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Assessing the Impact of Phasing Out Battery Cages and
Switching to Colony Cages in the Poultry Industry of New
Zealand

By

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Dedication

This research is dedicated to my beautiful wife Bandra, my handsome son Luyando and my lovely daughter Lushomo.

Acknowledgments

Firstly, I would like to thank The Almighty God who has made it possible for me to get this far. I believe God has been with me throughout my studies even when the going used to get so tough such that sometimes I thought of giving up. My trust in God helped me to endure all the hard times because I believe I could do nothing without God on my side.

It is true when they say, "Happy wife happy life." During the period of my studies, it was the most trying moments for my marriage. My marriage was hanging on a thin line which was almost breaking. I never used to spend enough time with my family, especially my young children who needed me the most. My wife used to get angry with me and complained daily. I would like to greatly thank her for giving me a chance to complete my studies.

I would also like to thank my supervisor Dr. Shamim Shakur from Massey School of economics and finance. Dr. Shakur was there for me from the first day I approached him to be my supervisor. I have learned a lot from him in research and other academic cycles. His academic profile has also been an inspiration to me and helped to aim high. I know he has been very patient with me as a learner, especially when he had a busy schedule.

The other word of thanks goes to The Poultry Industry Association of New Zealand, especially John Corbet the communications manager. John played a pivotal role by introducing me to the egg producers to complete the survey. It was not easy to recruit farmers, John suggested different ways to try and bring participants on board. I remember an email to remind farmers was sent every week for a month. I really appreciate his effort. Last but not the least, the egg producers themselves who had to spare their precious time to complete the survey. I would not have completed the survey without collecting data from the farmers. With a great feeling of gratitude and respect, I say thank you.

Declaration

I, Harold Mayaba, declare that this research represents my own work and that it has not been previously submitted for a Degree at Massey University or any other University and that it does not incorporate any published work or material from other publications. I have also acknowledged all the sources used in this thesis.

Signed: Date:

.....

Approval

This Thesis of Harold Mayaba entitled; *Assessing the Impact of Phasing Out Battery Cages and Switching to Colony Cages in the Poultry Industry of New Zealand* is approved as fulfilling the partial requirements for the award of the Master Degree in Agri-Commerce at Massey University

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Date:

Abstract

This research aims to assess the impact of phasing out battery cages on New Zealand's poultry farming. In 2012, the New Code of Welfare for layer hens came with a recommendation to phase out battery cages in favor of colony cages as an alternative production system. A 10-year phasing out period was offered for a smooth transition to the new system such that it will be illegal to raise hens in battery cages after 2022. However, seven years into this transition period, about 44.7 percent of eggs are still being produced under the battery cage system in New Zealand, suggesting high compliance cost on farmers. Other production systems used by egg producers include; barn, colony and free-range system.

A review of the literature offered some general leads into the demerits and merits of alternative production systems, their impacts on the welfare of hens, and the cost of production. In order to assess the impact of phasing out of battery cages in the New Zealand context, a survey was conducted on the poultry farmers to establish how they have been affected by the New Code of welfare. The survey was complemented by follow-up face-to-face interviews or telephone calls to these participants. Besides descriptive data analysis, preliminary regressions were conducted on selected variables. Secondary data were combined with survey data to obtain these results. A better understanding of the impact of phasing out battery cages that this research offers is important as farmers are making decisions on the best production methods to use in this new environment.

Keyword: *Barn, battery cages, colony cages, free-range, poultry.*

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List of acronyms

MAF	The Ministry of Agriculture and Forestry
MPI	Ministry for Primary Industries
NZ	New Zealand
PIANZ	Poultry Industry Association
AAFC	Agriculture and Agri-Food Canada
UEP	The United Egg Producers
OACC	Organic Agriculture Centre of Canada
AV	Aviary
BR	Barn
UEP	The United Egg Producers
SPSS	Statistical Package for the Social Sciences
CC	Conventional cages

1.0 Current State of the industry**1.1 Production**

New Zealand is one of the countries with an ideal chicken farming environment. Being isolated from other countries, the poultry industry is free from many pests and diseases that are common in other countries. In the year 1773, Captain James Cook brought the first batch of hens in New Zealand, these birds have been providing New Zealand with the vital protein and nutrients (Egg Producer Federation, n.d). New Zealanders are now consuming about 226 eggs per person per year, which is double the number consumed in the 20th century. Because the demand for eggs has been increasing, the production methods have continued to evolve in order to meet such demand. From 2002 and 2009, egg production and consumption has been increasing. As reported by Nimmo-Bell (2010), production and consumption have been going up from the year 2002 when production was very low, steadily increasing to their highest levels in 2005, followed by a fluctuating trend in later years. Figure 1.1 and Table 1 below shows the domestic production for the egg industry of New Zealand for a period of 8 years.

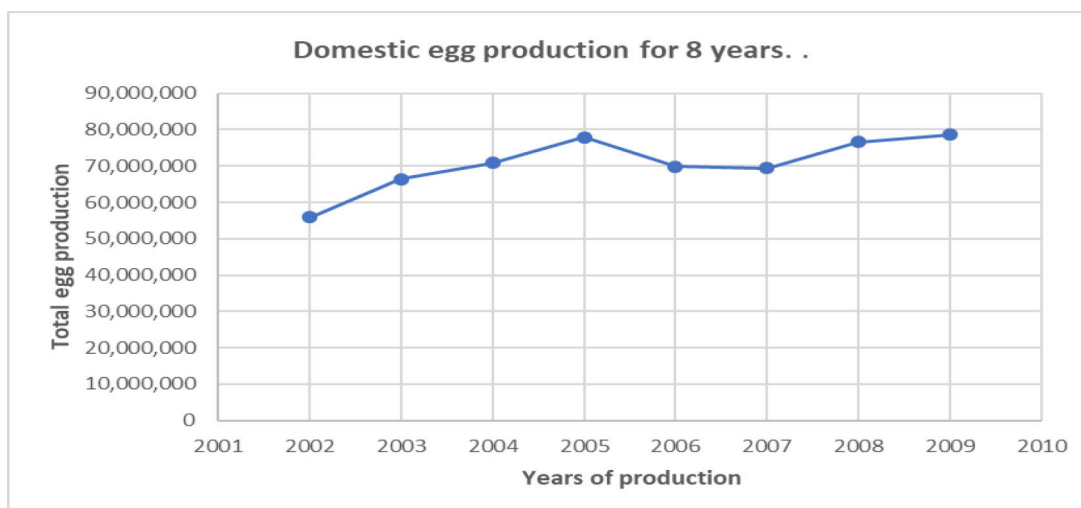


Figure 1.1: Domestic production of eggs.

Source: Ministry of Agriculture and Forestry (2010)

Table 1: Egg production and bird population.

Year	Dozen eggs No.	No. of birds	Dozen of eggs per birds	
2000				
2001				
2002	55,964,430	3,217,360	17.39	
2003	66,431,948	3,057,973	21.72	
2004	70,905,849	Not available	Not available	
2005		77,933,181	3,348,916	23.27
2006		69,780,113	3,011,425	23.17
2007		69,341,843	2,994,202	23.16
2008		76,635,716	3,405,415	22.50
2009		78,575,736	3,321,059	23.66

Source: Ministry of Agriculture and Forestry (2010)

The above information on egg production which shows that production has been steadily increasing for almost a decade was used by The Ministry of Agriculture and Forestry (MAF) which is now called Ministry for Primary Industries (MPI), to ascertain that rising costs from the new Code of Welfare would be mitigated by a growing demand for eggs. The conclusion was that the growing demand for eggs will work to help prevent farmers exiting the industry even when the cost of production increases. According to MAF (2010), from 2009, New Zealand allowed the importation of dried (processed) egg. This move was going to help the industry by importing more dried eggs if the cost of domestically-produced eggs increases due to the phasing out of the battery cages. There was a concern though regarding the importation of dried-processed eggs. The dried eggs may come from countries with lower welfare standards for the hens compared to New Zealand. This means a double blow to domestic egg producers by (i) banning battery cages, while (ii) allowing importation of a product from countries with lower hen welfare standards.

1.2 Market for eggs from the battery cage system

Before the New Code of Welfare for the layer hens was introduced in 2012, over 80 percent of eggs in New Zealand was produced using the battery cages (Hemsworth et al. 2015). Eggs from free-range, barn and colony systems make the remainder of the market. According to a survey conducted by Nimmo-Bell, (2010), the number of birds from battery cages were 2,882,400. These birds were producing about 25 dozen eggs annually each for a total of 72.06 million dozen eggs per year. These numbers show that the phasing out of battery cages can have a significant effect on the supply of eggs in New Zealand. The domestic market is the

primary market for eggs from battery cages. The major buyers of these eggs are the supermarkets, small retail shops, and some industries that use the eggs in food preparations.

This can be seen in Figure 1.2 below.

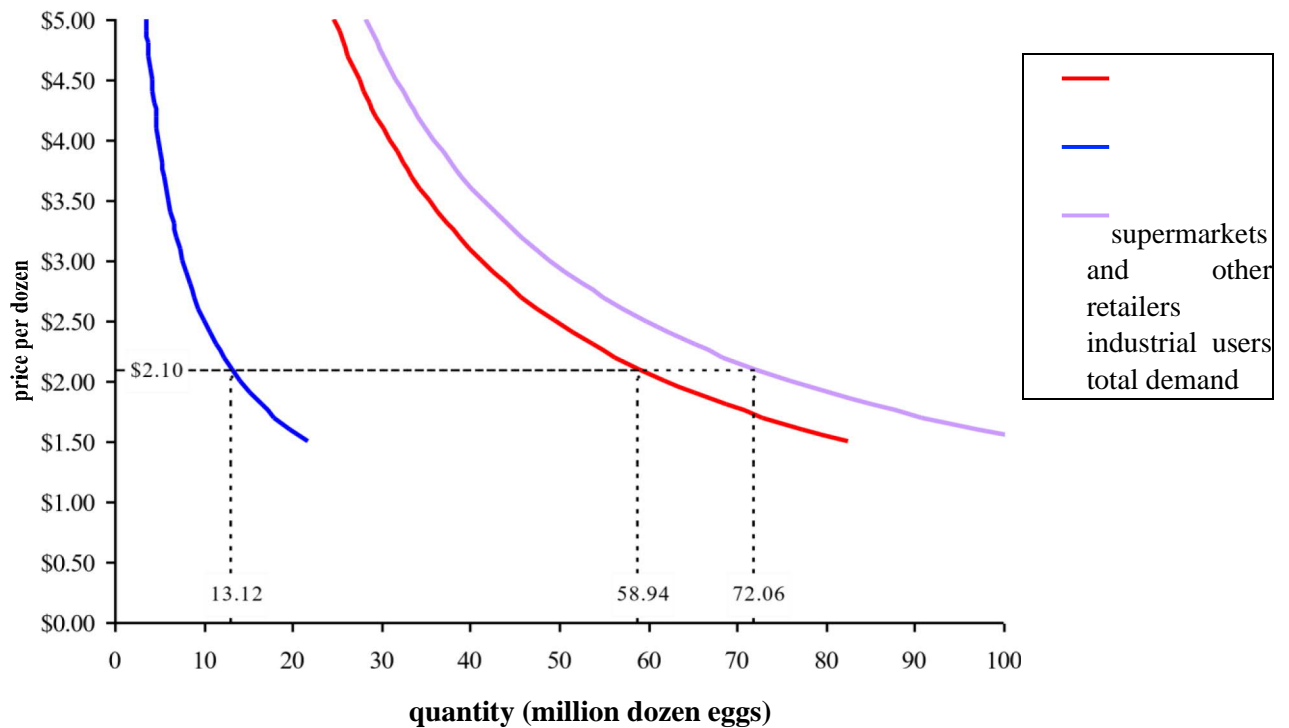


Figure 1.2: Demand for the caged eggs.

Source: Ministry of Agriculture and Forestry (2010), now called Ministry for Primary Industries (MPI) since 2012

1.3 The potential changes in the egg industry

The phasing out of battery cages will see some changes in the redistribution of the egg farms.

Colony cages were proposed to replace the battery cages, but some farmers may opt to

replace the battery cages with other production systems like free-range or barn system. The following section will discuss the possible redistribution of the egg farms and the causes of these changes.

