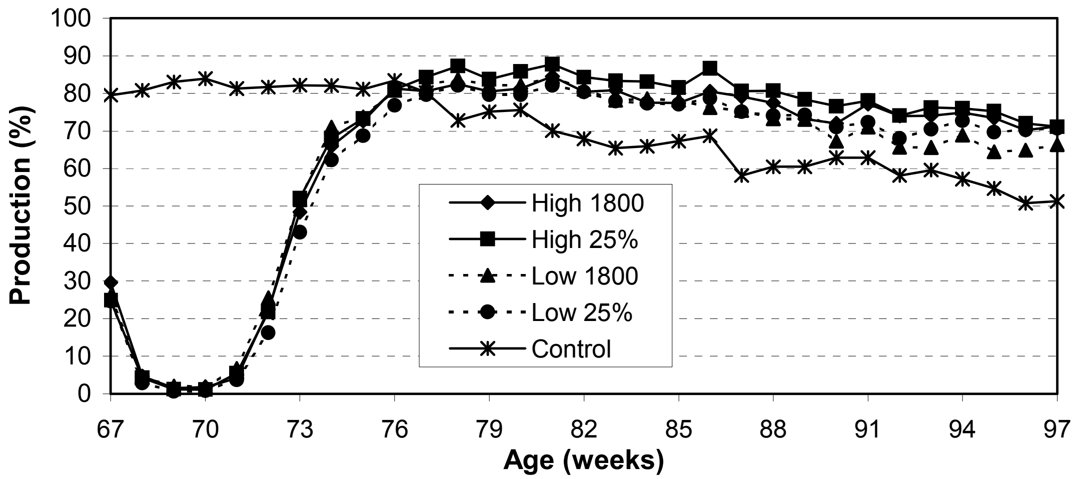

Figure 4: Post moult egg production.

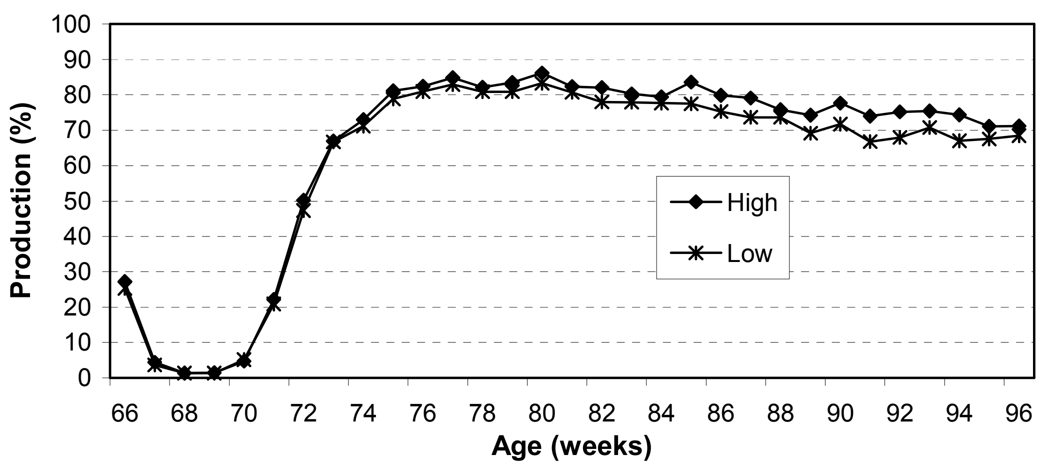

Figure 5: Post moult production of high pre-moult production birds (average of High 25% and High 1800 treatments) in comparison to low pre-moult production birds (average of Low 25% and Low 1800 treatments).

Mortality

Pre moult

Mortality from 16 to 66 weeks was 6.8%, an average of 0.14% per week..

During the moult period

Fourteen birds out of the starting flock of 577 died during the 4-week moult period. This is a total of 2.43% at an average of 0.61% per week. Six of the birds (43% of mortality) died in the first week of the moult period while 5 died in the last week (36%) of the moult period.

Post moult

Not including the control birds, 15 birds died between 70 weeks (when the birds were refed) and the completion of the trial at 97 weeks. This is a total of 2.66% which equates to a weekly figure of 0.098% per week. This is below mortality rates observed during the first laying cycle.

Specific Gravity

Pre moult

The average specific gravity of a sample of 60 eggs at 66 weeks of age was 1.080.

Post moult

Table 2: Specific gravity during second cycle egg production.

Treatment	**Age (weeks)**			
	75	**80**	**90**	**97**
Control	1.077^{a}	1.077^{a}	1.075^{a}	1.075^{ab}
High 1800	1.085^{b}	1.080^{ab}	1.081^{b}	1.078^{ab}
High 25%	1.085^{b}	1.080^{ab}	1.080^{b}	1.077^{ab}
Low 1800	1.083^{b}	1.079^{ab}	1.080^{b}	1.075^{a}
Low 25%	1.084^{b}	1.082^{b}	1.082^{b}	1.079^{b}

^{abc} – means with different superscript letters are significantly different (P<0.05)

Specific gravity remains at an acceptable level (at or above 1.075) in all treatments until the end of the trial (Table 2). Specific gravity begins to decrease in the period between 90-97 weeks and, in the Low 1800 treatment, specific gravity falls to a level equal with the control birds at 97 weeks.

2.4 Discussion

There was no significant difference between the production levels recorded by the birds moulted back to 75% of starting weight compared to those birds moulted back to 1800 grams. This is not surprising as both groups of birds reached the target values within a day of each other. As stated previously it was originally planned to take the set weight birds back to 1600 grams (about 10% above point of lay body weight) however, due to the extra moult time needed to get down to this weight, this was not possible without significant mortality. It is purely conjecture whether the extra weight loss would have had any positive influence on production. Without doing a number of trials on similar birds in terms of age, pre moult performance and weight it is very difficult to make definitive recommendations based on the current data.

Importantly though, there was a significant difference between the post moult production of the combined High treatments compared to the combined Low treatments. This suggests that the performance of the birds during the first cycle is likely to be an excellent indicator of second cycle production. Since the first cycle performance of a laying flock is closely related to the rearing of the flock, it is hypothesised that there will be a strong relationship between the rearing and first cycle management of a flock with second cycle performance. The performance of the highest producing birds in the second cycle was very encouraging and indicates that, with the right flock, moulting can be done very effectively in the brown birds. Production peaked at 88%, remained at above 80% until 88 weeks and remained at above 75% until 95 weeks of age.

The trial conducted did not have the capacity to measure feed intake which prevents us from conducting an accurate economic analysis on the results achieved. However, the average production of the 4 treatments combined between 70 weeks (time that birds were refed) and 97 weeks was 73.2% which, if we use the economic modelling provided in Chapter 1, would indicate that the result achieved by moulting this flock is financially superior to the traditional first cycle strategy. The superior financial returns of moulting this flock compared to the single cycle strategy will be exacerbated if only the performance of the High production treatments is considered (average of 75% during the same period).

Those birds that were not moulted and continued laying throughout the trial provides data suggesting that strain of bird used in this experiment is capable of laying profitably past the current practice of 72 weeks. Production in these birds remained at above 80% until 76 weeks of age and above 70% until 81 weeks of age. The only issue with these birds is that specific gravity has fallen to 1.077 at 80 weeks, which may cause downgrading of an increasing number of eggs.

There appears to be 2 distinct periods during the moult period where mortality occurs. Forty three percent of total mortality during the moult period occurred during the first week of the moult period (6 birds out of 15). It is likely that some birds, presumably the lighter or weaker birds, are simply unable to cope with the sudden withdrawal of nutrients. These birds are likely to be unproductive and would have died regardless of the length of moult. The second period of mortality is during the last week of the moult period (33%). As stated previously the body weight of the birds in this trial was well above the breed standard and it took much longer than is commercially practiced to remove the required body weight. This longer than expected moult period appears to be directly responsible for these mortalities and they would not be expected to occur in a commercial situation where body weights are closer to the breed standard and the moult period is only 2-3 weeks. More research is required to assess whether moulting these heavy birds for 4 weeks was necessary, or whether similar second cycle production results would have been observed if the moult period was restricted to 2-3 weeks, albeit with a lesser weight loss.

As expected the specific gravity of eggs was rejuvenated by the moult process while the control birds continued to decline. Specific gravity in all moulted birds remained at or above 1.080 until 90 weeks of age after which it declined. Assuming that the accepted industry value for specific gravity is 1.075 or above, the current experiment indicates that eggshell quality would decline below acceptable levels after approximately 100 weeks if birds were moulted at 66 weeks. Interestingly the specific gravity of eggs from the non-moulted birds was still at 1.075 at 97 weeks of age, although this is likely to be due to egg production being down to 50%.

