RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

# Profitability comparisons of imported and local strains of Commercial Layers

**A report for the Rural Industries Research and Development Corporation**

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# Foreword

The development of new strains of layers has ceased in Australia, and the importation of genotypes from the Northern Hemisphere has presented problems and challenges in the Australian poultry industry. These have arisen because climate, housing and management in our industry differ from those in the countries where the imported genotypes were developed. Moreover, until recently, the majority of Australian farmers have used standard single-deck Californian type laying cages in sheds with minimal environmental control. In contrast, control of climate and light levels is common practice in the Northern Hemisphere. Stocking densities and Australian layer diets (based on wheat and meatmeal) are also usually rather different from those used in European and northern American countries.

Perhaps partly for these reasons, imported birds have not fulfilled all the promises of high liveability and egg production under Australian conditions. It is of major economic importance to understand the reasons for high mortality and morbidity and sub-optimal performance from the imported birds, and to determine which of the imported strains are most viable economically. It is also necessary to better understand how management options such as diet, cage-density or lighting can be modified for the imported birds to ameliorate problems such as cannibalism.

The project was developed following a literature review, interviews, consultation and surveys with relevant stakeholders in the egg industry in Australia and was commissioned by RIRDC to investigate the commercially important issues identified above. Seven commercially available layer strains were investigated under, as far as possible, conditions similar to those found on commercial farms in Australia. Where possible, the imported birds were compared with their Australian counterparts.

***Aims of the project***

The original objectives of this project were:

- to compare egg production, egg quality and profitability between different strains of imported and Australian layers, during normal laying cycles under commercial conditions, and
- to determine the importance of nutrition, disease, climate and birds-per-cage, on mortality, egg production, egg and eggshell characteristics in these layer strains. The relative profitability between the strains was also to be determined.

The findings presented in this report are directly relevant to the egg industry, and will lead to more refined management recommendations for layers in Australia.

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

This report, a new addition to RIRDC's diverse range of over 700 research publications, forms part of our Egg 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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**Peter Core**
Managing Director
Rural Industries Research and Development Corporation

# Acknowledgments

We thank the Egg Industry Research and Development Council and the Rural Industries Development Fund for financial assistance and the companies (Bartter, Baiada, Hy-Line and Inghams/Tegel) and the NSW Egg Producers Co-Operative for their collaboration, advice and ‘in-kind’ support.

The Companies, as the suppliers of the different strains of day-old chickens, were helpful in providing details of vaccinations given at the hatchery, and other information and advice on the rearing of their chickens.  Both conventional and ‘new/testing’ vaccines were used at the hatcheries.

Dr R.B Cumming performed macroscopic post mortem examinations on all birds that died in the combined flock of about 8,000 hens making up the studies covered in this report.

We acknowledge the contributions of the Poultry Research and Teaching Unit at the University of New England for their collective support for the experiments undertaken in this project. Drs Steve Walkden-Brown, William Wong and Ian Colditz, and Ms Amy Grima are co-authors on a published report of Experiment 3 and are thanked for their major contribution to this experiment.

Facilities and the management and feeding of birds at ‘Laureldale’ were overseen by Mr Norm Thomas, Director of Rural Properties and his staff including Mr Gary Cooper and Mr Mark Porter.

# Contents

# Executive Summary

## S.1 Experiment 1. (Layer strain comparison)

Egg production, egg quality and profitability of 6 strains of commercially available layers (four imported and two Australian strains: over 3,500 birds in total) were evaluated under Industry conditions at the University of New England's poultry farm 'Laureldale' in 1996-97.

Commercial one-day-old pullets were obtained from hatcheries where they were vaccinated according to the protocols used at that time by the suppliers at their hatcheries. Subsequently the birds were reared on a commercial farm near Tamworth, where they received typical commercial management. At 16–18 weeks of age, they were transferred to 'Laureldale' and housed in five-bird or three-bird cages and production traits were monitored until the birds were 66 weeks of age. The conclusions were:

- Profitability differed markedly between strains under our semi-commercial conditions
- An Australian strain was the most profitable under our conditions when eggs were marketed by the dozen but imported strains were more profitable when eggs were marketed by weight.
- Birds housed in one shed at 3/cage were more profitable than those in another shed at 5/cage.
- Mortality from Marek's Disease (MD) and cannibalism was much higher in imported birds than in Australian strains.

## S.2 Experiment 2 (Causes of mortality)

The mortality patterns were analysed for the flock used in Experiment 1, based on post mortems done on all birds that died. The ranking of strains in terms of mortality differed between stocking rates. Mortalities from MD were greatest in the period before 'peak lay' whereas cannibalism complex were substantially higher in the imported strains. Either the natural MD virus in this trial was not highly velogenic, or the Australian strains were highly MD resistant as the Australian strains had only 6-8 % mortality to 66 weeks of age whereas mortality in the imported layers was 23–44%.

Mortality from cannibalism complex in the imported strains was significantly higher in the imported birds. Cannibalism mortality was higher in the five-bird cages and was more sustained after peak lay than in the three-bird cages.

## S.3 Experiment 3 (Metabolic basis of MD resistance)

An experiment was set up to investigate whether there were differences between the Australian and imported strains of layers in their immune characteristics that might explain the higher resistance of the Australian genotypes to Marek's Disease. Levels of mortality were related to measurable indices of both humoral and cell-related immunity. In particular, the Hy-Line Brown strain had the highest mortality in this experiment and in Experiment 3 exhibited the lowest indices for both types of immunity.

## S.4 **Experiment 4** (Layer strain comparison)

A second comparison of layer strains was undertaken in 1997-98 with a flock of just over 5,000 birds. The strains compared were: **Hy-Line Gold**; **Hy-Line CB**; **Tegel Hi-Sex**; **Tegel Super Brown (SB2)**; **Tegel Super-tint** and **Baiada IsaBrown**. This trial appears to have been the only comprehensive random sample laying test undertaken in Australia at this time using commercially available birds.

All details of vaccination procedures at the hatchery were kindly supplied by the Companies supplying day-old chicks. The Hy-Line birds (Gold and CB) received only conventional Webster's vaccines. The Baiada IsaBrown birds received Rispens and HVT. Inghams birds were vaccinated as follows: Tegel Supertint (Rispens R988 cell associated), Tegel Hi-Sex (Rispens R988, CR6, HVT) and Tegel SB2 (Rispens R988, CR6 HVT and Maravac).

The Hy-Line Gold – one of the two strains receiving only Webster's conventional vaccines– had the highest mortality (47%): the Hy-Line CB which was the other strain receiving only Webster's vaccines, had lower mortality (8%). This strain was developed from the SIRO-CB in Australia, which had proved very resistant to local MD virus in our earlier trials. The marked difference in mortality between these two strains indicates that there is a strong genetic component leading to resistance to MD challenge.

Egg numbers per bird in the laying period differed significantly between the strains, although the range was narrow (287–301 eggs). Egg-mass production between strains covered a wider range (16.5–18.1 kg) reflecting also the differences in egg weight between the strains. Although all eggs produced generally had sound shells and contents of good quality, there were significant differences in measured egg quality characteristics between the strains, affecting their market value.

## S.5 **Experiment 5** (Mash *v.* pellets)

In general there were no major differences in feed intake, or feed conversion efficiency between birds given their diets in mash or pelleted forms. However, there was a tendency ($P<0.12$) for the birds given the mash diet to have a higher total mortality (16.9% vs 13.1%). Similarly, there was no significant effect of form of diet on deaths from MD, but again there was a tendency ($P<0.15$) for the mash to be associated with a higher mortality due to MD.

There was no detectable effect of form of diet on the incidence of vent peck (2.8% vs 1.8%) but the numbers of deaths in this category were small.

Egg production did not differ ($P>0.05$) between birds given their diets as a pellet or as mash. Although there were significant differences in most measures of egg quality, the differences were fairly small in practical terms.

## S.6 **Experiment 6** (High sodium diets and cannibalism)

Across the 6 strains, addition of supplementary sodium to the diet had no significant effect on total mortality, or on deaths due to cannibalism.

There were no significant effects of diet on egg production or on egg quality. An interesting observation was that the high-sodium diet resulted in hens laying eggs with a higher shell reflectivity (*i.e.* lighter coloured shells) and slightly darker yolks, although this was not of practical significance.

## S.7 Opportunities for new projects

By February 1998, evidence was emerging to suggest the new vaccination procedures were effective in reducing the incidence of Marek's Disease in early lay. This trend continued into 1999, suggesting the problem of MD in Australia would be greatly reduced in the future – as long as the new vaccines remain effective.

It may be worthwhile, however, as a form of insurance against breakdown in the vaccination programs, to study the effects of early-life nutrition and disease isolation during pullet rearing on their later resistance to MD challenge during lay. Researchers at UNE could undertake investigations to determine whether there are benefits from raising pullets in isolation from MD challenge on the development of later resistance to MD. Studies could be made of both vaccinated and unvaccinated chickens using a shed at 'Kirby' refurbished under project UNE63A.

## S.8 Publications arising from this RIRDC project

**Nolan, J.V., Roberts, J.R. Thomson, E., Ball, W. and Cumming, R.B.** (1998). Production and economics of four imported and two Australian layer strains in two caging systems. *Proc. Aust. Poult. Symp*. **10**: 85-89.

**Cumming, R.B., Ball, W. and Thomson, E.** (1997). Mortality patterns in Australian and imported laying hens. . *Aust. Vet. Poult. Assoc., Sydney.*

**Cumming, R.B., Ball, W. and Nolan, J.V.** (1998). Mortality patterns in Australian and imported laying hens. *Proc. Aust. Poult. Symp*. **10**: 168-171.

**Cumming, R.B., Ball, W.,** (1999). Mortality patterns in layers receiving different Mareks Disease vaccines. *Aust. Vet. Poult. Assoc., Sydney.*

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**Walkden-Brown, S.W., Wong, C.W., Nolan, J.V., Grima, A.L. and Colditz, I.G.** (1999). Differences in immune competence amongst layer strains. *Proc. Aust. Poult. Symp*. **11**: 168-171.

# 1 Project Background

The development of new laying strains in Australia has ceased, and the importation of genotypes from the Northern Hemisphere has presented challenges in the Australian poultry industry which arise because climate, housing and management in our industry differ from those in the countries where the imported genotypes were developed. Until recently, the majority of Australian farmers have used standard single-deck Californian type laying cages in sheds with minimal environmental control. Stocking densities and Australian layer diets (based on wheat and meat-meal) are also usually rather different from those used in the Northern Hemisphere, and perhaps partly for these reasons, the imported birds have not always fulfilled all the promises of high liveability and egg production.

It is of major economic importance to understand the reasons for high morbidity and sub-optimal performance from the imported birds, and to determine which, if any, of the imported strains are more economically viable than their Australian counterparts. It is also necessary to better understand how dietary management or cage-density of the imported birds can be modified to ameliorate problems in the different strains.

## 1.1 Relevance of this project and potential benefits

A number of current industry questions and concerns about the imported genotypes were investigated in this project. These included:

- What is the relative profitability of imported and Australian strains of layers under typical Australian layer production conditions?
- How well do the imported strains meet the production expectations in variable conditions of climate, nutrition, disease challenge and social and other stressors?

We hypothesised that:

- individual strains would be affected in different ways by being placed in 3-bird or 5-bird cages
- some strains would not meet production expectations and would not react identically to nutritional variations, disease challenge, climate variations and other forms of stress,
- these challenges would produce between-strain differences in mortality, morbidity and production characteristics that will determine the long-term economic value of the individual strains
- the tendency for birds to vent peck would be dependent on strain and sodium chloride concentration in the diet.

## 1.2 General objectives

The original objectives of this project were:

- to compare egg production, egg quality and profitability between imported and Australian layers, during normal laying cycles under commercial conditions.
- to determine the importance of nutrition, disease, climate and birds-per-cage, on mortality, egg production, egg and eggshell characteristics.
- to determine the profitability of the strains when similarly managed.

# 2. Experiment 1. Production and economics of four imported and two Australian layer strains in two caging systems

## 2.1 Introduction

Imported strains of laying hen are likely to be subject to a wider range of environmental, disease and management stresses in Australia than in their countries of origin. High mortality of imported layers from Marek's disease (MD) and cannibalism has been major sources of economic loss in recent years.

A comparison was made at the University of New England of the production and profitability of imported (Lohmann Brown, Hy-Line Brown, IsaBrown, HiSex) and Australian (Hy-Line CB, Tegel Super Brown) strains of layers up to 66 weeks of age under management conditions that are typical of many Australian poultry farms.

## 2.2 Materials and methods

All birds were hatched between 16 and 30 January 1996 and then subjected to identical treatment, after leaving their hatcheries of origin, until 66 weeks of age. All chickens were vaccinated at their hatcheries against MD and Infectious Bronchitis (IB) and reared in wire-floored cages near Tamworth. At 3 weeks of age, they were re-vaccinated for IB (A3 virus; in-contact method) and at 14 weeks for Avian Encephalomyelitis and IB (Vic S; in contact). The birds were beak-trimmed at 10 days and at 8 weeks of age. At 17-18 weeks of age, they were moved to the 'Laureldale' poultry farm (University of New England) where they were housed in single-deck laying cages, at either 5 birds/cage (Harrison cages; Shed 1 – 550 $cm^2$/bird) or 3 birds/cage (Californian cages; Shed 2– 500 $cm^2$/bird). At this stage, the birds were accustomed to 14 h daylight. Daylength was then increased in steps of 20 min /week to 16 h (at 24 weeks). Imported strains were selectively beak-trimmed at 31 weeks of age.