1.4 Possible re-distribution of the egg farm

A few studies have indicated that the phasing out of the battery cages in New Zealand will be costly for the farmers. As noted by Hemsworth et al. (2015), the time frame of phasing out the battery cages is likely to impose serious financial costs on the farmers. Due to the increased cost of doing business in the industry which is inevitable, one consequence expected is the redistribution of egg farms as farmers are evaluating available options. According to Murra & Harnett (2010), some possible actions include moving to free-range, barn, aviary systems or exiting the industry. The redistribution of the egg farms will affect the supply of eggs in the markets (Murra & Harnett, 2010). As most of the farmers adopt a system with lower production costs, an increased supply of eggs from that system would drive prices down in the long run. As shown in Figure 1.3 below, there will be an increased demand for alternatives to the battery system. More farmers will enter the industry adopting non-cage systems (colony, free-range and barn) lowering the prices of eggs on the market.

1.5 Increased Costs and Decreased Supply of eggs

The phasing out of battery cages and adopting new production systems comes with increased costs. According to Matthews & Sumner (2015), the cost of production increases due to increased feed wastage and feed intake, the labor costs of training workers, energy costs and the cost of investment, etc. The more significant cost is the capital cost required to invest in new equipment, land, and new buildings. The increased costs result in some egg producers to exit the industry. As shown in Figure 1.3 below, some suppliers will exit the industry due to uncertainties and competition. This reduces the number of eggs supplied, making the price to rise. Nimmo-Bell (2010), also noted that the increase in cost is in two folds when switching to colony system; (i) the additional capital cost of colony systems, including additional shed space, and (ii) the cost of replacing existing cages before the end of their useful life. They estimate the capital cost of replacing battery cages with colony cages to be between \$150 million and \$45 million. In the longer run, these annual costs were estimated to be between 10% and 14%, that is expected to be passed on to the consumers increasing the price of eggs. According to Nimmo-Bell (2010), the colony systems cost approximately \$29 per bird compared to a cost per bird of \$20 for the caged systems, with another \$20 for the additional shed space requirement for the colony system bringing the total to \$49 per bird. Borrowing requirement by farmers to finance a change to colony systems (including purchase of additional buildings and equipment) ranges from \$660,000 for small farms to \$8,500,000 for large farms.

On the other hand, Murray & Harnett (June 2010), estimated that the total cost per bird in a colony system is at \$41.83. This can be seen in Table 2 below. This estimated total cost includes the capital cost of colony system, cost of replacing battery cages, and additional shed space cost. Before embarking on a project of building new sheds for a different system, farmers are required to get a resource consent at an estimated additional cost of \$21,000 per farm (NZ Institute of Economic Research, 2001).

Table 2: Estimated costs per bird in a colony system

Variable (per/bird)		Capital and fixed costs	
Item	Estimated Cost	Item	Estimated Cost
Feed	\$20.50	Land	\$600,000
Labor	\$7.00	Sheds for 25,000 birds	\$500,000
Packaging	\$3.87	Rearing shed	\$500,000
Day old purchase price	\$2.96	Manure shed	\$24,000
Rearing	\$4.00	Buildings	\$50,000
Distribution	\$3.50	Resource consent	\$25,000
		Grading Floor	\$200,000
		Grader	\$350,000
		Equipment	\$50,000
		Vehicles	\$450,000
		Houses/other buildings	\$220,000
		Cages per 25,000 bird shed	\$750,000
		Rearing Cages	\$824,093
		Feed mill	\$982,040
Total per bird	\$41.83	Total for a seven sheds farm	\$19 million

Source: Murray & Harnett (2010)

The phasing out of battery cages is in three stages, with the last stage of phasing out to be done in 2022. During the period of phasing out battery cages, the number of hens will continue to fall, thereby pushing egg prices up. As reported by Gerard Hutching (2019) of News Stuff, the chief executive of The Poultry Industry Association (PIANZ) Michael Brooks said new rules requiring changes from current cages had led to significant uncertainty for farmers. The national flock reduced by 600,000 hens between June 2018 and January 2019, resulting in a total population of 3.6 million. At an average of six eggs per hen per week, this means 300,000 dozen fewer eggs a week. According to Stats NZ (2019), by December 2018, the national number of hens was 3,720,772, and the total production was 94,748,832 (in dozens) for the year 2018 (see Table 3 below). The information from Stats NZ and those from The Poultry Industry Association is different. PIANZ indicated that within six months, the total number of hens in the country had reduced by 600,000 resulting in low production. However, the total production from Statistics NZ is showing higher figures in the last 16 years.

Table 3: Egg production for the industry for sixteen years (2002 – 17th January 2019)

Production period (years)	Number of hens	Total production per year in dozens
	3,217,360	
	3,057,973	
2002	3,176,349	55,964,430
2003	3,348,916	66,431,948
2004	3,011,425	70,905,849
2005	2,994,202	77,933,181
2006	3,405,415	69,780,113
2007	3,321,059	69,341,843
2008	3,350,290	76,635,716
2009	3,275,711	78,575,736
2010	3,254,568	80,014,750
2011	3,192,896	81,911,285
2012	3,450,845	79,599,542
2013	3,452,002	79,653,871
2014	3,665,679	84,219,665
2015	3,775,472	85,524,678
2016	3,720,772	89,590,659
2017		93,021,127
2018		94,748,832

Source: Stats NZ (2019)

Apart from the above - mentioned costs, another cost that comes with the transitioning from the battery to colony cage system is the economic life of the housing equipment. The practice of the industry is that cages last for 20-25 years while the sheds last for 25 years. From the analysis done by Nimmo-Bell (2010), they used a life expectancy of 25 years for both sheds and cages, while MAF's analysis used 25 years for the sheds and 8 years for the cages. If battery cages are replaced with the colony or any other system before the end of the useful

life of these cages, this becomes costly to the egg farmers because of incurring capital expenditure earlier than initially scheduled.

Chart: Map of egg market dynamics

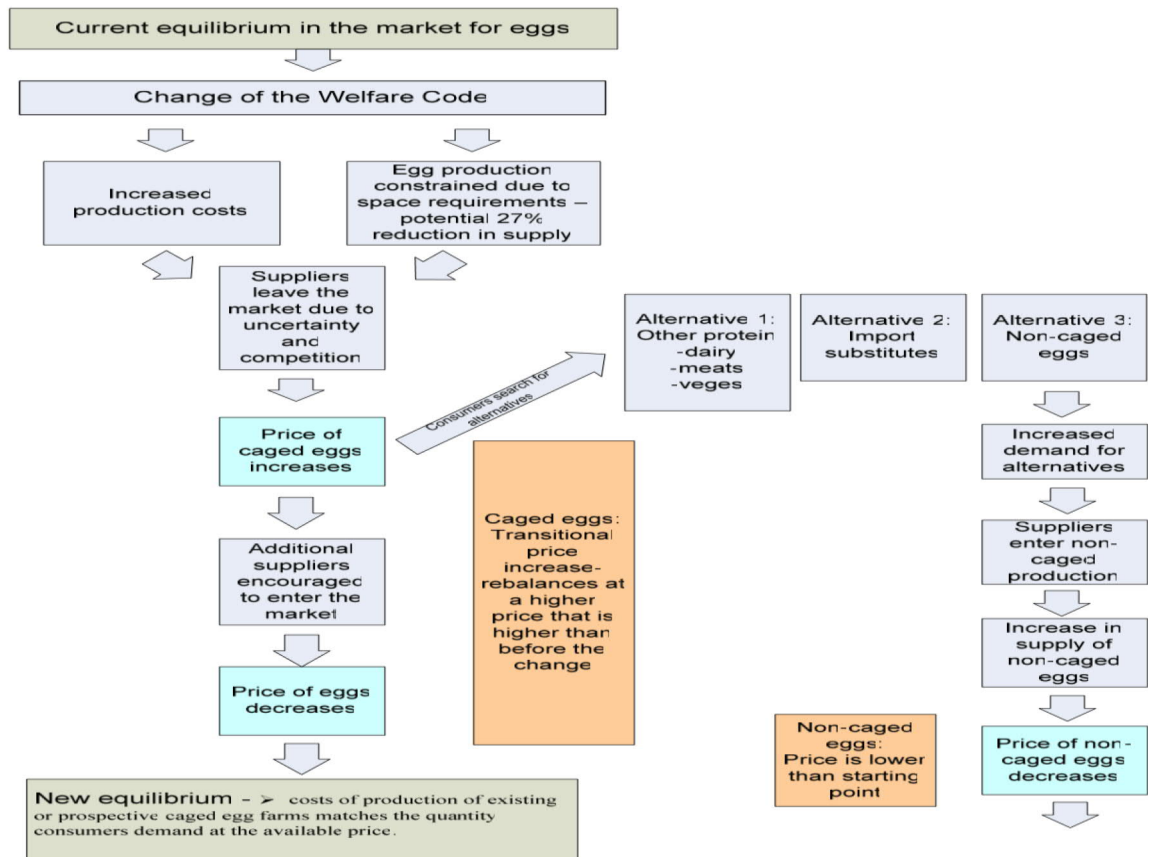


Figure 1.3: Graph showing egg market dynamics before and after the introduction of the Welfare code.

Source: Murray & Harnett (2010).

1.6 Uncertainties and challenges farmers face during the phasing out period of battery cages

After a decision was made to phase out the battery cages in the year 2012, the colony cages were recommended as an alternative. As noted by Lorna & Niel (2010), colony cage system works to be

the best alternative to replace the battery cages due to low production cost compared to free - range and barn systems. Some farmers started converting to colony cages as per recommendation. Even after colony system was picked as an alternative to battery cages, animal welfare advocates continued to put pressure on supermarkets to completely phase out any form of cages as they considered colony cages to be still as bad as battery cages. According to News hub (2018), Countdown, Fresh Choice, and Super Value announced that they would stop selling eggs from any form of cage system by the year 2025. Foodstuffs which owns New World and Pak 'N' Save also followed suit by announcing that they will be cage-free by 2027. This move has put egg producers under duress. According to Nimmo-Bell (2010), the life span of cages is about 25 years. This means some farmers will have to phase out colony cages before the expiring period which becomes a cost to producers.

1.7 Justification of research

1.7.1 Problem statement

In New Zealand, egg producers continue to express concern regarding the pace at which the battery cages are being phased out. According to Mellor (2015), the phasing out has raised fears over the possible ruin that is likely to be faced by a significant number of commercial egg farmers. By 2016, about 80 percent of eggs sold in New Zealand were from caged systems (Widowski et al. 2016). Organic, barn and free-range eggs make up the remainder of the market. Recent statistics suggest further that the sale of cage eggs has increased by 6.5 percent compared to a 2.5 percent increase in the sale of free-range eggs (Shimmura et al. 2015). Hence, these scholarly observations indicate that caged eggs are a promising path and

that the need to examine the impact of phasing out of battery cage system from the industry. It is expected that conventional caged systems will be phased out by 2022 as required by law (Widowski et al. 2013). Widowski et al. (2013), noted that the largest supermarkets in New Zealand have responded to the consumer pressure by selling only barn and free-range eggs in the next decade. Initially, the supermarkets accepted the move to switch from battery cages to colony system but later indicated that by 2022 they would only be selling barn and free-range eggs. Again, the supermarkets adjusted to 2025 and 2027 as the time they will stop stocking eggs from colony system. Some of these supermarkets include Countdown and other supermarkets under the Foodstuffs chain. The new acceptance brings uncertainty especially to those farmers who have already switched to colony system. Based on these observations, the phasing out of battery cages is projected to disrupt the egg market. Despite these scholarly assertions, various issues remain unaddressed. For instance, most of the past studies do not give an insight into the current trends in New Zealand poultry industry's use of battery cages and how farmers are responding to the new law.

Furthermore, previous studies fail to unearth some of the perceived benefits of adopting colony cages and whether these benefits out-weighs the demerits. Finally, most of the previous studies fail to examine some of the challenges that farmers face during the period of phasing out of battery cages, nor do they recommend solutions to the perceived challenges. This shows that there is no enough information about the industry for stakeholders to base their decisions on.

