Contributing Factors to Floor Egg Issues

Avoiding the issues with best practices

A report for

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Executive Summary

This report investigates the history and development of the poultry industry. It also investigates the incidences of increased floor eggs and several techniques to help alleviate the issues.

The history and the development of the industry are important to understand problems that arise in the modern-day industry. To keep birds out of contact with their own faecal matter to avoid disease outbreaks and contamination on eggs also led to the perfect system to avoid floor eggs. This system is battery cages and have their advantages. It also determines total eggs from a hen and if they are laying at all (Biomed Central, 2009). These systems have been outlawed in the European Union (EU) and are often frowned upon in other countries by increasingly concerned consumers. Barn laid or free range now give the hen an opportunity to lay eggs in problematic areas again.

Floor eggs are any eggs laid outside of the ideal nesting system that is provided. A floor egg has a severely increased chance of contamination and therefore a lower percentage of hatch. Floor eggs also must be collected at regular intervals by employees. If there is an abundance of floor eggs to labour, costs will increase, and overall hatchability will decrease.

As part of this research, the author visited several rearing, breeder and layer farms and it was clear to observe that management from day old to peak production is key. There are numerous different set-ups, equipment and manufacturers across the world. There are different genetics, scales and generations to add diversity to the industry. Nonetheless, with all these differences there are answers for each situation and many strategic elements are the same.

Birds need to be reared effectively with perching similar to the slats used in production housing. Rearing managers need to be observant, and weight/body condition uniformity is essential for collective light stimulation for hens. If the hens are all of similar stages of maturity, then encouraging them at the right time towards the nesting system is much simpler. Hens need to become familiar with the production shed prior to the laying period. Equipment and layout need to be taken into account, as well as ventilation. Floor egg percentages can be reduced with a holistic approach to the bird's environment and management.

Figure 1: Laying hen from Kipster, Netherlands, 2018 (Source: Author)

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Foreword

Poultry companies and businesses, both including laying and broilers-breeders, have had difficulties with floor eggs at least once within history. I began my love of Australian agriculture when I started my studies of Animal and Veterinary Bioscience at the University of Sydney in 2009. I never had the privilege of growing up on a farm or being involved in agriculture until I completed my degree in 2013. Since then I had been within the management team for one of the largest broiler companies in Australia. I began as a relief manager on the breeder farms and bear witness to floor egg problems in some farms and not others. The layouts and equipment were either identical or very similar. I have always had a mind for puzzles, and this was no different. I moved up to an assistant manager role on a farm that had some of the worst floor egg percentages and with little help from upper management we were still able to reduce the number but not to a justifiable percentage.

I was promoted to a ten-shed breeder farm with very minimal floor egg issues. We were able to keep the percentages low but not low enough for manufacturers standards. Without guidance and knowledge from upper management, this puzzle was not getting solved any time soon. Nuffield presented me with an opportunity to explore the poultry industry across continents and allowed my mind to be blown away. The experience and knowledge from managers that I have met will always be valuable. Floor eggs do not seem as much of an issue now as they did before. It comes down to keeping things simple and not over complicating situations, knowing your equipment and knowing your birds. The managers that had amazingly low percentages of floor eggs were the managers that were passionate and knew their birds. They would put that extra effort in during the crucial times and it paid off.

Figure 2: Chicken reigns in the 21st century, 2012 (Source: O'Brien)

Acknowledgments

There have been so many people and companies that have helped me throughout my Nuffield journey. First and foremost, I would like to acknowledge Nuffield Australia, Nuffield International and AgriFutures Australia for giving me the opportunity and support.

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- Vencomatic/Prinzen
- Big Dutchman
- VDL, DMC
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Thank you also to the many small businesses I visited for a fantastic story, tea or coffee and inspiriting devotion and passion to the birds.

Objectives

- To describe the history of the poultry industry.
- To describe the issues related to floor eggs and why the poultry industry needs to reduce this number.
- To discuss whether manufacturers, equipment, layout of the shed and management styles impact on the percentage of floor eggs.
- To describe the best advice given from several experiences, leaders, and companies on floor eggs and how to combat these issues.

Chapter 1: Introduction

The poultry industry has been growing since the domestication of the fowl. This industry encompasses many different species of poultry, typically members of the orders *Galliformes* (such as chicken and turkeys) *and Anseriformes* (such as duck and geese) although chicken is still the major meat and egg used throughout the world. Currently worldwide, the overall meat industry is projected to produce 336 million tons of meat according to the Food and Agriculture Organization of the United Nations (FAO, 2018). The USA, China and Brazil are leading the increase in production for poultry meat. The poultry industry is projected to produce 37.5% of the overall meat production closely followed by pig meat at 36% (Conway, 2019).