This trial indicates that moulting brown egg layers can be done successfully and birds can produce at a high rate in the second cycle. One of the critical factors appears to be the management of the birds during the first cycle (and thus rearing) and moulting therefore should be considered as an extension of the first cycle and not in isolation. The second issue raised by this experiment is that birds are capable of producing past the 72 weeks generally practised in the commercial egg industry, and producers should, at the least, be looking at extending first cycle egg production.

2.5 References

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Chapter 3

Moulting of Commercial White Leghorns

3.1 Introduction

As part of a separate research program the productivity and bodyweight profiles of a commercial strain of White Leghorn was recorded during its first laying cycle. It was decided to moult these White Leghorns to provide additional scientific information for the research program undertaken in this report. In a small pilot experiment the birds were housed individually and closely assessed for body weight and productivity prior to, during and following a moulting program. The study provided researchers with insights into why some birds do not resume egg production following a moult, and also provides some indications of the biological constraints to moulting.

3.2 Methods

Seventy-four commercial White Leghorns were housed 5 birds per cage in a controlled environment shed. At 54 weeks of age, 34 of these birds were randomly selected, housed individually and then moulted. Production was monitored through to 84 weeks of age. Production figures given in the results section prior to 54 weeks are an average of the entire 74-bird flock housed 5 birds per cage, while results post 54 weeks are an average of the 34 individually housed birds. Body weight of these birds was measured at regular intervals.

During the moult period birds were fed a barley diet at the rate of approximately 40 grams per bird per day supplemented with marble chips at the rate of 3 grams per bird per day. The birds were only fed if they had finished the allocation of feed and marble chips from the previous day. Water was freely available at all times. At the time the layer feed was removed, lights were taken from 16 hours light per day down to 8 hours light per day. At the completion of the moult period lights were returned to 16 hours light per day.

3.3 Results

Production

Production peaked at 88.9% in the first cycle and 85.9% in the second cycle (Figure 1) and persistency of production was similar in cycles 1 and 2 (Figure 1). In these individual bird cages social competition is eliminated and the biological potential of the moulting process can be evaluated more precisely. Under these circumstances second cycle production was approximately 3-4% below the first cycle with similar persistency.

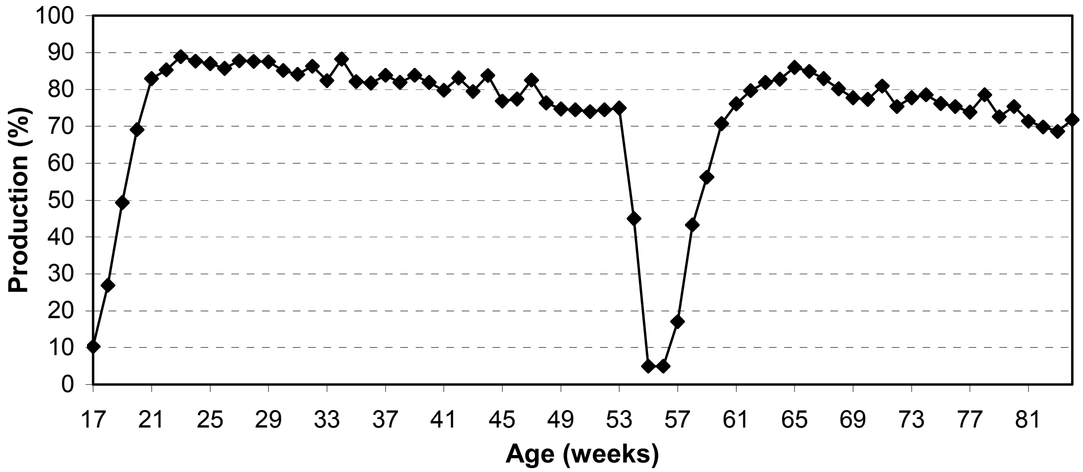

Figure 1: Average of first and second cycle production performance. Production figures are for 74 birds housed at 5 birds per cage in cycle 1 and 34 birds housed individually in cycle 2.

Body Weight

Average body weight of the entire flock at 16 weeks of age was 1456 grams and the body weight at the end of the first production cycle (54 weeks) is just over 1760 grams. This increases to approximately 1855 grams at the end of the second cycle at 82 weeks of age (Figure 2). On average the birds body weight declined by approximately 23% during the moult period.

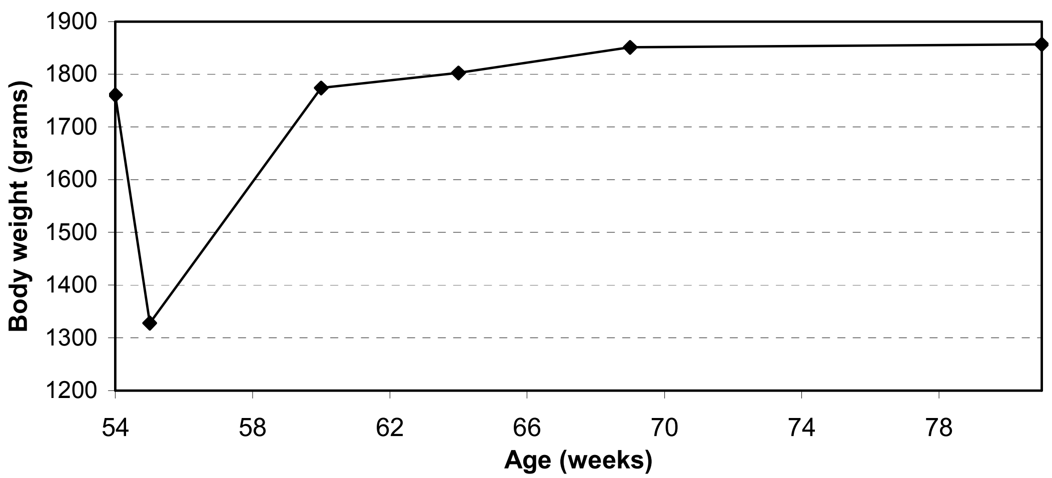

Figure 2: Body weight of birds during the moult period. Results are average body weight for 34 individually housed birds.

Individual Bird Assessments

Prior to the moult period, production was assessed in each of the 34 individually housed birds for a period of 10 days. Average production was calculated to be 75% and, of the 34 birds assessed, 4 were found to be laying at 50% or below.

Table 1 provides body weight information on those birds laying below an average of 60% during either the first or the second laying cycle. Two birds (4 and 16) (6% of flock) performed poorly during both laying cycles, two birds (29 and 35) (6% of flock) performed poorly during the first cycle but were rejuvenated by the moult process and produced at a high level during the second cycle, while bird 33 (3% of flock) performed well prior to the moult but poorly in the second cycle.

If the 3 birds (4, 16 and 33) that performed poorly during the second cycle are excluded from the analysis, the peak production of the remaining birds reaches 88.9% with an average of 77.7% in the second cycle. The corresponding figure for the peak production across all birds is 85.7% and 75.1%. This equates to an overall improvement of 3% average production, and illustrates that second cycle production performance could match performance of the first cycle with additional management refinement and improvement in performance of a relatively small proportion of the flock (9%).

Table 1: Assessment of pre and post moult body weight in birds with low initial production (as measured for 10 days prior to moulting) or low performance (<60% average) during the second cycle. Percentage weight loss is given for those birds that performed poorly during the second cycle.

Bird Number	Initial production	Ave. 2nd cycle production	BW prior to moult	% weight lost during moult	BW at end of 2nd cycle
4	**40**	**33.3**	1680	25.0	1530
16	**50**	**57.7**	2000	21.5	2090
29	**40**	78.3	1900	25.8	2010
33	90	**53.4**	1630	24.5	1680
35	**10**	76.2	1980	18.2	2490

The best 11 birds (33%) from the flock averaged above 80% from 58 to 84 weeks and were birds that, on average, lost 28% of body weight during the moult period. The remaining birds (ie birds that averaged below 80%) had an average weight loss of 23.1%. For the three birds (4, 16, 33) that performed poorly after the moult the production peaked at only 66.7%, while the average production for the second cycle was 48.1%. Thus approximately 9% of the flock averaged 48% production in the second cycle while the remainder of the flock averaged 78%.

3.4 Discussion

There are a number of important findings to result from this research illustrating the benefits of being able to study birds individually. The small pilot study indicated that moulting can effectively rejuvenate a proportion of birds in a flock. In this experiment about 6% of birds (29 and 35) that produced poorly towards the end of the first laying cycle were rejuvenated to produce at a high rate in the post moult period. Alternatively there are birds that produce poorly pre and post moult and cannot be rejuvenated (birds 4 and 16) and some birds (bird 33) that are damaged by the moulting process to an extent that production declines significantly between the pre and post-moult periods.

