Submission No 398

INQUIRY INTO USE OF BATTERY CAGES FOR HENS IN THE EGG PRODUCTION INDUSTRY

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Submission to the NSW Legislative Council Select Committee on the Use of Battery Cages for Hens in the Egg Production Industry

To the Hon Emma Hurst MLC, Animal Justice Party (Chair)

Submission by George Arzey, Poultry Veterinarian

Summary

As a poultry veterinarian with extensive knowledge of the layer industry and experience dealing with hens in the different housing systems, I find it difficult to reconcile confining a sentient animal, reportedly capable of feeling pleasure and pain as well as positive and negative emotions, in a barren and extremely restricted environment that does not enable the basic behavioural needs - an environment with a restricted space not enabling easy turning, wing stretching, wing flapping, scratching, preening, perching and nesting. It also does not enable infirmed sick hens to find a safe space to rest/recover, often resulting in these hens being trodden by the healthy cage mates unless they are quickly removed.

The housing of hens in cages is unique among production animals. This situation has been progressively recognised by the community with gradual but persistent decreases in the consumption of battery cage eggs in Australia. The NSW Government Independent Consultation Report (2018) acknowledged that – "*the social licence for conventional cage egg production has been significantly eroded"* and 99% of people across Australia that responded to Animal Health Australia reportedly opposed conventional cages.

In countries like New Zealand, Canada, the EU block and some states in the USA battery cages have been banned. In some respects, the Australian egg industry has also recently recognised the inevitable demise of the battery cage system and its replacement with free-range/barn housing systems.

Numerous advantages are claimed by the battery cage supporters but some of these advantages over non-cage housing, when scrutinised are inaccurate and others are not as comprehensive or consistent as suggested. For example, claiming food-safety superiority of battery cage eggs is misleading and does not reflect reality. Aspects of the environmental and work health safety credentials of battery cages could also be questioned. So could other claimed advantages.

While indeed mortality is lower and infectious disease status is better in the battery cages, these aspects are completely addressed through the use of furnished cages that although are still cages, offer better animal welfare outcome than battery cages. It is prudent to recognise that since high mortality is considered an important animal welfare element, the currently mandated cage space allowance of 550 cm^2 per hen is contributing to mortality in the cage system, as the literature shows that when floor space decreases, within a range of 650 to 300 cm^2 per hen, bird welfare generally decreases and mortality increases.

In the free-range and barn housing systems, significant mitigation of the mortality rate can be achieved through a better management of the range and the flocks (e.g. diet, tree canopy, shelters, netting) as well as developing better specific health modulators and the choice of suitable genetic breeds. Non-cage systems are not easy to manage and require dedication and intensive and effective observations in order to achieve optimal welfare

goals. The most critical element that affects the welfare outcomes in free-range and barn systems is the wide variability in the management and facilities of both systems. This results in hen welfare outcomes varying from poor to good (NSW Consultation 2018) and this provides also an insight into some of the reasons for the vast variability in mortality reported from various sources and ultimately the ability to address this and other aspects.

Based on Australian studies (Glatz et al 2008) with a reported mean mortality of 2.58% in free-range flocks and 1.8% in battery-cage flocks, a free-range hen would have a 1.4 times higher likelihood of dying compared with a caged hen. Nevertheless, the likelihood of hen's exposure to this risk is very low (0.026). By contrast, the likelihood of hen's exposure to deprivation of movements and severely restricted behavioural repertoire in battery cages is a certainty (likelihood of 1) - an event to which all hens are exposed for a long duration.

Whether the risk of death that may take hours or days is preferred by the hen to the certainty of being in a small cage for its life, is up to the community to judge. If mortality and health status are accepted as a crucial animal welfare element, would the lower mortality from natural causes among human prisoners in Europe and the USA by comparison to the general population, be a sufficient welfare justification to curtail the freedom of the entire population?

The reported egg choices of consumers would suggest that the egg farming system is the primary influence on the decision, although Industry would probably argue that such a choice is afflicted by poor knowledge and if given time and opportunity to better educate the public, consumers will come around to appreciate the battery cage system. I would suggest that the trend against battery cage eggs is too robust and consistent to be reversed or halted and while hen welfare has several dimensions, including health, it is still difficult to justify holding a sentient animal in battery cages, in a system described .by a major scientific review (Nicol et al 2017) as effectively preventing hens performing even simple locomotor and comfort movements. The adherence to this system becomes highly questionable when an alternative cage system (furnished cages) provides much greater behavioural comfort than battery cages without compromising any production traits. It offers some remedial behavioural advantages and enables some welfare improvements.

Ultimately while I would rather see hens in properly managed free-range or barn flocks (preferably the Rondeel barn housing developed in the Netherlands), than hens in cages, I would also rather see hens in improved cages (e.g. furnished cages) than in battery cages.

Significant animal welfare farming improvements are bound to be associated with higher costs. According to Animal Health Australia (2017), the difference between the battery cage standards cost ($709 million) and non-cage option amounts to $416/$419 million extra costs. Based on 2017/2018 egg production in Australia, 8.2 cents extra for every dozen eggs produced over the next 10 years would pay for the structural costs of options banning battery cages. Assistance to producers should be considered, thus reflecting the public good aspect of the changes. Ongoing production costs, according to Australian egg industry data provided to Animal Health Australia (2017) are 3% higher per dozen eggs in furnished cages vs conventional cages. The production costs of barn and free-range egg farming are higher than the furnished cages production costs.

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About myself

I am a poultry veterinarian with more than 37 years' experience in the poultry industry, mostly as a senior veterinarian and technical specialist with NSW DPI (I left DPI in 2013). During these years I provided and participated in diagnostic field services to poultry producers in NSW, emergency disease investigations and control (e.g. Newcastle disease and Avian Influenza), zoonotic diseases investigations (e.g. Chlamydiosis), Salmonella Accreditation programs, research into: respiratory diseases of poultry and their treatment and control, efficacious vaccination against Infectious Laryngotracheitis, Fowl Pox and Newcastle disease, epidemiological investigations of Avian Influenza in Australia in poultry and wild birds and Salmonella surveillance and investigations in layer flocks. I have visited many poultry enterprises in NSW and I am familiar with hen welfare issues.

Preface

In 1976 when I started my veterinary course in Queensland, the Council of Europe published a convention stating that farm animals should be given *"space appropriate to their physiological and behavioural needs".* Our class was blissfully oblivious to the undercurrents and conventional cages were largely accepted as the norm. The number of scientific publications that touched on animal welfare and animal emotions (based on Web of Science), was very low before the dawn of the 21st century. Research into animal behaviour, including poultry, is on the rise but whether it will facilitate the recognition of the intolerable from the tolerable and the desired from the acceptable and identify the hen's preferred housing option remains to be seen.

In 2009 the EU Lisbon Treaty defined animals as 'sentient beings', capable of feeling pleasure and pain. The New Zealand animal welfare strategy 'Animal Welfare Matters' (2013), recognised that "animals are sentient – they can feel pain and distress". This is also reflected in Canada, the EU and the USA animal welfare policies.

Recently the Victoria Government stated that *"It is a moral imperative that if in doubt, we must assume an animal feels pain and can suffer and, therefore, take action to avoid, minimise or alleviate such pain and suffering".* http://agriculture.vic.gov.au/pets/care-and-welfare/animals-and-people/what-is-sentience.