All strains were given, *ad libitum*, a grower diet from 14 to 18 weeks and a pre-layer diet from 18 to 22 weeks of age. From 22 weeks of age, all birds were offered a crumbled diet formulated to provide (per kg) 11.6 MJ of metabolizable energy, 175 g crude protein and 37 g calcium (Millmaster, Tamworth – further details are given in Appendix 1*)*. Shed 1 had 11 replicates each of 40 birds for each of 4 strains, i.e. Hy-Line CB, IsaBrown, Tegel Super Brown and Hisex strains were each represented by 440 birds (5 birds/cage in 88 cages), whereas the Lohmann Brown and Hy-Line Brown strains were represented by 12 replicates and 480 birds/strain. In Shed 2, each strain had 4 replicates each of 33 birds (132 birds/strain). The replicates were evenly placed throughout each shed.

Birds that died were replaced up to 25 weeks of age. Post-mortem examination was made on all birds that died to 66 weeks of age. Feed intakes and egg productions of birds were determined from 22 to 66 weeks of age. Eggs were collected (30/strain) at random from all treatments at intervals of 4 weeks. Costs and returns were recorded to enable net returns per bird housed to be determined.

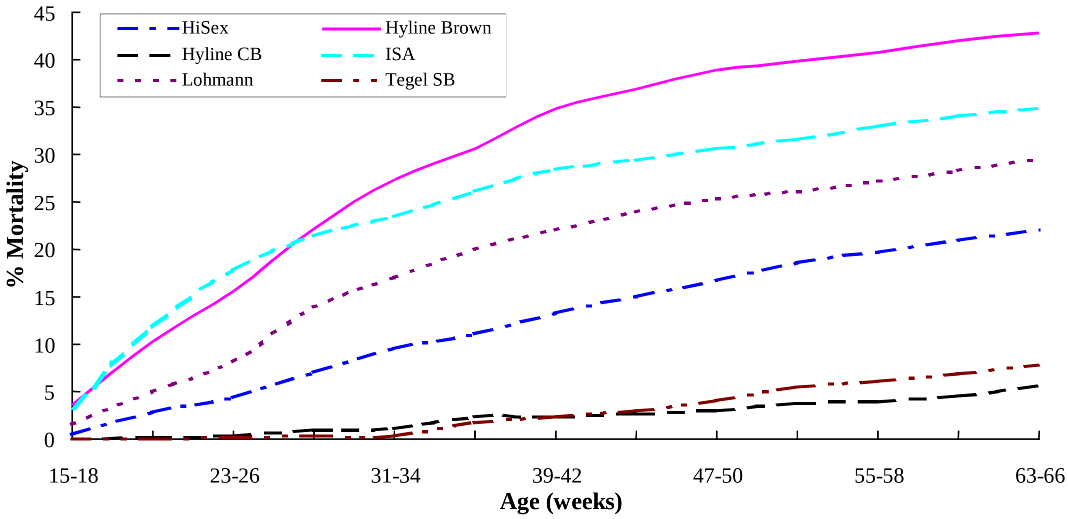
Results were analysed statistically by analysis of variance.

## 2.3 Results

Mean live weight of birds at 18 weeks of age ranged from 1.48-1.75 kg, increasing to 2.18-2.37 kg at 66 weeks of age.

Cumulative mortality for each strain across treatments and sheds are given in Fig. 2.1.

***Figure 2.1 Cumulative mortality in each of 6 strains of layers from 18-66 weeks of age***




Post-mortem examinations indicated that the majority of deaths were due to Marek's disease (MD) and cannibalism. Of the imported strains, the Hy-Line Brown and IsaBrown had the highest incidence of MD, whereas the Hisex and Lohmann Brown birds showed some MD resistance: deaths due to cannibalism occurred in all imported strains and were greater ($P<0.05$) in 5-bird than 3-bird cages, and highest for Lohmann Brown birds. The Australian genotypes were almost totally free of MD and the 2-3% of deaths attributed to cannibalism was apparently not affected by the number of birds/cage.

Lohmann Brown, HiSex and Hy-Line Brown hens were first into lay, reaching 50% hen-day production at 21-22 weeks of age. All strains reached peak hen-day production at about 27 weeks of age.  Hen-day egg production peaked at over 90% for the Australian strains, and between 84 and 90% for the imported strains. Hen-day production declined more rapidly in the Australian strains and was lower ($P<0.05$) than in the imported strains after 45 weeks of age.

Differences ($P<0.05$) in hen-housed egg production between the strains were smaller than in hen-day egg production as the fall in egg production from 45-66 weeks in the Australian strains was offset by their lower mortality (Fig. 2.2). Egg weight increased in all strains as the hens aged, but the Australian strains laid lighter eggs at all times (Fig. 2.3) and, as a consequence, had a lower egg mass production at all times (Fig. 2.4).

*Figure 2.2 **Differences in hen-housed egg production (HHEP) in 6 strains of layers to 66 weeks***

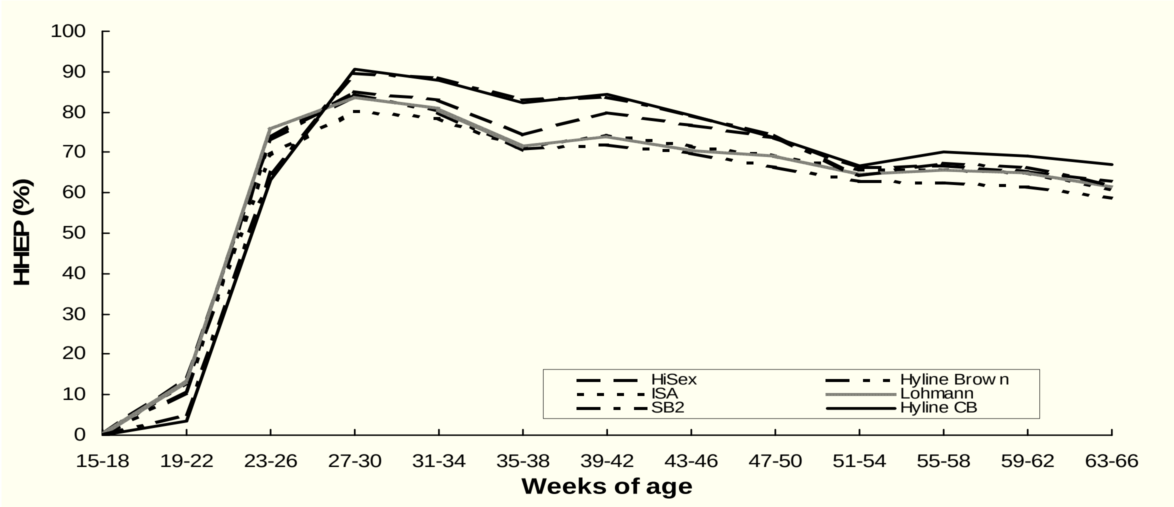



*Figure 2.3 **Differences in mean egg weight with increasing age between strains of layers***

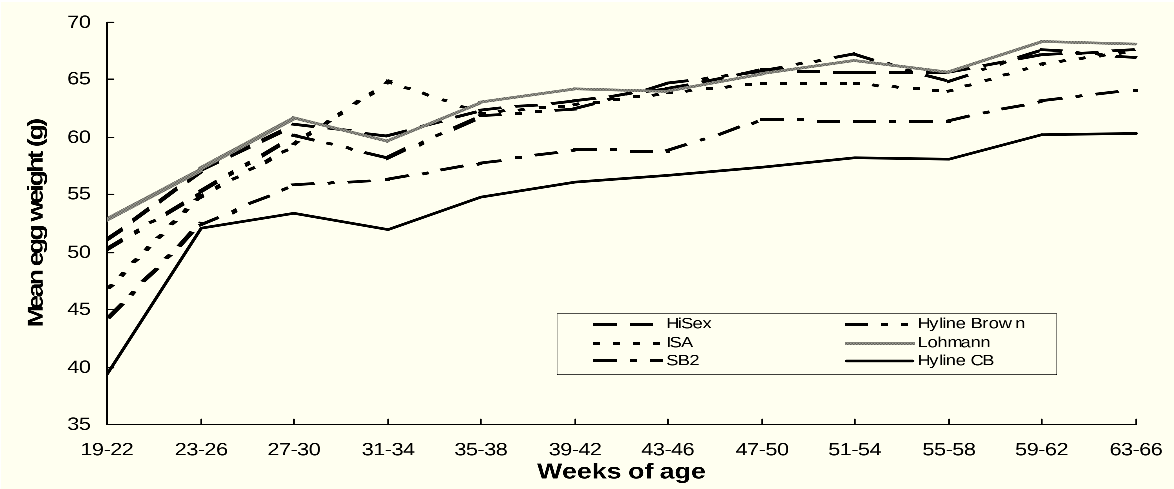
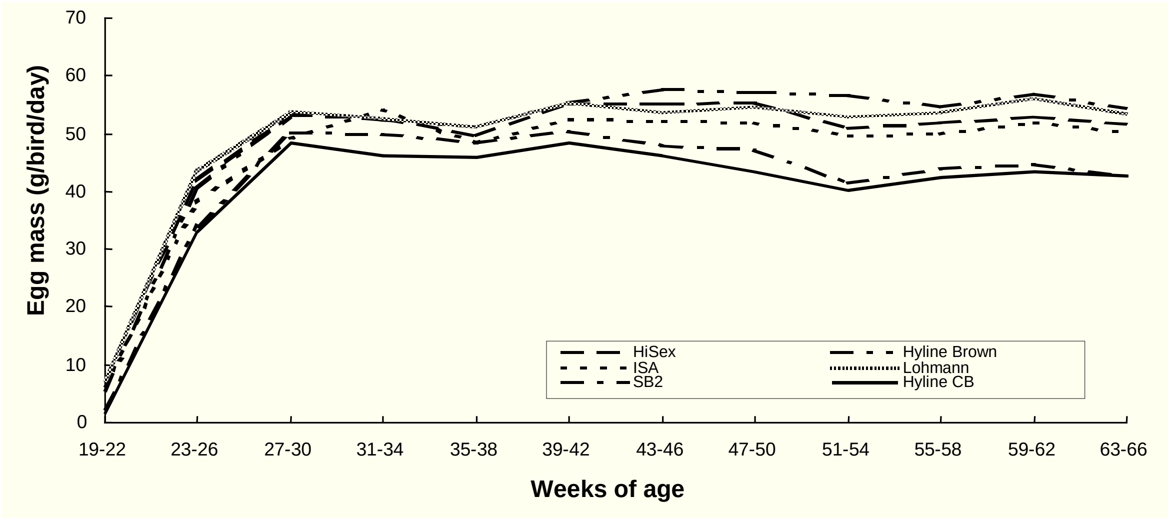



*Figure 2.4 **Egg-mass production of 6 strains of layers from 22-26 weeks of age***



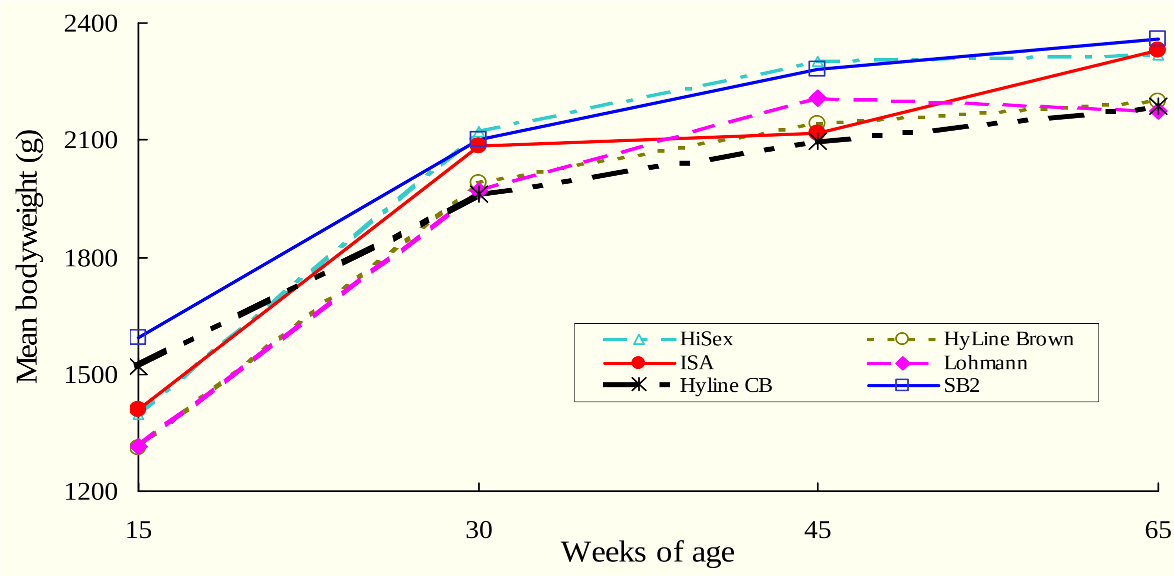
Feed intake, and feed conversion ratio (feed intake/eggmass) were higher (P<0.01) in the two Australian genotypes than in the imported strains (Table 2.1).