A close examination of the body weights of these individual birds may begin to provide an explanation for these differences. The body weight of birds 29 and 35 was above average both before and after the moult, whilst the body weight of birds 4 and 33 was approximately 100 grams below the average body weight. Perhaps the moulting process produces excessive tissue catabolism in these lightweight birds, reducing body weights to thresholds below which egg production cannot easily be re-initiated. Based on this model markedly superior post moult egg production could be achieved if the proportion of these lightweight birds could be eliminated. A threshold standard needs to be defined for moulting of different genotypes, but most of the potential gains are likely to arise from more attention to flock uniformity in both the rearing phase and the first cycle. These studies suggest however that flocks with a high proportion of under weight or light birds are not likely to respond well to a moulting process. Furthermore there is significant potential to close the gap between first cycle performance and second cycle performance by close studies of flock uniformity and threshold weights for effective rejuvenation following moulting.

The use of individual birds in this small pilot experiment has been invaluable in more closely defining reasons why birds and flocks may not produce well in the second cycle, and it will be important to continue this work in brown egg layers. Chapter 4 reports on a commercial flock of Hisex browns, a portion of which were housed in single bird cages and provides further insights into the factors responsible for the success or otherwise of moulting layers under Australian conditions.

Chapter 4

Commercial Evaluation of Moulting

4.1 Introduction

An important part of any experimental program is to validate findings in a commercial environment. A commercial producer in Victoria, who was moulting a portion of his flock, agreed to closely monitor the results of their moulting program with the assistance of the researchers. The aim of this work was to provide further insights into moulting of the commercial brown egger used predominantly in the Australian egg industry. This chapter provides a summary of those findings.

4.2 Methods

A commercial flock of 3728 Hisex birds was moulted at 69 weeks of age. During the first cycle all birds were housed 5 birds per cage in a multi-aged flock in a new multi-tier controlled environment shed. The birds were removed from this environment and placed into a conventional two tier naturally ventilated shed and housed 3 birds per cage. Out of the population of 3728, 80 birds were housed individually to further the work discussed in chapter 3. The 80 birds housed individually were weighed at regular intervals and this was assumed to be the average body weight of the flock. Production figures are presented for both the entire flock and also the 80 individually housed birds. At the time of transfer, all lights in the conventional shed were turned off and the light provided was natural day length (birds were moulted in the first week of December). During the moult period birds were fed a diet consisting of whole oats and 2% limestone. The aim was to moult the bird's back to 1600 grams.

After the moult period birds were refed ad lib. The layer diet used to refeed the birds provided 2900 kcal/kg energy and 18.5% protein. At the time of refeeding lights were returned to 16 hours daylight and birds were monitored through to 90 weeks of age. At the end of the trial all birds from the 80 birds individually housed that had poor egg production (an average of below 60% between weeks 72-90) were post mortemed in an attempt to ascertain the reason for their poor performance.

4.3 Results

Body Weight

The average body weight of the flock prior to the moult period was 2083 grams (range 1615 – 2805). During the 12 day moult period the birds were moulted back to 1639 grams, an average loss of 21.3% (range 12.2 – 31.5). This was slightly above the target weight but due to managerial issues this was a convenient point to refeed the birds.

In the post moult period the birds quickly rebounded to above 2000 grams and reached a maximum body weight of 2127 grams in week 86, 2% above the pre moult body weight.

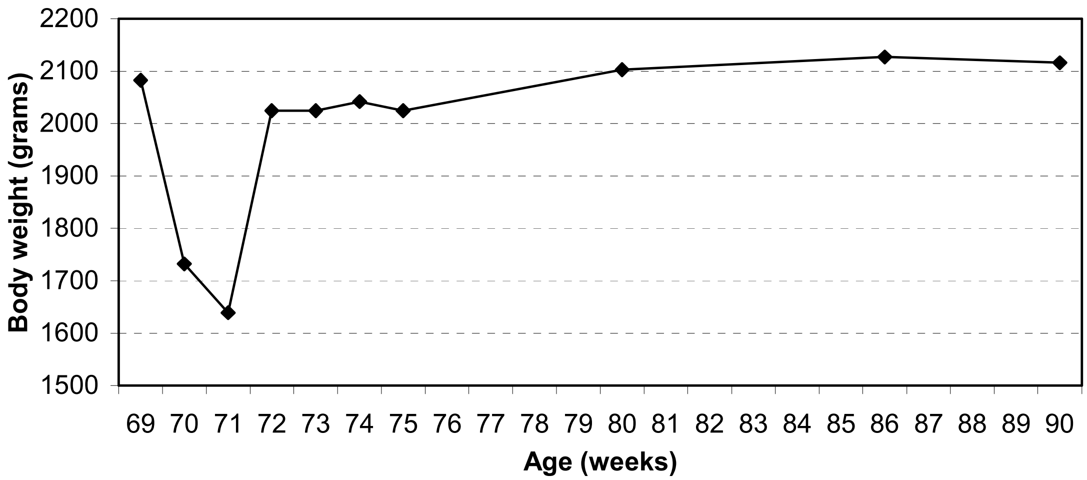

Figure 1: Body weight of birds during the moult period and second cycle. Results are average body weights of 80 individually housed birds.

Feed Consumption

Average feed consumption was 31.5 grams per bird per day during the moult period. No assessment of feed consumption was possible during the laying phase.

Production

Second cycle egg production for the entire flock peaked at 83.8% in week 79, and held above 80% for 10 weeks. Average production from week 72 (first week of lay for the second cycle) until the end of the experiment at week 90 was 75.1%. Production was persistent until week 88 after which egg production started to decline more rapidly.

Egg production in the 80 birds housed individually was superior to the main flock until week 79 after which production was superior in the main flock.

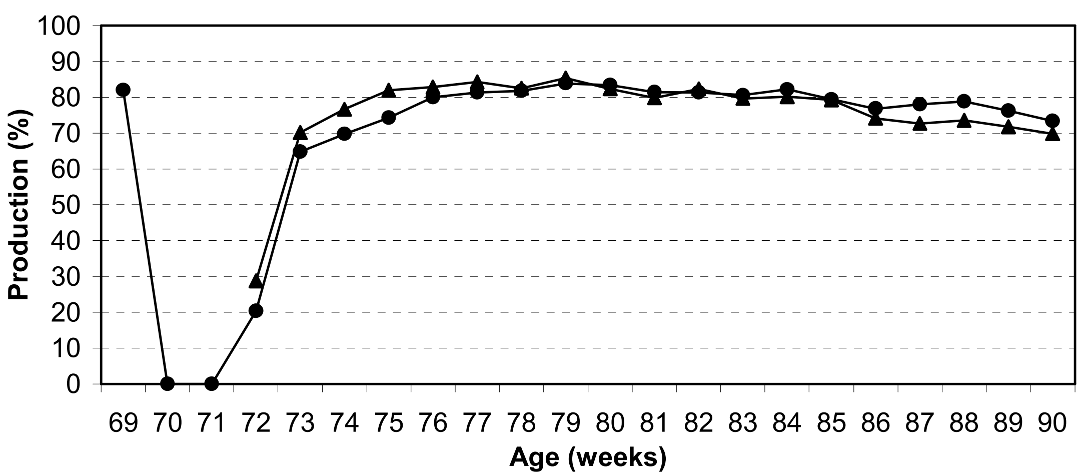

Figure 2: Average second cycle production performance for the entire flock (●) as well as the 80 birds housed individually (▲).

Mortality

Thirty-six birds died or were culled during the 12-day moult period (0.97%) from 3,728 birds. During the second laying cycle mortality averaged 0.18% per week. This is slightly above the expected mortality of approximately 0.1% however the farm manager indicated that the mortality figures are similar to results achieved over many years in that particular shedding type, even in first cycle flocks.

Body weight versus production

The relationship between production and body weight is illustrated in Figures 3 and 4. Figure 3 indicates that those birds that averaged above 85% during the experimental period are birds that averaged 2102 grams at the start of the moult and 2140 grams at 90 weeks. The birds that averaged below 75% during the experiment were, on average, those birds that started the moult at just over 2000 grams and weighed approximately 2050 grams at the experiments end. Figure 4 shows that the birds in the bottom 25%, in terms of body weight prior to the moult, are the poorest performing birds. Birds in the top 25%, in terms of body weight prior to the moult, do not perform as well as the 2 more moderate groups but are still producing significantly more eggs than the lightest birds.