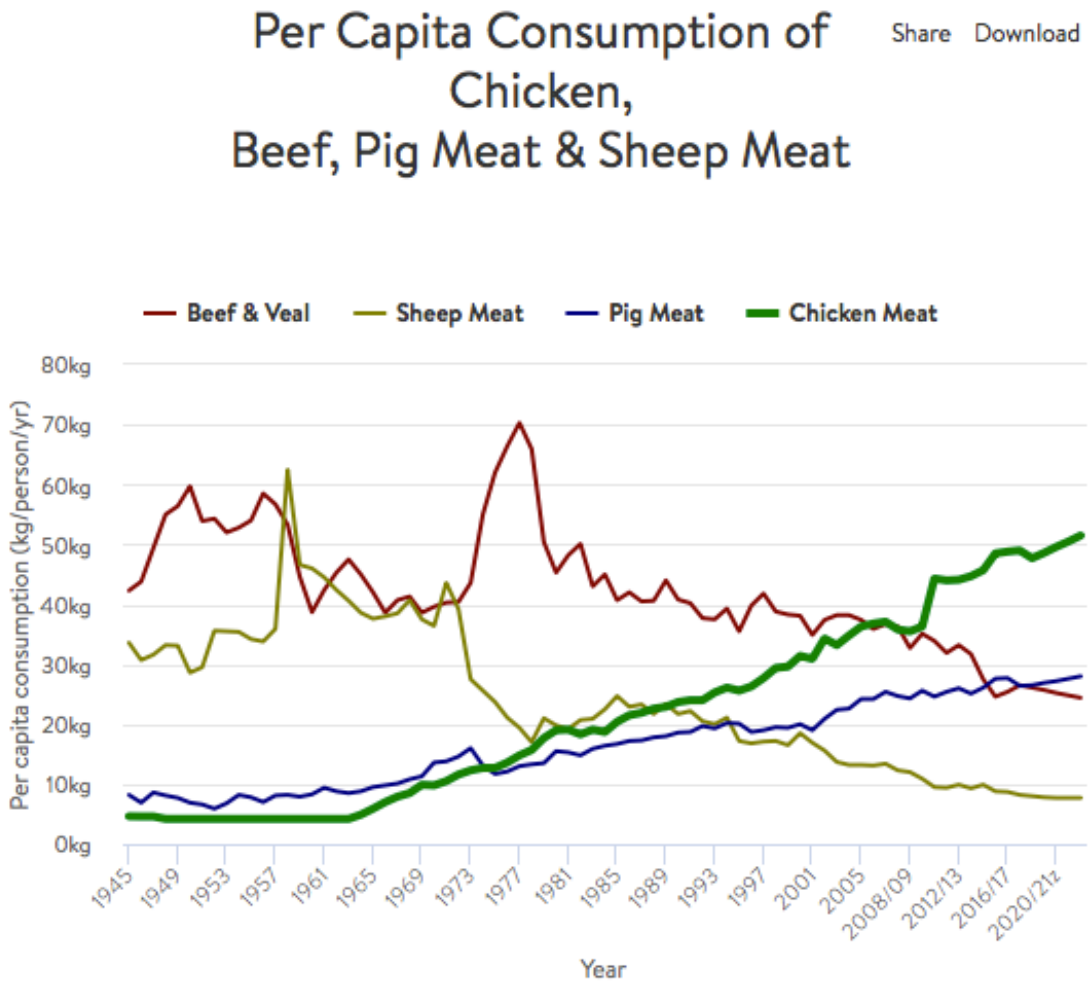

Figure 3: Per Capita Consumption of Chicken, Beef, Pig & Sheep Meat, 2018 (Source: ACMF)

The chicken industry is largely divided up into two different smaller industries, the layer and the broiler industries. Both industries provide a source of protein, although the layer industry provides consumable eggs for the public whereas the broiler industry provides the chicken meat. Egg and chicken meat consumption has been rapidly growing worldwide as chickens are readily available and the cheaper meat, as shown in Figures 3 & 4 (Conway, 2019). The chicken also is an animal that does not come with religious connotations and, therefore, is a preferred meat in the Islamic and Hinduism religions (Patience, 2016). The meat has been quite competitive when compared to other meat sources as the feed conversion is so low due to extensive research into nutrition and genetics.