**Table 2.1 Cumulative mortality (% hens housed), hen-day and hen-housed egg production, mean egg weight, feed intake, total egg-mass production (kg), and feed conversion ratio (FCR, g feed/g egg-mass) in 6 strains of layers (from 22 to 66 weeks of age).**

| | Hisex | Hy-Line Brown | IsaBrown | Lohmann Brown | Hy-Line CB | Tegel SB |
|---|---|---|---|---|---|---|
| Mortality (%) | 21.4 | 37.5 | 30.2 | 27.8 | 5.6 | 7.9 |
| Eggs/hen-day (%) | 81.5 | 84.9 | 78.7 | 82.5 | 77.6 | 77.1 |
| Eggs/hen housed | 222 | 188 | 200 | 191 | 237 | 231 |
| Egg weight (g) | 63.6 | 63.2 | 63.2 | 64.0 | 56.3 | 59.2 |
| Egg-mass prod. (kg) | 14.5 | 13.6 | 13.8 | 14.2 | 13.7 | 13.1 |
| Feed intake (g/d) | 133 | 137 | 129 | 132 | 134 | 135 |
| FCR (g/g) | 2.58 | 2.54 | 2.61 | 2.50 | 3.11 | 3.00 |

The change in live weight of the birds is given in Fig. 2.5.

***Figure 2.5 Live weight change in birds from 15 to 65 weeks of age.***




Profitability was assessed by subtracting costs (of rearing pullets, including replacements between 18 and 28 weeks, feed and packaging materials, but excluding overheads, labour and other running costs) from income (from egg sales and spent birds) (Table 2.2).

**Table 2.2 Net returns ($ per hen housed) in Shed 1 (5-bird cages) and Shed 2 (3-bird cages) for 6 strains of layers (income and costs from hatching to 66 weeks of age).**

| | Hisex | Hy-Line Brown | IsaBrown | Lohmann Brown | Hy-Line CB | Tegel SB |
|---|---|---|---|---|---|---|
| Shed 1 | $3.54^{\phi}$(4.63)* | 2.03 (5.16) | 1.57 (5.31) | 3.47 (5.68) | 4.17 (1.63) | 2.90 (1.75) |
| Shed 2 | 3.92 (6.07) | 2.68 (5.88) | 2.13 (5.34) | 5.14 (7.32) | 5.93 (3.85) | 4.46 (3.80) |

***Net return = [return from egg sales + spent hens] - [costs of rearing + feed + egg packaging]***

$^{\phi}$Assuming all eggs sold by the dozen @ $1.30. *Assuming all eggs sold by the kg @ $1.725/kg.

## 2.4 Discussion

Although the different strains were compared under identical conditions, these conditions did not always exactly match those recommended by the companies concerned. For example, the birds were subject to increasing daylength to initiate laying only after 18 weeks of age – even though the imported strains would probably have been subjected to this regime somewhat earlier under commercial conditions, whereas the Australian strains would normally have been started a week or two later. The advantages or disadvantages for each strain cannot be determined, but were considerd likely to be minor.

The mean live weights of the breeds at 18 weeks approximated those recommended in the relevant Management Guides with the exception of the Hy-Line CB, which was about 1 kg over weight at 18 weeks of age. Weights of birds tended to move above the recommended weights later in lay for some breeds, e.g. the IsaBrown and Tegel birds, where the mean weight at 66 weeks was about 2 kg above the recommended weight. Options recommended to control feed intake to restrict live weight, such as increasing the shed temperature for part of the day or restricting the amount of feed offered were not practical under the conditions of this experiment. The Lohman birds, on the other hand, maintained a weight profile close to the management recommendations throughout the pre-lay and laying period.

It was necessary to selectively beak trim the imported strains at 31 weeks of age to reduce the incidence of cannibalism, whereas there was no major problem with cannibalism in the Australian strains and trimming was not undertaken. The beak trimming would probably have affected the egg production of the imported strains for a short time after the operation, although there was no significant drop in the weekly eggmass production in the week of beak trimming relative to the preceding week.

Deaths due to cannibalism were significantly greater in birds housed at 5/cage than in those housed at 3/cage, although floor space in the two types of cages (550 v. 500 $cm^2$/bird) and the trough lengths available to each bird (10 cm/bird) were similar. It is probable therefore that it was the number of birds within a cage and their social interactions that affected production.

The high mortality among imported strains confirmed the Australian industry experience and our earlier research for the EIRDC (Nolan *et al*. 1997) and showed there was still a major mortality problem in 1997 with the recently imported strains. The imported strains at that time were, however, capable of feed-efficient egg production and excellent egg quality (Roberts *et al.* (1997) which would have been further improved if the mortality problems had not been present.

The profit margin obtained for each strain depended on the method used to market eggs. Selling 'by the dozen' in Armidale was more profitable for the Australian strains despite the higher packaging costs, whereas selling 'by the kg' was more profitable for imported strains. The relative returns from egg sales markedly affected the profitability ranking of the birds.

Studies of this type will be needed to provide experimentally controlled, early and independent evaluations under Australian conditions of the profitability of layers as new strains become available.

## 2.5 References

**Nolan, J.V., Roberts, J., Thomson, E.S., Ball, W. and Cumming, R.B.** (1997). Comparison of the performance of three imported and two Australian layer strains on three diets. *Proc. Aust. Poul. Sci. Symp.* (ed. D. Balnave) **9:** 161-165.

**Roberts, J.R., Leary, A.M., Ball, W. and Nolan, J.V.** (1997). Egg and egg shell quality in five strains of laying hen and the effect of hen age. *Proc. Aust. Poul. Sci. Symp.* (ed. D. Balnave) **9:** 126–129.

# 3. **Experiment 2.** Mortality patterns in Australian and imported laying hens

## 3.1 Introduction

The recent importation of laying strains from the northern hemisphere into Australia has led to problems concerning bird livability. Mortalities due to MD and the cannibalism complex have been particularly evident. The imported strains, when vaccinated with conventional Australian Marek's vaccines, do not appear to be well protected against MD and heavy losses have been reported in the field. A number of reasons have been put forward, including the argument that the imported birds have been challenged by very velogenic strains of the MD virus.

A total mortality survey of two Australian and four imported strains of laying birds to 66 weeks of age was based on post-mortem examination of all birds that died in Experiment 1. The rearing conditions to 16 weeks of age, and the management conditions in the shed at 'Laureldale' were typical of many Australian poultry farms. The results indicated that mortality from MD and 'cannibalism complex' was substantially higher in the imported strains. Mortality in the imported strains from cannibalism complex was significantly higher in five-bird than three-bird cages, and the ranking of strains was influenced by housing system.

## 3.2 Materials and Methods

The management of the birds was as described in Experiment 1. Birds that died were replaced up to 22 weeks of age.

A macroscopic post-mortem examination was made on all birds that died up to 66 weeks of age. During autopsy, deaths were categorised according to the most obvious abnormality or lesion likely to have been the prime reason for death of the bird. Features diagnostic for MD included growths involving the ovaries, spleen, kidneys, liver and heart muscles, as well as the typical thickening of the brachial and sciatic nerves. Hens dying from MD were almost invariably out of production.

Cumming (1974) suggested that cannibalism was closely associated with salpingitis/peritonitis, and Jordan and Pattison (1996) recently made the same suggestion. The conditions included in the cannibalism complex as used here are prolapse, vent peck, cannibalism, and salpingitis/peritonitis. These conditions can be described as follows:

a) *prolapse*, where the cloaca was everted, sometimes containing an unlaid hard-shelled egg, the tissues engorged with blood and showing signs of pecking.
b) *vent-peck*, where the cloaca was usually damaged and contused with portions of the reproductive and/or digestive tract sometimes missing. Such birds are often anaemic.
c) *cannibalism,* where a portion of the body, usually the back and thighs had been eaten away.
d) *salpingitis and peritonitis,* where there were macroscopic signs of inflammation of the oviduct and/or the peritoneal cavity. This condition varies from acute to chronic and the lesions vary accordingly. In the acute cases, the ovary is active and the prominent

lesion is marked venous congestion of the ovary and oviduct, which usually contains small (1-4 ml) flockules of white to yellowish pus. There may be similar flockules of pus in the peritoneal cavity as well. In the chronic form, the bird is generally emaciated, the ovary atrophied and the oviduct distended with concentric layers of inspissated pus. Hens may die showing symptoms varying from the acute to the chronic form.

e) *nephritis* – due to damage in the vent area occluding the terminal portion of the ureters.

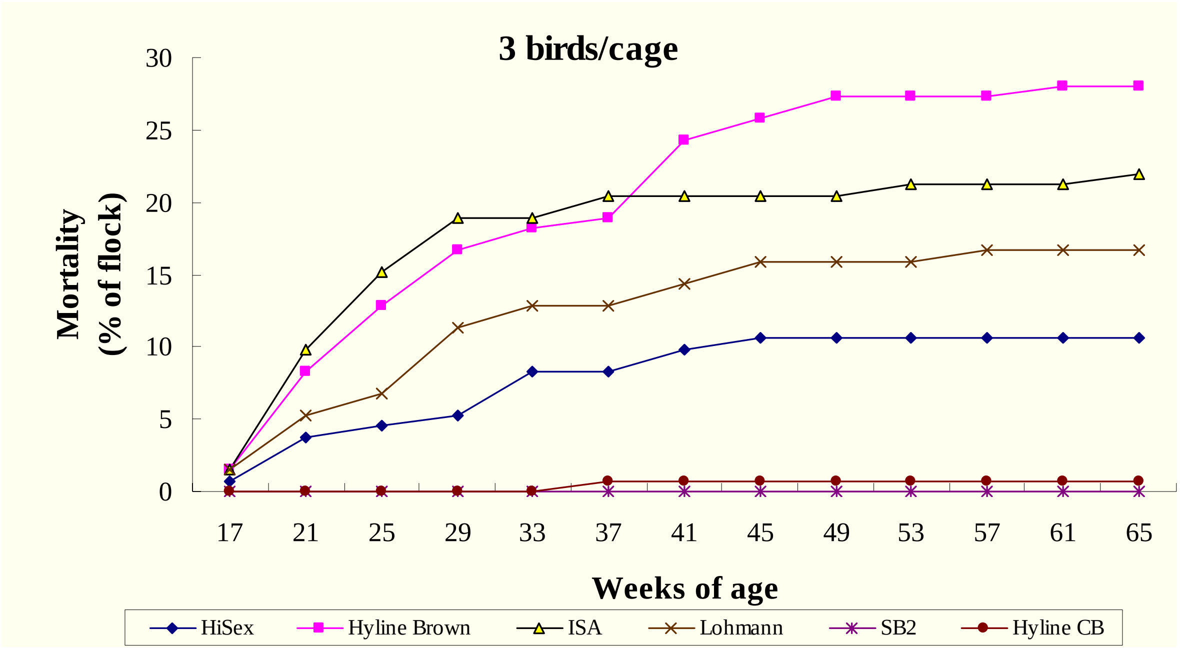
Usually the birds in categories a, b and c were in full production, as indicated by their comb development and ovarian activity.

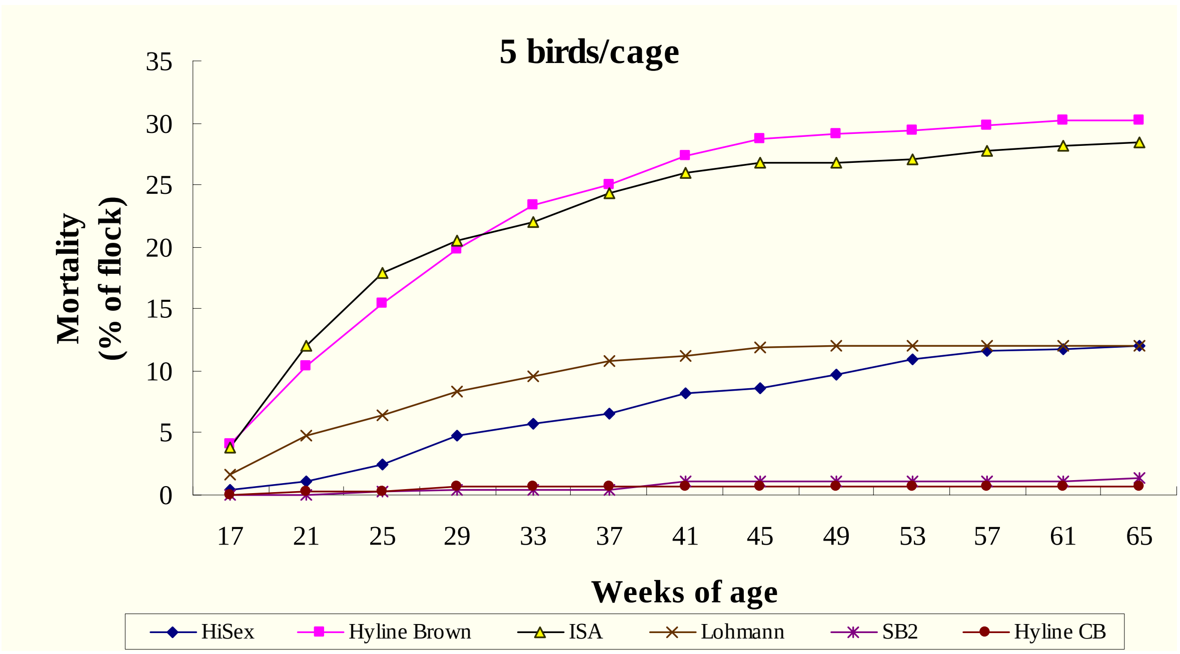
## 3.3 Results

Cumulative mortality from 18 to 66 weeks of age in the six strains housed in the three- or five-bird cages is shown in the three figures. MD mortality is shown in Figure 3.1, cannibalism complex mortality in Figure 3.2, and total mortality in Figure 3.3. As can be seen from the figures, the two categories of MD and cannibalism/cannibalism complex accounted for about 90% of the total mortality.