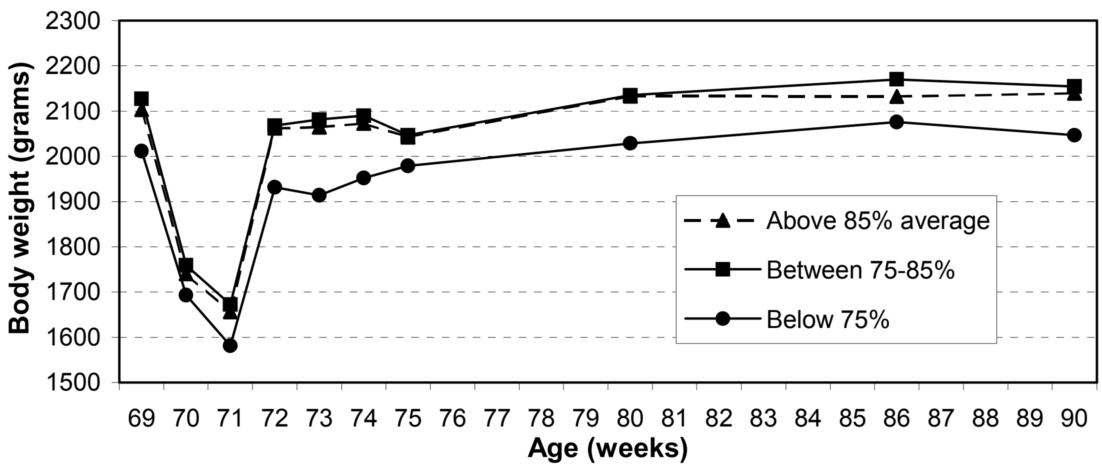

Figure 3: Comparison of body weight profiles between birds divided into groups based on average production during the experimental period.

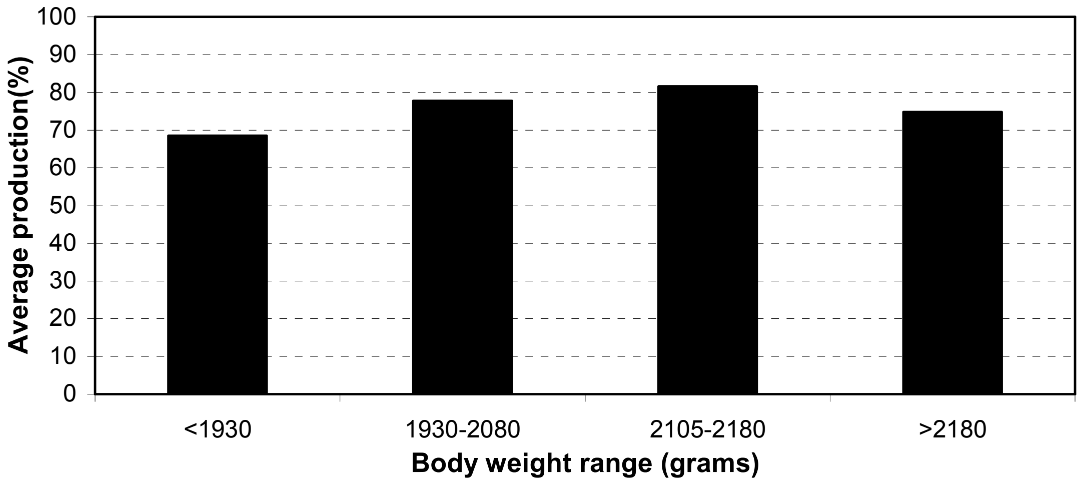

Figure 4: Comparison of average post moult production levels after division of birds into 4 equal groups based on body weight prior to the moult.

Post mortem examination of poor layers

All of the birds that had an average production of under 60% from 72-90 weeks of age were post-mortemed at the end of the trial. The findings from each post mortem can be seen in Table 1.

Table 1: Average production, body weight and pathological findings of those birds producing at below an average of 60% between weeks 72-90.

Bird	Average production from 72-90 weeks (%)	90 week body weight (grams)	Pathological findings
1	50.8	1740	Diffuse adenocarcinoma affecting mesentery, intestine, pancreas and oviduct
2	11.1	2270	Normal appearance
3	54.8	2130	Egg peritonitis
4	52.4	2110	Normal appearance
5	15.1	2580	Salpingitis
6	27.8	2010	Diffuse adenocarcinoma affecting mesentery, intestine, pancreas and oviduct
7	54	1770	Normal appearance
8	30.2	1880	Normal appearance
9	48.4	1460	Diffuse necrotic foci and abscess-like in liver
10	48.4	2390	Diffuse adenocarcinoma affecting mesentery, intestine, pancreas and oviduct
11	13.5	1720	Normal appearance
12	40.5	1900	Diffuse adenocarcinoma affecting mesentery, intestine, pancreas and oviduct
13	55.6	2300	Normal appearance

4.4 Discussion

There is a clear significant relationship between the weight of the birds prior to moulting and production in the second cycle. The highest producing birds during the second cycle were those birds in the range of 2100-2200 grams prior to the moult period, with birds below this range having significantly lower productivity (Figure 3). A closer examination of the relationship between the pre-moult body weight with average production over the whole moult period (Figure 4), suggests that production averaged between 75 to 81% for the birds above 1930 grams live weight, but only 68% in birds below 1930 grams live weight. The under weight birds respond poorly to the moult program and significantly depress overall second cycle production. It is also interesting that there is a trend to lower production performance in the very heavy birds (>2180 grams), but the decreases in production are not as marked as seen in the light birds.

The results achieved with this flock indicate the importance of flock uniformity in maximising productivity in the second cycle. Birds with body weights outside the optimum range at the start of the moult will, in general, produce at a lower level than those birds within the optimum range. Flock uniformity relates strongly to the rearing period and also to the management of the birds during the first cycle. Moulting should therefore be viewed as just a part of the overall management of the birds and not as a remedy to 'fix' problems in later lay. The critical component of successfully moulting birds is the quality of the birds moulted. It has become increasingly apparent that poor birds in the first cycle will be poor birds in the second cycle.

Chapter 5

Studies of Salpingitis, Egg Peritonitis & Cannibalism in a Barn Layer Flock

5.1 Introduction

Studies to date on barn production systems indicate significant problems with growth and flock uniformity in the early lay phase (16-30 weeks of age), which appears broadly correlated with a high incidence of blood stained eggs and mortality. Some barn producers have surmounted these problems by significantly increasing point of lay pullet weight by 15-20% above that suggested by the breed standards. Additional refinements of flock body weight distributions are still required to bring flock performances closer to cage standards. More attention to both pullet weight and flock body weight distributions through the early egg production phase is likely to produce very significant improvements in both mortality rates and egg production in barn systems. Recent analysis of the layout of barn sheds and the relationships with bird behaviour and flock uniformity indicated that additional thought should be given to the position and number of feeders and drinkers in barn sheds, and the behaviour of birds of different body weights within the shed environment. The major problems with the barn systems appear to be both pullet quality and its interaction with sub-optimal shed layouts.

5.2 Materials and Methods

An "all in all out" barn egg layer farm was chosen to investigate anecdotal reports of a higher incidence of salpingitis and egg peritonitis in flocks at 50 weeks of age. The farm consisted of 7 similar sheds using a common feed source, and pullets were introduced from a single rearing farm over a period of approximately one-week at 18 weeks of age. All sheds had a similar layout and similar access to natural light. All birds were beak trimmed prior to arrival at the laying farm. The farm manager provided records of body weight and mortality for each of the 7 sheds.

Five sub-samples of dead birds were collected consecutively over 4 weekly periods from flocks aged between 50-55 weeks. The dead birds were subjected to post mortem examination, carcasses were weighed and the pathological findings were recorded for each individual bird. Causes of mortality were divided into cannibalism, vent trauma, oviduct impaction, egg peritonitis, salpingitis and other causes.

5.3 Results

Body weight

Initial analysis across the 7 sheds illustrated a marked delineation between groups of sheds. Sheds 1, 2 and 3 had acceptable low cumulative mortality, whilst sheds 4, 5, 6 and 7 had unacceptably high mortality despite similar shed layouts, nutrition, light intensity and management.

The average combined body weight of the low mortality sheds (1, 2 and 3) was significantly ($P<0.01$) higher than the average combined body weights of the high mortality sheds (sheds 4, 5, 6 and 7) (Figure 1). The pullet weight at time of delivery (16 weeks) was a bulk weighing from the entire rearing flock and thus there is no difference between the 2 groups shown in Figure 1. However on weighing the birds on the farm after separation into different sheds, significant differences were seen between the 2 groups (Figure 1).