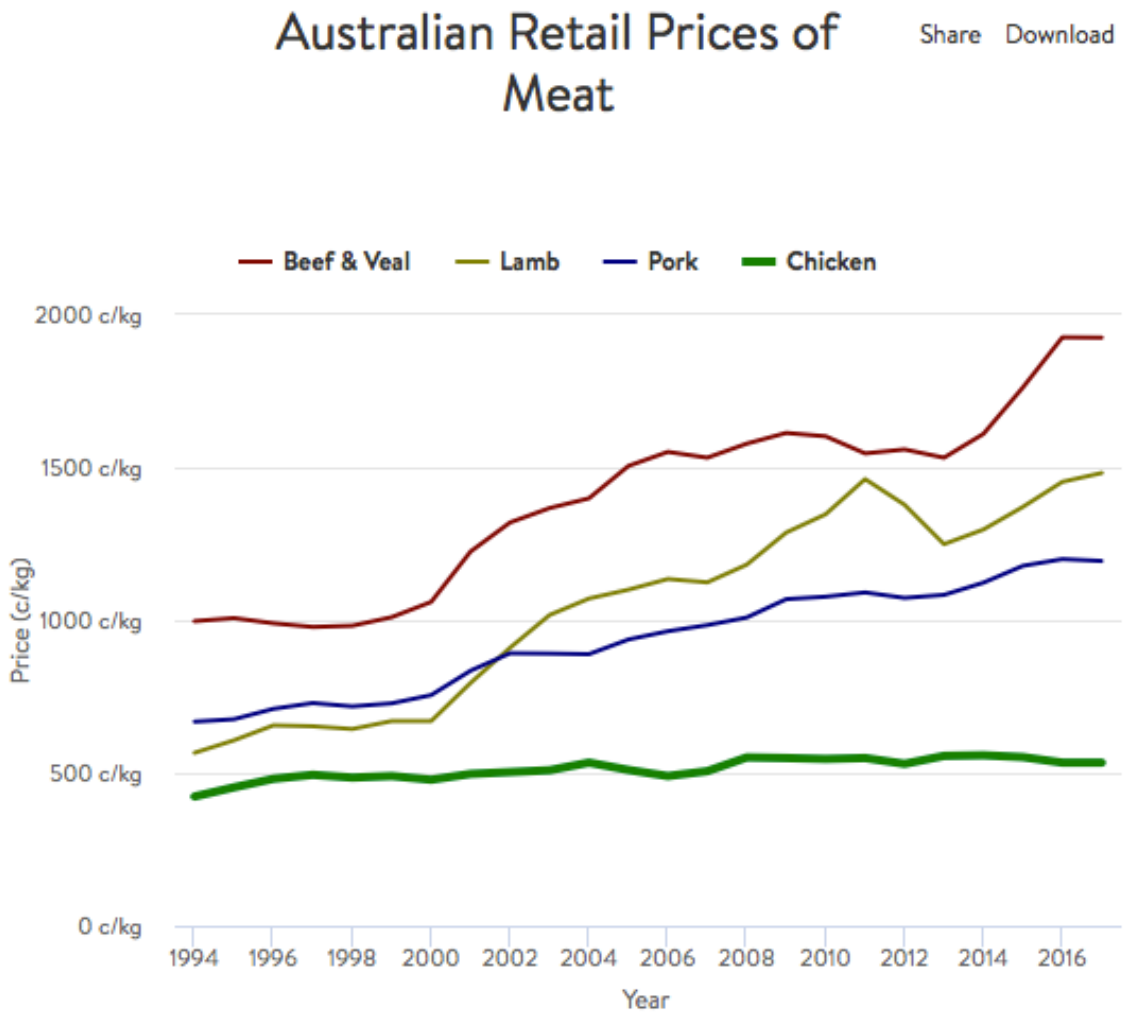

Figure 4: Australian Retail Prices of Meat, 2018 (Source: ACMF)

The First Fleet arriving in Australia in 1788 had poultry aboard the ship and the Australian poultry industry has grown from this point (PoultryHub, 2018). As PoultryHub (2018) explains the First Fleet had chickens, ducks, turkeys, geese and a number of wildfowl on board. A

growing market and interest from consumers have led to the expansion of the poultry industry within Australia (PoultryHub, 2018). Both meat and egg consumption is steady, and expected to increase in the coming years (Conway, 2019). Last year, 653 million chickens were processed in Australia to provide meat for human consumption and an average of 48.8 kg/capita was consumed, as shown in Figures 3 & 5 (Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2018). Almost all chicken consumed in Australia is grown domestically with less than 1% being imported under strict protocols (Australian Chicken Meat Federation (ACMF), 2018).

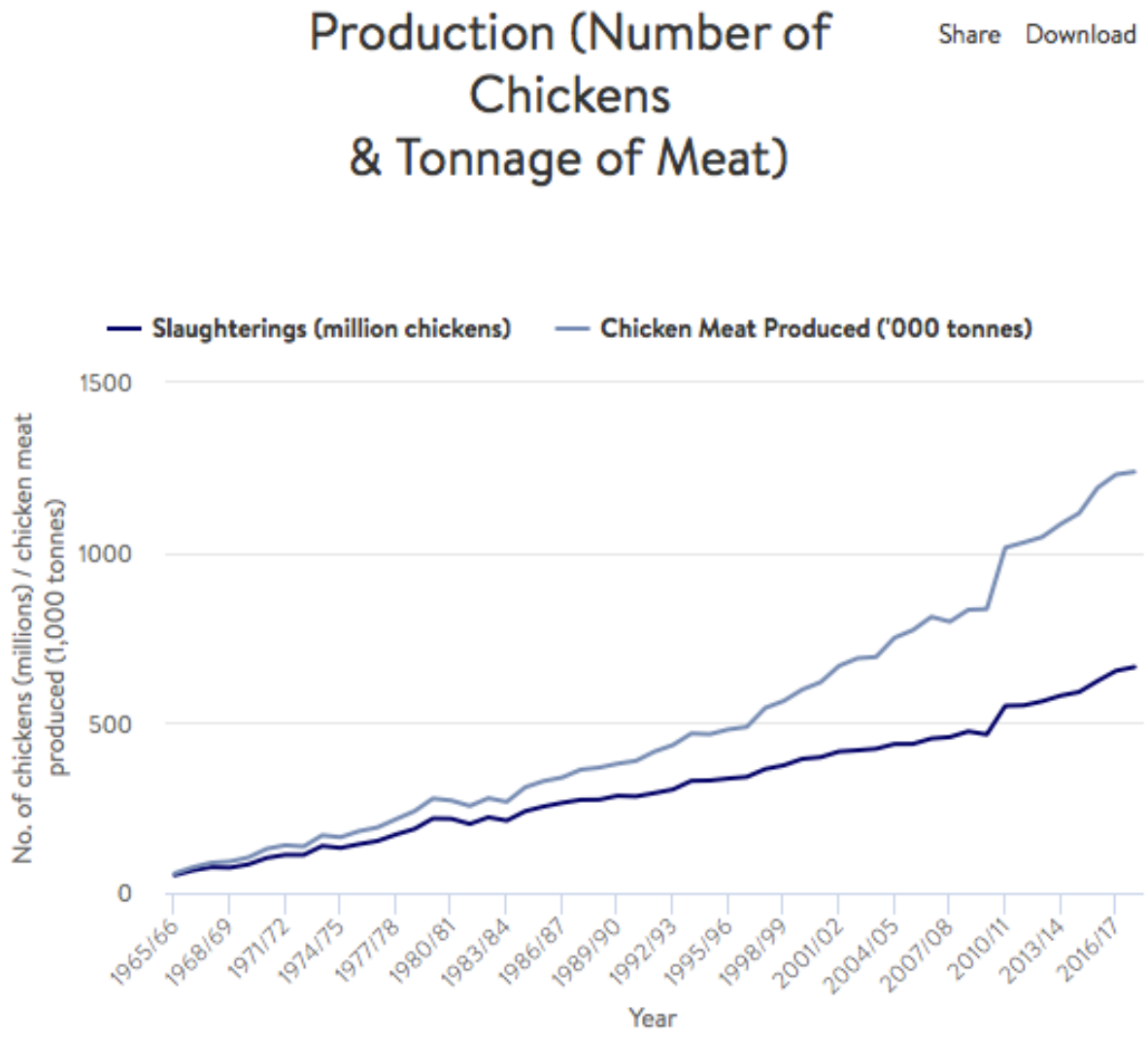

Figure 5: Chicken Meat Production, 2018 (Source: ACMF)

Many attributes of the poultry industry have improved over time such as housing, ventilation, genetics, feed and management techniques. Although, like all other agricultural industries, these products are biological and changing all the time as is the climate around them.