Western Australia was reported to push for battery cages to be banned within 10 years. In its submission to a federal review (Animal Health Australia 2017) of poultry welfare standards, the WA government argued for a replacement of the battery cages with larger "furnished" cages that have nest boxes, perches and scratching pads (https://www.theaustralian.com.au/news/wa-stands-along-in-bid-to-ban-battery-cages-for-chicken/news-story/64cd31d733a949d383ad93879b0b2a8d).

The NSW Government commissioned a consultation process (March 2018) in response to Animal Health Australia Public Consultation on Poultry Standards and Guidelines (2017). The report concluded that "*there is recognition that the social licence for conventional cage egg production has been significantly eroded. This is reflected in the fact that 165,000 people across Australia responded to Animal Health Australia and* ***99%*** *reportedly opposed conventional cages".*

In Australia, the RSPCA has been actively campaigning against the battery-cage system, arguing that they provide a *completely barren environment, where hens experience extreme confinement and suffer behavioural restriction resulting in very poor muscle and bone strength, a high rate of bone fractures, frustration, abnormal behaviours, and poor welfare.*

The Australian Veterinary Association (AVA) currently has a policy proposal pending voting that includes the following - *The AVA supports the phasing out of conventional cage systems for commercial egg production in Australia, because scientific evidence indicates that conventional cages compromise most measures of layer hen welfare when compared with all other forms of housing. The AVA supports research and development to address*

welfare issues of other housing systems. The Australasian Veterinary Poultry Association (AVPA) does not support this position. In its submission to Animal Health Australia 'Public Consultation for Australian Animal Welfare Standards and Guidelines Poultry (2017), the AVPA wrote: *The AVPA recognises that its membership has divergent views on this issue and a consensus could not be reached within the subcommittee that formulated this submission or the broader membership* (I was a member of this subcommittee).

Nicol et al (2017) in a major scientific review of the peer- reviewed scientific literature titled Farmed Bird Welfare Science Review, concluded that at the high stocking rates and small cage sizes typical of a conventional cage (battery cages), hens are effectively prevented from performing even simple locomotor and comfort movements.

Cage-housed hens require 475 cm^2 for standing, 540-1005 cm^2 for scratching, 771-1377 cm^2 for turning, 652-1118 cm^2 for wing stretching, 860-1980 cm^2 for wing flapping, 676-1604 cm^2 for feather ruffling and 814-1270 cm^2 for preening (Dawkins et al 1989). These figures (except standing) are well above the currently mandated space allowances in Australia, being 550 cm^2 for an average layer in battery cages (approximately 25 cm x 22 cm or 29cm x 19 cm or any other similar combinations of horizontal space).

A review of cognition, emotion, and behaviour in the domestic chicken (Marino 2017) concluded that *chickens perceive time intervals and may be able to anticipate future events, chickens are behaviourally sophisticated, have complex negative and positive emotions, as well as a shared psychology with humans and other ethologically complex animals. They exhibit emotional contagion and some evidence for empathy.*

A Director of Australian Egg stated that confinement *"is something we can't win the argument on. "From the day that they're housed, they're in that cage for the rest of their life"* (Oct 4 2015 https://www.news.com.au/finance/business/manufacturing/do-cage-eggs-have-a-future-in-australia/news-story/a4ead13d4f0cb5f540c21695b8f9ccef). However, he argued that other welfare aspects including health, food-safety and price favour the conventional cages.

John Dunn, CEO Egg Farmers of Australia, acknowledged that *"there is community interest and concern about cage egg production and at the* Australian Poultry Science Symposium in Sydney in 2018 he also raised "*the dilemma of explaining the multi-faceted dimension of trading-off certain natural behaviours for a better welfare dividend in health".* Subsequently in September 2018, he acknowledged that the manufacturing of battery cages has stopped and the transition to furnished cages and eventually barn or free-range egg production systems has been underway since 2002 (https://farmers.org.au/news/egg-farmers-on-track-for-a-cage-free-future/)

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It is apparent that the community is sufficiently concerned about egg production in cages to influence the direction the industry takes but arguments still prevail in the industry that alternative systems other than cages expose the hen to other risks and thus while the battery cage system drastically curtails their ability to move and perform normal behaviour, it improves other welfare aspects such as predation, cannibalism, disease risk, etc.

In the absence of the ability to recognise animal preference to die or suffer ill-health vs life-time confinement in a very small space, pondering whether one negative welfare aspect is preferable to another aspect, would be influenced by humans' own preferences and

perceptions of different impacts. Science currently offers very little on the crucial question whether hens prefer to live in cages, or outdoors and in barns and perhaps suffer some mishaps. A patient community could wait for a scientific messiah to quantify the comparative level of suffering imposed on the individual hen by permanent deprivation of freedom vs death or ill-health but meanwhile, community attitude and opinions are being formed on the basis of existing scientific data, value and moral judgement guided by society's growing aversion to some farming practices. A survey conducted by CSIRO (2018), reported that participants that purchased eggs indicated that egg farming system (e.g. cage, free range, barn, organic) was ranked number one in terms of buying decision. Industry agreement to a temporary regulated cap on cages could be viewed as a reflection of the significant opposition among consumers to battery cage eggs. (http://www.medianet.com.au/releases/154593/).

Many claims and counter claims have been raised against various hen housing systems. The 2017, Animal Health Australia document - Proposed Australian Animal Welfare Standards and Guidelines Poultry, Consultation Regulatory Impact Statement, provided a list of advantages and disadvantageous for the 3 main hen housing systems. Generally, this list suffers from inaccuracies, simplification and occasionally is factually questionable. Significant elements of costings associated with the banning of battery cages such as additional land, additional hens and facilities can also be challenged since the inputs used for the estimates are questionable. Other concerns are assumptions that are not applicable to small flocks (most free-range flocks are), not considering surplus eggs especially in the cage system and ignoring the land elasticity of many free-range farms now that permitted stocking on the range has been raised 7x (to 10,000 hens per Hectare) the previous range stocking density.

Adherence to accurate facts and sound data is often absent from the debate and comparisons between the systems are not always accurate or helpful.

Claims of advantages

It has been claimed, including in the Animal Health Australia RIS (2017) document, that the conventional cage system by comparison to alternative systems (barn and free range) is able to provide:

1. The safest eggs
2. Higher environmental and Work Health Safety impacts from non-cage housing
3. Reliable provision of feed and water;
4. Efficient management of adverse weather risk, temperature and ventilation (provided appropriate and functioning equipment is used);
5. Easiest system for inspecting hens;
6. Lowest incidence of disease.
7. Lowest mortality
8. Easiest system to clean

Before dealing in greater details with these claims, it is worthwhile considering that scientific and field data makes it clear that modifications to the battery cage systems that result in what is categorised as furnished cages/enriched cages, although far from ideal,

undoubtfully provide the hens with a greater behavioural repertoire than the battery cages. Data demonstrate that none of the disadvantages attributed to the barn or free-range systems can be found in this system. Furthermore, production parameters in the furnished cages are of higher value than those encountered in battery cages. While furnished cages are still cages and a system that does not enable a full behavioural repertoire, nevertheless, it provides the hen with a greater behavioural scope than battery cages, with no reported other adverse welfare aspects. It enables a compromise that although unpalatable to many members of the community (including myself), nevertheless, provides the hen with more than what it has now.

All the above claimed advantages for the battery cage system are discussed in details below.

The safest eggs

Animal Health Australia (2017) listed a higher food safety risk in non-cage systems and Industry representatives argued (NSW Consultation 2018) that there has been little consideration of the higher food safety risks associated with barn and free-range production compared to battery cages.