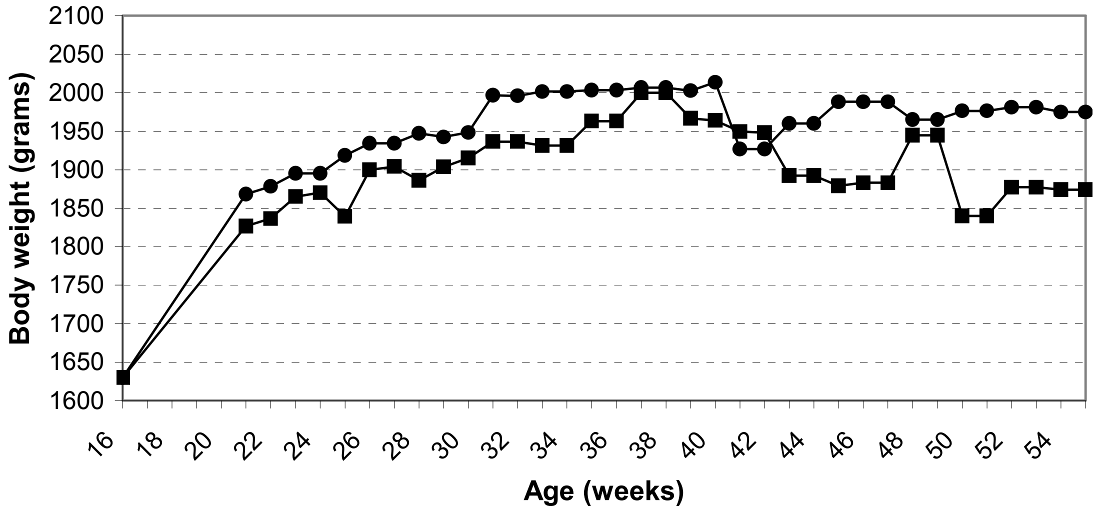

Figure 1. Comparison of average combined body weights of low mortality sheds (sheds 1, 2 and 3) (●) and combined high mortality sheds (4, 5, 6 and 7) (■).

Mortality

The numbers and pattern of mortality was different across the 7 sheds. Average mortality from each of the 7 sheds can be seen in Figure 2. The combined average mortality of sheds 1, 2 and 3 was significantly ($P<0.01$) lower than the combined average of sheds 4, 5, 6 and 7 (Figure 3). Differences in mortality between the two groups of sheds began to emerge at 28 weeks of age. The differences in mortality accelerated significantly after this point (Figure 3).

Figure 2. Cumulative mortality of 7 different barn sheds on the same farm.

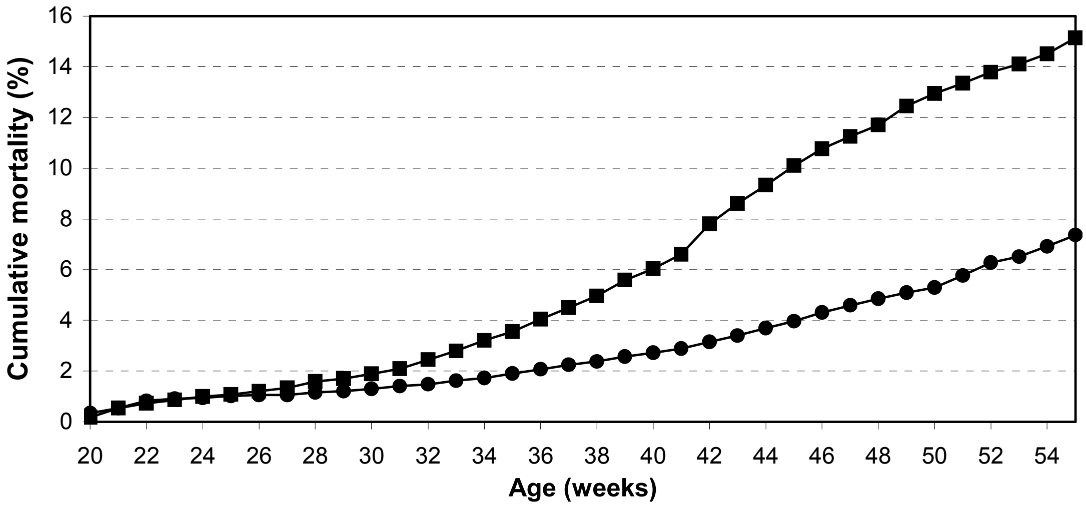

Figure 3. Comparison of average combined mortality for sheds 1, 2 and 3 (●) and combined mortality for sheds 4, 5, 6 and 7 (■).

Results of Pathological Examinations

Of the 70 carcasses subjected to post mortem, a number of birds showed evidence of more than one pathology (Table 1). The proportion of dead birds obtained from the low mortality sheds in comparison to the high mortality sheds reflected the relative mortality, with 33% of dead birds collected from sheds 1, 2 or 3 and 67 % collected from sheds 4, 5, 6 or 7. There were no significant differences in the type of diagnosis recorded between groups of sheds.

In the birds with vent trauma, other pathologies such as egg impaction, egg peritonitis and salpingitis were frequently observed. Approximately 62% of the birds with vent trauma had developed egg peritonitis/salpingitis and approximately 52% of birds with vent trauma had developed an impacted oviduct. Only a relatively small proportion of the mortality (11%) had egg peritonitis/salpingitis without evidence of vent trauma or oviduct impaction.

Table 1. Pathological findings of 70 laying hens housed in barn shedding.

Pathology observed	Number of birds exhibiting pathology	% of birds exhibiting pathology
Cannibalism	35	50
Vent trauma	24	35
Egg peritonitis/salpingitis and vent trauma	15	22
Oviduct impaction and vent trauma	13	18
Egg peritonitis/salpingitis without vent trauma or oviduct impaction	8	11
Other	8	11

5.4 Discussion

Previous research completed at PIRVic has shown that body weight management may indirectly impact on the incidence of reproductive disorders (AECL project EGG 01-10). Low pullet body weights at point of lay can result in a higher incidence of cloacal haemorrhage as indicated by blood staining of the shell surface. In these circumstances it has been hypothesised that the flock will be more vulnerable to cloacal eversion with haemorrhaged tissue, which is likely to increase the incidence of beak inflicted trauma to the cloaca and oviduct. Beak inflicted trauma can then result in oviduct impaction, and ascending infections of the oviduct that may develop into salpingitis and egg peritonitis. In more severe cases, vent pecking and trauma would produce cannibalism behaviour in the flocks.

The main variable in the current study appears to be the variation in body weight between pullets at the time of placement into layer sheds. Average body weights in the higher mortality sheds were significantly below those in the low mortality group, a fact which became apparent on the first weighing after the birds were received at the laying facilities. In the flocks with a higher incidence of mortality due to cannibalism the average live weight of the affected flocks was 50-75 grams lower than the flocks with a moderate mortality. Even this slight difference in average live weight is likely to increase the proportion of under weight birds (1500 to 1600 grams mature weight), particularly if the body weight variation is large (750-800 grams). Flocks with a large variation in body weight will be much more susceptible to slight reductions in average body weight and significant increases in the proportion of light birds will result.

An assessment of mortality indicates that 85% of the dead birds had severe cannibalism and/or vent trauma and only 11% of birds had other causes of mortality. These results clearly illustrate the significance of picking behaviours as causes of mortality in this alternative system, and also illustrated a very strong interrelationship with oviduct impaction, egg peritonitis and salpingitis. The association described between vent picking and egg peritonitis/salpingitis has also been described by Cumming (2000), and it seems likely that the primary aetiology of egg peritonitis/salpingitis is a result of traumatic injury to the cloaca. The alternative hypothesis suggests that the aetiology can also be a descending bacterial infection, but the close association with vent trauma in both these studies and those by Cumming (2000) suggests that pathology in most circumstances is likely to be associated with vent trauma.

Support for these hypotheses is provided by recent epidemiological research from the UK which suggests that early/precocious onset of lay in pullets is strongly correlated with mortality due to cannibalism (Potzsch *et al*, 2001). The excellent cross-sectional study of vent pecking in alternative systems undertaken by Potzsch *et al* (2001) illustrated that vent pecking occurred in 36.9% of 198 flocks and, in affected flocks, the incidence was as high as 3.5% with approximately 50% of the vent pecking resulting in mortality. With an outbreak of vent pecking most farmers used low light intensity to control the problem. In this extensive epidemiological study the early onset of production (< 20 weeks of age) increased the risks of vent pecking by 4 fold compared to flocks that had a later onset of production. Furthermore, these authors suggested that the flocks with precocious egg production would inevitably have lower body weights with a higher egg weight to body weight ratio and this would increase the risk of cloacal mucosal damage. The authors also suggested that sudden increases in egg size may also increase the risks of injury to the cloacal mucosa. In these studies vent pecking also appeared strongly correlated with egg peritonitis and the authors suggested that vent pecking may precipitate egg peritonitis.