1.7.2 Background and need

In the poultry industry, battery cages constitute housing systems in which columns and row arrangements are identical and connect in a given unit. There are different definitions for battery cages. One legal definition noted by Loworn et al. (2009), states that battery cages are high-volume, small cages to house chickens for egg production. According to Widowski et al. (2013), battery cages are primarily employed for egg-laying hens or layers. On the other hand, Elson (2015) documented that colony cages entail improved housing systems that offer more space for hens to nest, stretch their wings, perch, and even scratch. Lorna and Niel (2010), also observed that furnished colony cages appear to offer an acceptable solution to society's welfare concerns relating to housing layer hens in conventional cages while maintaining an equivalent level of production from inputs of birds, feed, and power. Colony cages which are also known as 'furnished' or 'enriched' cages which can house between 20 - 90 birds, but in most cases 40 - 60 birds, are cages with nest area, perches, claw shortening devices, and an area that allows for scratching, foraging and dustbathing (Abrahamsson & Tauson,1993).

1.7.3 Time frame for phasing out battery cages and their likely outcome

In New Zealand, the decade-long period of phasing out of battery cages and replacing the system with recommended colony cages comes in the wake of anger among the animal welfare advocates that also led to dissatisfaction in the poultry industry. For their part, the animal welfare advocates argue that time allowed to convert to colony cages are too long and that they do not lend much improvement (Wilson, 2013). On the other hand, the industry

contends that the phase-out timetable remains punitive, crippling, and brutal (Hemsworth et al. 2015). Overall, the industry indicates that it remains amenable to phasing out battery cages, but the timeframe proposed is likely to impose a significant financial cost. With farmers affected by the perceived costs in the initial stage, the industry asserts further that the consumers will ultimately bear the incidence of this cost burden (Mellor, 2015).

Despite industry opposition caused by the phase-out timeframe, other scholarly observations hold that the perceived benefits that might accrue from this decision cannot be overemphasized. Widowski et al. (2016) documented that with over 80 percent of New Zealand's hens kept in the battery cages, they lead to significant economies of scale; However, Shimmura et al. (2015) cautioned that the plentiful and cheap eggs produced out of this housing system come with non-economic costs. The latter study established that battery cages severely restrict the ability of the birds to perform most of their perceived behaviors. Widowski et al. (2013) concurred that battery cages fail to meet the requirements stated in the Animal Welfare Act. However, those opposed to the adoption of colony cages argue that they are likely to attract inferior products in terms of egg quality; yet the market continues to demand better welfare standards.

Apart from the mixed outcomes regarding the economies of scale of battery cages and the perceived production of inferior products when colony cages are adopted, the issue of price increase has also arisen in New Zealand's poultry industry. For example, Elson (2015) observed that the ban on battery cages might lead to an increase in the retail price of eggs. They estimated that the adoption of colony cages is likely to attract a price increase of about

10 - 14 percent. The implication is that the cost of a dozen eggs might increase by about 49 cents from their current levels.

Other studies contend that the ban of battery cages (or adoption of colony cages), combined with changing consumer preferences, might see most of the industry players opt for the barn and free-range egg production. Citing an example from the UK where battery cages were banned from January 2012, Hemsworth et al. (2015) observed that the production costs of the organic, barn and free-range eggs has continually surpassed caged eggs. From these observations, it is evident that the switch from battery cages to colony cages in New Zealand might pose a significant impact on consumers, the industry, farmers, the general economy, and even the dynamics surrounding organic, barn and free-range egg production. This study seeks to examine the impact of phasing out battery cages and switching to colony cages on New Zealand's poultry industry.

1.7.4 Cage capacity

The capacity of each battery cage is about 5 - 10 birds. Many farmers house hundreds of these cages in a single building. Research has found that the battery cages tend to be barren whenever they are exposed to invariant environments. Such barrenness leads to substantial violation of the welfare of the hens that also compromise their performance as egg layers. The restriction on the movement of the hens forms the basis of most of the criticism aimed at the battery cages (Agriculture and Agri-Food Canada (AAFC) 2012, p.2). The locomotory behavior restricted by the cages includes exploration, comfort movements such as wing

flapping, scratching that are vital in exercises. The outcome is inactivity that may lead to osteoporosis that may cause the fracturing of bones, which is unfortunate for the egg-laying chicken (Gregory & Wilkins 1991, p. 25).

The colony cages act as modified cages which came about to act as an alternative that would also improve the conventional cages. Many European countries, like UK and France, are already taking up this opportunity to improve the welfare of their poultry and realize better yields in egg production (Agriculture and Agri-Food Canada (AAFC) 2012, p.2). There are similarities in the composition of the colony cages with the battery cages, but different in aspects of ample space for the colony cages, nest box, a perch, and have a greater height compared to the battery cages (Agriculture and Agri-Food Canada (AAFC) 2012, p.2). The colony cages allow hens to engage in a variety of movement behaviors, which is also an environment that is necessary in achieving the required level of welfare for the animals.

1.7.5 Design and size

The design and size of the battery cages vary and can hold 5 - 10 birds or more depending on the size. The colony cages can hold between 20 - 90 birds (Abrahamsson & Tauson,1993). On average, the largest colony cage can hold up to sixty birds that may also be stacked to hold as many birds as possible. Many of these colony cages are stacked vertically in about 12 tiers high (Bell & Weaver 2012, p.4). The developers included a catwalk for every three tiers that also show additional features in their composition that is also different from the conventional setup. Many of them have the nest box on one side or a corner of the cage. The cage may also have a single perch that runs parallel to the feed, although one may have several perches

within a cage. There may also be a T-shaped perch arrangement in addition to perches that run crosswise in a manner that is perpendicular and parallel. There are also laws that guide the size of a cage in which a hen can be housed. The recommendation is for a cage to have space amounting to about 750cm² for every hen (Bell & Weaver 2012, p.4). Space should be enough to allow significant behavioral movement that would also improve the welfare of the chickens.

It is also essential to assess the colony cage as an alternative that is already in use in different parts of New Zealand and the world. Other alternatives include; barn and free-range systems that help house the hens in a manner that does not raise as many issues in their behavioral display. The barn system ensures that the hens do not have access to the outdoors but have nest boxes and perch areas in addition to areas with some litter that allows dust bathing, which occurs naturally. The barns may be built-in single or multilevel structures depending on the preference of the farmer and the number of hens to be kept. The multi-level barns also referred to as percheries or aviaries, utilize vertical space which helps increase the stocking rate. The vertical space within the building should be enough to allow different movements for the hens for proper development. It is essential to note that the different levels of the aviary need to be structured legally. Among the EU countries, the requirement is that each bird should have about 1,111 cm² of space (Bell & Weaver 2012, p.46). In the United States, based on the guidelines of the egg industry, the space requirement is 929cm² to 1393cm² for every hen (Bell & Weaver 2012, p.46).

1.7.6 Hen Welfare

Agricultural authorities in New Zealand are systematically phasing out the conventional caging systems to replace it with more humane alternatives. This move is in line with laws throughout the European Union, where it is illegal to confine egg-laying chickens in the battery cages. The local authorities in New Zealand also made an effort to ensure that the battery cages were phased out in the egg industry (Bell & Weaver 2012, p.6). The emphasis is to provide space to allow improving the welfare of the hens significantly. The space allowance needs to be in vertical and horizontal dimensions of the enclosure to allow the manifestation of natural behavior. The battery cages are restrictive in allowing hens to engage in natural movements that are important for their development.

The concerns that led to the phasing out of the conventional cages include the limitation of space allowance and impediment that limits the vital natural behavior of the hens (Bell & Weaver 2012, p.7). The restrictive design prevents the hens from exercising, causing conditions such as osteoporosis, skeletal weakness, and liver pathology. These conditions inhibit the ability of the hens to produce eggs effectively (Olsson & Keeling 2005, p.260). Evidence from scientific research shows that hens that are kept in cages for a long time have a bad temperament compared to those that are left to roam freely. Bad temperament affects production, reducing the total number of eggs produced per year.

Lack of space is not the problem, but the fact that the hen has to be confined to the detriment of the welfare of the hens is the concern. Research shows that hen tends to utilize large space

when given an opportunity, which allows them to engage in natural behavioral movements (Dawkins, 1985). The distance between two birds should be enough to allow activities without interfering with the reproductive processes designed for the hens. Further, studies reveal that any space that is below 500cm² may limit vital hen behavior. It is typical for hens to utilize large spaces in the outdoors when they move out of their flock mates. The dispersal of the hens is essential in improving the welfare of the hens.

There is complexity in the crowding and the utilization of space especially when a farmer engages in large-scale chicken farming. Commercial farmer's priority is achieving profitability rather than welfare, which means that the utilization of space focuses on limiting the space for rearing the hens (Olsson & Keeling 2005, p.260). Research has revealed significant insights regarding the utilization of space for commercial egg production. The availability of space could translate to setting it up for use for a large population of the chicken or minimizing their movement to accommodate as many of them as possible. There is a need for farmers to develop a better understanding of the requirements of space utilization as far as commercial egg farming is concerned. The fact that hens can use the same space at different times means that farmers can develop strategies to share the space among the birds. The display of behavior seems to be an area of great significance especially when it addresses the issue of local crowding (Olsson & Keeling 2005, p.261). Exercise is vital as it helps to reduce the occurrence of skeletal fractures that are common in the cage environments. Also, the hens are unable to explore their environments because of the restrictions and cannot perch mainly because of the height of the cage (Dawkins 1985, P. 345). Dust bathing may not be achievable

in such environments even though some of the cages have facilities meant for such activities. Some of the colony cages have nest boxes to support related activities, but there are still questions on whether the space set aside for nesting is adequate.

The situation is quite different for facilities that do not utilize the cages since the hens are free to move around and display the natural behaviors. In fact, the farmer has more choices in organizing for nesting and the utilization of littering space that is used for dust bathing. Accommodating dust bathing in the limited space may be possible but may not be sufficient given the extent of the activity associated with dust bathing. Hens can move over great distances in a shed using colony cages. The fact that there may be different levels in the barns does not deter the hens from moving around as the system allows to perch anywhere. Perching and roosting is an activity that requires substantial vertical and horizontal space. This is evident especially at night when all other conditions seem to be natural. Hens prefer perches placed above the ground rather than those placed close to the ground.

2.0 Introduction

The previous chapter highlighted the uncertainty surrounding the egg industry after the major supermarkets announced that they would no longer accept eggs from colony system by the year 2025 and 2027. With 80 percent of eggs from the battery cage system (as of 2016), phasing out the battery cages will change the structure of the industry. Not many researchers have researched on the topic under discussion, especially after supermarkets decided not to accept colony eggs later. Of the few research conducted on the phasing out of the battery cages, they focused mainly on the expected rise in egg prices due to disruption in the supply, without unearthing how the farmers are responding to the changes. Other researchers focused on the welfare and suitability of the colony cages with less consideration of other alternative production systems.

This section will discuss previous research done on the topic focusing on closely related literature. The first part will evaluate the characteristics of the battery cages with its limitations to allow birds to engage in some natural behavior as indicated by Bell & Weaver (2012, p.7). The second part will focus on the characteristics of the colony cages and how this system is an alternative for birds to show their natural behavior and movements as noted by Dawkins (1985). The third section of the literature review will discuss the other alternatives that poultry farmers can switch to following the phasing out of the battery cage system. These other production systems include free-range, aviary, and barn systems. The last part of the

literature review will discuss the regression models used in the industry to predict the changes in price and production of eggs.