Therefore, new problems arise all the time and experts of the field try to solve or minimise these problems. Both the layer and broiler industries have their own problems as they have different genetics, equipment, setup and key performance indices. There are some similarities when you compare the layer industry with the parent stock of the broiler industry because even though their goals are slightly different, both systems are dealing with egg production. Floor eggs are detrimental to hatching within the breeding system, but they also cost extra labour in collecting them if there are too many and occurs in both industries (Matthews & Sumner, 2015).

Hens tend to lay in one certain spot for their whole laying life. Once they have found an appropriate nest, they will return there approximately every 25 hours to lay an egg (United States Department of Agriculture (USDA), 2011). This means that when a hen learns to lay an egg outside of the nests provided, she will continue to do this for the rest of her laying life unless that nesting space is not suitable anymore. Management is key to directing birds where to go and teaching them good behaviours from the start. Rearing and production managers are both important in producing a great flock with great results in production, fertility and hatchability.

Chapter 2: History

Domestication

There is some dispute about when or where the first chicken became domesticated. The exact time when domestication of the chicken is very unclear, however, there are estimations from 7,000-10,000 years ago (Lawler & Adler, 2012; Hirst, 2018). Although it is known that 'modern day' chicken's (Figure 8) genetics originated from the Red Junglefowl (*Gallus Gallus*) with some hybridization with the Grey Junglefowl (*Gallus sonneratii*) as shown in Figures 6 & 7 (PoultryHub, 2018).

Figure 6: Female Red Junglefowl, n.d. (Source: Harrison)

Figure 7: Female Grey Junglefowl, n.d. (Source: Krishnappa)

Figure 8: Female Domesticated Chicken, n.d. (Source: Pflanzio.com)

There is a story that describes chickens were first discovered on the side of road in Greece in the first decade of the 5th Century BC. The tale explains that the Athenian general, Themistocles, who was on his way to confront invading Persians, stopped to watch two cockerels fight and summoned his troops to watch. It seemed that the two male birds displaying instinctual and aggressive fighting inspired the soldiers to repel the invaders and persevere with their civilisation. With such a profound effect on history and to see chicken as a staple meat in many cultural diets now, these two ancestral cockerels should have perhaps fought somewhere else (Lawler & Adler, 2012).

Figure 9: Cockerel Fighting, 2012 (Source: Gonzalez)

Before domestication, chickens naturally lived in the jungles and forests. They displayed natural behaviours such as flocking, dustbathing, foraging, roosting, brooding, fighting, etc. They are ground dwelling species that prefer very dense vegetation, for scavenging and protection from predators (PoultryHub, 2018). Then came the realisation of the benefits for keeping chickens and having them provide a nutritious daily intake of protein. They became quite a staple in family's backyards. Not only could chickens provide reliable food, but they could also be eaten after they were not needed for egg laying. Chicken and eggs are now a staple meat in many diets across the globe. Chicken dishes seem to cross the cultural borders with ease. It seems to be a favourite of this era with its mild taste which absorbs any flavour to the delight of anyone's taste.

World War I

After peace came from WWI, the opportunity for the beginning of the poultry industry came as well. Ex-soldiers were encouraged into agriculture. The government supplied special training or financial aid, particularly in the United States of America (USA) (USDA, 2011). The capital needed to begin in agriculture was quite large and many decided on poultry as it had the least required. Therefore, many ex-servicemen became poultry keepers as a source of income for themselves and their families after the war. This also provided a source of protein for the general public in times of recovery for the nation (Egg & Poultry Industry Conference (EPIC), 2017).

This increased interest and push into the poultry sector saw a rise in the industry and allowed for forward movement (Farmers Weekly, April 2014). Some backyard chicken producers also ended up with more eggs than necessary and began selling to local communities. People also soon realised that chickens are a great source of protein and they grew more quickly than larger production animals. During the early 20th century, research and trials from the Scientific Poultry Breeders Association were well into publication. There were numerous pedigree breeders and trade agreements across the world (EPIC, 2017).

Figure 10: Advertisement after WWI for Poultry, 1918 (Source: USDA)

The year 1930 saw the first commercial type of battery cages (EPIC, 2017). Cages had been long used aboard ships for a supply of fresh eggs before this (PoultryHub, 2018). Producers began using them to keep birds out of contact with their own droppings to prevent spread of diseases (EPIC, 2017). Advantages of cages also included the saving on land and labour (EPIC, 2017). Their application was also a way of producers to keep track of birds that were laying and to identify their percentage of production (EPIC, 2017).

The business of the poultry industry as we know it today came in the 1950s when many countries were past hard times (USDA, 2011). Nutritionists also understood minerals and vitamins more to help formulate effective feed and hens did not need to scratch outside in the soil to gain the additives they were missing (EPIC, 2017). During this same period, the use of light to stimulate laying production within hens became perfected and widespread (EPIC, 2017). This increased the production of eggs and therefore increased the production of broiler meat as well, so both industries flourished (EPIC, 2017).

Many different control systems then became standard for these specialised sheds for layers, breeders or broilers, such as lighting, heating, insulation and cooling; all depending on outside climate (Farmers Weekly, April 2014). Through the ages, poultry farming has not been drastically different between countries. There are small differences in the setup of housing, equipment used and how food or water is distributed, although all the underlying principles are identical. Chickens are kept within parameters usually with access to a hen house, given food, water, and eggs are collected, or the chickens are processed. Throughout the ages, farmers have been continuously developing their businesses and struggling with changing consumer views more recently. To further develop a business, security is needed in a product and to be a reliable source. Reliability whilst working with the environment and biological systems can be very difficult.

Early producers found that the changing environment and predators were an issue and an easy solution was to house chickens. They also found there were benefits to controlling diseases and parasites whilst the birds were housed. Biosecurity was in its early stages of understanding and farmers did not have a word for it, but they knew that it kept a healthier flock of birds (Sandilands, Moinard & Sparks, 2009).