This is an aspect, potentially of emotional impact on consumers and such claims should be built on sound data.

Holt et al (2011) in a comprehensive review concluded that there is no general consensus on the food safety superiority of one housing system over another.

A more recent review (Whiley et al 2015) also concluded that "*currently there is no consensus regarding the impact of caged, barn and free-range egg production has on Salmonella contamination of eggs".*

The Through-Chain Salmonella Risk Identification Final Project Report, a report for the Australian Egg Corporation Limited by K Hewson and R Chia (2016) stated that:

- there are published articles that conclude that either free range or cage eggs are a higher risk for food safety.
- there needs to be movement away from discussion about whether free-range eggs or cage eggs pose a higher risk for human salmonellosis,
- the ultimate risk factor will be the quality of the flock management.

Australian studies indicated that fewer free-range flocks than indoor flocks were found to harbour Salmonella (Safe Food Qld 2015). In the NSW Food Authority survey (NSWFA 2013), single tier cage farms were reported with the lowest Salmonella prevalence (10%), followed by free-range farms with moveable sheds (34%), free range fixed sheds (50%), multi-tier cages and barn (100%). Jones et al. (2016) detected a significantly higher proportion (95%) of conventional cage hens testing positive for *Campylobacter* compared with furnished cages (91%) and non-cage hens (85%) housed on the same research farm. Another study (Van Hoorebeke et al. 2010) sampled a total of 292 commercial laying hen farms in Belgium, Germany, Greece, Italy and Switzerland and identified conventional cage housing as a specific risk factor for Salmonella shedding. Messens et al (2007) reported higher penetration of cage eggs by Salmonella (16%) than free range eggs (6%) at 14 days

storage time. Nicol et al (2017) reported that in eggs from hens orally inoculated with *Salmonella Enteritidis, no* increased pathogen shedding or colonisation was detected in non-cage systems and one experiment found that hens in conventional cages continued to shed pathogen for a longer period than hens in furnished cages or non-cage systems. A study cited by Nicol et al (2017) identified conventional cage housing as a specific risk factor for *Salmonella* shedding.

Even the most ardent supporter of non-cage systems would stop buying eggs from these housing systems if they encountered health issues as a result of consuming such eggs. The recent Salmonella Enteritidis outbreaks in NSW also involved free-range and barn farms but the two first reported infected farms were cage farms and the infection was reported to spread via various epidemiological links to other farms, including free range and barn farms.

It would appear that the higher food safety status attributed to battery cages is not supported by data or reality.

Environmental impacts and Work Health Safety Issues

Higher environmental impacts from non-cage housing were also brought up in Animal Health Australia (2017) document and the report for the NSW Government (2018).

Generally, larger buffer zones are required to minimise environmental impacts on neighbours in the case of intensively housed poultry, especially controlled environment cage facilities that on average are likely to house more birds than free-range and barn flocks.

Several comparative environmental issues are discussed.

1. Higher nutrient run off from free range farming was listed as a disadvantage in the free range system (Animal Health Australia 2017) but there are other environmental impacts that require comparative consideration such as dust, noise and odour on neighbours, or indeed, the beneficial effects of poultry free range systems on utilisation of grain belt paddocks/orchards and the control of weeds (Glatz et al 2004).
2. The run-off aspect attributed to free-range operations is an oversimplification laced with suppositions. Any runoff would depend on topography, catchment area, type of ventilation, shed foundation, distribution of birds on the range and other management strategies. RIRDC report (2015) eluded to the lack of data on the environmental impacts of free-range farms. It concluded that "*nutrient concentrations in the range soils were, in general, found to be slightly higher than the control areas in nitrogen and ammonium concentrations, and slightly lower in phosphorus concentrations. No evidence was found of a relationship between number of years of free-range operation and amount of nutrient build-up in the subsoil, meaning the concentrations of nutrients deeper in the soil was not increased by the amount of time the farm had been operating*". The RIRDC report concluded that the majority of the nutrients on the free-range farms were captured on the range during short, intense, infrequent storm events. i.e. run-off.
3. Odour emissions from free-range sheds in the case study (RIRDC 2015) were found to be comparable to odour emissions measured from conventional style sheds. The report stated that "*finally, when the whole-of-range odour emission rates are compared against the shed odour emissions, it becomes clear that emissions from the range area are*

virtually of no consequence". The report also stated that "*while the pop-hole exits may have the highest odour emission rate per unit of area, these areas take up such a small percentage (about 1%) of the whole range, that the contribution of the pop-hole exits to a whole-of-range odour emission rate is minimal"*

4. Data has shown that personnel total dust exposures are significantly higher in floor-housed versus cage-housed operations. However, time spent in different housing systems also plays a role, especially on chronic manifestation of exposure. Other important elements apart from dust include endotoxins. Higher endotoxin concentrations in cage housing were observed. Also, significant differences in symptoms were observed between cage-housed and floor-housed workers with current and chronic phlegm occurring more frequently in workers from cage-housed facilities. (Just et al 2009). The author commented that observations of higher total dust concentrations in floor-housed operations are not in agreement with the observations of greater respiratory dysfunction in cage-housed workers. Workers from cage-housed operations typically experienced greater symptoms. Another important aspect to consider is the number of animals in each house and the time staff spend inside sheds in different systems. In this respect since the majority of free range farms are small farms, the comparison between levels of dust considering the vast difference in the number of animals housed in the typical cage system or the length of time staff spend in sheds housing small flocks vs large flocks is unlikely to provide a true reflection of the comparative WHS situation.
5. Noise - since most free-range farms (and barn farms) are smaller than cage farms, the movements of vehicles, feed trucks, cleaning operations etc are likely to be less intense in the case of barn and free-range farms compared with cage farms.

Reliable provision of feed and water

It is difficult to argue that potentially the provision of feed and water is not as reliable in the barn system as in the cage system but it is also prudent to recognise that the cage and barn systems are not infallible. On a number of occasions, I was called to diagnose egg production drops in cage layer flocks, only to find blocked water nipples or the entire water supply line in the upper tier of cages without water. The assertion that water supply in cage system is more reliable is questionable. Furthermore, in terms of impact, the consequences are more severe in a cage system since a larger number of birds are likely to be affected simultaneously if the system fails.

It is correct that birds that free range (and if the feed and water supply is indeed inside the shed as recommended for biosecurity reasons) may not be able to access feed as frequently as healthy birds in cages. However, it should also be considered that when the feed is provided to free-range birds inside the shed, access to the feed may be of longer duration each time the hen enters the shed, thus compensating for the 'lost time' outside the shed. Furthermore, birds in outdoor systems may be able to utilise the feed more efficiently as a result of the ingestion of grit stones leading to a better gizzard development and better nutrient utilisation (Svihus 2012). It is also possible that access to an outdoor area will increase retention time in the crop, and thus potentially improve efficacy of the digestion process (Svihus, 2012). Thus, when comparing housing systems, it is imperative to consider all the physiological and metabolic aspects that affect feed intake and utilisation.

Efficient management of adverse weather risk, temperature and ventilation (provided appropriate and functioning equipment is used);

It is difficult to argue that the scope for efficient management of adverse weather risk, temperature and ventilation is not as reliable in the barn system as in the cage system. However, reports of mass mortality events in the barn and cage systems would suggest that management and emergency preparedness is the key, more so than a specific housing style.