2.1 Comparisons between battery cages and colony cages

As mentioned in chapter one, the existing battery cages are expected to be phased out by 2022 while new battery cages will be prohibited. Battery cages are high-volume, small cages to house chickens for egg production (Duhaime, n.d). In contrast, colony cages are improved cage housing system which can provide more space for the layers (hens) to be able to nest, scratch, perch and stretching their wings. The trend of phasing out battery cages comes in response to a New Code of Welfare to which New Zealand's poultry industry remains unexceptional. However, the move has drawn mixed responses and results from some of the recent scholarly studies. According to Hemsworth et al. (2015), by 2016, over 80 percent of eggs in New Zealand was produced via battery cages. Widowski et al. (2016) documented further that most of the battery cages house 3 - 5 hens in minimum areas. Thus, the battery cages end up restricting the hens from expressions of normal behaviors. Thus, proponents of the move acknowledge that the demerits arising from these restrictions (associated with battery cages) might be curbed and even end up improving the quality of products in the market. However, those in opposition to the move hold that the prohibition of battery cages is likely to cause an unacceptable effect on the stability of egg supply, the industry structure, and the price of eggs (Elson, 2015). Therefore, it is evident that the switch from battery cages to colony cages is predicted to come with merits and demerits. However, the scope of these scholarly studies is limited in various ways. For instance, the findings do not sensitize

audiences regarding some of the challenges that the egg farmers and the rest of the industry have faced during the ongoing phasing out of battery cages. Furthermore, the studies do not highlight specific long term disruptive effects that this might have on the poultry industry. By addressing these gaps, the proposed study is deemed appropriate and well placed to pave the way for the implementation of solutions to any challenges that are identified. In another study, Widowski et al. (2013) sought to find out the possible adversities that countries such as New Zealand and their poultry industries are likely to experience after adopting colony cages. The authors report that by exploiting the switch to colony cages fall short of the fundamental purpose envisioned by the Animal Welfare Act. Specifically, the study highlighted that the emphasis on colony cages might allow factory farms to keep animals in cruel states; including poultry farms. Therefore, these observations are important because they point to some of the adversities that the industry is likely to face due to the adoption of colony cages. However, the assertions could be criticized in such a way that they do not recommend some of the feasible solutions that New Zealand's poultry industry may adapt to ameliorate the negative aspects with which the colony cages are associated. Indeed, the current study seeks to determine whether parallels can be drawn between these past scholarly observations and the outcomes obtained from primary data in this research. In so doing, the study will also establish possible solutions to any challenges that might be documented.

Despite the above-mentioned negative outcome that might arise due to the shift from battery cages to colony cages, Shimmura et al. (2015) indicated that the phase-out practice is promising because the New Code of Welfare is likely to pave the way for hens to live in

environments capable of meeting their welfare needs. Mellor (2015) concurred that the colony cages might prove more beneficial to farmers because they will produce high-quality products that the general public will accept and improve their financial position than battery cages. Also, the welfare of the hens will improve by carrying out various normal behaviors; including scratching, pecking and perching. In similar research, Hemsworth et al. (2015) documented that most of the colony cages are bigger than battery cages and that they can house 40 - 60 birds. Additionally, the study indicated that secluded scratching areas, perches, and nesting areas characterize colony cages. These observations are worth acknowledging because they meet the requirements of the New Code of Welfare for the hens and promise quality eggs.

Additionally, Widowski et al. (2016) documented that colony cages are cost-effective because they attract a cost of about \$150 million compared to the \$250 million associated with free-range housing systems. However, these scholarly studies falter in various ways. For example, the findings do not give an insight into the current trends in the use of battery cages within the poultry industry of New Zealand. Also, these studies fail to indicate whether the benefits accruing from colony cages might outweigh the demerits (such as the new costs that the farmers face by hearing from farmers themselves). Therefore, the study addresses these gaps by documenting both the merits and demerits expected to arise from colony cages and then predict the cost-effectiveness of the new housing systems.

In a study done in the USA by Elson (2015), the central objective was to assess whether colony cages produce the non-use (benefits that human beings do not benefit directly) and use benefits (benefits that human beings directly benefit from) more than consumer and

producer costs. It was observed that colony cages and other cage-free mandates attract a cost of \$38 billion while the benefits stand at \$57 billion. Hence, it was concluded that the benefits accruing from colony cages as housing systems for hens outweigh the costs. In a similar study, Widowski et al. (2013) documented that the benefits of colony cage outperform the costs, but 95 percent of these benefits are likely to be enjoyed by small populations with stronger preferences for the welfare of farm animals. As such, the authors concluded that the shift towards colony cages is beneficial, but most of the positive effects remain pronounced on the part of small populations concerned with farm animal welfare. From these findings, what remains unaddressed is the solution to the disproportionate distribution of benefits associated with colony cages. Further criticism can be made in that they do not examine the recent trends in the egg farmers' use of battery cages, thus failing to predict the possible trend in the adoption of colony cages in contexts such as New Zealand.

Other studies have focused on the aspect of purchasing decisions that consumers hold about farm animal well-being. For instance, Shimmura et al. (2015) researched in the USA to understand whether the decisions by some of the consumers purchasing eggs and egg products are dependent on the well-being of the hens. In their findings, about 77 percent of the participants indicated that low pricing was key to their purchase decisions, while 49.25 percent indicated that the welfare of the hens drove their decisions to purchase. Hence, concluded that governments ought to assume an active role in the promotion of the welfare of farm animals in all production systems. From these findings, it shows that a significant number of consumers have their decisions shaped by how the farm animals, which produce the respective products are treated. Their findings also fail to achieve the attribute of context

specificity (incorrect perspectives). The current study will fill in the gap by focusing on the specific context of New Zealand's poultry industry.

2.2 Characteristics of battery cages and limitation of natural hen behavior

There are not many studies related to this topic concerning the subject of battery cages. However, there seems to be significant research on the uptake of the colony cage technique to realize an improvement in the welfare of users, as demonstrated by Appleby (1984, p. 242). New Zealand is already making significant steps to phase-out the conventional caging techniques for rearing egg-laying hens. The authorities in the country are also taking steps to institute initiatives that would lead to the improvement of the welfare of the birds. The issue of welfare for the birds is not new in New Zealand and from around the world, as seen in Appleby's book. According to Appleby (1984, p. 242), the corporate sector is also playing an important role in supporting welfare improvement efforts. The corporate sector has proved influential, as their advice to farmers to stop using cages seem to be working. It is essential to note that some of the corporate organizations are large food chains that cooperate with farmers to acquire foodstuffs. This is the reason why their contribution to improving the welfare of the birds is vital. There is no doubt that the local animal welfare advocates across different locations in New Zealand have been paying attention to the growing concerns for the deteriorating welfare of the hens for a long time. Appleby's work reports that many farmers for more than two decades now have been making considerations to make a transition from the battery cages to a better alternative (Appleby 1984, p. 243). Some of them contemplated the colony alternative, while others are willing to go all the way by adopting

other alternatives like free-range and barn systems. The colony cage approach is the most advisable of all the techniques by farmers as it allows the hens to move freely and express their natural behaviors with few restrictions while maintaining the economies of scale similar to that of battery cage system. Many of the farmers may not be aware that the colony cages do not provide for the majority of the behavioral and physical needs of the hens. There is a need to create attention to enable all the stakeholders in the egg production industry to understand the benefits and the limitations of using the colony cages rather than going the direction of colony cage techniques. There is a need to understand that the cages that are available for commercial use restrict the full expression of both physical and behavioral attributes of the hens.

Follensbee et al. (1992, p. 8) posit that the battery cages are detrimental towards the physical development of the hens by denying them the opportunity to flap wings, run, fly and even perch. Research shows that failure to engage in such exercises is likely to lead to various illnesses that include bone osteoporosis and liver pathology. The expression of natural behavior is vital towards the development of the hens, which also reduces their productivity (Appleby 1984, p. 242). For this reason, the authorities emphasize the use of colony cage approaches and other alternatives, which are capable of allowing the hens to express themselves fully. The cages cause fear, unrest, and frustrations among the hens while the colony cage alternative ensures better plumage, fewer foot injuries, and reduced lesions.

The conventional battery used by most farmers consists of small cages and sloping floors that are welded to ensure that eggs roll out into collection trays. The manufacturers of these cages

produce them in different types and sizes including the old style that is still usable in different parts of New Zealand (Appleby 1984, p. 242). The authorities in New Zealand proposed different recommendations that would see the hens engage in different natural activities. Nesting behavior is one of these activities and very important for the hens feels frustrated when prevented to have access to nesting boxes.

According to research by Follensbee et al., (1992, p. 8), hens find great motivation in finding nests especially when they are laying eggs. In some instances, it is easy to see a hen work hard to force open the door to access a nesting site (Follensbee et al. 1992, p. 8). There are variations in the quantity of eggs produced by hens. Some hens can lay above 320 eggs per year (Appleby 1984, p. 243). Researchers established that the hens were able to perform well following the access they had in the cage-free environments. Hens found in the cages face significant frustrations that limit their ability to produce as many eggs as those that are in colony cage environments. Studies by Follensbee et al. (1992, p. 9) indicate that the hens that are deprived of nesting facilities are likely to show frustrations for some time before laying an egg. The signs of such frustration include pacing around displacement preening, increased aggression, vacuum nesting, restlessness, increased aggression and certain sounds referred to as the grackle-call. A hen should not hold an egg for a long time before laying as it may cause the development of an extra layer of calcium. Consequently, most scholars recommend that farmers should allow hens to perform their pre-laying rites, as it is a legitimate welfare concern (Appleby 1984, p. 243). Providing the hens with suitable nests would meet an essential need for them and ensure that they produce accordingly.

Bos et al. (2003, p. 158) assert that battery cages restrict the hens in a way that do not allow the addition of nests while developers added only one nesting area for the colony cages. This is not sufficient for the production of the eggs because the hens require additional space for nesting. Limiting the number of nesting sites poses a challenge given the fact that birds sometimes have to compete to access a nesting area. There are instances where some hens tend to stay on the nesting site even when they are not laying eggs (Bos et al., 2003, p. 158). Hens stay in the nesting area because it is a private area where they may seek refuge. The fact that hens prefer a private location for a nesting area creates a challenge as some hens may prevent others from laying. Bos et al. (2003, p. 158) established that the setup of the colony cage environments is quite useful for the hens as there are multiple nesting boxes that the hens can choose. Research shows that hens still inspect a suitable nesting location even if there are several free nesting sites. They choose the nest boxes that they seem to be comfortable with and make a choice. Many colony cage farms try to provide a good number of nesting boxes to serve all the hens in within site. For instance, providing twenty nest boxes for one hundred hens seems like a standard practice that ensures that there are sufficient nesting locations for the hens. This way of practice is by the Code of Practice as legislated by the Canadian authorities which are similar in other countries around the world.

The United Egg Producers (UEP) in the USA suggested that the recommended space for colony cage housing should be about nine feet squared (0.84 square meters) per bird and each cage to house 100 hens (Bos et al., 2003, p. 158). This seems to be a sufficient surface to care for the eggs appropriately and ensure that they can produce as many eggs as possible. The

authorities in New Zealand have also emphasized the need to provide sufficient space to allow the hens to display their natural expression of physical or other behaviors. The authorities from New Zealand warn against limiting or depriving the birds the space to address welfare concerns accordingly (Mellor, 2015)

2.3 Perching behavior

Perching behavior is also an area of great interest, given that most egg-laying hens like engaging in such behavior. Perching is motivated by instinct that is a characteristic of hens and many other bird species. The essence of perching is to help conserve the body heat of the hens and maintain the bone strength and volume accordingly. Having a perch in the housing system of the hens is vital, as they are likely to do anything to access it (Bos et al. 2003, p. 158). For instance, hens can even force their way through a door to access a perch that may have been restricted from them. It is essential to set up perches of different heights to allow the hens to engage in different activities including walking and standing (Dawkins 1985, P. 345). They also prefer to perch on higher grounds to stay off the ground, which is an ideal position for most hens. Hens tend to perch on high grounds at night, and the colony cage setup allows the hens to perch at night or any other time of the day. Some hens also climb on the high perches to escape from other aggressive hens that cause trouble. This behavior also reduces injuries among the vulnerable hens and allow them to become assertive in their activities.

According to Dawkins (1985, P. 345), this is not a feature available in the battery cages, and the colony cages only provide limited heights if they have perches. The fact that the vertical

height in the battery cages is only 18 inches makes it difficult to have a perch that can be used by the hens. This means that natural perching is not possible with the hens as the cages are just about the heights of the hens (Dawkins 1985, P. 347). Colony cage environments provide sufficient space to make natural perching a reality for the hens.