As shown in Figure 3.1, losses from MD generally began early, and peaked around the 25–35 week period. MD losses were substantially higher in the imported than local strains with essentially similar mortality and ranking of the strains between the two housing systems.

*Figure 3.1 Cumulative mortality (% of flock) in 6 strains of birds from Marek's Disease during the period of lay*

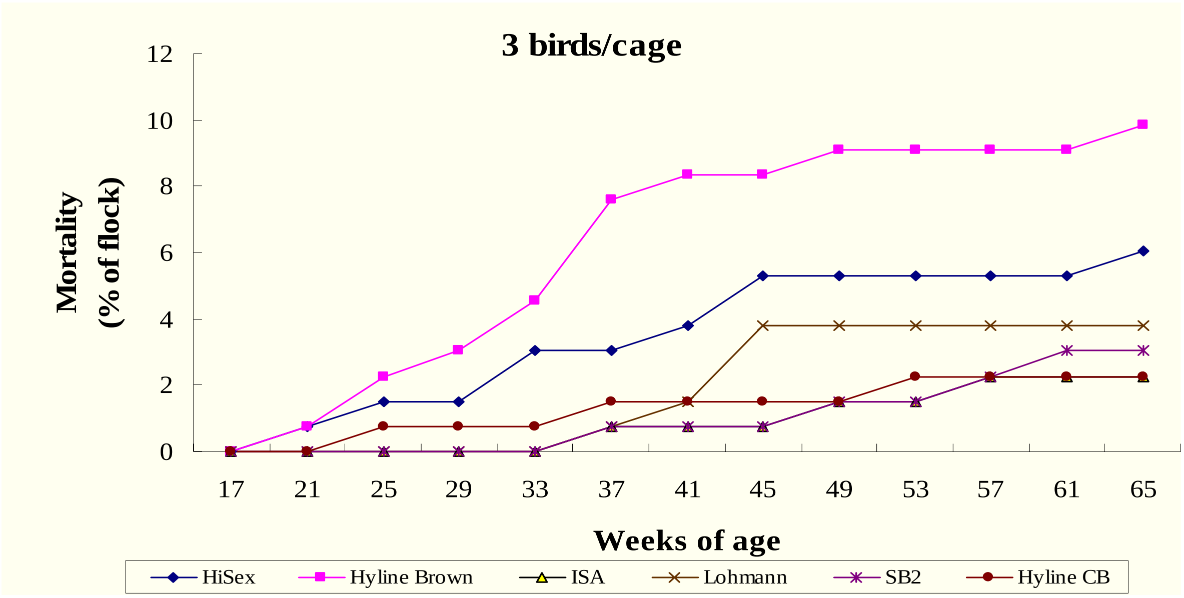


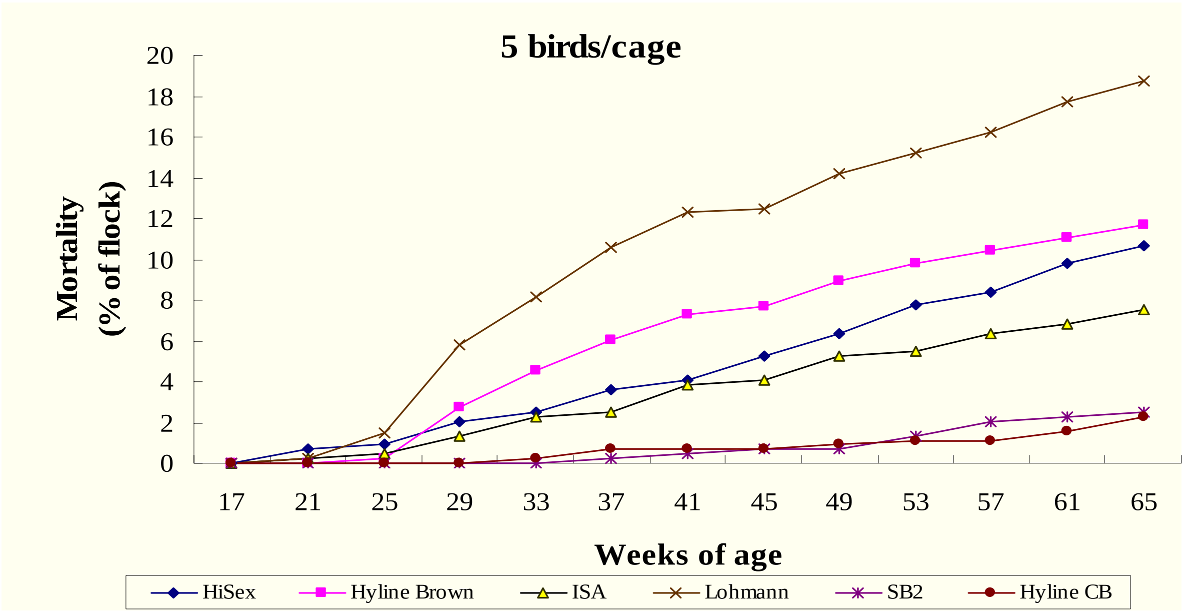



The losses from cannibalism complex (Figure 3.2) tended to occur later, significant losses starting at about 25 weeks of age. Again, mortality from this cause was considerably higher in the imported than local strains. There was a difference between the two housing systems in the level and pattern of mortality from this cause, and in the relative ranking of the strains. Overall, cannibalism mortality was higher in the five-bird cages and continued to increase over the laying period whereas, in the three-bird cages, mortality tended to plateau in all strains at about 40 weeks of age.

Within the imported strains, there was a marked change in ranking in the two housing systems, with the Lohmann Brown birds showing the highest cannibalism-related mortality in the five-bird cages, but low to moderate absolute and relative mortality in the three-bird cages.

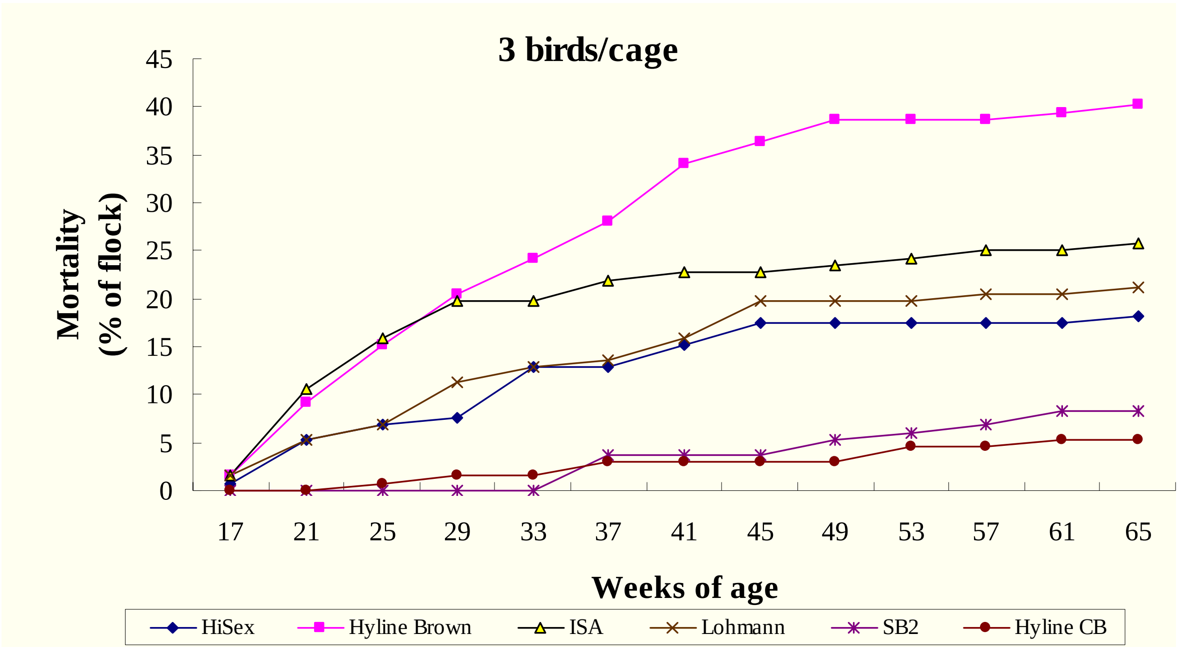
***Figure 3.2*** ***Cumulative mortality (% of flock) in 6 strains of birds from cannibalism during the period of lay.***

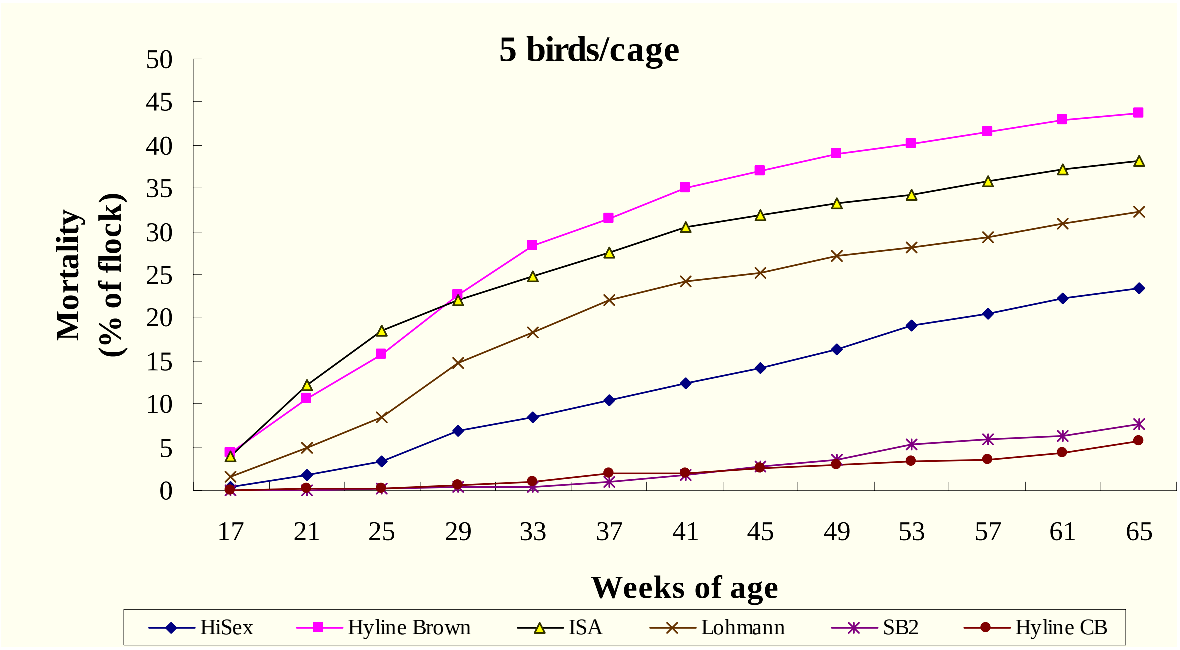


Overall, the total mortalities in the imported breeds were considerably higher than those recorded in the Australian strains, with somewhat higher mortalities occurring in the five- than three-bird cages, in some strains at least (Figure 3.3).

***Figure 3.3 Cumulative mortality (% of flock) in 6 strains of birds from all causes during the period of lay.***



## 3.4 Discussion

It has been suggested that the susceptibility of the imported birds to MD may be because very velogenic MD virus strains are present in Australia. We did not assess the virulence of the MD virus that infected the birds in this trial. However, as all birds were housed together, the two Australian strains must have been strongly resistant to the naturally occurring virus at ‘Laureldale’, or the virus was of relatively low virulence, as the Australian genotypes recorded less than 2% mortality up to 66 weeks of age from this condition. Irrespective of the virulence of the MD virus providing the challenge, there were clearly marked differences in the resistance of the birds to the MD challenge.

Crossing of the MD-resistant Australian strains with imported genotypes, development of more efficient vaccines, or raising young birds in isolation to reduce the MD challenge in early life may be ways of reducing economic losses due to high MD-related mortality. Ways of reducing cannibalism also need to be improved. The use of beak trimming, lower light levels in sheds, diets with higher fibre content, differences in numbers of birds per cage or cage design are possible management options that require further investigation.

Environmental conditions in the two sheds were generally similar except for the stocking density. The higher mortality of the birds that were stocked 5 per cage relative to those stocked at 3 per cage, were therefore most probably due to stocking density *per se*. The differences in mortality between stocking densities were due mainly to the higher rates of cannibalism in the birds at the higher stocking density. However, higher incidences of MD MD were also apparent at the higher stocking density especially in the IsaBrown birds. This may have been related to some form of non-specific stress with, for instance, effects on feeding behaviour of some birds in each cage unit. Continued assessment of the causes of mortality, especially as related to the effects of the number of birds per cage will be essential.

The cannibalism mortality results suggest that husbandry procedures such as beak trimming and lighting levels in sheds, which appear to be adequate for Australian strains, may need to be modified to accommodate the generally increased susceptibility of the imported strains. The effect of fibre in the diet may also be worthy of investigation.