Clearly this broad epidemiology indicates that factors other than beak trimming practice can have very profound effects on the incidence of vent pecking and mortality due to vent pecking. In our study the impact of beak trimming, light intensity and diet did not cause significant variation. It seems likely that the problems of mortality, cannibalism and vent trauma can be managed by focussing attention on the pullet management. Clearly the egg production in flocks that achieved mature average live weights of 2.0 kg and above was vastly superior to those flocks with mature body weights under 2.0 kg. The consistent attainment of this mature weight in barn egg production systems seems likely to augment economic performance very significantly. Based on this study Barn egg production can be achieved with acceptable standards of mortality (sheds 1, 2 and 3) and that these outcomes appear to operate independently of beak trimming practice, light intensity, shed layout and nutrition. Pullet quality and/or acquired behaviour of pullets appear to be the major variables in the study accounting for rates of mortality.

5.5 References

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Chapter 6

Study of Body Weight Distribution and Uniformity in Selected Egg Layer Flocks in Victoria

6.1 Introduction

Research undertaken on flocks with different average body weights has clearly demonstrated that the incidence of cloacal haemorrhage is markedly increased in birds with low body weights (EGG 99-06, EGG01-10). This cloacal haemorrhage seems likely to be implicated in mortality due to salpingitis/egg peritonitis and cannibalism, but a definitive causal relationship remains to be described. Despite the lack of definitive causal linkages, there is a high probability that significantly under weight birds, in comparison to the breed standard, in multiple bird cages will experience a high incidence of cloacal haemorrhage, and that secondary beak trauma to the cloacal haemorrhage may result in cessation of egg production and mortality.

There is a strong argument therefore to undertake studies of flock body weight distributions amongst the elite high technology farms for both cage and barn systems, to identify management and technology that can be used to influence the proportion of under weight birds. Most of the high technology cage farms utilise modern cage technology for pullet rearing, whereas most barn farms use floor or deep litter rearing. Anecdotal evidence suggests that body weight distributions and flock uniformities will be superior for cage than floor rearing but these relationships need to be validated objectively and the relationship between low body weight birds and mortality more clearly defined. Important variables could be the type of rearing systems, cage type, adherence to breed body weight standards, beak trimming practice etc. It is anticipated that a best practice model of pullet rearing will be identified for the Eastern States of Australia as a yardstick for the national industry. Producers will be encouraged to develop strategies to lower the incidence of under weight birds, and there is likely to be a positive correlation between the proportion of severely under weight birds and overall mortality. A similar approach will be taken to the methodology adopted by Euribrid, B.V. Info (1997) October that examined body weight distributions at different ages, and then established correlations with important production traits such as peak production, persistency of production and mortality. The applied research undertaken by Euribrid, BV, (1997) suggested that the 6-week body weight was the best predictor of lifetime performance. Furthermore, it seems likely that these correlations would involve both average live weight and live weight uniformity that has developed by 6 weeks of age.

From a practical standpoint the issues of moderating mortality in the cage and barn systems are subtly different, but complementary, and reflect the relative evolution of the two sectors. The common feature is the presence of low body weight birds in flocks that are more susceptible to cloacal haemorrhage. The problem of low body weight birds appears accentuated in the barn systems, but has provided some important insights into strategies that can be used to moderate mortality in cage flocks. The application of these approaches amongst the elite egg producers has the potential to raise Australia's biological performances to levels that exceed world's best practice. An annual mortality of 2% is an achievable target for the elite producers with more emphasis on management of the body weight distribution for the pullets. By targeting the best producers with the highest technology, and the best body weight management strategies, it may be possible to identify models achieving hen housed egg production of 320-330 eggs, and 2% annual mortality with no reliance on routine beak trimming.

Long standing epidemiological studies, complemented with some single bird cage studies undertaken over the last 10 years, suggests that egg production is probably optimised across the mature body weight range of 1800 to 2400 grams in the first cycle of egg production. The breeding companies recommend an average live weight of approximately 1900-2100 grams with a variation on either side of the average recommended weight of 200 grams. This would produce a flock with 80% of the birds ranging in weight from 1800 to 2200 grams. Birds between 2200 grams and 2400 grams will still achieve high levels of egg production, but birds below 1800 grams seem likely to have reduced production capacity and an increased susceptibility to oviduct dysfunction and mortality. In studies of commercial layers at 40-70 weeks of age it is extremely rare to find birds with mature weights of less than 1500 grams, but there are significant populations (5-10%) of birds ranging in body weight from 1500 to 1700 grams (AECL project Egg 01-10). We are hypothesising that the sub-population of light birds will be reducing production capacity and be contributing to bird losses through oviduct haemorrhage, vent trauma, cannibalism and oviduct dysfunction.

Based on these arguments it seem likely that the traditional method of defining uniformity and adequacy of body weight management may be insufficiently sensitive to predict the proportion of significantly under weight birds and the extent of the inadequacy of the body weight. Body weight uniformity is conventionally described as a percentage of the flock's body weight which is spread between 10% above and below the average body weight. Using the traditional methodology at least 10% of the birds can be under the uniformity pattern described by 80% plus or minus 10% of the mean. For example if the mean body weight of brown egg layers at 18 weeks is 1500 grams then up to 10% of the birds could be in the body weight range of less than 1350 grams. If there are a significant proportion of the birds in the weight range of 1150-1200 grams then it seems likely that a significant proportion of the flock population may not attain a mature weight above 1600-1700 grams. At these body weights the probability of poor production and cloacal haemorrhage is significantly increased. A superior mathematical model is to examine the total flock variation and then compare this relationship to the average live weight and a live weight "cut off point" which ensures that birds attain a live weight of at least 1700-1800 grams assuming average bird growth rates. A precise definition of the cut off point probably needs more analysis, but it is clear that a mature weight of 1650 grams or below significantly increases the risks of oviduct dysfunction. In terms of whole flock performance 5% of the flock is likely to be very significant for both mortality and egg production.

New bench marks of performance suggest that egg laying flocks can achieve annual mortalities at a commercial level of 3-4% with egg production performances of 90% hen day production to 60 weeks of age (Tom Grimes, personal communication). The attainment of this elite type of performance is likely to be dependent on improvements in the body weight distribution to reduce the proportion of under weight birds from the current standards of 10%. These elite high performing flocks need to be bench marked for uniformity and it seem probable that the body weight distribution will be very narrow with almost all birds in the range of 1800 to 2400 grams.

Although, the over weight pullets are not as much concern as the underweight pullets from a mortality and productivity standpoint, the over weight pullets will allocate more feed ingredients to maintain their body requirement rather than egg production. The result will be a relatively uneconomical egg production due to their higher feed intake and consequently higher feed conversion rate. On the other hand, since they produce bigger eggs, the eggshell quality may not be satisfactory because of the limits on the ability of the shell gland to deposit calcium on the surface of the egg membrane. This may result in increased egg breakage and increased vulnerability of eggs to bacterial contamination.

Major factors affecting early body weight uniformity include:

- day old chick weight
- flock density
- drinker and feeder space

- feed composition such as energy density, protein component and food safety (mycotoxins in the feed)
- temperature
- ventilation and air quality
- light intensity and behaviour
- health status of the flock
- beak trimming practice

In the current study we examined the body weight distribution of 9 different commercial layer flocks to compare their uniformity under different management regimens to existing standards and new mathematical models of uniformity.

6.2 Material and Methods

Six layer farms were selected and flocks from each farm were assessed between 16 and 22 weeks of age. A sub-sample of 100 pullets were weighed individually at each farm from two different strains (1 ISA brown flock and 8 Hyline brown flocks). Birds were randomly sampled and weighed during the morning period from each farm (A, B, C, D, E and F) and body weight was recorded with a precision of 10 grams. Average body weight was calculated and compared with the body weight standard provided by the breeding company. Pullets on farms A and B were reared in cages in environmentally controlled sheds while pullets on farms C, D, E and F were reared on the floor in curtain sided broiler type sheds. Farms A and B manufactured their own stockfeed whilst farms C, D, E and F purchased stockfeed from a commercial company.

6.3 Results

Table 1. Average body weight (breed standard is given in parentheses), weight range, flock uniformity based on average body weight (% of 100 birds with body weight ± 10% of average) and flock uniformity based on breed standard (% of 100 birds with body weight ± 10% of breed standard) of 8 farm visits. Farm A had 3 different flocks weighed.

Farm	Flock age (weeks)	Average body weight (grams)	Range (grams)	Uniformity based on average weight (%)	Uniformity based on breed standard (%)
A (1)	18	1730 (1500)	750	76	33
A (2)	18	1760 (1500)	780	76	24
A (3)	19	1660 (1570)	640	75	68
B	21	1630 (1720)	620	76	78
C	19	1610 (1570)	870	69	70
D	23	1820 (1800)	770	74	72
E	16	1440 (1360)	430	84	69
F	18	1700 (1500)	715	81	39

There was a wide variation in body weight distribution of the farms studied (Table 1). All flocks exceeded the average body weight recommended by the breeders except for farm B (Table 1). The highest body weight uniformity measured against the breed standard was seen on farm B, while farm E had the highest uniformity based on the flock average body weight. The lowest variation in total body weight range was obtained by farm E.