2.4 Dust bathing

According to Dawkins (1985, P. 345), dust bathing is another essential behavior for hens, but this is restricted for hens in the battery and colony cages. There is a tendency of the occurrence of stale oil and hens use dust bathing to remove it, in addition to damaged feathers. Battery cages do not have the dust bathing facility or a litter to allow bathing. Similarly, most colony cages do not have a litter and are unable to provide natural dust bathing experience to the hens. Scholars believe that dust bathing is an important social activity for hens as it gives the hens the important motivation when they see other hens engage in the activity. The litter provides adaptive qualities to the hens especially when they bath together since the activity reduces their vulnerability to possible predation. The energy they produce at that particular time makes it difficult for predators to attack them (Dawkins 1985, P. 345). There is also a chance that the hens may become competitive in a manner that may create disruptions or fights at some point. Limited litter creates competition that may prevent other hens from engaging in dust bathing activities that are necessary for their welfare. Aerni et al. (2000, p.16) argue that some farmers include automated doors to help restrict the hens from accessing the litter for some duration during the day. The purpose of these automated doors is that it helps deter hens from laying eggs in the litter. Studies show

that litters help motivate the hens to improve their productivity. Sham dust bathing also occurs in the areas where there are restrictions such as wire mesh, but it mainly occurs as a sign of frustration among the hens. Dust bathing is an activity that results in pleasure, which makes it essential for the hens as far as their welfare is concerned. There is a general agreement among scholars that welfare improvement should not just be about avoiding suffering. It should be about actively implementing measures to improve the welfare of the hens. The essence of all this work is to allow the hens to show their natural physical and behavioral expression as it leads to positive affective behavior among the hens. The outcome is good welfare that leads to the realization of wellbeing for hens that translates to significant improvement in egg yields (Dawkins, 1985, P. 345).

2.5 Foraging

Colony cage environments support foraging, which is an activity that hens engage in when they are well motivated (Aerni et al. 2000, p.16). They may engage in the activity even though they may have access to abundant feeds. Scholars believe that hens engage in this activity because the process of looking for food and manipulating it is just as important as feeding itself. Some hens that do not have enough space to forage result in feather pecking, which is an indication of foraging behavior. The issue of concern is that failure to have some substrate to motivate the foraging may lead to injuries because of constant pecking.

Brunberg et al. (2011, p. 1146) assert that there is a general agreement among scholars that the battery cages do not allow any form of foraging and scratching. Also, it is a form of exercise that may lead to weak skeletal structure among the hens due to failure to forage.

Research indicates that infrequent foraging among hens may lead to overgrown claws, which is dangerous. Hens found in colony cage environments are likely to display foraging activities than those found in caged environments (Aerni et al. 2000, p.17). The fact that foraging is associated with substantial walking that means that the hens engage in exercises that helps strengthen their bones. This is quite contrary for hens in battery cages that may only engage in pecking with minimal movement.

Battery cages consist of wire floors that cannot allow the hens to scratch and forage appropriately as illustrated by Lambton et al. (2010, p. 33). This inadequacy is likely to lead to weak bones, as the hens in the cages do not walk around, in addition to overgrown claws that are dangerous when they scratch other hens or themselves (Lambton et al. 2010, p. 33). Moreover, overgrown claws are not strong enough and can easily break and cause injuries that increase their vulnerability to infections.

2.6 Impact of battery cages on behavior and health of hens

The analysis done by Lambton et al. (2010, p. 33) demonstrated that the battery cages are unsuitable for hens and commercial egg production. The fact that they restrict the expression of vital behavior necessary to improve the welfare of the hens makes them unsuitable. Exploration is also an essential activity for the hens, and they need space to explore their environments because it is their behavior. The fact that hens are inquisitive animals means that having the space to explore is an important motivation. Suppressing exploration using cages is likely to cause a reduction in expressive behavior. According to Bos et al. (2010, p. 33), suppression of natural behavior also causes depression and may

lead to a reduction in their productivity. The colony cage environment ensures that the hens can show a wide range of behavioral activities. The housing systems with outdoor access are even more important, mainly because of the additional complexity in the choices to explore their environments accordingly (Bos et al. 2003, p. 159). The hens that are confined in the battery cages can only stand, sit and just slightly movement, which is not the exercise required to realize an improvement in their welfare.

One common characteristic among the hens that are under confinement is the fact that they engage in avoidance behavior. It is essential to note that fear is also a prevailing feeling for the hens given the fact that they are not able to engage in natural behavior important for their welfare improvement. The hens kept in the battery cages are more fearful compared to the hens that are kept in colony cage environments. The elevated perches in colony cage environments also allow the hens to get away in case they are exposed to environments of aggression. This is not possible with the hens kept in battery cages because of the restriction to even move around. Restricting the movement of hens amplifies the problem and makes it necessary to provide more room for the animals to move around. Research shows that hens have a high tendency of having bone weakness especially the hens that are kept in the cages. The main reason behind this occurrence is their limited movement in the cages unlike the hens kept in colony cage areas. The bones of caged hens are weak and prone to breaking when the hens are taken out of the cages (Gregory & Wilkins 1993, p. 25). This situation is contrary to hens raised in colony cage environments because they exercise all the time, which makes them strong. Further, studies indicate that about 30 percent of the hen raised in cages

has fresh bone fractures. This is different from the percentage of hens in colony cage areas, which is about 14 percent. There is a chance that caged birds may hurt themselves inside the cages especially when they are being removed out of the cages.

Caging of hens is not acceptable from an animal welfare point of view, as they get hurt although they provide benefits to the farmers that keep them. The injuries that the hens acquire when they are in the cages is an indication that they are unable to cope with the environment in which they are kept. There is a chance that the pain that these animals feel is excessive and is the cause of the great concern of most agricultural officers and animal welfare advocates. The high number of bone fractures of the hens is also indicative of the possibility that there may be bone splinters among the hens. Research also shows that caged hens also have higher incidences of lesions including the hyperkeratosis that results from standing for a long time (Gregory & Wilkins 1993, p. 26). The slope in the cages where the hens are kept cause pressure on the overgrown claws of the hens. The pressure leads to more injuries on the soft tissues of the feet and may lead to infections.

2.7 Challenges of colony cages

It is essential to note that animals in a colony cage environment also face challenges that also require the attention of the stakeholders to find a viable solution. All the welfare issues that arise from colony cage environments require better management to address them adequately. Breed selection has also been employed in other cases to address the challenges experienced in the colony cage areas (Organic Agriculture Centre of Canada (OACC) 2009, p.

7). One of the most common challenges in the colony cage environments is pecking injuries. Feather pecking translates to injurious pecking if the hens become aggressive and hurt others due to persistent attacks (Dixon 2008, p. 78). Cases of cannibalism have also been reported among other hens which happens because it is a behavioral characteristic of the hens (Choct & Hartini 2005, P. 111). Severe pecking causes harm to other hens and leads to stripping of the plumage that exposes their bare skin. The exposed bare skin rouses cannibalism because the hens are tempted to bite the skin (Choct & Hartini 2005, P. 111). There may be perceptions that the pecks are aggressive acts, but it is essential to note that these are foraging peck behaviors that are normal among hens that are targeted on the wrong targets (Nicol 1987, p.328). Pecking should not be directed towards the feathers, but rather to the ground. Proper management would ensure that hens have enough substrates to ensure that they do not turn on other hens.

Injurious pecking occurs in all housing systems, including colony cage and caged environments. The egg-laying hens are usually in flocks and have a tendency of pecking each other in case of any provocation (Bos et al. 2003, p. 159). The fact that the hens are free to move around means that the hens may have the opportunity to fight each other. On the other hand, hens in battery cages do not encounter as much pecking because the cages prevent exposure to other hens (Nicol 1987, p.329). The problem of severe pecking is associated with overcrowding in the colony cage areas. This issue may be addressed by proper management measures to ensure that there are programs to reduce such cases, for example reducing the

light in the sheds. According to Dixon (2008, p. 77), feather pecking is a problem linked with fright in the hens and many hens that are likely to peck are in the battery cages. The fact that the animals are in bigger cages does not reduce the occurrence of severe pecking that is evident in the colony cage areas. Hens in the colony cage areas peck other hens because of the possible aggression of other hens and the moment, they start pecking and it may become a confrontation. Efforts to manage hens in the colony cage areas should focus on ensuring that their forages are directed to the substrates on the ground. Implementing these and other measures is likely to provide a solution to resolve the issues associated with injurious pecking. A farmer may consider various approaches to achieve success in controlling cannibalism and feather pecking among the hens (Choct & Hartini 2005, P. 112). It is essential to note that farmers may adopt an incorporated approach to achieve useful results on the issue of injurious pecking. These approaches include environmental, genetics and experiences associated with early life. The farmers may also devise strategies to manage the crowding and the lighting in a better way.

The genetic approach revolves around the breeds that farmers have in their stocks. Farmers select breeds that are docile and do not have a higher likelihood of feather pecking. The characteristic of feather pecking, and resultant cannibalism is associated with certain breeds or strains. It is selecting strains that do not tend to engage in such characteristics and is likely to reduce the occurrence of the injurious pecking (Savory et al. 1978, p. 14). The genetic composition of the hen is important when selecting the breeds to keep as it determines

successful breeding. The challenge in the layers industry is that there are not many breeds from which they can choose.

A study on hen mortality conducted by Choct & Hartini (2005), established that the Bovan Gold line hens and the ISA brown had the least mortality compared to other breeds. Also, the study established that there was no difference in injurious pecking among the hens in the colony cage environment with trimmed beaks compared with those hens in the battery cage system. The shaver brown is a common commercial breed in New Zealand and different parts of the European Union where battery cages for commercial layers are already banned. Most scholars claim that the shaver brown is the best breed to keep because it is not aggressive, and birds may not harm each other. The breed also shows a low tendency of feather pecking that is the reason some hens acquire injuries in the colony cage environments. It is essential to note that the breed also has a hard body that helps it endure free-range structures that are synonymous with the colony cage environment (Hansen et al. 1993, p. 108). The issue of cannibalism and feather pecking may also occur because of the selection of breeds that are aggressive unintentionally. Understanding the genetics of the hens is important in establishing how to protect them from possible aggression (Choct & Hartini 2005, P. 113). Trimming the beaks of the birds may not be a solution as research has shown that there is a line of birds that have a low level of feather pecking even if there have long beaks. Most scholars advise that hens that are calm and portray robust temperament are the best to keep in the colony cage areas. Such breeds can also be produced scientifically, and the scientific companies that produce these breeds have the opportunity to produce large quantities. This would significantly reduce the issue of feather pecking in the colony cage environments. The

commercial breeders may convince the scientific institutions to produce large quantities of these birds for commercial purposes. The challenge is whether the less aggressive breeds can still produce as many eggs per year compared to the aggressive breeds.

2.8 Other alternatives to the battery cage system

When the New Code of Welfare for the hens came into force in New Zealand, the colony cage system was recommended to replace the battery cage system. However, farmers were at liberty to shift to other production systems that were cheaper as long as they meet the animal welfare standards. According to Rodenburg et al. (2005), other alternative production systems available include; free-range, barn and aviary systems. Below are the definitions of these production systems;

- **Free-range system.** This is a system where the hens are free because they are loose housed and can have access to the outdoors.
- **Barn production system.** Under this production system, the hens are loose-housed with litter on the floor but have no access to the outdoors. This system has an area for the dust-bath and also have nest boxes.
- **Aviary system.** This is a type of a barn system; the difference is that it has multiple tiers which give the birds extra perching area.

There is not enough information from research about production performances from different production systems that can help farmers make well-informed decisions. It is evident that different production systems considerably do affect the performance of the hens in terms of production traits such as egg weight, feed efficiency, daily feed consumption, and mortality (Suto et al., 1997). Among the variable costs that increase the

cost of production in egg production is the cost of feed. A research by Ahammed et. al. (2014) compared the feed intake among the three production systems (Aviary, barn, and battery cage systems), Chae et al. (2014). They documented that average feed intake from these systems differed significantly. The hens from the barn system consumed higher, while the lowest feed intake was from the battery cage system. This can be seen in Figure 1.4 and Table 4 below showing feed intakes at different stages of production for the three production systems.