Among the negative reasons to keeping the birds inside was the increased number of floor eggs. The hens' natural behavior is to scratch at the ground and find a suitable nest which is usually dark and comfortable. Shavings or other litter was commonly added to the ground of the coop to give the hens the ability to behave natural dustbathing and foraging habits. Hens found this to be suitable nesting material which usually meant producers would add litter to the nest boxes as well (Arcuri, 2018).

Producers found that some birds were not choosing the nests provided to lay their eggs and this increased the amount of labour requirements. This also meant extensive cleaning of these eggs so that they could be used for human consumption to please customers or incurring a decrease hatch percentage or chick quality (USDA, 2011).

The most efficient and effective way to stop eggs being laid where managers did not want them to lay was to put the hen exactly in the place where they want the eggs to be laid. From this stemmed the battery cage system that is still being used in some countries today (Dorminey, 1974).

Chapter 3: Floor Eggs

Floor eggs are considered second grade or dirty eggs as the shell of the egg has a higher risk of being contaminated (Smeltzer, Orange, Peel & Runge, 1979). Modern day nesting systems have specially designed nest mats to reduce the contamination on the egg by minimal touch. The egg belt that the eggs roll on to usually exclude access from the hen to avoid contamination there as well (Personal communication, Jansen, 2018). It is important to protect the egg from contamination for both the commercial laying and broiler breeder industries as diseases can be transferred from microorganisms and they can be a danger to food safety, animal and human health (The University of Edinburgh, 2017).

The Cuticle

The eggshell has pores in it to provide air movement for the developing chick (Wilson, Suther, Bain, Icken, Jones, Quinlan-Pluck, Olori, Gautron & Dunn, 2017). If the shell is contaminated with unhealthy bacteria when gas exchange happens, then bacteria can be pulled into the inside of the shell. Not only does this affect the chick being born but this is an easy way for salmonella to be transmitted to humans if the egg is not collected and washed in a timely and strict manner (USDA, 2011). Salmonella can be carried by a chicken and not show symptoms and that means it can also be passed through the reproductive tract into the egg. Sanitisation of the eggs is necessary if there is salmonella present in the chickens or surrounding areas (USDA, 2011).

The cuticle is a protein layer (*Figure 11*) that is secreted through the oviduct onto the egg just prior to lay (The University of Edinburgh, 2017). This protein layer is crucial for the protection of the egg. Once an egg is laid the cuticle is wet and requires a cooling down period where it hardens and then is effective against bacteria (The University of Edinburgh, 2017). The degree of cuticle quality naturally varies between bird and egg which means that a high standard of care needs to be taken at all times (The University of Edinburgh, 2017).

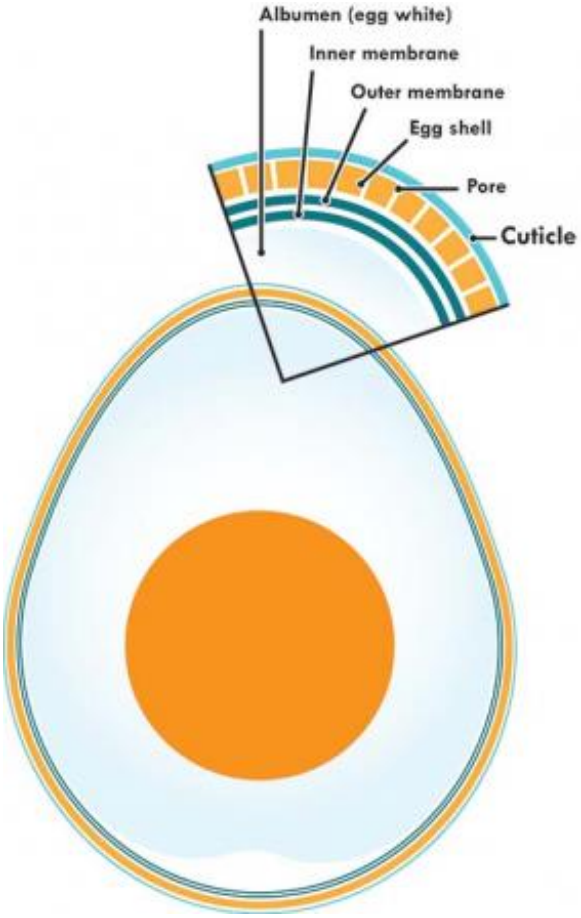

Figure 11: Egg Diagram, 2017 (Source: The University of Edinburgh)

This not only increases labour cost for picking the floor eggs up, but it is also less hygienic, and the eggs have more chance of being contaminated (Nernberg, 2018). Once an egg is contaminated with excrements or bacteria on the litter then there is less likelihood it will hatch or if it does, that the chick will survive or produce well. In a study, van de Brand, Sosef, Lourens and Harn (2016) found that the percentage of eggs that hatched from floor eggs was 74.4% compared to 92.6% from eggs that were laid in the nesting system. This is an incredible economical loss to a business.

Hen Behaviour

Floor eggs must be picked up off the floor at regular intervals. This is mainly due to hen's innate behaviour, when a hen sees another egg she will happily sit on that egg and lay her own egg. This is due to natural behavior of wanted a clutch of eggs but also because it is an indication that it is a good place to lay eggs (Blair, 2012). As Blair (2012) explains, the chicken believes this is safe place and that the previous egg has not been disturbed and can be added to her clutch. Therefore, the longer an egg is on the floor the more encouragement for more

hens to lay on the floor as well (Webster, 2007). These eggs need to be picked up as soon as possible to train the birds that it is a bad place to lay her eggs.

Increased Labour

Labour cost for many countries is the highest cost in the operation and increased floor eggs means more staff are needed to pick them up off the floor (Paycor, 2018). In countries where labour is not the highest cost, the reduction of hatch percentage is still large because the hens are bought, fed, watered and sheltered to produce eggs and if they do not hatch then it is a waste of all costs involved. There is also a higher risk of back and wrist injuries due to increased manual handling for collecting floor eggs.