Adverse weather risks are not unique to free-range hens (although heat stress mortality is often reported in free-range flocks). On the other hand, the consequences of ventilation failure and high temperatures in battery cages/furnished cages and barn housing under control ventilation/tunnel ventilation systems are far more serious than the impact in naturally ventilated sheds or standard free-range houses.

Rohnke (2015) wrote that the flooding in March 2015 in the east coast area of NSW resulted in a state-wide egg shortage and significant bird losses, including pullets, occurred. Such an impact on the state egg production was unlikely to be a result of floods affecting small size hen farms and most free-range farms are of a small size.

Studies in Australia (McGahan et al 2013) reported temperatures below and above the optimal and patchy ventilation and regulation of temperature even in controlled environment sheds.

It should also be considered that 1.3 million hen capacity exists in the alternative production systems e.g. free-range housing in tunnel ventilated sheds that enable temperature and ventilation control (G McGahan, et al 2013). The very large Young free-range flocks and Maitland free range flocks that suffered the avian influenza outbreaks in 2012 and 2013) were housed in tunnel ventilated sheds. The broad-brush approach used to justify arguments against free-range flocks ignores the availability of weather control measures in free-range flocks and assumes that all free-range flocks are bound to be exposed to harsh environmental conditions regardless of their ability to remain in environmentally controlled sheds or other sheds when necessary.

It has been claimed that the exposure to severe environmental conditions, or alternatively, restricting the hens to indoors in inclement weather causes stress to birds because it changes their daily routines. However, this argument ignores the fact that layers are naturally disinclined to venture outdoors when severe environmental conditions exist and therefore, the inducement of stress because of inability to venture outdoor is questionable under circumstances that the birds by their own choice do not want to venture outdoors.

While it is recognised that a change in routine management can lead to stress, I am not aware of scientific data that assessed the stress induced as a result of birds' normal inclination to stay indoors in severe weather conditions.

Easiest system for inspecting hens;

I have found that on a flock level, the detection of abnormal flock appearance and behaviour is easier to detect in a barn system than a cage system and on an individual bird

health level, the detection of sick and dead birds could be logistically easier when birds are occupying one level regardless of whether they are on the floor or in cages.

Generally, the capacity to detect abnormalities would depend on the clinical signs. For example, abnormality of gait, paralysis and other nervous signs are easier to detect when birds have the opportunity to walk and exhibit normal behaviour i.e. not in cages. The tendency of sick birds to occupy the areas along the shed wall would also make the inspection easier in barn flocks.

The detection of respiratory diseases (nasal and ocular discharges) was easier when the single tier cage system dominated the scene and all birds were placed at the operator eye level. However, the claim that it is easier to inspect the health/behaviour of birds in cages considering the high prevalence of the multi-tier system suffers from oversimplification, especially when considering the top and bottom tiers. Not only is the task more arduous in the multi-tier cage system, it is also significantly more time consuming. This point on its own would tend to impose a potential compromise of the inspection in multi-tier cage systems.

Lowest incidence of disease and highest level of biosecurity

The lower level of infectious diseases in cage systems is not disputed but there are also metabolic and physiological diseases/conditions with little association with biosecurity. Some significant mortality causes are associated with metabolic, physiological conditions, injury and pecking rather than infectious agents.

Biosecurity is defined in the National Farm Biosecurity Technical Manual for Egg Production (2015) as measures taken to prevent or control the introduction and spread of infectious agents to a flock. The assertion that the cage system has the highest level of biosecurity is perplexing. Why biosecurity in barn systems is deemed inferior to the one in cages as in both systems birds are in secured housing is indeed enigmatic. The bio-exclusion in the barn would depend similarly to cages on the biosecurity policy and HACCP practices that are in place. The studies by Scott et al (2016) reported the presence of wild birds in 56% of cage and barn flocks and in 52% of free-range barns. Although there is a scope for higher level of biosecurity in cage and barn housing than in free-range flocks, the figures above do not illustrate that a higher level of biosecurity is encountered in cages by comparison to barn or indeed free-range flocks.

It should be considered that the lower level of infectious diseases in cages could be more a function of availability of all the vaccines required for this housing system, a process that has taken more than 40 years. Before the advent of effective vaccines to control respiratory diseases like Chronic Respiratory Disease or Infectious Coryza, I encountered these diseases commonly between 1980 and mid-2000 in many cage layer flocks in NSW. The development of these vaccines in Australia was a direct result of the high prevalence of these diseases in layer flocks and their economic impact e.g. Infectious Coryza (Arzey 1984). Given the same time frame and resources, the free-range and barn flocks could reach a much lower infectious disease incidence. Indeed, vaccines against spotty liver disease that affects predominantly (but not exclusively) barn and free-range flocks are now being developed. Pending the efficacy of these vaccines a significant disease and a cause of mortality in non-cage birds could be reduced or eliminated.

Emerging diseases like Newcastle disease and Avian Influenza are often mentioned as a biosecurity issues in outdoor flocks. However, all but one of the Newcastle disease outbreaks in Australia between 1998 and 2002 were in indoor flocks. The single Newcastle disease outbreak in a free-range farm (Rylstone) originated from an intensive farm that delivered live poultry from Sydney. All of the Avian Influenza outbreaks until 2012 were in indoor flocks, cages as well as barns. The 2 outbreaks in free-range flocks in 2012 (Maitland) and 2013 (Young) were in very large flocks (50,000 and 160,000 hens respectively). The critical impact of the size of the flock on risks such as Avian Influenza, is often ignored (see also under the Management section).

Mortality

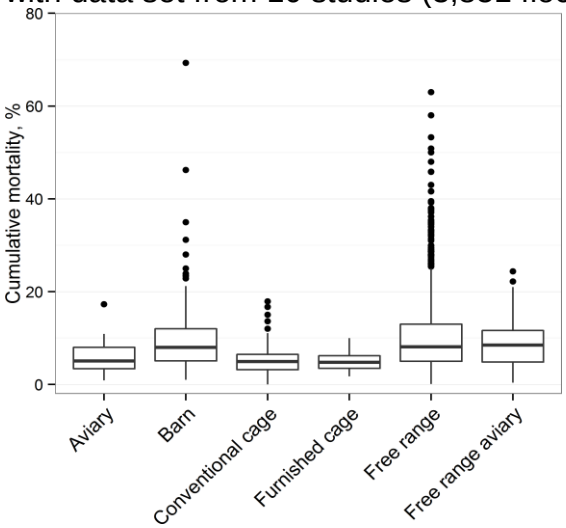
Information provided at meetings during the formation of the consultation report to the NSW Government (2018) indicated that the approximate mortality rates in cage, barn and free-range systems were 2% - 3%, 10% – 15% and 15% to 18% respectively. This type of comparison suffers from oversimplification and the figures are not in agreement with published data, nor are they consistent with figures provided by the Industry to Animal Health Australia (2017) 4%, 8% and 12% for cage, barn and free-range respectively.

None of the above figures is consistent with mortality figures reported from Australian large-scale comparative trials on 46 flocks and 1,000,000 hens (Glatz et al 2008) that indicated a much more modest comparative difference of less than 1% between free-range and cage hens (1.8% cages vs 2.58% in free-range or, 1.4 times higher mortality).

Extensive European studies (LayWel 2006) reported a difference in mortality of only **3.5%** between cages and alternative systems; 8.3% - cages, 7.1% furnished cages and 11.8%- alternative systems. The project reported significant differences in end of lay mortality according to breed and beak-trimming status.