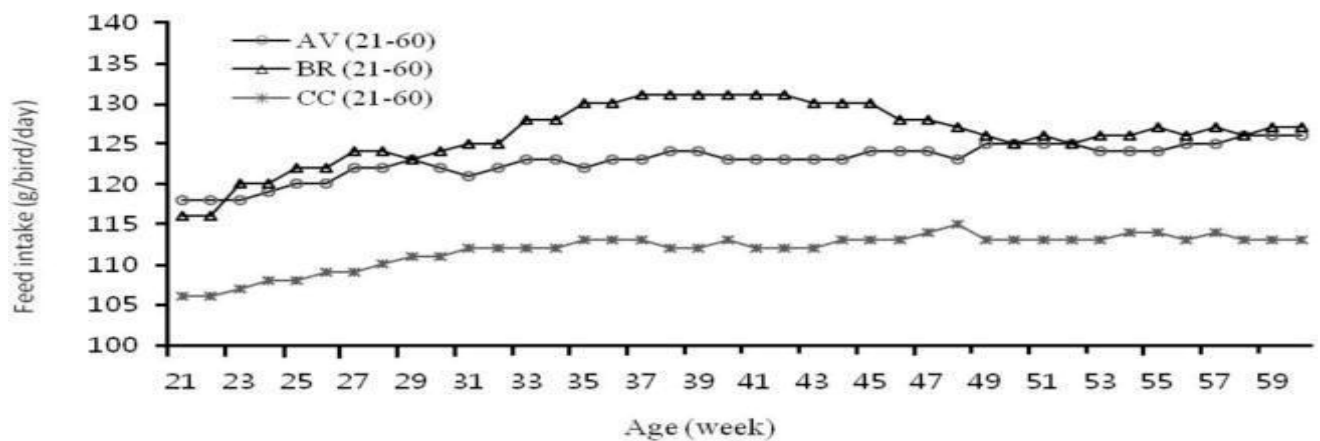


Figure 1.4: Comparison of feed intake (g/bird/day) of layer chicken under different rearing systems. AV, aviary; BR, barn; CC, conventional cage.

Source: Ahammed, et al, (2014)

The cost of production for every production system is one basis that egg farmers would use to decide on which system to adopt as an alternative to battery cages (conventional cages). According to Ahammed et al. (2014), barn system has the highest cost of feed followed by the aviary system. The battery cage system has the lowest cost of feed. The high cost of feed translates in high prices for the eggs. See Table 4 below which shows the direct proportion relationship between the cost of feed and the price of the eggs.

Table 4: Cost comparison among different rearing systems

Parameters	Aviary (AV)	Barn (BR)	Conventional cage (CC)
Feed cost (\$/10 eggs)*	0.78 (113)	0.87 (126)	0.69 (100)
Sales price (\$/10 eggs)*	3.0 (167)	2.5 (139)	1.8 (100)

*Feed and egg price were adjusted according to the price of the local market.

Entries within bracket () is showing relation index referring to the value of CC as 100. **Source:** Ahammed et al. (2014)

In the free-range system, the feed intake is also very high due to increased movements. The other attribute of the free-range system is the spatial behavior that the birds can portray (Lay et al., 2011). On the other hand, it is important to manage the range in order to avoid the paddocks to become a breeding area for disease-causing organisms. As noted by Rodenburg et al. (2005), chickens do not utilize the whole range area provided; usually the area near the shed is overused and left with no grass developing muddy areas. It is important to note that, the above-mentioned alternatives to replace the battery cages have some demerits too. Rodenburg et al. (2005), reviewed that the litter used for dust baths can increase the prevalence of diseases if not kept dry. Also, the sheds can be dusty affecting humans and birds with a possibility of causing respiratory problems.

2.9 Use of Regression Model in egg industry

Different researchers in the egg industry have used different approaches and regression models to predict the egg production and other variables like price. Ahmad (2011) used three different regression models to ascertain the best method to predict the egg production. According to Ahmad (2011), using feed consumption as an independent variable to predict egg production, the general regression neural network was superior compared to linear regression and Gompertz nonlinear model. In place of linear regression, researchers use multiple regression which is more superior. As stated by Laerd Statistics (2018), multiple regression is superior because it allows you to determine the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained.

Predicting the future price of eggs is a complex issue. In most cases, this is done using a combination of regression analysis and experienced-based intuition to build a model, which is later improved to suit the market conditions (Ahmad & Mariano, 2006). According to Ahmad & Mariano (2006), even after collecting costly and reliable data, in many cases the analysis does not produce high confidence to explain the variations in egg price. Ahmad & Mariano (2006), suggest that neural networks method is more reliable for egg price forecasting than a simple regression analysis because it recognizes the previous pattern of egg prices and then predicts the future price more efficiently. The general regression neural networks have been compared to other methods by many researchers. In most literature, neural networks were found to perform better (Zhang, Cao & Schniederjans 2004;

Kourentzes 2013; Arunraj & Ahrens 2015; Mitrea, Lee & Wu 2009; Gazdíková & Šusteková 2009; Vojteková & Bartošová 2009). With all the positives about general regression neural networks, Ahmad et al. (2018) state that this method has some limitations. For example, this method is too complicated and need proper training. When using it with a large database, it is essential to reduce the data dimensionality using a data reduction technique (Ahmad et al. 2018).

2.10 Summary of the literature

The literature concludes that battery cages (conventional cages) do not allow hens to engage in their natural behavior. The system prevents hens from showing behavior like foraging, dust bathing and perching. This is one of the reasons why some animal welfare advocates pushed for the New Code of Welfare for the hens in New Zealand. From the literature, most scholars favor the colony cages over battery cages because the colony systems allow hens to portray their behaviors naturally. On the other hand, the colony system has its demerits that have been highlighted by some researchers. For example, the colony system encourages pecking among hens because of crowding them in one big cage. The pecking in the colony cages creates another problem which cannot be overlooked especially among the animal welfare advocates. The literature also reviewed that, there are other alternatives to battery cage production system that are available. These include free - range, barn and aviary systems. Among all the possible alternatives that farmers can adopt to replace battery cages, the cost of production is higher due to increased movements of birds. Other production traits that are affected by different production systems include; egg weight, feed

efficiency, and mortality rate. This means any trait that increases the cost of production will have adverse effect on businesses.

All the literature reviewed in the previous chapter does not highlight the current challenges that egg producers in New Zealand are facing. The phasing out of the battery cages is still ongoing, resulting in new trends in the industry. The New Zealand poultry industry is changing in terms of farm sizes, production systems used as farmers replace the battery cage system with other alternatives. There is a gap in the literature because most of the research was conducted in other countries in the past. Even the research conducted within New Zealand fails to accurately reflect the current situation of the industry because it was conducted before the phasing of the battery cages was implemented. This was done to predict the challenges farmers were likely to face during and after the period of phasing out battery cages.

The other gap in the literature is that there is no link in the topics researched or their findings in other countries to the expected impact in New Zealand after the battery cages are phased out completely. Most of the literature from other countries where the battery cages have been banned in the recent years concentrates on the reasons of phasing out the system in terms of animal welfare without showing the negative impact (e.g., increased cost of production) on the producers themselves. Also, the literature does not show the redistribution of farms in those countries after the battery cage system was phased out. There are different production systems that egg producers can adopt. Hence, this research will fill the gap to show how farmers are responding to the New Code of Welfare for the

layer hens. Some research has been conducted to inform the poultry industry in New Zealand about the expected impact of introducing the New Code of Welfare for the hens. However, there has been less or no follow up research to establish what the egg producers are doing on the ground. The expected cost of production projected from the research conducted was based mostly on estimates. Most of the results are not the actual costs from farmers in other countries that could have been used to determine the expected cost of production in New Zealand. Even if the actual figures of cost of production from other countries were used to make estimates on the expected increase or decrease in the cost of production farmers were to experience in New Zealand, these could not be very accurate because of the situation is different in every country. This research brings out the latest situation in terms of changes taking place in the industry (e.g., changes in the cost of production) and challenges involved as farmers adapt to the colony and other production systems.

3.0 Introduction

This section of the report highlights how the data for the research was collected and analyzed. A combination of different methods was used to collect data from the egg producers to increase the response rate. Secondary data was also collected from the industry requiring a different approach when analyzing. Because of different sources of data (from the survey and Statistics New Zealand), the analysis for the survey and secondary data was done separately.

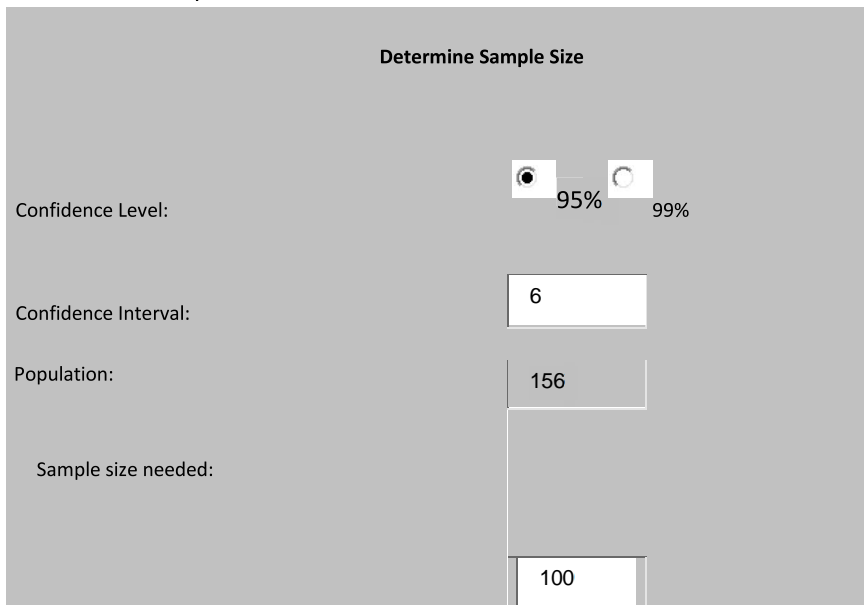
3.1 Research setting and sampling.

The research conducted for this project covers New Zealand's poultry industry (layers) in its entirety. For primary data collection, a questionnaire survey was combined with a dose of oral interviews. The survey involved egg producers using different production systems in the industry. The qualitative part of the research enhanced the findings from the survey. As noted by Creswell (2013), combining quantitative and qualitative methods in research helps to overcome the weaknesses that one method has with the strength of another method. For this research, quantitative and qualitative data were collected by using the same questionnaire by including open-ended questions to capture qualitative data. This was followed by interviewing a selection of farmers with the same questions for qualitative data gathering that were used in the questionnaire. This approach was used in order to know the trend in which respondents answered the open-ended questions and the survey questions.

Sampling was conducted randomly in recruiting participants. A sample size of 100 was drawn from a population of 156 farmers, using a 95% confidence level and confidence interval of 6.

This was determined by using the online calculator shown below:

Table 5: Sample online calculator



The image shows a screenshot of an online calculator titled "Determine Sample Size". It features four input fields and two radio buttons. The "Confidence Level" field has two radio buttons, with "95%" selected. The "Confidence Interval" field contains the value "6". The "Population" field contains the value "156". The "Sample size needed" field contains the value "100".

Field	Value
Confidence Level	95%
Confidence Interval	6
Population	156
Sample size needed	100

Source: Creative Research Systems (n.d)

3.2 Method of data collection and analysis.

3.2.1 Data collection.

For recruiting participants, a cover letter and participation information sheet were included (see Appendix A in the appendices section). An application was made to the ethics committee to use PIANZ (Poultry Industry Association New Zealand), to send questionnaires directly.

The initial attempt to recruit participants by sending emails received only 10 responses. There was a need to bring on board more participants. Letters were used to try and bring out more participants. From a total of 20 postal letters that were sent, only 5 responses were received. Later, an online survey platform, Survey Monkey was used. From the online survey, 20 more participants came on board with responses. The use of Survey Monkey increased the number of participants bringing total to 35 representing 22.4% of farmers from the industry. The response rate for the survey was 35%. The 35 participants (farmers) represented 46 Farms from the industry. The number of participants is lower than the number of farms because of some farmers operate more than one farm. The number of farms covered for this research is similar to a survey which was conducted by Nimmo-Bell in (2010) which had a representation of 41 farms. A summary of their survey returns is shown in Table 6 below.

Table 6: Groups of farms and total number surveyed.

	Group A	Group B	Group C	Total
Total No. of Farms (where data gathered)	8	13	20	41
Total Number of Birds	1,727,600	796,200	358,600	2,882,400
Average Number of Birds	215,900	61,200	17,900	
Median Number of Birds	160,100	61,200	19,400	
Average Egg Production	300	300	290	
Number making own feed	6	9	9	24
% Total Bird Number in Group	60%	28%	12%	

Source: Nimmo-Bell (2010).

After the survey, 10 farmers were interviewed in order to enhance the data collected from the survey. These are the farmers who indicated in the questionnaire that they were available for an interview. 7 interviews were done face-to-face and another 3 through a phone interview.