With the increasing spotlight from animal welfare groups and their influence on the wider community, poultry companies have had to embrace the free-range lifestyle. This is necessarily not a bad thing, but floor eggs were never an issue in a cage system. Many diseases that affect the poultry industry are airborne (Lycett, Bodewes, Pohlmann, Banks, Banyai, Boni & Kuiken, 2016). Therefore, having birds access outside has increased the chance of these birds contracting life threatening diseases due to wild bird contamination (DeMederios, Lunetta, Sullivan & Turner, 2016). Unfortunately, with the quick growth of the poultry industry and increasing trend of keeping backyard poultry, the incidence of salmonella and E.coli contamination have grown (DeMederios et al., 2016). Many poultry companies within Europe have huge risks due to migrating flocks of birds. Every year there are plans in place to help contain avian influenza outbreaks as it is commonly spread by migratory birds (Lycett et al., 2017).

Each bird and each flock can be very different and needs to be managed specifically to those birds (Webster, 2007). Floor eggs may not be a problem one year and the next year, even if things seemed to be managed in the same way, a floor egg problem may develop. This is the reason why knowing your equipment and birds is imperative.

Chapter 4: Manufacturers and Equipment

Floor eggs have been a continuous issue across the years and manufacturers, geneticists, behaviourists and managers have all different views of the solutions. Convincing a bird to lay her eggs in a particular area is not a simple task. Unfortunately, there is no simple step by step procedure to be able to eliminate this problem. A holistic approach to this problem is recommended as each expert has very good points and with this knowledge floor eggs can be avoided.

There are two general nesting systems for commercial production, individual or communal based. The 1980s saw the development of a communal automatic laying nest (Compassion in World Farming, 2013). This system had the ability to open and close the nests when needed and an automatic belt system could be installed to automatically deliver the eggs to one place for collection. Most commercial breeder broilers use or plan to use communal nesting systems (Matthews & Sumner, 2015).

There are several companies that produce similar nesting systems. In the past, manufacturers have been blamed for their nests not being desirable and the hens finding the floor more appealing (Cooper & Appleby, 1995). Manufacturers have continuously developed their products to suit the hen and her comfort (Personal communication, Hulman, 2018). From the colours of the nesting system, material the nest mat is made from, height of the nesting system to slat, amount of darkness in the nest, and to the angle that the nest mat sits at (van Lierop, 2018). These slight differences are what make the nesting systems unique to each manufacturer. All manufacturers of poultry equipment and companies produce particular breeds publish documentation on how to use the equipment correctly and gives details on bird behavior (Personal communication, Hulman, 2018). These documents have recommendations on how to train the birds to lay in the nesting systems (Personal communication, Hulman, 2018; Personal communication, Bushell, 2018).

Figure 12: First nest box made by Jansen himself, 2018 (Source: Author)

Manufacturers and managers have been working hand in hand to alleviate floor eggs as much as possible. There has been extensive research and trials into the birds behaviour and their reactions to changes of nesting systems. Each manufacturer is continuing these trials for new and developed products for the new and developed genetics of each major breed (Personal communication, Bushell, 2018).

Chapter 5: Layout

The layout of the shed can have quite an impact on the bird. The fewer barriers in the way of a hen to her nesting site the better. Minimal shadowing outside of the nesting system is also preferable (Personal communication, Hodgkinson, 2018). Hens prefer shadows as this protects her from predators that may attack her when she is vulnerable or seek out her egg after she has laid it. Most nest boxes will have enough opening to allow a hen into the nest and some have flaps in the way as well to increase that protective feeling in the nesting system (Personal communication, Jansen, 2018).

Layer

The multi-tier slatted system and aviary systems, as seen in Figure 13, are popular in the laying industry as it increases space within a shed. Different breeds of chicken are used for commercial laying and they are much more agile and lighter in body weight, as they are not bred for meat production (Personal communication, Hodgkinson, 2018). The nutrition provided through the feed goes straight into egg production instead of excess muscle and this means the birds are much more active and can utilise the vertical space. This system also saw a reduction in floor eggs, which could be due to agility of the bird and the ease of the hen to get to the different tiered nest boxes (Farmers Weekly, 2014). Often these systems can be closed and prevent the bird from going on the floor. Many managers keep the birds closed inside the system for a few days after transfer so that they can get used to the feeders, drinkers and nests (Personal communication, Hodgkinsons, 2018).

Any obstacle in the way can deter a hen from finding an ideal nest, therefore, feed tracks on a hoist system can be lifted out of the way after feeding to accommodate movement. If a hoist system is not possible then the feed track should be lifted high enough that the birds can easily fit under the track and still be able to eat. Drinker lines need to be at an ideal height so that birds can easily drink from them and they can move easily underneath them as well (Personal Communication, Neumann, 2018).

Figure 13: Aviary system in Layer farm, n.d. (Source: Roy's farm)

Broiler Breeder

Excess muscle growth on the broiler breeder reduces the ability to increase space vertically in a shed. Ideally a cockerel's feeding system will be opposite to where the nesting system is. The nesting system needs to be a safe place away from the roosters (Personal communication, Bushell, 2018; Aviagen, 2018). A hen will want to eat, drink and lay her egg in peace. This is a good reason why many shed layouts include a feed system and drinker system on the slats closer to the nesting system. Mating should be happening on the litter when a hen is dustbathing, scavenging and displaying natural courting behaviours (Personal communication, Bushell, 2018). Depth of litter may also play a part in encouraging or discouraging floor eggs. Too thick a layer of litter and it becomes quite comfortable for the bird to nest in. A good depth is between 2-5cm of litter (Personal communication, Nicholls, 2018; Cobb, 2018). The source of litter depends on price, availability and climate/ventilation.