## 3.5 References

**Cumming, R.B.** (1974). *Proceedings Australian Poultry Science Convention,* p.207. Hobart. World Poultry Society Association.

**Jordan, F.T.W.** and **Pattison, M.** (1996). In: *Poultry Diseases.* 4th edition, p. 41 (eds F.T.W. Jordan and M. Pattison). Saunders, London.

**Nolan, J.V., Roberts, J.R., Thomson, E., Ball, W.** and **Cumming, R.B.** (1998). *Proceedings Australian Poultry Science Symposium* **9**: 85-89.

# 4. **Experiment 3.** Differences in immune competence among layer strains

## 4.1 Introduction

Differences between layer strains in their susceptibility to death from Marek's disease were evident in our layer strain comparisons (Experiment. 2).

We hypothesised that the differences in mortality between strains subjected to the same challenge conditions and undergoing the same management might be related to different levels of immune competence between the strains.

We investigated humoral and cell-mediated immunity and lymphocyte populations in 5 strains of commercial layers at about the time of peak lay at 'Laureldale' poultry farm. The Hy-Line Brown strain, which exhibited the highest level of mortality in Experiment 2, and the Hy-Line CB, which had the lowest level of mortality in Experiment 2, were both included in this experiment.

## 4.2 Birds and management

Tegel SuperBrown2 (SB2), Tegel Hisex, IsaBrown (ISA), Hy-Line commercial CB (CB) and Hy-Line Brown (HLB) chicks were hatched in February 1997 (week 0) and given standard MD and IB vaccinations. At 15 weeks, the birds were vaccinated against Egg Drop Syndrome (EDS) using an inactivated vaccine (Intervet®) then transferred to the University of New England 10 days later and run as a commercial layer flock (total of 3155 birds placed). In addition to live weight (LW) and mortality data (Mort.), immune variables were measured as follows:

a) Humoral immunity. Specific antibody titres against EDS were determined by ELISA in plasma samples collected at weeks 16.5, 31 and 57 (n=12/strain at each sampling).
b) Cell-mediated immunity. This was determined by the change in wattle thickness 24 h after injection of phytohaemagglutinin (PHA, 80µg in 100µl normal saline) adjusted for the change in thickness in the other wattle injected with 100µl saline (Week 57, n=12).
c) Lymphocyte phenotype. At weeks 31 and 57, blood samples from the same 8 birds from each strain were collected and the percentage of lymphocytes in the CD4+ (helper) and CD8+ (cytotoxic) classes determined using fluorescence-activated cell sorter analysis.

## 4.3 Results

EDS titre, PHA-wattle thickness and CD4+ and CD8+ lymphocyte percentages differed ($P<0.05$) between strains (Table 4.1). Overall, the indices were numerically lowest for the Hy-Line Brown strain, but there were no clear patterns relating to the recorded levels of mortality.

**Table 4.1 Strain effects on immunological indices in layers (means ± SEM).**

| Variable | Layer strain | | | | |
|---|---|---|---|---|---|
| | CB | Hisex | HLB | ISA | SB2 |
| $Log_{10}$ EDS titre | $1.92 \pm 0.07^{ab}$ | $2.10 \pm 0.09^{bc}$ | $1.83 \pm 0.07^{a}$ | $1.92 \pm 0.12^{ab}$ | $2.31 \pm 0.07^{c}$ |
| PHA resp. (mm) | $1.05 \pm 0.44^{ab}$ | $1.52 \pm 0.84^{ab}$ | $0.83 \pm 0.47^{a}$ | $1.72 \pm 0.92^{b}$ | $1.44 \pm 0.75^{ab}$ |
| CD4+ lymp. (%) | $58.5 \pm 1.9^{c}$ | $52.1 \pm 2.6^{bc}$ | $49.7 \pm 1.6^{ab}$ | $54.9 \pm 3.0^{bc}$ | $48.3 \pm 2.3^{a}$ |
| CD8+ lymp. (%) | $15.3 \pm 0.9^{a}$ | $17.1 \pm 2.1^{a}$ | $16.2 \pm 1.1^{a}$ | $16.1 \pm 0.9^{a}$ | $20.1 \pm 1.2^{a}$ |
| LW (Wk 31, kg) | $1.97 \pm 0.05^{a}$ | $2.23 \pm 0.05^{a}$ | $2.03 \pm 0.06^{a}$ | $2.02 \pm 0.06^{a}$ | $2.03 \pm 0.00^{a}$ |
| LW (Wk 57, kg) | $2.09 \pm 0.08^{a}$ | $2.31 \pm 0.04^{a}$ | $2.30\ 0.10^{a}$ | $2.28 \pm 0.07^{a}$ | $2.22 \pm 0.09^{a}$ |
| Mort. (Wks 16-63, %) | $7.6^{a}$ | $29.8^{c}$ | $25.2^{c}$ | $25.8^{c}$ | $12.3^{b}$ |

***$^{abc}$ Means within rows not sharing a common superscript differ significantly ($p<0.05$).***

## 4.4 Discussion

The differences in immuno-competence between the strains generally support the hypothesis that levels of mortality are related to measurable indices of both humoral and cell-related immunity. In particular, the Hy-Line Brown strain – which exhibited the lowest indices for both types of immunity – had the highest mortality in this experiment and also in the strain comparison in Experiment 3.

It is possible that the differences in the responses of the different strains were innate, or that the differences were due to genotype x environment interactions. It is possible, for example, that the diet being offered to all the birds was more suitable for some strains than others and that this may have differentially affected their immune status.

# 5 **Experiment 4.** Comparisons of egg production, egg quality and mortality in commercial layer strains

## 5.1 Introduction

This experiment was another 'semi-commercial' comparison involved approximately 5,000 layers. The strains (and numbers of each strain) compared in Expt. 3 were: **Hy-Line Gold** (718); **Hy-Line CB** (911); **Tegel Hi-Sex** (866); **Tegel SB2** (837); **Tegel super tint** (840 birds) and **Baiada IsaBrown** (874). This trial appears to have been the only random-sample laying test with imported strains of layers undertaken in Australia in 1997-98.

## 5.2 Birds and vaccination

The Hy-Line birds were hatched on 31 July 1997, and Tegel and Baiada birds on 4 August 1997. All details of vaccination procedures at the hatchery were kindly made available to us by the Companies supplying day-old chicks.

The Hy-Line birds (Gold and CB) received all Webster's vaccines (Maravac ½ dose, Websters CA 2 doses, and Websters HVT 4 doses). The Baiada IsaBrown birds received Rispens and HVT. The Inghams birds were vaccinated as follows: Supertint (Rispens R988 cell associated), Hi-Sex (Rispens R988, CR6, HVT) and SB2 (Rispens R988, CR6 HVT and Maravac).

The birds were raised under identical conditions from day-old by a commercial producer near Tamworth and transported to Armidale on 18-19 November 1997. They were then given a commercial pre-layer diet until 5 January 1998 when they were given their experimental diets.

Birds were 20 weeks of age on 22$^{nd}$ December 1997. They were allocated to their cages so that replicates of birds were blocked throughout the two sheds that housed the birds. Until this date, the birds were subject to natural lighting (increasing day length). On this date, lights were turned on and then lighting was to be increased weekly to 16 hours.
No replacements for birds dying in individual pens were made after 22 December 1997. Reasons for death were determined by post-mortem for all birds that died.

## 5.3 Diets

Three diets were obtained from a commercial supplier (Millmaster, Tamworth). They were instructed to supply diets formulated to their commercial layers specifications. Diet 1 was supplied as a crumble, Diet 2 as a mash. Both of these diets were formulated to contain sodium chloride at a concentration of 0.18% of dry matter. Diet 3 was a crumble virtually identical to Diet 1, except for the addition of sodium chloride (1 kg NaCl/tonne). The treatments were blocked so that replicates of each treatment were represented equally within replicate blocks of each strain which were represented equally throughout the sheds.

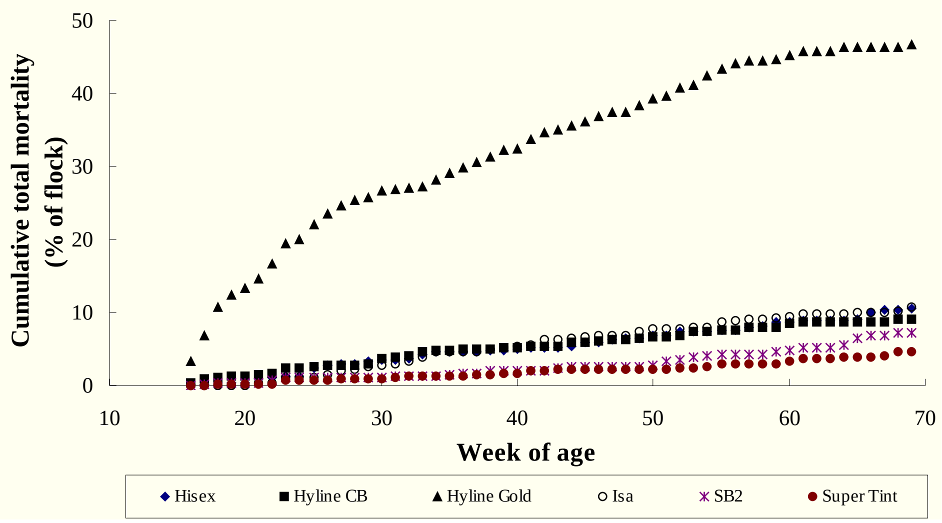
Feed allocation to the birds and egg production were recorded throughout the trial. Complete egg collections (n=10) were made at 5–8 week intervals throughout the period of lay, and egg and egg-shell quality estimates were made on all batches of eggs. The experiment was terminated on 6 December 1998 when the birds were 66 weeks of age.

## 5.4 Results

### 5.4.1 Mortality

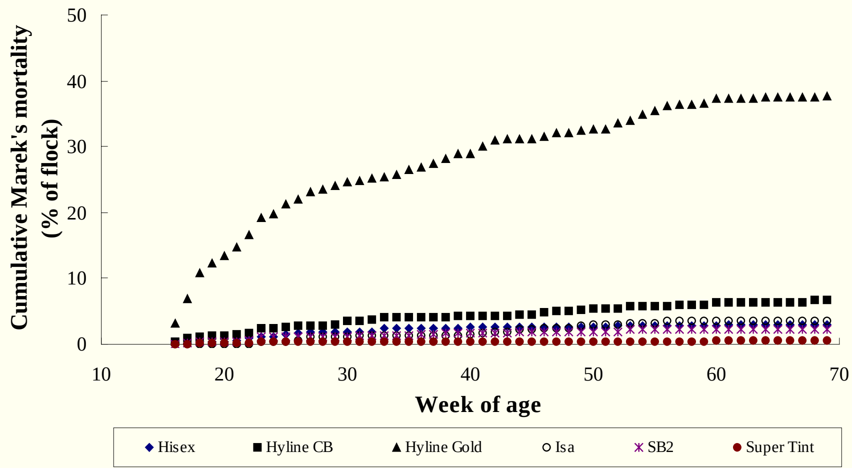
Total mortality from all causes and all diets was highest in the Hy-Line Gold (47%) and lowest (5%) in the Super Tint birds. Mortality in the other strains was less than 11% (Fig. 5.1).

***Fig. 5.1*** ***Cumulative mortality from all causes in 6 strains of layers in the period from 18 to 66 weeks of age***



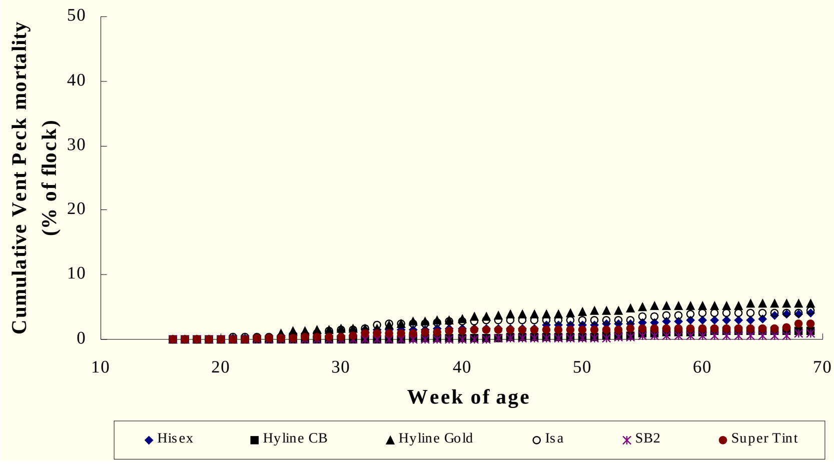

The cumulative mortality from MD is given in Fig. 5.2.

***Figure 5.2*** ***Cumulative mortality from Marek's Disease in 6 strains of layers in the period from 16 to 66 weeks of age***




The cumulative mortality from the cannibalism complex (mainly vent peck) is given in Fig.5.3.

*Figure 5.3 Cumulative mortality from the cannibalism complex (mainly vent peck)*




A summary of the causes of death (based on macroscopic post mortem examinations) during the period of lay is given in Table 5.1.