Mean levels of on-farm mortality during the laying period, for a total of **1,486 flocks** in Great Britain, were reported (Weeks 2012) to be 5.39% (cages) 8.55% barn and 9.52% (free-range), thus a difference of **4.1%** mean mortality between cages and free-range.

Studies published by Weeks et al (2016) and represented (below) as box plots for mean cumulative and range mortality in each housing system between 60 and 80 weeks of age with data set from 10 studies (3,851 flocks).



The data by Weeks demonstrated the following aspects;

- No significant differences in mean mortality between furnished cages (FC) and conventional cages (CC) but a higher range of mortality in CC (up to 20%) than in FC (less than 10% upper range).
- A wide range of cumulative mortality from very low across all housing systems to extremely high (up to 50% and 60% cumulative mortality in barn and free-range in a minority of cases.
- A higher mean cumulative mortality of 6%-7% in barn and free-range flocks compared with cage flocks (4% -5%).

There is no doubt that overall the available data suggests a lower mean mortality in the battery and furnished cage systems than the mortality in free-range and barn systems Mortality is accepted as a significant measure of animal welfare. However, it is important to consider the great variability between flocks within the same housing system and the immense variability between different studies. In particular, stock should be taken of the very modest difference in mortality reported in the independent studies on 46 flocks in Australia (mentioned above).

Mortality could reflect the disease status of a flock but in free-range flocks cannibalism and predation are dominant causes (mortality from cannibalism in cages and barns is often mitigated through dim lighting programs with 10 lux or less). The mortality in flocks across different housing systems is also affected by a myriad of factors not the least the quality of management that in free range and barn flocks must be spot-on in order to achieve optimal results. Additionally, important aspects are the quality of sheds, the quality of the range area and the fencing, breed of hen, location of flocks, size of flocks, age, the length of time birds are kept alive on the farm (production cycles longer in free-range flocks), dietary composition, feed particle size, beak trimming status (and the method of beak trimming).

For example, mean levels of mortality at end of lay in white feather layers, beak trimmed was reported to be 3% and in brown feather layers, beak trimmed it was 9.3%. In the same genetic strain of birds, without beak trimming, mortality was reported to be 10.5% and 19% in white and brown layers respectively (Nicol et al 2017). Most layers in Australia are brown strain layers and unfortunately, they also dominate the non-cage system. Furthermore, Singh et al (2017) reported that 50% of free-range farms surveyed in Australia did not beak trim their hens. Just a few examples to demonstrate the complexity of the issue and a reason to be cautious when comparing the mortality data of different housing systems without due attention to specific circumstances.

It is also prudent to recognise that if indeed high mortality is an important animal welfare element, keeping hens in cages under the currently mandated space allowance of 550 cm^2 per hen should raise concerns because as floor space decreases, within a range of 650 to 300 cm^2 per hen, bird welfare generally decreases, as measured by either higher mortality, lower egg production and body weight or poorer feed conversion (Widowski et al., 2016).

The mortality level in different housing systems would ultimately dictate the predicted likelihood that a bird would die in each system prior to being killed at the end of the production cycle. From the Australian studies it can be deduced that a bird would have a 1.4 times higher likelihood of dying in free-range compared with a bird in a cage. Nevertheless, the likelihood is still very low when the actual mortality figures are considered (2.6 birds out of every one hundred birds = a likelihood of 0.026). If mortality is taken as an

indicator of bird welfare, the likelihood of a bird being exposed to this event is very low (0.026), unlike the likelihood of a bird being exposed to deprivation of movements and severely restricted behavioural repertoire in battery cages, which is a certainty (likelihood of 1), since all birds that are kept in this system are invariably being exposed to this event uniformly and for a long duration. Even at the assumed higher comparative mortality figures of 4% and 12% between battery cages and free-range (Animal Health Australia 2017), the likelihood of a hen dying in a free-range system is 0.12 which is still a low likelihood by comparison with the likelihood of exposure to behavioural deprivation which is 1 (a certainty) in battery cages. The degree of certainty and the duration of the adverse welfare impacts are both a useful tool that may help to reach a better understanding of the relative importance of various welfare impact like, for example, mortality vs deprivation of movement and behavioural repertoire.

Causes of mortality

While the total mortality provides a useful welfare indicator, the causes of mortality serve to refine this indicator.

Fulton (2017) reported that in egg producing chickens, many of the natural causes of death are associated with making an egg. This is common to all housing systems.

The author also stated that the causes of normal mortality in commercial egg-laying chicken flocks have been described very little to date. He reported the causes of mortality of a commercial high-rise cage egg farm, housing approximately two million white leghorn chickens in 16 egg-producing flocks. The top 15 causes of “normal” mortality, in order of prevalence, were: egg yolk peritonitis, low calcium, gout, self-induced moult, salpingitis, caught by spur, twisted intestine, cannibalism, tracheal plug, septicaemia, fatty liver syndrome, internal egg laying, hepatitis, and prolapsed vent. Other causes noted were hyperthermia (heat stress during summer), trauma, coccidiosis, ovarian tumours, being egg bound, urolithiasis, peritonitis (not egg yolk induced), leg fracture, caught in the structure, tumour (other than ovarian origin), wing fracture, exsanguination, and cardiomyopathy.

Overall the cumulative mortality was low, nevertheless, the report disclosed some of the less reported and yet common mortality causes in cage facilities. These were not so different from the causes of mortality I observed when I started with NSW DPI as a veterinary officer in 1981 with duties that included the routine examination and autopsy of layers housed in cage facilities at the Poultry Research Station at Seven Hills. It is important to emphasis these mortalities as they are not often documented, often ignored and accepted as a normal mortality but nevertheless, they reveal that the cage layer system is not free of significant mortality events although they seem to be accepted as normal.

There is a need to distinguish between causes of mortality from infectious agents and those from other causes. For example, egg peritonitis with almost double mortality was reported in cage hens compared with free-range hens (Morrison 2011).

Often the difficulty of keeping predators such as crows, foxes and eagles from attacking poultry on the range is raised. Indeed, this is a management challenge that can be ameliorated by various mitigation strategies such as using dogs, proper fencing, provision of tree canopy and shelters on the range as well as netting (similar to that used in orchards).

Causes of mortality from infectious agents were reported (Fossum et al., 2009) to vary between different housing systems with higher vulnerability to viral diseases in cage hens than the free-range systems (30% vs 4.4% in free-range). Even when bacterial diseases were considered, the cage hen still faced a significant risk with 65% of mortality being caused by bacterial infection. The mortality data below is not necessarily applicable to Australia and as the authors indicated, represent a unique period in one country.

Causes of mortality in hens submitted for routine necropsy in Sweden (2001-2004) (Fossum et al., 2009)

Housing system	Bacterial diseases %	Viral diseases %	Parasitic %	Cannibalism %
Cages (conventional and furnished)	65	30	10	5
Non-cage	73	11.6	18	19
Free-range	74	4.4	22	26

The UK Veterinary Diagnostic Laboratories autopsy results for the period 1995-2010 cited in Morrisons (2011) reported much higher egg peritonitis, septicaemia, salpingitis, air-saculitis, Infectious Laryngotracheitis and starved out in hens in cages than barn or free-range. Unfortunately, it is difficult to find similar Australian data although RIRDC studies (Nolan et al 2001) reported high mortality from cannibalism in cage birds (but no comparison). I observed mortality from vent pecking not infrequently in cage hens.

It should be considered that the lower level of some infectious diseases in cages could be more a function of availability of all the required vaccines, a process that has taken more than 40 years to be accomplished.