Figure 14: Individual nests in Broiler Breeder farm, n.d. (Source: Chicken Farmers of Canada)

Figure 15: Communal nests in Broiler breeder farm, n.d. (Source: Jansen Poultry)

The nesting system needs to be placed in a way that any one bird is no more than a few metres away (Personal communication, Jansen, 2018). Feeding systems on hoist winches are ideal to get the tracks or pans up out of the way so that birds can move freely underneath and eliminates it as an obstacle. Feeders (that cannot move) and drinkers need to be at an optimal height for efficient use and effective movement around the shed (Personal communication, Nicholls, 2018). Nipple drinkers at the right pressure for the amount of birds can successfully quench the birds' thirst and do not create boundaries to other birds (Personal communication, Nicholls, 2018). Some broiler breeder sheds have additional perches, and these should be higher than the nesting system as birds tend to roost at the highest point possible (Personal communication, Hodgkinsons, 2018)

Chapter 6: Management

There is a reoccurrence of four fundamental questions when discussing floor egg issues and how it can be resolved. These four questions can be used in a backyard or a commercial sense.

1. What is the breed of bird you have and what is the genetics behind that bird? What is it bred for? Laying or broiler breeder?
2. What nesting system do you have and does the surrounding equipment complement that nesting system?
3. What is the stocking density that would suit not just the nesting system, but also the other equipment in the shed, the floor space and are you looking for quantity or quality?
4. Is your management on that farm going to give 110%?

The last question is not numerical and very hard to predict but it cannot be looked over. Management is possibly the most important aspect of dealing with floor eggs. The first three questions can be sorted out with everything to specification, but without good management then there will still be issues within the flock (Personal communication, Ruiz, 2018). If the management team has the obedience and assertiveness to give 110%, then there is more flexibility in the answers for the other three questions.

There are remarkable and memorable people within the poultry industry throughout Europe and within Australia. The most extraordinary people are the ones who still have the passion for the industry and the people. These types of entrepreneurs make for fantastic management of farms, hatcheries, processing plants, feed mills or any other aspect of the poultry industry. They have very few issues or problems because they are aware how crucial it is to put the extra hard work into the vital times. This does not just improve production or profitability, this improves bird welfare and the work ethos (Personal communication, Hook, 2018).

Rearing Management

There are crucial times within a flock when management is key. Rearing has a very important role in avoiding floor eggs, among other things. More often than not, nesting systems are placed on a slatted type floor to reduce litter building up in the nests and hopefully clean the birds' feet walking towards the nest to avoid the nests becoming dirty (Personal

communication, Jansen, 2018). Some other nesting systems simply have them higher off the ground so the bird must jump up into it. Regardless, rearing managers must take into account the layout of the sheds that these birds will be for the rest of their lives. Lighting and regular feed is also essential for the ideal growth and welfare of the bird as well as the uniformity of the flock. Avoid using electric wires and use anti-perch wire above drinker lines. Jumping is healthy and important for the hen's bone and muscle development, therefore, this behaviour should not be discouraged by the use of electric wires (Aviagen, 2018).

Perches

The rearing farm must have perches due to regulations in most countries. If the manager can use the same slatted flooring to encourage the birds to jump up, the birds will be more comfortable with this setup and make the job for the production managers a lot easier (Gunnarsson, 2010). The presence of perches significantly decreases the incidence of floor eggs. An experiment showed a decrease of 3-5% of floor eggs by giving the birds the opportunity to exhibit normal perching behaviour earlier in life (Brake, 1987). The opportunity of perching means that the birds are not afraid to jump on to the slats and nesting boxes in production. Appleby, Duncan & McRae (1988) proved that perches reduced the number of birds laying their first egg on the floor. Birds that were reared without perches showed 86% of the flock lay on the floor for their first egg which would then encourage other birds to lay there as well. Having perches reduced this percentage to 21% which is a much easier number of hens to train to move into the nesting boxes.

Handling

Over handling birds during the rearing stage can also have detrimental effects as the birds will become too comfortable with human interaction. Part of the teaching techniques in production is to walk the birds and encourage them up on the slats and into the nesting system as they begin to hit sexual maturity. It is not possible to move the birds if they are too used to seeing humans all the time and they will get out from under their feet (Cobb, 2018; Personal communication, Bushell, 2018).

Production Management

There are two general procedures for breeding farms. Day old to death, is a term used to describe birds being reared in the same sheds they will be producing eggs in. The other system is a transferred system where the birds are reared until approximately 18-20 weeks on one site and then caught and unloaded into different sheds at a different site. Birds are commonly transferred just before sexual maturity to a production farm. This enables more birds to be reared in a smaller shed due to not needing nesting systems and the birds are moved before they get to full adult size. Also, it takes half the time to rear a flock of broiler breeders as opposed to production. This means at a rearing site they can rear for two different laying sites (Personal communication, Nicholls, 2018).

Transfer

Just before sexual maturity of the bird is when staff and management must be teaching the birds where to lay their eggs. There is a higher chance of floor eggs when birds are moved at 23 weeks as opposed to 18 weeks of age (Dorminey, 1974). Ideally, transferring the birds gently onto the slats is best as the birds will explore that area first which is where the drinkers and nests are located (Aviagen, 2018). Transfer should be done throughout the night or early morning when it is dark. This is to keep the bird calm. Transferring birds will cause some amount of stress and feed rates should be increased prior and after transfer for a few days to reduce weight and condition loss (Personal communication, Nicholls, 2018). The shed needs to have good air movement and to be within 20^{O}C-22^{O}C. Heat and cold stress can have a very negative and detrimental effect on the hen's ability to lay and her broiler chick quality (Pereira, Nääs, Romanini, Salgado & Pereira, 2007).