3.2.2 The method of analyzing data.

The approach used to analyze data for this research was a multifaceted one. This is because the research data were from three different sources; survey, interviews and secondary data. Respondents were grouped according to their farm sizes for easy management of data. The data from the survey conducted was analyzed by using Excel to produce graphs and table. This was done after responses from farmers were compared and grouped in clusters of common themes. The data from the interviews were analyzed first by coding responses from farms using standard themes. The coding was done by using numbers which later were used to generate graphs and tables using Excel. EViews statistical package was used to analyze secondary data from Stats NZ and the Poultry Association of New Zealand. The relationships between independent and dependent variables were analyzed and compared with responses from the survey to establish the likely future trends.

4.0 Introduction.

This section will focus on the data analysis, the results of the survey and related discussion. The results will establish the current trend in the use of battery cages in the industry. The results will show the perceived benefits of using colony cages in terms of hen welfare improvement from the farmers' perspective. The result section will also highlight the adversities of the egg market caused by the changes in the industry and challenges farmers have faced or anticipate facing during the phasing out of battery cages. The demographic information (the age and gender) about participants will be analyzed first. The last part of the data analysis section will bring out the specific results about the objectives of the research. The objectives of the research are as follows;

- To determine the current trends in New Zealand poultry industry's use of battery cages.
- To establish some of the perceived benefits of adopting colony cages in the poultry industry of New Zealand.
- To predict possible adversities that the egg market and egg farmers might face in the wake of the poultry industry's switch from battery cages to colony cages.
- To examine some of the challenges that farmers have faced during the phase-out of battery cages in the poultry industry of New Zealand.
- To recommend possible solutions to the challenges that farmers have faced during the phaseout of battery cages in the poultry industry of New Zealand.

The analysis section will focus on the number of years each participant has spent in the industry and different housing systems that farmers are using, including recent trends in farm sizes. The re-distribution of production systems will be analyzed and how farmers have adopted colony cages since the introduction of the New Code of Welfare. Also, the perceived benefits of hen welfare improvement in the colony system from farmers' point of view will be analyzed. The next part will analyze the challenges farmers have faced which include increase in cost of production. Recommendations from farmers about better ways the transitioning from battery cages to colony or other systems will be summarized. The data analysis section will conclude with a regression analysis that will show relationships among variables of interest. The regression will establish possible future trends in egg production, egg prices, number of farms, hen population and number of workers on farms.

4.1 Data analysis, results and discussion.

The nature of the industry surveyed meant the sample size and the response rate was rather low. As a result, using a simple method of producing tables and graphs in Excel was sufficient to analyze data from the survey. The qualitative data analysis was done by first identifying the common themes in the data collected. These themes were grouped in a table and counted the number of respondents who gave similar answers.

The other set of data analyzed was the data collected from previous research in the industry and statistical information from Statistics NZ (2019). The regression model using Eviews was designed to show relationships among variables of interest (hen population, egg prices, number

of workers on farms, number of farms and productivity). Also, the possible future trends of these variables were projected as the structure of the industry is changing in terms of re-distribution of production systems and farm sizes. Forecasting was done using Excel on expected trends up to the year 2023.

4.2 The demographics of respondents and farm sizes.

4.2.1 The age of respondents.

The survey was designed to capture the different age groups of the participants. The bar chart below (Figure 1.5) shows the different age groups of the respondents used for the survey. The age range was from 20 - 40 year and above. Majority of the farmers are over 40 years of age and very few farmers are below 40 years old. Figure 1.5 below shows that 77% of farmers are over 40 years old. Farmers who are between the age of 20 - 25 are presented by 6%; this is same for those who are between the age of 26 - 30 years old. The second majority age group are the ones between the age of 31 - 35 years old. Farmers that are between the age of 36 - 40 years old are the minority with a 3% presentation.

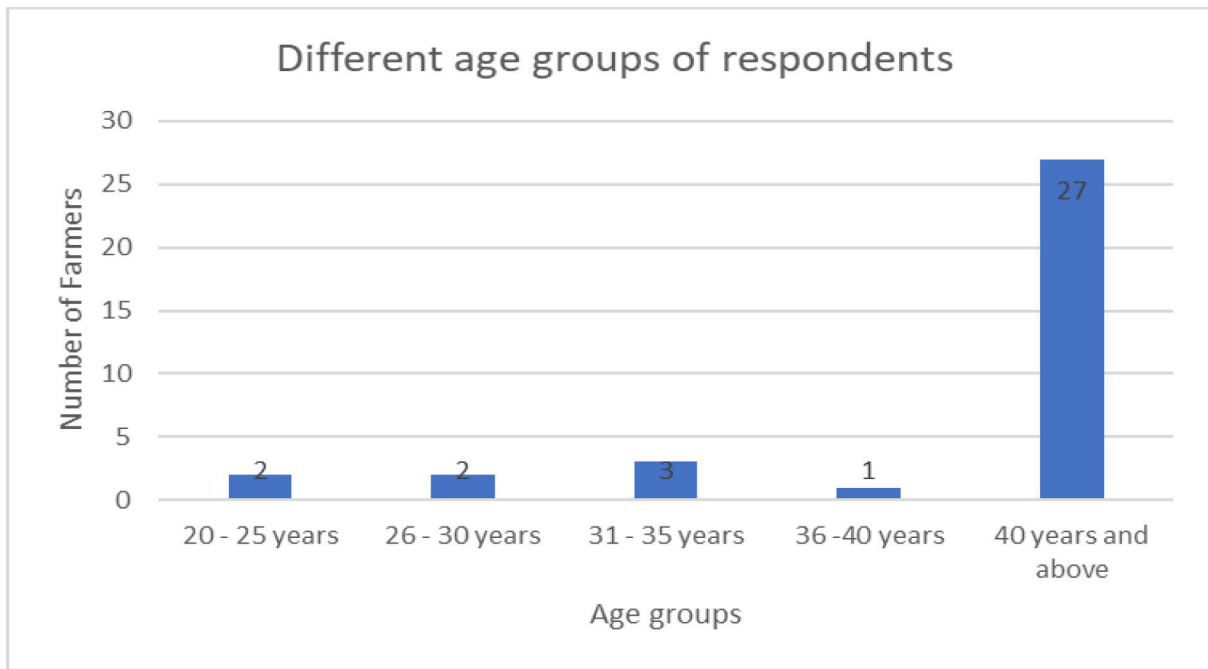


Figure 1.5: Bar chart presentation of different age groups of respondents.

4.2.2 The gender of respondents.

Figure 1.6 below shows the gender percentages of respondents for the survey. From the information below, it shows that the majority of the participants for the survey are men represented by 66%, while 34% for female participants.

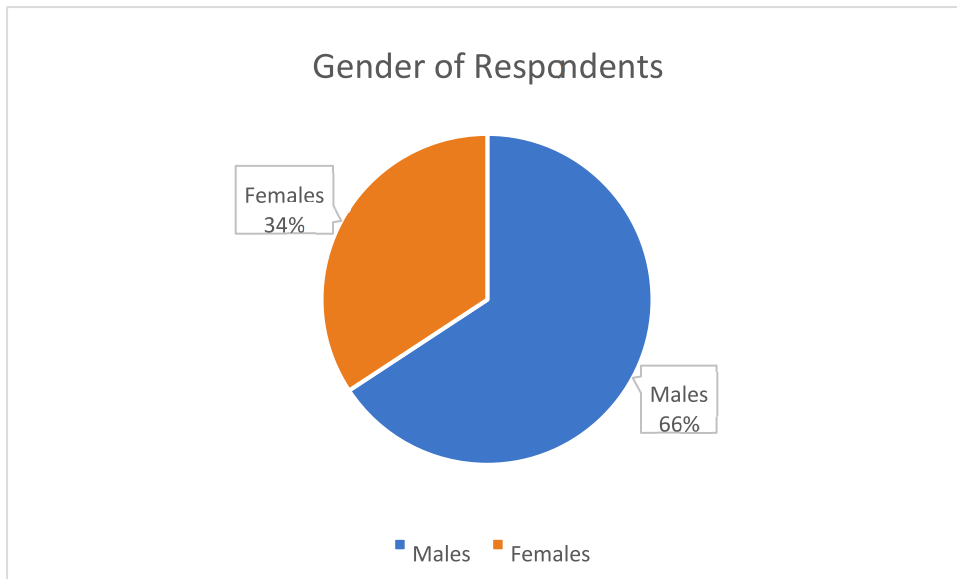


Figure 1.6: Pie chart presentation of gender for respondents

4.2.3 Respondents' years of farming.

The table below summarizes the length of service in poultry farming. Table 7 shows that most egg farmers (42.9%) have been in farming for a period of between 11 - 20 years. While 37.2% of farmers have been in the industry for 1 - 10 years and these are the second majority. The egg farmers who have been in farming for less than a year are represented by 8.6%.

Table 7: Number of years of participating in poultry farming.

No. of years in farming	Less than one year	1 – 10	11 - 20	Over 20years
No. of farmers	3	13	15	4
Percentages	8.6%	37.2%	42.9%	11.2%

4.3 Research objective one: - To determine the current trends in the poultry industry’s use of battery cages.

4.3.1 Different production systems used by farmers in the industry in comparison to battery cages.

Figure 1.7 below presents the trends in the use of different production systems in the egg industry among farmers. The most widely used production system is the free-range system with 56 %. The battery cage system is on second with 19 %, barn has a share of 5 %, the colony system with 9 %, rear farmers are represented by 10 % and the least being the organic system on 1%. Even though there are many free-range farms, the battery cage system still produces more eggs in the country than the other systems due to the intensive mode of farming used. As stated in chapter one, about 44.7 % of eggs in New Zealand are still produced under the battery cage system.

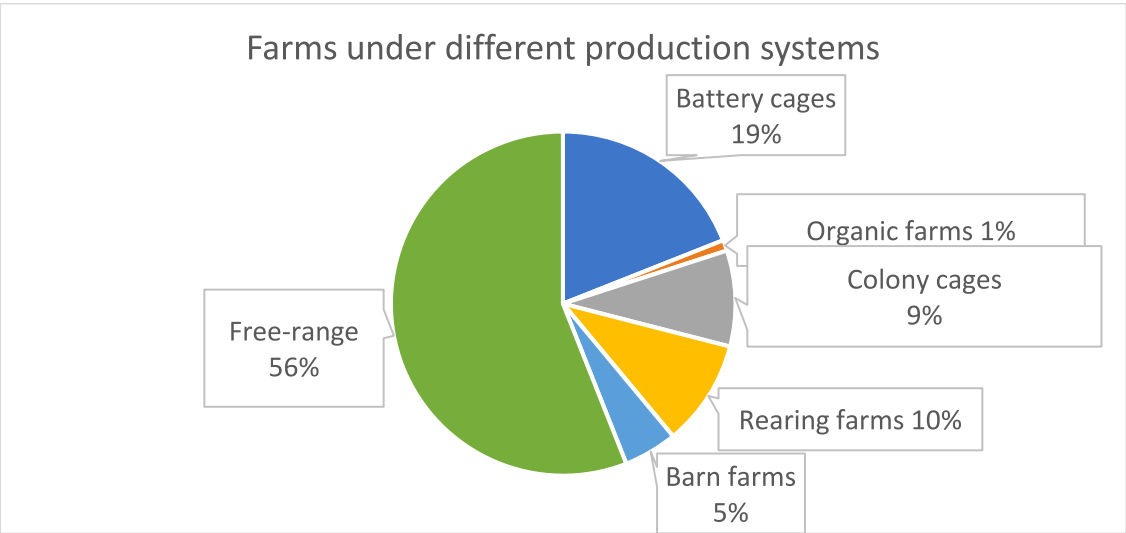


Figure 1.7: Pie chart presentation of farms under different production systems during time of research.

4.3.2 The sizes of farms.

The sizes (hen population) of the farms for egg producers are related to the production systems used. Figure 1.8 that follows summarizes the information about the sizes of farms (in terms of bird numbers) and percentages of farmers represented by each category of farm size. The sizes of different farms are categorized as small, medium or large. The majority of farms are under the category of small farms with birds between 5,000 - 20,000 birds. The medium farms have between 20,000, and 50,000 birds and Large farms have 50,000 birds and above. In percentage terms, 66% of the farms are classified as small, 14 % medium and 20% are under the category of large farms.