Comparative Australian data on causes of mortality is sparse and the available overseas studies do not provide a consistent picture but demonstrate the need to recognise disease in broader terms rather than only infectious diseases. Nevertheless, it is necessary to recognise that currently the disease incidence is higher in free-range and barn birds than in birds in cages.

Easiest system to clean (Difficulty in cleaning range area between flocks thus leading to build up of pathogens in the environment)

Exposure to UV light serves as an important disinfection tool in the outdoor environment and pasture rotation can also enable further ‘sterilisation’ of the outdoor environment. However, it is true that comparatively it is more difficult to clean the range environment provided that the comparison is done with single age conventional cage houses. It is impossible to effectively clean cage houses if they house birds of different ages and many of the conventional cage houses are multi-age.

Management

Animal welfare outcomes can vary from poor to good depending on the quality of the housing facility, stocking density and the management. These aspects are important regardless of the production system, but sound management is a critical aspect of free-range production and it should be recognised that many operators are inclined to view free-range simplistically as a mere extension of barn housing with the provision of popholes and some additional fencing rather than acknowledging the complexity of the system, seeking innovative solutions and striving to realise its potential. At the same time, although non-cage egg production is much more demanding and complicated than cage production, I experienced situations where people without basic knowledge or experience with poultry started free-range enterprises.

In the UK, Prof Nicol stated that "*it would be nice to think that the free-range system currently gave birds the best welfare. The problem is that the management of free-range systems in the UK at the moment is so variable, that although you get some brilliant farms, you also get some that are really, really not good."* (BBC Nov 2013).

My experience with the RSPCA accreditation of a layer flock provides me with the knowledge that a free-range operation under good management can achieve good results. The accreditation scheme requires attention to many husbandry aspects, attention to details and intensive monitoring of participating flocks as well as optimal record keeping (https://rspcaapproved.org.au/wp-content/uploads/2017/02/RSPCALayerhensStandards.pdf)

The interactions between welfare and management as well as emergency disease risk are also influenced by flock size and this aspect is often ignored when disease risk (like Avian Influenza) and ability to optimally manage the flocks are considered. The bulk of free-range farms in Australia would be small farms. The presence of a large number of small farms is likely to reduce the risk of highly pathogenic Avian Influenza (HPAI) as the smallest flock ever reported with HPAI in Australia was a 17,000-hen barn farm and the only 2 free-range farms that contracted Avian Influenza (in 2012 and 2013) were farms with very large free-range flocks of 50,000 and 160,000 birds.

The association between flock size and HPAI outbreaks was acknowledged by the Australian CVO during appearance at the Rural and Regional Affairs and Transport Legislation Committee (Nov 2013) - "large populations of birds allow for the evolution of some virus subtypes to more highly pathogenic forms". Additionally, studies highlight that company farms and large farms are many times more likely to spread Avian Influenza than small independent farms. (Leible et al 2010, the European Panel on Animal Health and Welfare 2008, Sharkey et al 2008).

The size of the flock will also have a significant bearing on the incidence of cannibalism and severe feather packing (Bestman et al 2003). Large flocks are more prone to these behaviours.

The optimal management of free-range flocks also requires the management of the range in order to provide the optimal environment, encouraging hens to explore the outer range rather than aggregating near the shed apron. This is an important aspect capable of reducing aggregation, disease, pecking and cannibalism as well as increasing biosecurity. Chielo et al (2016) stated that *birds observed to forage at the outer range are often showing*

signs of better welfare than those closer to the shed. These aspects of the management of free-range flocks are often ignored. In order to achieve these optimal results, the provision of an appropriate canopy of trees and shrubs for shelter and encouragement of ranging behaviour is critical and will ameliorate many adverse aspects that can be experienced in free-range flocks. Environmental features in the outdoor range were reported (Rault et al 2016) to have a large influence on the number of hens in these areas as well as on the behaviour displayed by hens while in these areas.

A study by Koning et al (2017) on 4 commercial free-range operations (3,000 - 11,700 hens) demonstrated the imperative role that sound management plays in free-range operations. Among other advantages gained by hens under enriched management system, it was found that hens utilising the range effectively had better plumage scores with lower feather loss and decreased areas of bare skin compared with birds scored in the shed.

The condition of the feathers could be viewed as a proxy for aggression, pecking and cannibalism which is one of the significant causes of mortality in non-cage systems. It shows that appropriate management of free-range flocks can address significant mortality issues attributed to free-range and that in many cases the higher mortality in free-range and barn flocks is not a function of the system per-se but rather the quality of the facility and the management.

The conundrum

It is apparent that each of the housing systems presents different opportunities, advantages and disadvantages that are given different weights by community members. Some are of welfare nature and others are of logistics, management, environmental and financial nature. There is not one system that will tick all the boxes.

Solely from an animal welfare perspective, the higher disease incidence and mortality in non-cage systems may present a conundrum to some and ultimately with a choice of preferring a system that severely restricts the movements and the natural behavioural repertoire of sentient animals or systems that mitigate these deficiencies but currently result in higher mortality and disease incidence.

Similar arguments could be extended to other production animals where certain management practices could be reducing injury and mortality (e.g. sow stalls). The Pork Industry committed to pursue a phase out of sow stalls by November 2017 although this restraint applied only during pregnancy.

It is worthwhile mentioning that a large study on mortality rate of male prisoners in Europe found that the standardised mortality rate from natural causes among prisoners was lower than the general population and this was consistent with similar studies in the USA (Fazel et al 2006). Would this present a conundrum?

Currently, mental impacts on animals and suffering cannot be quantified in anything other than subjective or individualistic human terms. Ultimately it is a value judgement by individuals and the community that will determine whether death of individual hens that may take hours or days (if not attended to and/or culled) is preferable to inability to move and inability to perform natural behavioural needs that last a life time and affects the entire flock.

It is extremely difficult to evaluate the severity of welfare impacts since some communities may regard death as a more severe impact than inability to move or vice versa. However, a framework for assessment and guiding choices could be considered based on subjective parameters like

- duration,
- the number of affected animals and
- the likelihood of a welfare impact on individual animals.

A welfare impact could be severe and of long duration or of short duration. It may impact on a small number of animals or, on a large number of animals. The choice could be between an impact that affects more birds for a very brief period and an impact that affects fewer birds but for the duration of their life.

These considerations may enable some navigation of the various welfare domains. There is also the element of the degree of certainty that a negative impact would occur. For example, placing hens in free-range housing would not invariably result in their death and the likelihood of mortality of individual birds could be predicted on the basis of currently available mortality data to be low. However, it is a certainty that all 10.7 million birds in conventional cages in Australia would be affected by the lack of freedom to express innate behaviour.

The furnished cages

The furnished cages as the name suggests are still cages, nevertheless, they enable a greater behavioural repertoire and if properly constructed, they enable greater space allowance for each hen. I do not necessarily support this system but it is important to shed some light on it since it may provide some compromise and enable some welfare improvements. I would rather see hens in properly managed free-range and barn situations than hens in cages but I would also rather see hens in improved cages than in battery cages. Although the AVPA in their submission (AVPA Submission Oct 2017), supported the continuation of the battery cage system, it wrote "*Conventional cages and furnished cages should also be considered separately in light of different outcomes for welfare"*.

NSW Farmers (2018) maintained that the furnished cages cause more production system problems and issues around hen welfare than existing systems.

However, the available data suggest otherwise.