**Table 5.1 Cumulative mortalities due to Marek's Disease (MD), vent peck and other causes to 66 weeks of age.**

| Breed | Vaccination | MD (cum. %) | Vent Peck | Other | Total |
|---|---|---|---|---|---|
| HiSex | A | 3.0 | 4.1 | 3.5 | 10.6 |
| Hy-Line CB | B | 6.7 | 1.3 | 1.1 | 9.1 |
| Hy-Line Gold | B | 37.7 | 5.6 | 3.5 | 46.8 |
| IsaBrown | C | 3.5 | 4.6 | 2.8 | 10.8 |
| SB2 | D | 2.2 | 0.87 | 4.1 | 7.1 |
| Super tint | E | 0.65 | 2.4 | 1.5 | 4.6 |
| **Breed effect (p<)** | | **0.000** | **0.128** | **NS** | **0.000** |

A – Rispens R988, CR6, HVT
B – Maravac ($^1/_2$ dose), Websters CA (2 doses), Websters HVT (4 doses)
C – Rispens R988, HVT
D – Rispens R988, CR6, HVT and Maravac
E – Rispens R988 (cell associated)

### 5.4.2 Egg production

The cumulative egg production per hen and the cumulative egg-mass per hen over the period of lay for all 6 strains are given in Table 5.2.

***Table 5.2*** **Cumulative number of eggs per hen and egg-mass production of 6 strains of birds during the period of lay from 20–66 weeks.**

| **Breed** | **Total eggs** | **Egg-mass production (kg)** |
|---|---|---|
| HiSex | $293^{abc}$ | $18.7^{a}$ |
| Hy-Line CB | $284^{a}$ | $16.5^{c}$ |
| Hy-Line Gold | $298^{bc}$ | $17.5^{b}$ |
| IsaBrown | $301^{c}$ | $18.7^{a}$ |
| SB2 | $287^{a}$ | $17.1^{bc}$ |
| Super tint | $290^{ab}$ | $17.4^{b}$ |
| **Breed effect (p<)** | **0.013** | **0.000** |

### 5.4.3 Egg Quality

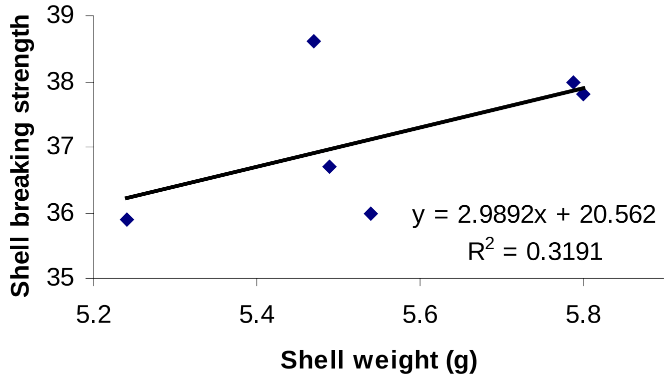
There were significant differences between breeds in the average egg weight and average quality of eggs produced throughout the period of lay (20-66 weeks of age, Table 5.3).

**Table 5.3 Egg quality differences between six breeds based on 7 samples of eggs collected at 6-8 week intervals.**

| **Breed** | **EggWt (g)** | **Shell Wt (g)** | **% shell** | **Shell BS** | **Shell De-form** | **Albu-men height (mm)** | **Haugh Units** | **Reflect-ivity** | **Yolk Colour (Roche scale)** |
|---|---|---|---|---|---|---|---|---|---|
| HiSex | $65.0^{e}$ | $5.79^{c}$ | $8.93^{a}$ | $38.0^{bc}$ | $266^{b}$ | $8.46^{b}$ | $89.8^{ab}$ | $35.7^{a}$ | $10.6^{a}$ |
| Hy-Line CB | $59.0^{a}$ | $5.24^{a}$ | $8.90^{a}$ | $35.9^{a}$ | $260^{ab}$ | $8.11^{a}$ | $89.4^{ab}$ | $48.3^{b}$ | $10.8^{b}$ |
| Hy-Line Gold | $60.5^{c}$ | $5.47^{b}$ | $9.05^{ab}$ | $38.6^{b}$ | $274^{b}$ | $8.41^{b}$ | $90.4^{a}$ | $42.6^{c}$ | $10.4^{a}$ |
| IsaBrown | $62.8^{d}$ | $5.80^{c}$ | $9.24^{c}$ | $37.8^{bc}$ | $246^{a}$ | $8.08^{a}$ | $88.2^{bc}$ | $36.9^{a}$ | $10.7^{b}$ |
| SB2 | $61.0^{c}$ | $5.54^{b}$ | $9.11^{bc}$ | $36.0^{a}$ | $249^{a}$ | $7.91^{a}$ | $87.6^{c}$ | $46.2^{d}$ | $10.6^{a}$ |
| Super tint | $59.8^{ab}$ | $5.49^{b}$ | $9.20^{bc}$ | $36.7^{ab}$ | $261^{ab}$ | $7.93^{a}$ | $88.3^{bc}$ | $64.4^{e}$ | $10.5^{a}$ |
| **Breed effect (p<)** | **0.000** | **0.000** | **0.000** | **0.000** | **0.011** | **0.000** | **0.000** | **0.0000** | **0.000** |

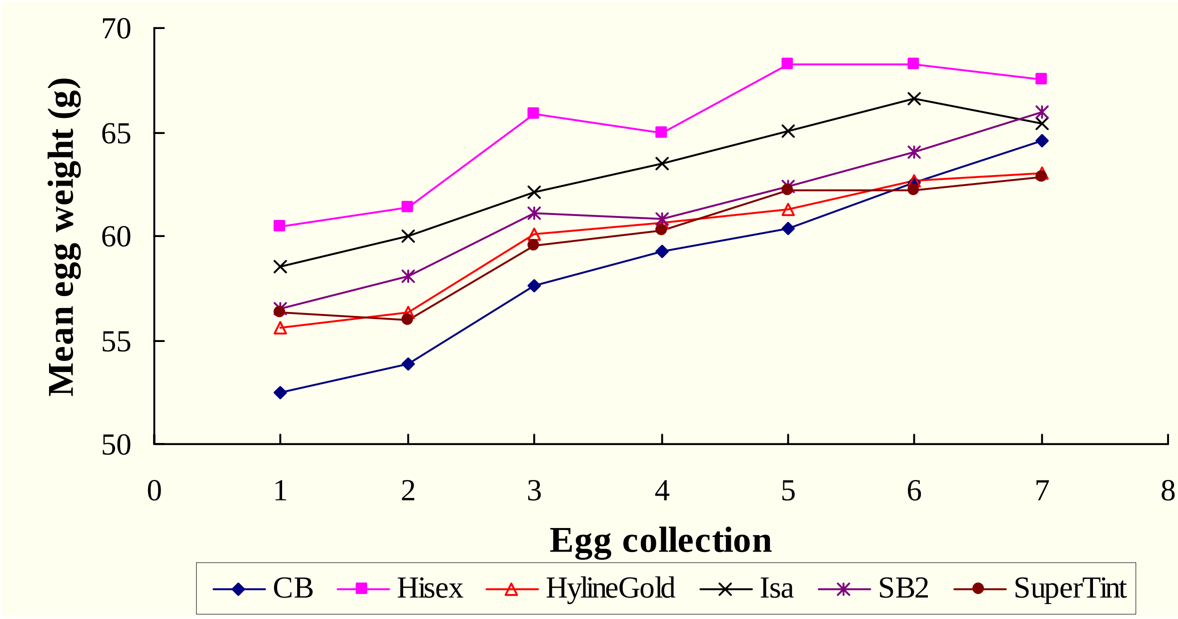
There was a tendency for shell breaking strength to be positively related to shell weight (Figure 5.4), which was itself related to egg weight.

***Figure 5.4 Relationship between shell weight and shell breaking strength for 6 strains of layers.***



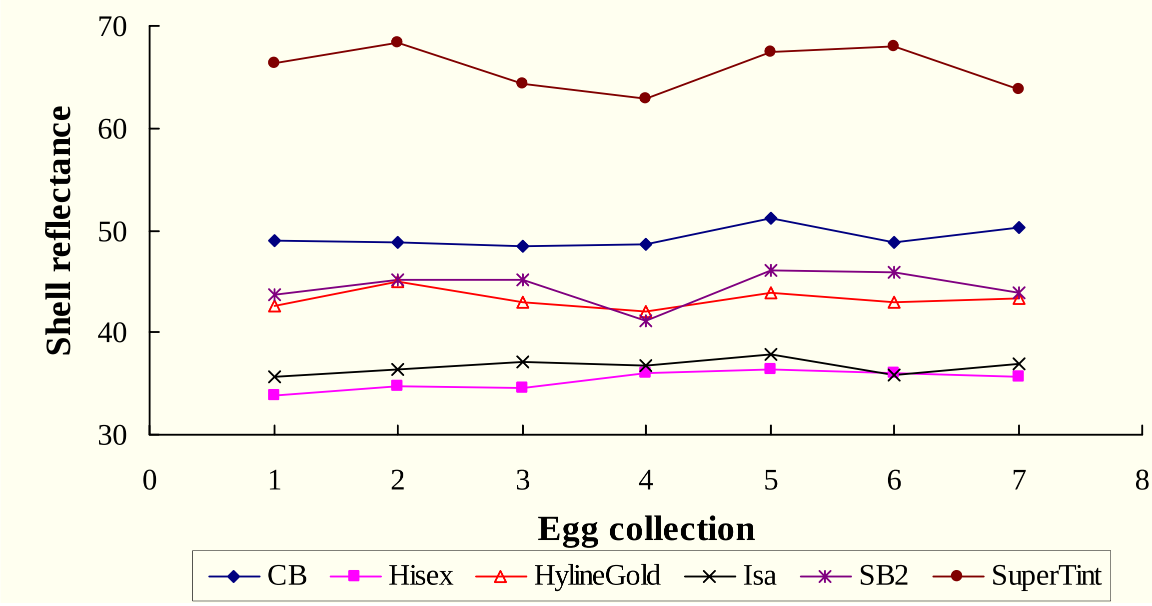

Egg weight increased as the hens aged in all 6 strains of layers (Figure 5.5).

***Figure 5.5 Average egg weight throughout the laying period (20-66 weeks) of 6 strains of layers (7 sampling times at 6-8 week intervals)***



Shell colour varied significantly between strains with the Tegel SB2 having the lightest coloured eggs and the Tegel HiSex and IsaBrown birds having the darkest brown colour (Fig. 5.6). There was no significant relationship between shell colour and shell strength.

***Figure 5.6*** ***Shell colour (reflectance) throughout the period of lay (20-66 weeks) in 6 strains of layers (7 sampling times at 6-8 week intervals).***




Resistance to shell deformation which is an index of the shell strength (Fig. 5.7), shell breaking strength (Fig. 5.8), and shell weight (% of egg weight) (Fig. 5.9) declined as the birds aged, but the shells were commercially satisfactory at 66 weeks of age in all strains.

***Figure 5.7*** ***Resistance to shell deformation in eggs collected during the period of lay 20-66 weeks from 6 strains of layers (7 sampling times at 6-8 week intervals)***

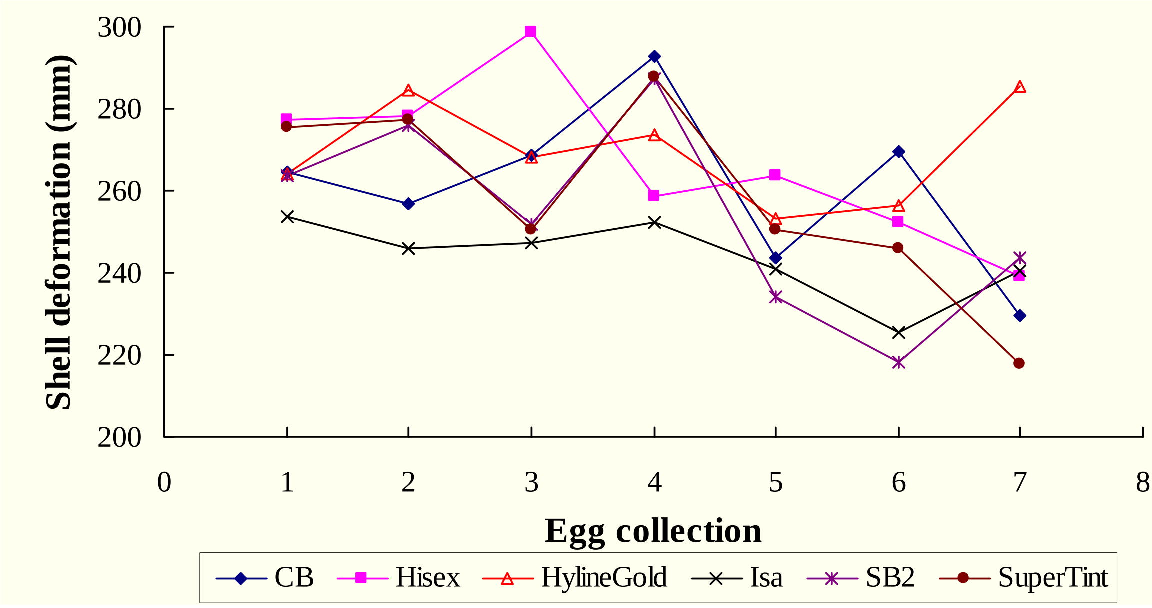


*Figure 5.8* ***Shell breaking strength (Newtons) throughout the period of lay (20-66 weeks) in 6 strains of layers (7 sampling times at 6-8 week intervals).***