Table 2. Percentage of birds **not** within ± 10% of the breed standard body weight that were under or over the weight range and the distribution of birds **not** within ± 10% of the average body weight that were under or over the average weight range.

Farm	Uniformity based on breed standard (%)	% under weight	% over weight	Uniformity based on average weight (%)	% under weight	% over weight
A (1)	33	0	100	76	46	54
A (2)	24	3	97	76	31	69
A (3)	68	6	94	75	44	56
B	78	100	0	76	46	54
C	70	34	66	69	45	55
D	72	43	57	74	52	48
E	69	0	100	84	25	75
F	39	0	100	81	42	58

In assessments against the breed standards, almost all those birds outside of the range of ± 10% of the breed standard were over weight on farms A, E and F. This is in direct contrast to farm B where all birds outside of the range of ± 10% of the breed standard were under weight. Farms C and D had a relatively even split between the over and the under weight birds based on the breed standards. In assessments against the average body weight for each visit, there was a similar percentage of over weight birds as compared to under weight birds (Table 2).

6.4 Discussion

A close examination of the scientific literature indicates that flock average growth rates and flock uniformities maintain relatively predictable relationships across flocks and provides a methodology for a mathematical standardisation of flocks. Average live weights can be expected to increase from point of lay (16-18 weeks) to a mature weight in a relatively predictable manner against breed standards. With a point of lay body weight of 1500 grams at 18 weeks of age, the flock average weight can be expected to increase 500 grams to reach 2000 grams by 40 weeks of age. Studies of flock body weight distributions indicate that uniformity remains relatively constant throughout the life of the flock (AECL project EGG 01-10). A set of theoretical comparisons can be made between flocks A (1), D and E. Each body weight distribution was converted to an average of 1500 grams for standardisation of comparisons (Table 3). For flock 1 from farm A, 230 grams was deducted from the live weight of every bird to equate for a transformation of the average live weight from 1730 grams to 1500 grams (Table 3). For the farm E flock 60 grams was added to the body weight of every bird to transform the flock average from 1440 grams to 1500 grams and in a similar way 300 grams was deducted from every bird in the flock from farm D (Table 3). The model therefore standardises average body weight but maintains the same uniformity parameters.

Table 3. Standardisation of flock average live weight to 1500 grams for farms A, D and E and assessment of proportion of lightweight pullets (weight range 1100 – 1300 grams). Figures presented in parentheses are the corrected values. All birds were Hyline.

Farm	Flock age (weeks)	Std weight (grams)	Average weight (grams)	Range (grams)	Uniformity based on average weight (%)	% light birds
A (1)	18 (18)	1500 (1500)	1730 (1500)	750	67%	9%
D	23 (18)	1800 (1500)	1820 (1500)	770	74%	15%
E	16 (18)	1360 (1500)	1440 (1500)	430	84%	0%

This transformation of the body weight data shown in Table 3 enabled a comparison between the farms for the proportion of light birds. For farm A the proportion of birds in the adjusted body weight range of 1100 to 1300 grams was 9%, for farm D the proportion was 15%, whilst for farm E the proportion was zero percent. The weight category of 1100 to 1300 grams will represent the bulk of the flock that achieves a sub-optimal mature live weight of 1500 to 1700 grams assuming an average flock growth rate of 400 grams. In this simulation two important features become obvious. Firstly the proportion of under weight birds in farm E is almost completely eliminated by the narrow variation in live weight (430 grams) and secondly that farm D has a much greater proportion of under weight birds that farm A despite a superior uniformity index (74% verses 69%).

Figure 1 clearly illustrates the advantage of the close alignment of Farm E to the breed average body weight recommendation, the narrow body weight variation and the complete elimination of lightweight birds. All birds in flock E are expected to reach a mature body weight in excess of 1.7 kg assuming average flock growth rates of 400 grams between 18 weeks and 30 weeks of age.

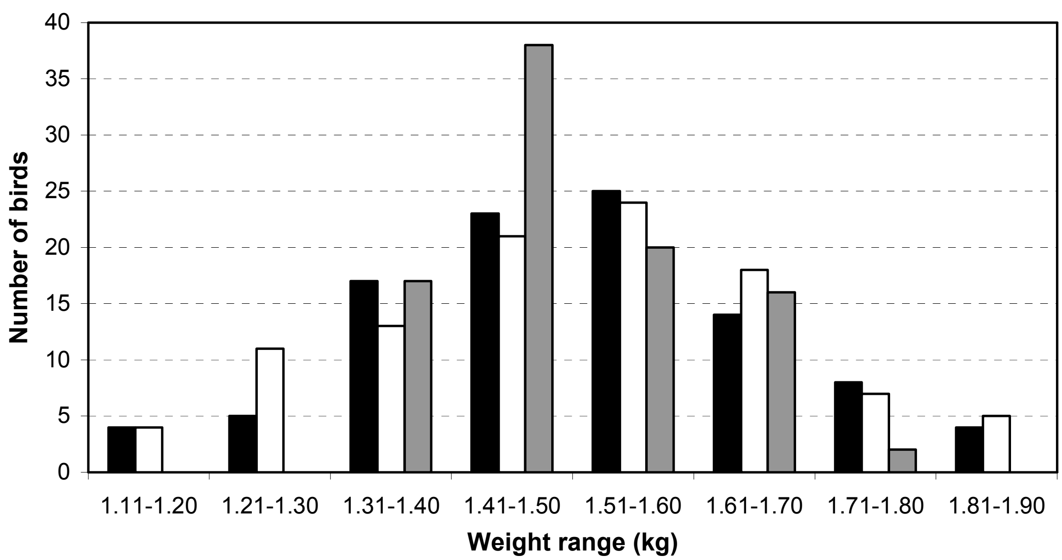

Figure 1: Distribution of body weights after standardisation of flock average live weight to 1500 grams for farms A (■), D (□) and E (■).

The critical threshold weights of the light birds will be dependent on the rate of growth of the flocks between 18 weeks and 30 weeks. The range of average flock growth rates observed in commercial flocks in Victoria varies from approximately 300-500 grams between 18 to 30 weeks of age. Table 4 gives an indication of the mature body weights of birds given different growth rates and varying 18-week-old body weights.

Table 4. Modelling of mature body weights with poor (300 grams), average (400 grams) and high (500 grams) growth rates between 18 to 30 weeks.

18 week old body weight (grams)	Flock average growth rate from 18 to 30 weeks		
	300 grams	400 grams	500 grams
1200	1.5 kg	1.6 kg	1.7 kg
1300	1.6 kg	1.7 kg	1.8 kg
1400	1.7 kg	1.8 kg	1.9 kg
1500	1.8 kg	1.9 kg	2.0 kg

With poor average flock growth rates all birds under 1400 grams at 18 weeks will be too light to attain a mature weight that will provide resistance to cloacal haemorrhage and produce high sustained production. With average flock growth rates between 18 and 30 weeks, birds less than 1300 grams at 18 weeks are again unlikely to meet their reproductive potential. However with high flock growth rates even the birds as light as 1200 grams may achieve appropriate mature body weights. In reality it seems likely that most flocks only gain 400 grams between 18 and 30 weeks and that an effective critical threshold weight will be birds weighing 1300 grams. Our current research information clearly illustrates that mature birds of 1600 – 1650 grams mature weight perform poorly compared to birds of 2000 grams. Additional analysis is required across the range of 1700 to 1900 grams to more precisely define a threshold, because it seems likely that the relationship between body weight and cloacal haemorrhage may not be linear.

The flock body weight distribution studies undertaken provide clear evidence for significant opportunities to improve pullet quality. This would involve reducing the overall variation in pullet body weights as well as eliminating the proportion of birds that are under weight. Additional research is required to more precisely define body weight thresholds below which productivity is compromised. At this stage we have objective data to suggest that mature body weights of approximately 1650 grams significantly increase the propensity of a bird to exhibit cloacal haemorrhage, but we need additional data on the nature of the relationship as weight is increased in the range of 1650 to 1800 grams. These studies should also include an examination of sudden shifts in egg weight in birds of different body weight ranges.

Following on from the identification of a best practice uniformity standard for pullet rearing (430 gram spread of body weight at 16 weeks of age), additional studies need to be undertaken to examine the uniformity of the pullet flocks at 2, 4 and 6 weeks of age, in 2-3 elite pullet rearing farms with divergent uniformity outcomes. Even at this early stage it seems unlikely that beak trimming per se will account for the variation described, because the best uniformity was recorded in a pullet flock with moderate quality beak trimming. The most likely possibility is that the high uniformity standards are achieved by close attention to the first few weeks of life. Applied research undertaken by Euribrid BV, (1997) indicates that the strongest determinant of life time performance is body weight at 6 weeks of age and it seems likely that compliance of average body weight against breed standard and the uniformity standard will be the most important.