Training

From the moment birds are put into the shed or sexual maturity begins the birds need to be encouraged closer to the nesting system. Layout of equipment will help employees move the birds. Usually the water source is put closer to the nests than feeders. Naturally a hen would eat food, drink water and want to lay her egg (Cobb, 2018; Aviagen, 2018). Trained employees need to be able to encourage the birds up onto the slatted area without causing stress. Some flocks and breeds can be reluctant to move. Well-trained staff will be observant and clap or whistle and disturb the hens a little more to get them moving. Birds need to be calmly moving

towards the nesting system without fluttering or jumping (Cobb, 2018; Aviagen, 2018). Flapping and jumping is a sign of stress and this can cause the bird injury if she is jumping over equipment in the shed. This can also lead to stress and the hens may lose weight and condition and reduce longevity.

Employees must be aware of the bird's behaviour. When walking the sheds, the birds must be comfortably getting up and not sitting back down on the floor. The bird must realise that it is not a safe place to lay an egg. Chickens get used to the same person and walking routines so once this happens other measures need to be taken so that the birds move again such as, whistling, talking, making noises, banging softly on the walls, waving plastic bags or taking in other equipment like different coloured buckets. An employee must be trained to realise how much to push the birds and when to move to the next stage.

Employees also need to keep an eye on the nests. Some systems allow for the lids to be opened which is good for the first few weeks so that hens can see into them but need to be closed periodically as the hens become more interested in the shadowed areas for safety when she lays her egg. A hen does not want to feel vulnerable and will seek an area that is protected from most sides and be dark so predators cannot find her or her nest easily. Employees need to be aware of these behaviours to adjust the environment to suit the hen as she comes into lay.

Collection

Floor eggs need to be collected at regular intervals to make sure all eggs are picked up in a timely manner. This prevents other birds laying with the eggs on the floor and also prevents egg eating habits (Cobb, 2018; Aviagen 2018). A bird's innate behaviour is to hatch a clutch of eggs. If a hen sees another egg she is inclined to sit on that egg and lay her own. If the eggs are on the floor, then this will increase the percentage of floor eggs. If the staff are picking up too many cold eggs off the floor, then the frequency of floor walks need to be increased. Cold eggs mean that the eggs are on the floor for too long and this will encourage birds to seek a clutch and become broody (Personal communication, Nicholls, 2018).

Conclusion

This report has investigated the complex contributing factors behind why some chickens lay on the floor as opposed to the nesting system provided. The simple answer is that the bird has found another nesting site that is more appealing to her. The complex answer is that rearing, lighting, training, litter depth, ventilation and staff all come into account when making the nesting system provided seem uninviting or not as pleasing. Therefore, with even a simple answer as to why, the complex answer is the one that will provide a solution to reduce floor eggs.

The genetics of the bird is continuously changing, and the poultry industry needs to be open for this change.

Equipment and management techniques need to adapt to the changing bird. Techniques that often worked in the past may not work as effectively in the future and new techniques need to be acquired. These new techniques come from the wider poultry community. This is why communication is of the utmost importance.

Each flock of birds will be slightly different; however, a good manager or stockman will be able to read the behaviour of the birds and adjust techniques in a timely manner.

Recommendations

These recommendations are for all small and large producers across the globe.

- Look specifically into the breed of bird and openly talk to the company or geneticist that supplies the birds. They often have documentation on reoccurring issues with birds in general and the pamphlets are very informative.
- Perching at rear. The perches need to be implemented as soon as possible in the rear. The sooner the perches are in, the decreased chances of having floor eggs.
- Keep the litter in the scratch area to a minimum within welfare standards.
- Ensure bird density is not over threshold on any equipment. Make sure all equipment is maintained and up to standard of the manufacturer. Keep open communication with all suppliers and manufacturers for more information.
- Lights in the production house must be evenly spaced to avoid shadows on the ground.
- Ensure that the birds are in production shed weeks before the first egg is laid. Dependent on nesting system and flock, open nests a small amount of time prior to first egg or wait until the first egg is seen. If possible, close nesting system an hour before lights off and open one hour prior to lights on to avoid roosting and therefore defecating in the nests.
- Clean air must be distributed evenly throughout the shed and draughts need to be avoided near nesting areas as birds find them unappealing.
- Encourage and train the birds to move onto the slats instead of being comfortable in the litter or scratch area by calmly walking through at regular intervals.
- Removal of floor eggs is necessary and needs to be regular.
- If there is an egg collection belt present in the nesting system, letting the belt come on slowly during feeding time is ideal. Turn the belt on for an extra 30 – 60 min a day after peak lay to get the birds acclimatised to it.
- Remove broken mats and clean dirty ones with fresh clean mats to make the nesting system more inviting to the hens.

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Plain English Compendium Summary

	Contributing Factors to Floor Egg Issues Avoiding the issues with best practices
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Objectives	This report investigates the history and development of the poultry industry and the incidences of increased floor eggs and several techniques to help alleviate the issues.
Background	The author worked for Baiada Poultry in NSW, Australia as a Breeder Farm Manager. There were incidences of high percentages of floor eggs recently which reduced hatchability and increased labour costs.
Research	This study was conducted in England, Wales, Ireland, the Netherlands and Germany. The information was collected from several managers, technical managers, genetic companies, equipment manufacturers, journal articles and published documentation. This report seeks best practices and advice on resolving the issue of birds laying eggs on the floor instead of the nesting system provided. This can apply to both the layer and broiler breeder poultry industries
Outcomes	The research found that there is a complicated solution to dealing with floor eggs. A holistic approach needs to be used to avoid a high percentage of floor eggs. Both the rearing and production aspects of the bird's life are important when trying to avoid many issues. Consultation with nutritionists, geneticists and manufacturers is key to understanding the whole system better and how you can use the knowledge to your advantage. Reducing the number of floor eggs will significantly reduce your labour cost throughout the production period and will increase hatchability in broiler breeder case. It will also reduce the cost of washing eggs in the layer industry. Therefore, increase the profitability of the businesses.
Implications	The Australian poultry industry has recently been in the spotlight of consumers and animal welfare groups. Poultry companies need to assure bird welfare is no compromised in way possible. In a biological system such as a poultry farm, when one problem is solved often others arise.
Publications	Formal presentation – Nuffield National Conference, Brisbane, 2019.