The furnished cage in Europe and Canada offers not only more behavioural scope but also more than 750 cm^2/hen space since properly designed, enriched cages enable a vertical dimension (perches) and intermittently a reduction in the number of hens that occupy the same floor area.

On the health and production side there are no trade-offs and the conundrum of "trading off-off certain natural behaviours for a better welfare dividend in health" does not exist. The NZ studies (2011) provided a useful insight on furnished cages

- Overall rate of mortality was lower than battery cages systems, especially when they were beak trimmed using modern Infra-red beak trimming equipment. The NZ study

(2011) reported lower mortality in battery cages initially, but rising to exceed that in furnished cages after 42 weeks of age.

- On economic assessments such as feed conversion the furnished cage birds performed as well, or better than battery cage birds. There were no significant differences in egg shell or internal quality parameters between the two systems. However, Haugh Unit (egg protein quality based on the height of its albumen) scores were significantly lower in battery cages than in the furnished cage groups.
- The furnished cages birds had a statistically significant increased risk of suffering broken claws than battery cage birds in the early weeks of lay, but battery cage birds had caught up by later in lay.

Comprehensive reviews concluded that furnished cages generally maintain the health benefits of conventional cages while supporting the expression of some of the hens' motivated behaviour.

- The recent Farmed Bird Science Welfare Review by Nicol et al (Oct 2017) concluded that the conventional cage prevents or constrains the performance of most comfort movements, and there are no resources to meet the birds' roosting and nesting needs. Compared with conventional cages (battery cages), hens in furnished or colony cages show lower levels of aggression and more comfort behaviour. They are also more able to dissipate heat during hot weather by adopting appropriate postures, an effect that halved mortality.
- A 2015 report of the EU egg sector (Horne and Bondt 2015) concluded that based on the field data of layer farms, it can be concluded that there were no major differences between the conventional and the enriched cage regarding egg production, mortality and daily feed intake.
- The Farm Welfare Animal Committee (UK) (2007) considered that all commercial systems of production for laying hens offer some compromise in terms of the hen's welfare. However, well managed enriched cage systems are able to offer the potential for an acceptable balance between the requirements for the hen's health and welfare, and public health, in combination with economic and environmental considerations.
- The Canadian Poultry (Layer) Code of Practice Scientific Committee (Widowski et al. 2013) concluded that, based on scientific evidence, "Cages furnished with nest areas, perches and scratch mats generally maintain health and hygiene benefits of conventional cages while supporting the expression of some of the hens' motivated behaviour patterns.
- Elson et al (2015) - Furnished cages which comply with the EU Directive (199/74/EC) can achieve the lowest death rates of commercial poultry housing systems for layer hens - 3% cumulative mean mortality.
- Occurrence of infectious diseases appears to be similar in furnished and conventional cages, whereas non-infectious conditions such as fatty liver and kidney disease and osteoporosis are more prevalent in conventional cages than in systems providing greater freedom of movement (EFSA 2005 and Tauson & Holm, 2002 in Lay 2011).

- Nicol et al (2017) - Compared with conventional cages, hens in furnished or colony cages show lower levels of aggression.
    - They are also more able to dissipate heat during hot weather by adopting appropriate postures (Guo et al., 2012), an effect that halved mortality in one study.
    - Aggression (as indicated by comb wounds) is reported to be lower in furnished cages than conventional cages (If aggression does occur in small groups it can also be reduced by the perches that enable subordinate birds to move away from dominant birds (Cordiner et al. 2001 and Hetland et al., 2003, in Nicol et al 2017).

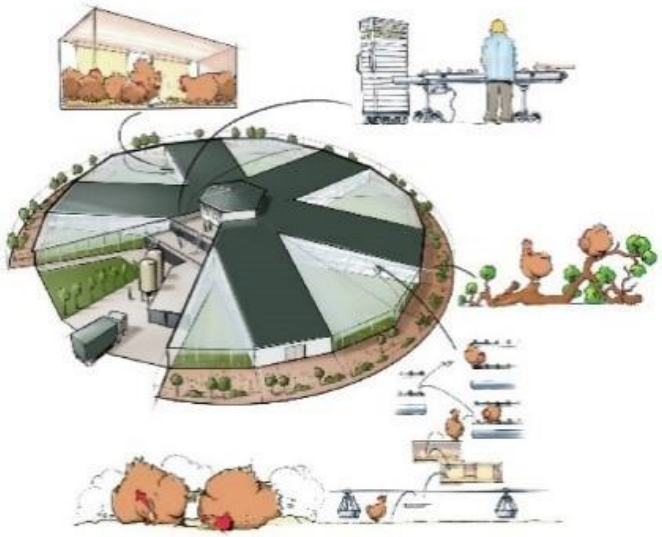
The acceptance of furnished cage eggs by supermarkets and consumers in Australia remains unclear and may influence producers' opposition to this. Across the Tasman, NZ egg producers have been warning Australian producers not to repeat the NZ mistake, explaining that the NZ supermarkets stepped in last year to announce that from 2025 they would no longer stock eggs from any caged system.

The European experience has not seen a smooth transition but the lesson is that even giant supermarkets must meet demands for eggs. 3 years after banning conventional cages in Europe 56.3% of eggs produced in the EU, were from furnished cages and 43.9% from non-cage housing. (The EU egg Industry 2017). Canadian producers (2016) are predicting that 65% of the hens will be in non-conventional housing within the next eight years and by 2031 85% of the hens will be in furnished cages.

The Rondeel System

(https://eggs.ab.ca/about/eggnotes/dec17-rondeel/ and http://www.lohmann-information.com/content/l_i_46_artikel12.pdf)

The System is a significantly modified barn system that enables day and night quarters and access to wooded area. The Rondeel barn accommodates 30,000 birds and has a characteristic circular design split into sub-units, each can house 3,000 hens.



It includes:

- Indoor multi-tier “night quarters” (in dark green) where the birds can eat, drink, nest and rest. The night quarter consist of three separate levels for feeding, nesting and egg laying, and perching
- A day quarter area with a roof system that can close when it is raining but open when it is sunny (also called veranda). This area has open-sided screens. In this area dust bathing areas are provided.
- Walls that open each morning, creating one environment for the birds with indoor and outdoor areas (in light grey colour between the dark green)
- An outdoor area that has a variety of artificial trees and structures to provide cover and a sense of safety. The outdoor range also has curtains that let light in, and can be seen through, but act as wind screens.
- A viewing area that puts visitors at the same height as the birds. People are encouraged to visit the farm whenever the birds are awake, and in any weather. This provides not just a transparent way of farming, but helps to connect society to the farm.
- A system that has “interesting” areas to peck and explore that help keep the birds busy and reduces aggression.
- Birds in the Rondeel system are not beak trimmed but are able to maintain good feather cover.

The impact on behaviour, including aggression, is summarised in the Lohmann link above. Lohmann reported that the Rondeel flock had better feather cover than the average seen in flocks of similar age.

While the system, including its wooded fringe, is not a free-range housing system, it provides hens with a comfortable accommodation, small flock size, good lighting, a scope for ranging behaviour and significantly improves the design and outcomes of the traditional barn system.

Both the furnished cages and the Rondeel system demonstrate that there are alternatives that enable a better welfare outcome than battery cages. The Rondeel housing would probably meet public expectation more than the furnished cages because it enables a wider scope of behaviours. Either way, banning the battery cages is likely to result in more innovations and further improvements to the alternative systems as well as encouraging research that should enable even better welfare outcomes in the coming years.

Economics in a nutshell

Significant welfare improvements are bound to be associated with higher costs.