Implications

- Egg producers should be looking to reduce pullet depreciation either by extending the length of the first laying cycle or by keeping birds for a second laying cycle.
- Moulting is economically viable in a number of circumstances, especially where producers buy their pullets at point of lay.
- Brown egg genotypes are capable of producing at very high levels in the second laying cycle, with production just below first cycle egg production.
- The major variable in determining second cycle production in this study was the quality of the birds moulted ie. the better the birds are through the first cycle the better the birds will be in the second cycle.
- Moulting should be seen as a whole of flock strategy and is reliant on the management of the birds in both the rearing phase and the first cycle.
- There is a small proportion of birds in a flock that are under performing in the second cycle, generally the lighter birds, that are decreasing flock averages.
- A small number of birds can be rejuvenated by the moult process but the majority of birds will produce at levels similar to the first cycle.
- Flock uniformity and average body weight at the end of the first cycle are critical determinants of performance in the second cycle.
- More research needs to be done on the time that the birds are moulted for, and the body weights that need to be achieved to optimise second cycle production.
- Pullet factors can be a major source of the variation in the incidence of cannibalism in egg laying flocks.
- Low pullet body weights seem likely to predispose flocks to cannibalism and other oviduct dysfunction.
- Vent trauma is strongly correlated with oviduct impaction, egg peritonitis and salpingitis.
- The variation in point of lay pullet body weight ranges from 430 to 890 grams in commercial flocks in Victoria.
- Most commercial flocks studied have populations of underweight birds ranging from 5 to 15%.
- A significant opportunity exists to reduce the proportions of under weight birds to almost zero by more attention to pullet management and the correct use of technology.
- A new benchmark of pullet uniformity, with an average body weight of 1500 grams at 18 weeks of age with a range of 1300 to 1800 grams, seems possible.
- This new benchmark standard should produce a mature weight of 2100 grams with a mature weight range of 1900 to 2300 grams which is probably optimal for longevity of production, low mortality, uniformity of egg size and maintenance of egg quality.

Recommendations

- Producers should assess the financial ramifications of keeping birds for a second cycle, in comparison to the traditional single cycle strategy, using the economic modelling developed.
- Additional research needs to be conducted to assess the impact of alternative moult diets on post moult egg production.
- Additional research needs to be conducted on a range of flocks to determine the optimal weight loss (either a percentage of pre-moult body weight or a set weight) required to maximise post moult egg production.
- Assess the impact of rearing and first cycle management, in terms of body weight and body weight uniformity, on second cycle egg production.
- Producers should, at the minimum, be looking to extend the length of the first laying cycle past the traditionally practiced 72 weeks
- Additional controlled studies need to be undertaken to define the threshold weights below which mortality and production are compromised.
- The flock uniformity studies need to be maintained to study the best practice (430 gram live weight spread) in relationship the pullet age.
- Additional elite performing flocks in the eastern states need to be examined for flock uniformity.
- The causal relationship between elite standards of body weight uniformity with low mortality and production performance needs additional definition.
- The standard of uniformity in flocks produced by different cage rearing systems needs more analysis.
- The concept of total body weight variation and a threshold lower weight needs to be adopted by the industry for further improvements in mortality and production.
- Additional studies of flock body weight variation in relationship to egg quality parameters should be undertaken.

Appendix 1

Control of Cannibalism and Reduced Reliance on Beak Trimming

Further improvements in the control of cannibalism and the capacity to eliminate beak trimming as a routine husbandry practice will be dependent on a improved understanding of the existing management variables that are implicated in stimulating cannibalism behaviours. The further evolution of the egg industry into well standardised housing systems with good light control will provide important mechanisms by which some of the major management variables can be controlled, and creates new opportunities to achieve improved standards of control over cannibalism.

At this stage it appears that the development of feather pecking behaviour in young pullets is strongly correlated with the development of cannibalism, and that the evolution of these behaviours can currently be controlled in modern poultry housing by the use of low light intensity rearing. A precise determination of the age dependent nature of these picking behaviours and the relationship to both light intensity and wavelength of light needs more scientific analysis. The next most important factor appears to be the management of flock body weights and the age of onset of lay. It is most important that the egg weight to body weight ratio in all birds is maintained in the "broad range" defined by the breeding companies to minimise the extent of cloacal damage and maintain the oviductal tissue free of haemorrhage and prolapse. Significant opportunities exist to improve the objective definition of these relationships between body weight, egg weight, age and cloacal haemorrhage. Apart from acquired or learned picking behaviours in pullets, the control of tissue haemorrhage in early egg production seems likely to be the next most important management process in reducing risks of cannibalism. A significant incidence of tissue haemorrhage will trigger a sequel of events resulting in birds learning severe picking behaviours from close associates. Once a flock has been sensitised to picking behaviours they appear much more sensitive to even short changes in light intensity and this could be the direct effects of visualising haemorrhaged tissue and/or just a behavioural stimulus.

Some existing farms with effective light control have been able to completely eliminate beak trimming. However the majority of the elite producers throughout Australia have recently adopted a laser trimming procedure on day-old chicks. More work on the definitions of cloacal haemorrhage and its relationship to body weight management will be required to move the elite producers to question the necessity for the laser trim. It seem highly likely that the mild beak trim achieved in day old chicks by the laser is only conferring a low level of resistance to cannibalism, and that the real control has been achieved by superior bird management and light control in the sheds on the elite farms.

Additional work will be required where the variables of elite pullet uniformity and a low proportion of under weight birds is combined with effective shed light management. Anecdotal reports have suggested annual mortalities as low as 3% can be achieved in elite performing flocks in Australia. The opportunity for this research has only arisen in the last 6 months of the project to consolidate some of these theories into causal relationships. These concepts need to be followed for at least the next 18 months to follow the mortality and production patterns of flocks with best practice uniformity. It should be possible to draw together these two models and to test objectively the impact of uniformity, low body weight variation and the concept of a critical lower body weight threshold.

Plain English Compendium Summary:

Project Title:	**Strategies to Improve Moulting Practices and Reduce Reliance on Beak Trimming**
AECL Project No.:	VAG-1A
Researchers:	Greg Parkinson and Peter Cransberg
Organisation:	Primary Industries Research Victoria 475 Mickleham Rd Attwood VIC 3049
Phone:	(03) 9217 4200
Fax:	(03) 9217 4299
Email:	greg.parkinson@dpi.vic.gov.au; peter.cransberg@dpi.vic.gov.au
Objectives	1) To provide economic modelling showing the cost benefits of moulting and to develop economically viable commercial moulting programs. 2) Undertake studies of pullet and laying flock body weight distributions in Victoria, and identify best practice combinations within the Australian Egg Industry in both cage and barn systems.
Background	Additional economic potential can be realised in the brown egg laying stocks used in the Australian Egg Industry by stimulating the adoption of flock recycling (moulting) using humane management approaches. Improvements in flock uniformity standards and reductions in under weight birds have the potential to lower national flock mortalities, improve persistency of production and facilitate significant improvements in the performance of recycled egg laying flocks. Reductions in the proportion of under weight birds provide large improvements in animal welfare outcomes.
Research	An investigation of the economic merits of moulting laying hens in comparison to single cycle strategies was conducted. Different methods of humanely moulting hens were assessed in an attempt to optimise returns. The body weight distribution of 9 commercial layer flocks was examined to compare their uniformity under different management regimes.
Outcomes	Economic modelling indicated that high pullet costs and low egg prices provide an incentive for moulting, but profitability is strongly influenced by post-moult egg production. High performing first cycle flocks provided superior second cycle performance, and an increased proportion of under weight birds has negative consequences for second cycle performance. Second cycle performance within 5% of first cycle performance is possible in brown egg layers. There is significant potential to improve body weight uniformity in the commercial industry. The consequences of these changes will be profound for production performance and welfare outcomes. The full realisation of the potential of flock recycling will also be achieved by improvements in flock uniformity and the elimination of the 5-10% of light birds evident in most flocks.
Implications	The body weight uniformity standards of most commercial flocks can be improved significantly with more precise studies of pullet management and flock variation standards. These improvements in pullet quality will have profound impacts on both first and second cycle production performance and on flock mortality and welfare. The potential gains are very large in terms of both economic and welfare outcomes.
Publications	Parkinson, G.B. and Cransberg, P.H. (2005). Influence of pullet weight on cloacal haemorrhage. World Poultry, **21(4):** 36-37.