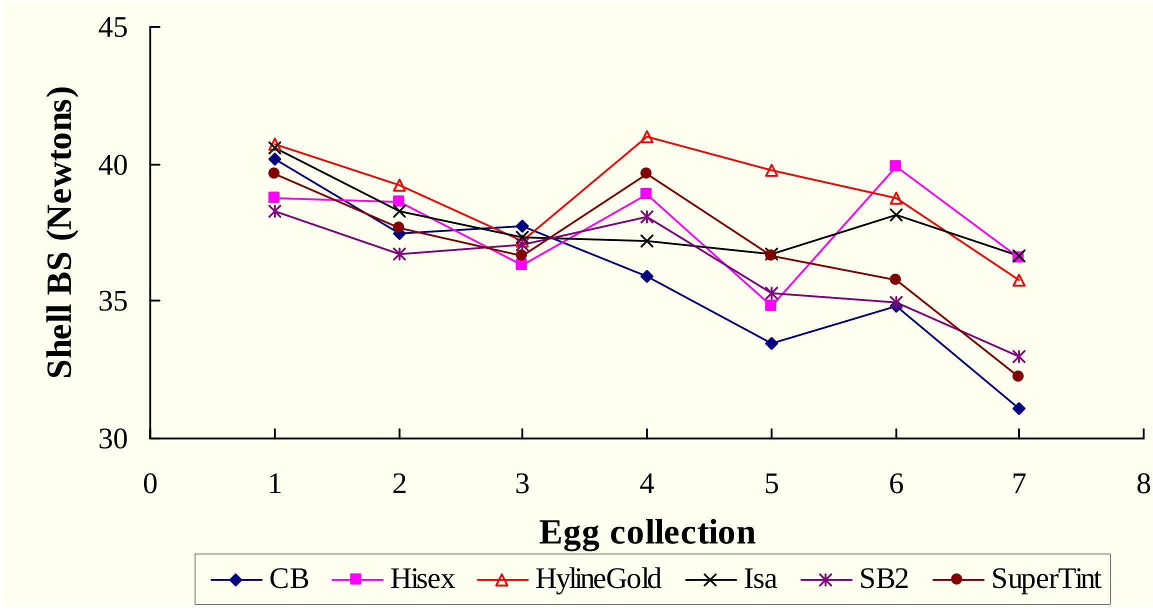
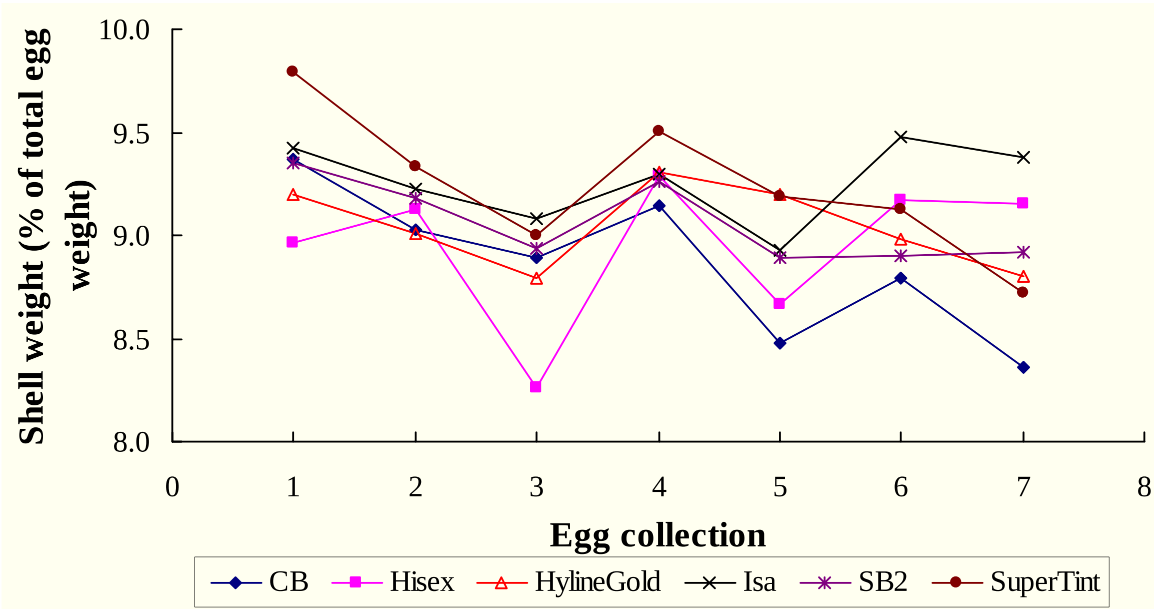



*Figure 5.9* ***Shell weight (as % of total egg weight) throughout egg laying from 20-66 weeks in 6 strains of layers (7 sampling times at 6-8 week intervals).***



Indices of the internal quality of eggs from each strain generally also declined with age (Figs 5.10–5.11).

***Figure 5.10** Albumen height in eggs collected throughout the period of lay from 6 strains of layers (7 sampling times at 6-8 week intervals).*

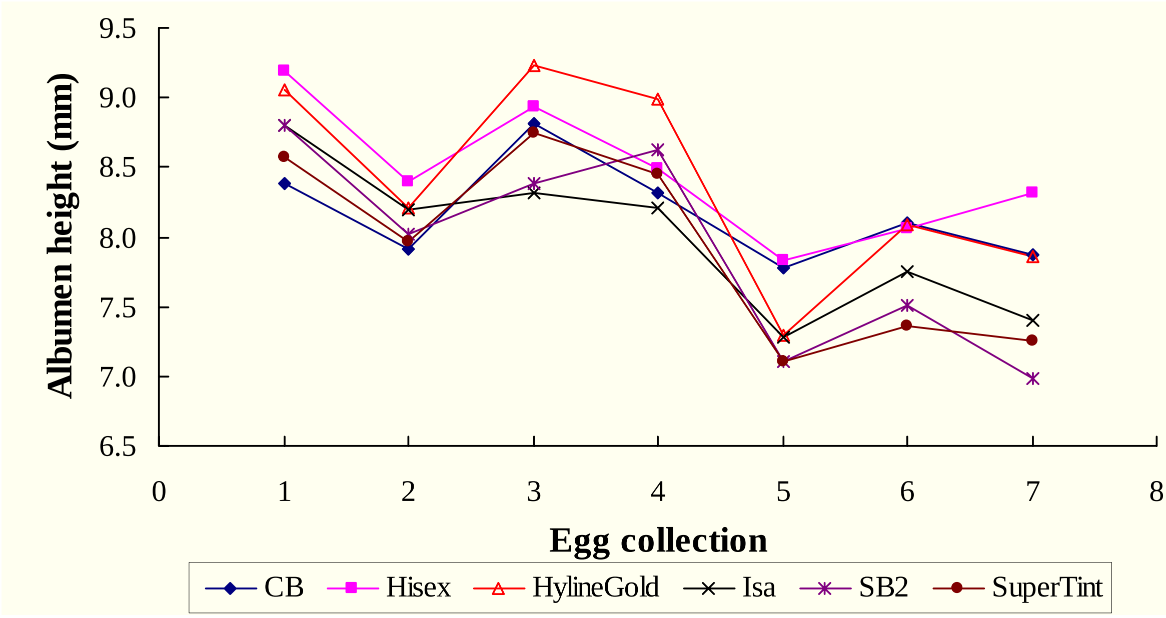
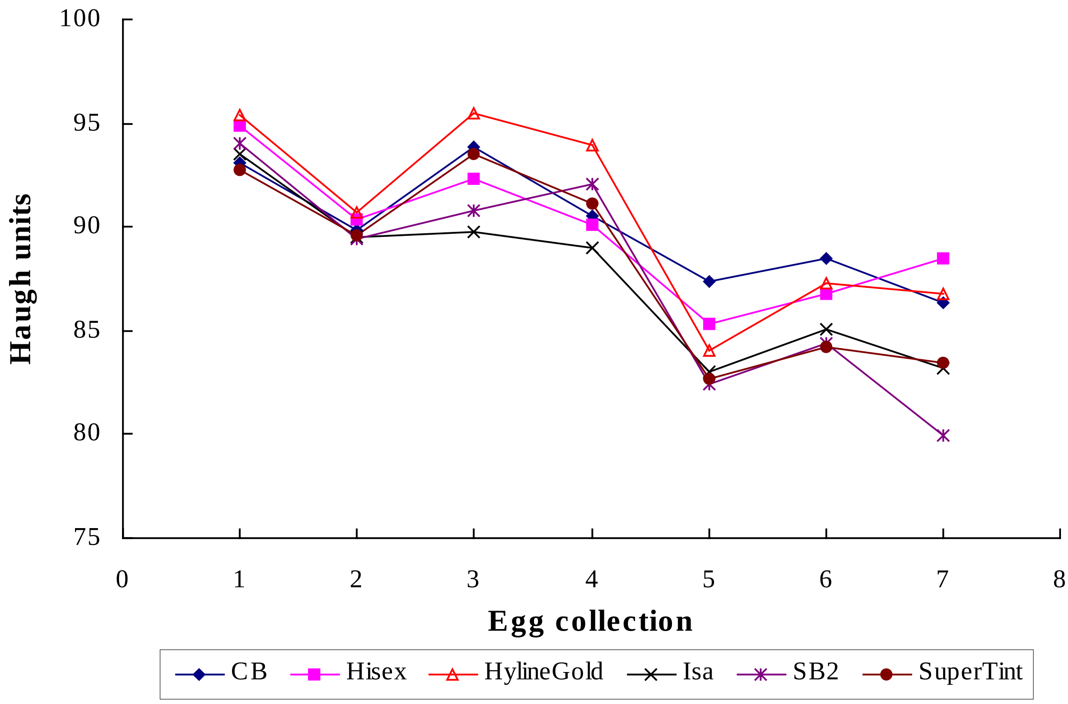
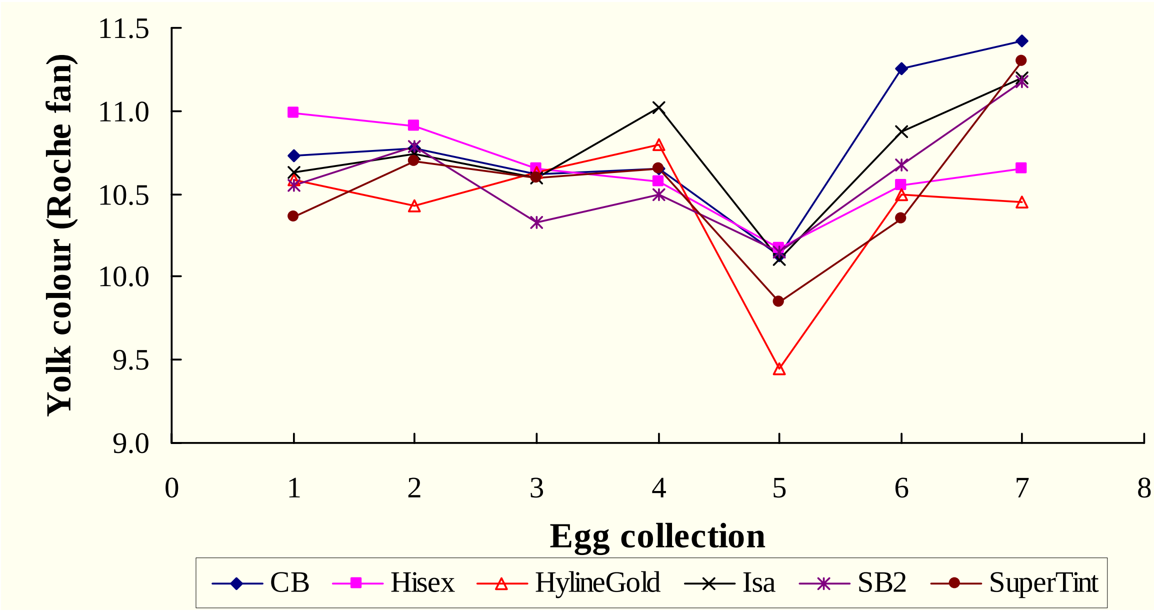



***Figure 5.11** Haugh unit differences between six breeds based on 7 samples of eggs collected at 6–8 week intervals.*



Yolk colour, on the other hand, was quite variable, probably reflecting variations in the inclusion by the commercial feed supplier of premix or yolk pigments in the feed (Fig. 5.12).

***Figure 5.12*** ***Yolk colour (Roche scale) of eggs collected throughout the period of lay(20-66 weeks) from 6 strains of layers (7 sampling times at 6-8 week intervals).***




## 5.5 Discussion

### 5.5.1 Mortality

There is evidence that one strain of bird, only conventionally vaccinated with Maravac and Webster's vaccines, was more susceptible to MD than the other strains that received the new Rispen vaccine, in addition to conventional vaccination, at the hatchery. The company concerned was interested in determining the level of natural immunity in this strain. The results indicated that the strain did not have a high level of natural immunity. However, this strain may have performed as well as the other strains if it had been protected with the new vaccines. Clearly the cross-breeding did not result in transfer of a significant degree of MD immunity. Other strains that had received a combination of newer and conventional vaccination procedures appeared to be quite resistant to MD challenge.