Apart from trying to judge the welfare aspects and being confronted with a web of pros and cons, as well as trying to grasp the thin line between mental and physical welfare impacts of various housing options, ultimately an important consideration for many is the $ and what society is prepared to pay to optimise the welfare of poultry.

According to Animal Health Australia (2017) Proposed Australian Animal Welfare Standards and Guidelines Poultry Consultation Regulatory Impact Statement (2017), costings could range from $709 million for the bare minimum proposed Standards and Guidelines to

$1,125 million for the option of phasing out conventional cages over a 20-year period or, $1,128 for the option requiring nests, perches and litter in cage and non-cage systems.

The difference calculated in this RIS between the basic battery cage standards cost ($709 million) and the cost of banning battery cages mount to approximately $416/$419 million extra costs over the proposed basic cage standards. Indeed, significant sums of money that could influence attitudes to various welfare friendly proposals.

Based on 2017/2018 egg production in Australia (515.7 million dozen eggs/annum), 8.2 cents extra for every dozen eggs produced over the next 10 years would result in $422.8 million intake and handsomely pay for the structural costs of options that are of higher welfare benefits than the battery cage system. A person that consumes 240 eggs per annum would pay an extra $1.64 per year, or $20 over 10 years to cover the structural costings associated with the implementation of non-cage options.

But there are also higher ongoing costs associated with different production systems. Australian industry data supplied to Animal Health Australia (2017) indicate the cost of production per dozen eggs to be 3% higher in furnished cages vs battery cages (166 vs 161 cents). Compared with the situation in Europe before 2012 (the banning of conventional cages), the production costs of eggs were reported to be 6% higher, although, on average, hens in the enriched housing system produced about 1.5% more eggs per 450 gm of feed consumed than hens in the conventional housing system (Horne and Bondt 2015). The production costs of barn and free-range egg farming are higher than the furnished cages.

Higher welfare does not necessarily lead to higher productivity. It is largely animals that stand to benefit and, in the event, that battery cage production is banned, producers should be assisted with some elements of the costings burden, thus reflecting the public good's aspect of the changes.

Higher costs did not stop countries like NZ, Canada and the EU introducing legislation banning the battery cage system.

Public good and financial burden

"Animal welfare is a classic public good" (Lusk et al, 2011). Higher welfare does not necessarily lead to higher productivity and there can be insufficient economic incentive for a poultry farm to reduce risks to animal welfare. Therefore, it is largely animals and the community that stand to benefit. Furthermore, the long-term viability of the investment in furnished cages is at the mercy of evolving community attitude. This is no different from any other business producing goods except that the investment in poultry welfare is mandated.

It is not clear that the market will allow producers to pass-on their full costs (replacement structures and operation) although operational costs are likely to be paid by consumers as they purchase the eggs. In the event that the battery cage system is banned, the public good's aspect should be reflected through the provision of financial assistance from the public purse.

In Germany, for example, the extra expense incurred by livestock producers for the implementation of additional animal welfare criteria is compensated at a flat rate via financial incentives independent of the market price (Germany focuses on animal welfare 2017). In Manitoba Canada (2013) a four-cent levy rebate on a marketable dozen eggs has been introduced to help producers cover transition costs (Canadian eggs among other agricultural products are subject to the supply management system and egg quotas).

Concluding comments

Considering the body of scientific evidence, there should be no doubt about the serious animal welfare impact of the battery cages. Those that are still teetering should reflect on the words in the Victorian Government document – "*It is a moral imperative that if in doubt, we must assume an animal feel pain and can suffer".*

The support for the continuation of battery cages and the lack of support for furnished cages shown by those arguing that higher mortality is an animal welfare consideration as important as depriving hens of their fundamental behavioural needs, seems curious considering that:

1. hens are killed regardless of good health when the flock reaches 70-80 weeks of age.
2. as cage floor space decreases, within a range of 650 to 300 cm^2 per hen, bird welfare generally decreases and mortality increases (Widowski et al., 2016). The mandated space in the battery cages in Australia is only 555 cm^2.
3. furnished cages address the health and mortality concerns and provide a better scope for behavioural needs.

Regardless of higher costs that maybe associated with the banning of battery cages, it is difficult justifying this housing system when the chicken is viewed as a sentient animal that requires a far greater space than currently mandated in battery cages. To continue to keep more than 10 million hens in Australia in the battery / traditional cage system for their entire life is a practice contrary to scientific evidence and large sections of the community preference. It is an unjustified, unique practice with severe impact on hen welfare. If nothing else emerges out of the current inquiry, at least the inadequacy of the space allocation in battery cages (550 cm^2) and its contribution to frustration and mortality should be acknowledged and steps taken to ameliorate the situation, increasing the mandated space allocation / decreasing the stocking density.

While it is clear that in the minds of some, the choice between free-range barn systems and battery cages presents a conundrum, this should only exist between equally deserving animal welfare risks. The comparative welfare risks (e.g. higher mortality) are not of the same risk magnitude for each hen (likelihood, duration and numbers) as the welfare risk associated with a permanent confinement in a space far smaller than is required by the hen for basic behavioural needs. Furthermore, disturbing aspects, like mortality rate, can be mitigated through improvements of the sheds and the design of the range, better management, genetic selection of hens more suitable for the free-range and barn environment and the development of housing system specific health strategies.

The demise of the battery cage system is inevitable and is reflected in Egg Farmers of Australia Chief Executive Officer acknowledging in September 2018 that " the transition to furnished cages and eventually barn or free-range egg production systems has been underway since 2002 (https://farmers.org.au/news/egg-farmers-on-track-for-a-cage-free-future/)".

Whether such transition should be allowed to progress at its pace or a time frame should be set is the crucial question.

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The argument for maintaining the battery cage on hen's welfare grounds comes to a naught when the furnished cage system is considered. While not achieving all welfare goals, nonetheless, it is a compromise that should be adopted in lieu of leaving the status quo preserved. There is little doubt that "furnished or enriched cages would be a better option than a bare cage. The literature indicates that in terms of stress, physiology, behaviour and health, the furnished cage performs very very well" (Dr P Hemsworth 2018).

Those members of the community that prefer to purchase free-range or barn eggs will continue to do so but those that purchase battery cage eggs are unlikely to object/reject eggs produced in furnished cages. The price differential has not proven to be a stumbling block in other countries.

The Rondeel system also provides an alternative to battery cages and the traditional barn system. It is a cageless system that has been reported to be with many positive attributes but unfortunately, I could not find sufficient scientific data to unequivocally support the advantages or sufficient data on mortality and disease issues in this system. Nevertheless, the possible advantages are likely to be of greater magnitude than the traditional barn system. Further exploration of data is required.

The free-range system does present a sustained management and range challenges and may not be the choice of many of my colleagues but alternatives such as furnished cages and the Rondeel system exist. They enable a much better welfare outcome than battery cages. The Rondeel housing would probably meet public expectation more than the furnished cages as it enables a wider scope of behaviours. Either way, banning the battery cages is likely to result in more innovations and further improvements to alternative systems as well as encouraging research that should enable the development of better systems than what is available currently and ultimately, better welfare outcomes in the coming years. The human mind that years earlier created the battery cages, now can be harnessed to deal with the issues that confront barn and free-range housing.

A mandated transition from the battery cage system is more likely to meet public expectations than exit at industry pace. Furthermore, it will benefit the hen and the community largely because a defined date will facilitate not only the uptake but also any research and development that is required in order to achieve optimal outcomes.

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