### 5.5.2 Egg production and egg quality

As expected on the basis of the breeder specifications, egg weight increased as the birds aged, so that the HiSex and IsaBrown birds in particular were producing eggs of greater than 65-70 g at the end of the laying period. In general, heavier eggs had heavier shells and the heavier shells were more resistant to breakage. Values for '% shell' did not differ significantly between strains and because shell strength and shell deformation indices were determined, shell thickness was not measured. The indices of shell strength (breaking strength and deformation) indicated that shell strength decreased throughout the period of

layFigures 5.7-5.8 but at no time was the commercial quality of the eggs compromised in any of the strains. It has been suggested that shell strength might be related to shell colour but there was no significant relationship found in this study.
Indices of internal egg quality (albumen height and Haugh units) also decreased as the birds aged but as with the decrease in shell strength measures, the quality remained commercially satisfactory in all strains until the birds were 66 weeks of age.

Yolk colours were variable, probably reflecting the variation in the feed mixes supplied by a large commercial supplier in northern NSW. This may indicate that there was a variable level of premix (supplementary minerals and vitamins) available to the birds as discussed below.

### 5.5.3 Experimental limitations

Diets delivered to the silos at 'Laureldale' from a commercial feed company were found to be variable between batches. This was suspected when yolk colour in eggs was found, in some instances, to be below 10 on the Roche colour scale, and regular samples were taken and analysed for crude protein and mineral contentThe samples were taken from the silos at 'Laureldale' within one day after each delivery of a new batch of feed, and great care was taken to obtain representative samples of each batch of feed by collecting samples from the top, middle and bottom of each silo. The estimates of crude protein and calcium concentrations varied considerably between batches and were, at times, outside an acceptable range.Trace mineral analyses by ICP-mass spectrometry confirmed there was variation between batches of feed in mineral concentrations presumably reflecting variable additions or poor mixing of the mineral/vitamin premix or inadequate blending of the pre-mix after its addition to the rest of the ingredients.

The commercial supplier was aware that the diets were to be used for experimental purposes and indicated that the quality control on the diets supplied was as high as, or higher than that applied to normal commercial customers. It is likely that the variation seen in this study is probably similar with that of other suppliers in this part of NSW.

This experience of variable feed composition from commercial suppliers may reflect a serious industry problem that needs further investigation.

# 6 **Experiment 5.** Mash *v*. pellets

## 6.1 Introduction

In a second shed, egg production from all 6 strains of the layers described in Experiment 3 was compared when the birds were given the same diet, presented as either mash or pellets.

## 6.2 Experimental conditions

The birds were raised as described for Experiment 3 above, and housed in an open-sided shed at a density of 3 birds per cage.

## 6.3 Results

In general there were no major differences in feed intake, or feed conversion efficiency between birds given their diets in mash or pelleted forms.

### 6.3.1 Mortality

There was no interaction between breed and diet. Total mortality did not differ significantly ($P>0.05$) between birds on the mash or pelleted diets. However, there was a tendency ($P<0.12$) for the birds given the mash diet to have a higher total mortality (16.9% *vs* 13.1).

Similarly, there was no significant effect of form of diet on deaths from MD, but again there was a tendency ($P<0.15$) for the mash to be associated with a higher mortality due to MD. There was no detectable effect of form of diet on the incidence of vent peck (2.8% vs 1.8%) but the numbers of deaths in this category were small.

### 6.3.2 Egg production

Egg production did not differ ($P>0.05$) between birds given their diets as a pellet or as mash.

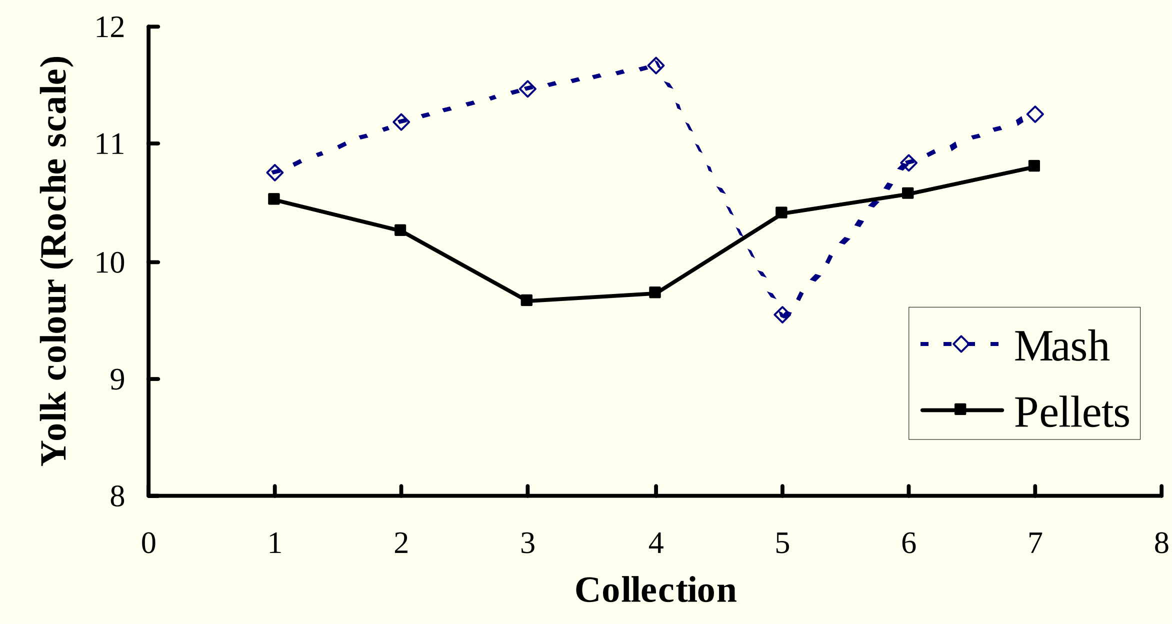
### 6.3.3 Egg quality

The presentation of the feed as pellets rather than mash resulted in significantly ($p<0.01$) higher egg weight, and shell breaking strength, and lower ($P>0.01$) albumen height, Haugh Units and yolk colour (Table 6.1). A notable effect was the high degree of variability (range 7-12 on Roche scale), irrespective of strain, in the yolk colour of eggs from hens given mash rather than pellets (Fig. 6.1).

***Table 6.1 Effect of giving feed as a mash or pellets on measures of egg quality***

| Diet form | EggWt | Shell BS | Shell Deform | Albumen | Haugh Units | Yolk Colour |
|---|---|---|---|---|---|---|
| Mash | 61.0 | 35.6 | 262 | 8.35 | 90.2 | 11.0 |
| Pellets | 61.6 | 37.9 | 256 | 7.93 | 87.7 | 10.3 |
| **Form of diet effect (p<)** | **0.004 **** | **0.000 ***** | **0.139 NS** | **0.000 ***** | **0.000 ***** | **0.000 ***** |

*Figure 6.1* ***Yolk colour (Roche scale) of eggs collected throughout the period of lay(20-66 weeks) from layers on mash or pellets (7 sampling times at 6-8 week intervals).***




Egg weight and shell weight increased as the birds aged irrespective of the form of the diet), whereas albumen height of egg whites decreased.

## 6.4 Discussion

Presentation of a layer diet in pellet form rather than as a mash produced significant heavier eggs with stronger shells which would normally increase the value of eggs, especially if sold by weight. A notable effect of providing the diet in the form of a mash was the variable nature of the egg quality characteristics, and especially of yolk colour which was noticeably more variable for hens given mash than for those given pellets. A different degree of feed selection by individual hens when given mash is a likely reason for this effect. It is also possible that the heating effect during the pelleting process changed the quality or digestibility of the protein or some other nutrient in the pellet.

When birds are offered mash diets, particle size and consistency of the ingredients can affect intake and dietary selection. Roller-milling of the ingredients, for example, is considered to produce a better mash than hammer-milling.

It is often argued that presentation of diets as mash rather than as pellets will be disadvantageous because the dominant birds in each cage will choose the more appropriate diets and the less dominant ones will therefore obtain a less-than-ideal diet from what is left. Conversely, it can be argued that provision of mash allows individual birds to more closely meet their current needs for various nutrients as their needs vary from day to day. However, it is possible that the possible benefits of choice feeding associated with mash will be counteracted by the negative effects of separation of the ingredients, or dustiness, or absence of a beneficial effect associated with heating during the pelleting process. The quality of a mash can also be affected by the amount of oil or tallow included in the mix."

# 7. **Experiment 6.** Effect on deaths due to cannibalism of normal- or enriched-sodium diets for layers

## 7.1 Introduction

Discussions with egg industry leaders indicated that there was a belief in the industry that cannibalism behaviour in layers may be reduced if sodium content of the diet is increased.

It was hypothesised that mortality due to cannibalism might be reduced if layers were given a higher sodium diet, and that reductions in mortality might be achieved without detrimental effects of the dietary sodium on egg production or egg and egg-shell quality.

In one shed (the Modern Shed) each strain was tested on one of two pelleted layer diets identical except for their sodium content, i.e. **Normal sodium** (0.17%), **Sodium-enriched** (additional 1 kg NaCl/tonne).

## 7.2 Experimental conditions

The study was made in 1998. The birds and their pre-experimental history were as described for Experiment 3. The birds were housed at a density of 3 birds per cage (Californian-style) in an open-sided shed. The diets were designated *normal-Na* and *Na-enriched* and given in pelleted forms.

## 7.3 Results

### 7.3.1 Feed analysis

Analysed by ICP analysis, these diets were found to have concentrations of 0.17 ± SD 0.037 and 0.22 ± SD 0.038 % Na, respectively (means for 7 analyses per diet for deliveries on 25 February, 27 April, 18 May, 14 August, 25 September, 13 October and 6 November 1998).

### 7.3.2 Mortality

There were significant ($p<0.0001$) differences between the breeds of layers in total mortality and in deaths due to MD ($P<0.0001$) and cannibalism complex ($p<0.05$) in this experiment (Table 7.1) that reflected those found in the larger flock of birds making up the strain comparison in Experiment 5.

**Table 7.1 Total mortality due to all causes in 6 strains of layers given normal-sodium or sodium-supplemented diets.**

| Breed | Total mortality (%) | Deaths due to MD | Deaths due to cannibalism |
|---|---|---|---|
| Hisex | 11.8[b] | 3.3[ab] | 4.9[bc] |
| Hy-Line CB | 10.0[ab] | 7.0[b] | 1.8[ab] |
| Hy-Line Gold | 43.3[c] | 34.9[c] | 5.1[bc] |
| IsaBrown | 10.6[ab] | 2.7[a] | 5.5[c] |
| Tegel SB2 | 7.0[ab] | 1.5[a] | 0.9[a] |
| Tegel Super Tint | 5.8[a] | 0.9[a] | 2.7[abc] |

The effects attributable to the sodium content of the diets on total mortality, and deaths due to Marek's Disease or cannibalism are given in Table 7.2

**Table 7.2 Total mortality and deaths due to Marek's Disease or cannibalism in birds from 6 strains given either a normal-sodium or a sodium-enriched diet.**

| **Diet** | **Total mortality** | **Deaths due to MD** | **Deaths due to cannibalism** |
|---|---|---|---|
| Normal Na | 14.9 | 8.1 | 3.8 |
| Na-enriched | 14.7 | 8.1 | 3.1 |
| **Significance** | **NS** | **NS** | **NS** |

There was no significant diet effect on total mortality across the 6 strains. Addition of supplementary sodium to the diet had no significant effect ($p>0.05$) on total mortality or on deaths due to cannibalism. It is possible that small dietary effects on cannibalism or total mortality were present, but with the low percentage of the flock dying from these causes, a much larger trial would be needed to confirm any positive effect.

### 7.3.3 Egg production

There were no significant effects of dietary sodium concentration on egg production.

### 7.3.4 Egg and eggshell quality

The addition of supplementary sodium in the diet did not affect average egg quality over the period of lay (Table 6.2). Yolk colour was significantly ($p<0.01$) darker and shell breaking strength tended ($p=0.11$) to be higher in the hens receiving the higher sodium diet.

**Table 7.3 Effects of addition of extra sodium to the diet on egg and eggshell characteristics averaged throughout the period of lay (20-66 weeks of age).**

| **Diet** | **EggWt** | **Shell Wt** | **Shell BS** | **Shell Deform** | **Albu-men** | **Haugh Units** | **Reflect** | **Yolk Colour** |
|---|---|---|---|---|---|---|---|---|
| Na-enriched | 61.4 | 5.61 | 37.3 | 262 | 7.69 | 86.2 | 47.0 | 10.1 |
| Normal Na | 61.5 | 5.60 | 36.6 | 256 | 7.73 | 86.5 | 46.4 | 10.0 |
| **Diet effect (p<)** | **0.713** | **0.784** | **0.106** | **0.164** | **0.489** | **0.449** | **0.606** | **0.001** |

## 7.4 Discussion

Across the 6 strains, addition of supplementary sodium to the diet had no significant effect on egg production or total mortality and, in particular had no detectable beneficial effects on deaths due to cannibalism.  The possibility that there may have been small dietary effects on cannibalism or total mortality cannot be excluded in this study, but with the low percentage of the flock dying from these causes, a much trial with many more birds would be needed to confirm any positive effect.

The high-sodium diet resulted in hens apparently laying eggs with slightly darker yolks, but the difference was small and of little practical significance. The addition of supplementary sodium to the diet had no adverse effect on egg quality in the conditions of this study.