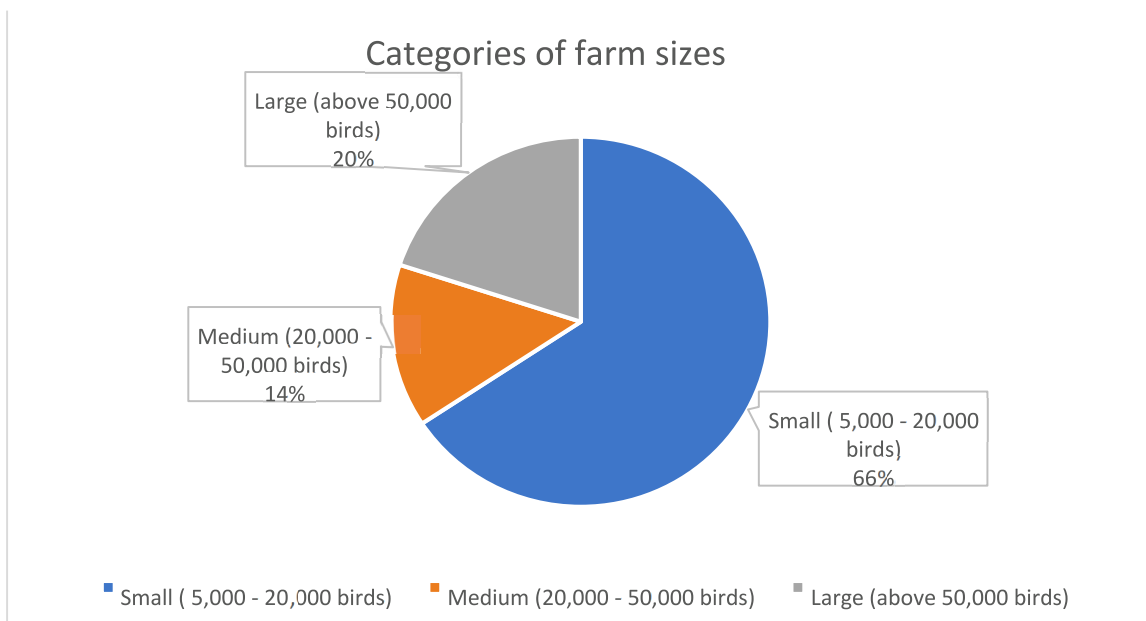


Figure 1.8: Pie chart showing categories of farm sizes.

4.3.3 Distribution of production systems among respondents

The distribution of production systems used among the participants for the survey was analyzed to establish the trend of using battery cages in the industry in comparison to other systems. The findings were similar to the results above (see section 6.4.2), in terms of production systems widely used and the least used. Table 8 below shows that the free-range system is the most common with 63%, battery cage system sitting on 19.6%, colony 13% and barn system 4.3%

Table 8: Production systems used by respondents for the survey.

Production systems	Battery cages	Free range	Colony	Barn
Number of farms	9	29	6	2
Percentages	19.6%	63%	13%	4.3%

4.3.4 Trends in adopting colony cage system in the layer hen industry

The summary of the trends in adopting colony cages is shown below in Table 9. The majority (34.3%) of the farmers are undecided on whether to adopt the colony cages. The second largest group are those who have fully adopted at 25.7%. Some farmers have partially adopted representing 17.1%, and there are many that have not adopted the system with a 22.9% representation.

Table 9: Colony adopting trends in the industry.

Colony adoption	Fully adopted	Partially adopted	Not adopted	undecided
No. of farmers	9	6	8	12
Percentages	25.7%	17.1%	22.9%	34.3%

4.3.5 Trends in switching from battery cage to other production systems in the layer hen industry.

The phasing out of battery cages is changing the distribution of production systems in the industry. Table 10 below shows that free-range is becoming more popular as an alternative even though the colony system was recommended to replace the battery cage system. About 41.0% of the farmers opt for free-range, a vast percentage of 33.3% are undecided, 7.7% have switched to barn system, and the remaining 17.9% are the ones that have adopted the colony cage system.

Table 10: Trends in adopting other production systems in comparison to colony system.

Production systems	Barn system	Free range	Colony	undecided
No. of farmers	3	16	7	13
Percentages	7.7%	41.0%	17.9%	33.3%

4.3.6 Changes in scale of production due to phasing out of battery cages

The phasing out of battery cages prompted some farmers to adjust their scale of production. These changes are presented in Figure 1.9 below. The highest percentage (46 %) of farmers indicated that they are increasing production, a higher percentage of 27 % are undecided, 15 % responded that they are decreasing and those not changing the scale of production are represented by 12 %.

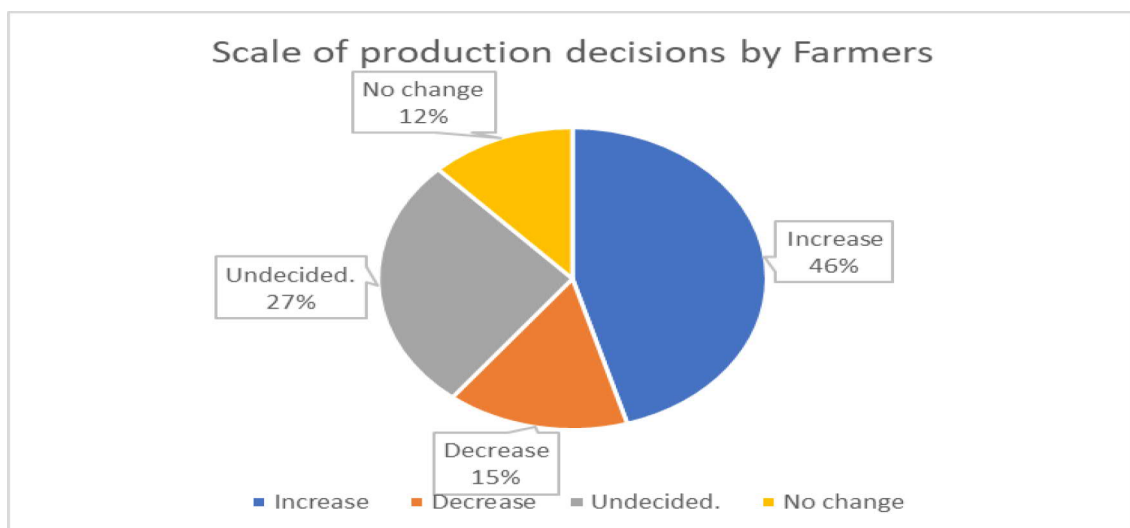


Figure 1.9: Bar chart presentation of the scale of production decisions by farmers.

4.4 Research objective two: - To establish some of the perceived benefits of adopting colony cages in the poultry industry.

4.4.1 Benefits of colony cages in terms of hen welfare improvement – from farmers' perspective

Table 11 summarizes the perceived benefits of using colony cages. The information is further presented in a bar chart which shows that most farmers did not give their views on each category of perceived benefits. Among all the perceived benefits, most of the participants indicated neutrality. The perceived benefits are; increased profits, improved hen behaviour, better egg quality, more customers, low labour costs, low mortality, strong bones, better hygiene and reduced stress. Responses from farmers indicate the majority either disagreed or strongly disagreed that colony cages are beneficial to farmers with the above-mentioned perceived benefits. Under this category, the responses range from 1 - 14, while for farmers who agree or strongly agree range from 1 - 8 responses.

Table 11: Summary of responses on the perceived benefits of using colony cages.

Benefits	Number of farmers and their responses					Non respondents
	In strong agreement	In agreement	Neutral	In disagreement	In strong disagreement	
Increased profits	1	3	10	11	5	5
Improved hen behaviour	5	6	8	7	2	7
Better egg quality	2	5	12	5	4	7
More customers	3	6	10	7	3	6
Low labour costs	-	1	8	14	6	6
Low mortality	3	3	9	10	4	6
Strong bones	1	8	18	4	1	3
Better hygiene	3	4	12	4	4	8
Reduced stress	5	6	8	3	1	12

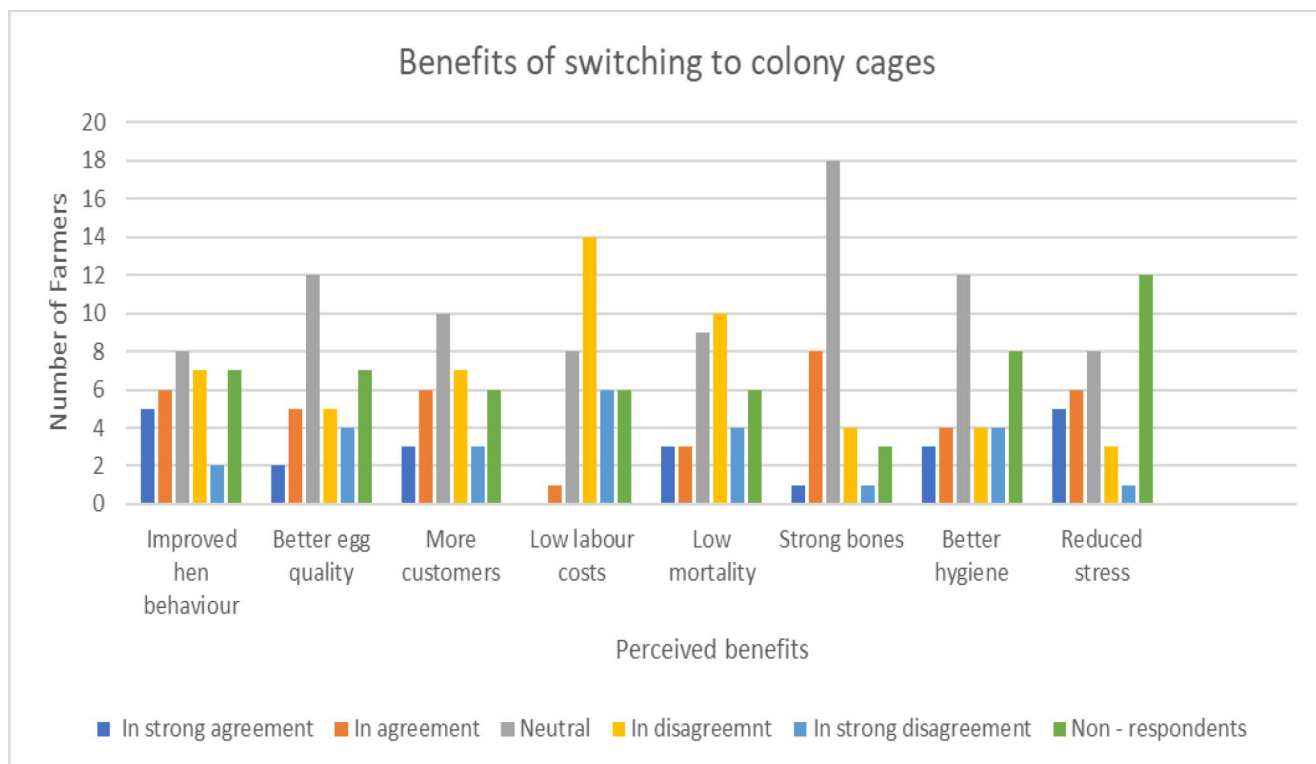


Figure 1.10: Bar chart showing the benefits of switching to the colony cage system.

4.5 Research objective three: - To predict possible adversities that the egg market and egg farmers might face in the wake of the poultry industry’s switch from battery cages to colony cages.

4.5.1 Adversities of colony cages in terms of hen welfare improvement – from farmers’ perspective

The anticipated adversities of using colony cages are summarized in Table 12 and Figure 1.11 below. The responses for the perceived adversities of using colony cages are similar to those given on the perceived benefits above. Most of the participants were neutral on all of the perceived adversities of using colony cages. Responses on neutrality range from 13 - 16

farmers (participants). Non - respondents on all the perceived adversities were 5 from the total participants of 35. The list of perceived adversities includes; cannibalism/pecking, poor bird welfare, high mortality, and sustaining of fractures. Most participants indicated that they either disagree or strongly disagree that colony cages can cause the adversities mentioned above. The responses range from 2 - 10, while those who either agree or strongly agree ranges from 1 - 8.

Table 12: Summary of responses on perceived adversities of using colony cages.

Number of farmers and their responses						
Adversities	In strong agreement	In agreement	Neutral	In disagreement	In strong disagreement	No-respondents
Cannibalism/pecking	1	8	14	5	2	5
Poor bird welfare	2	4	13	8	3	5
High mortality	-	3	14	10	3	5
Sustaining of fractures	-	2	16	8	4	5

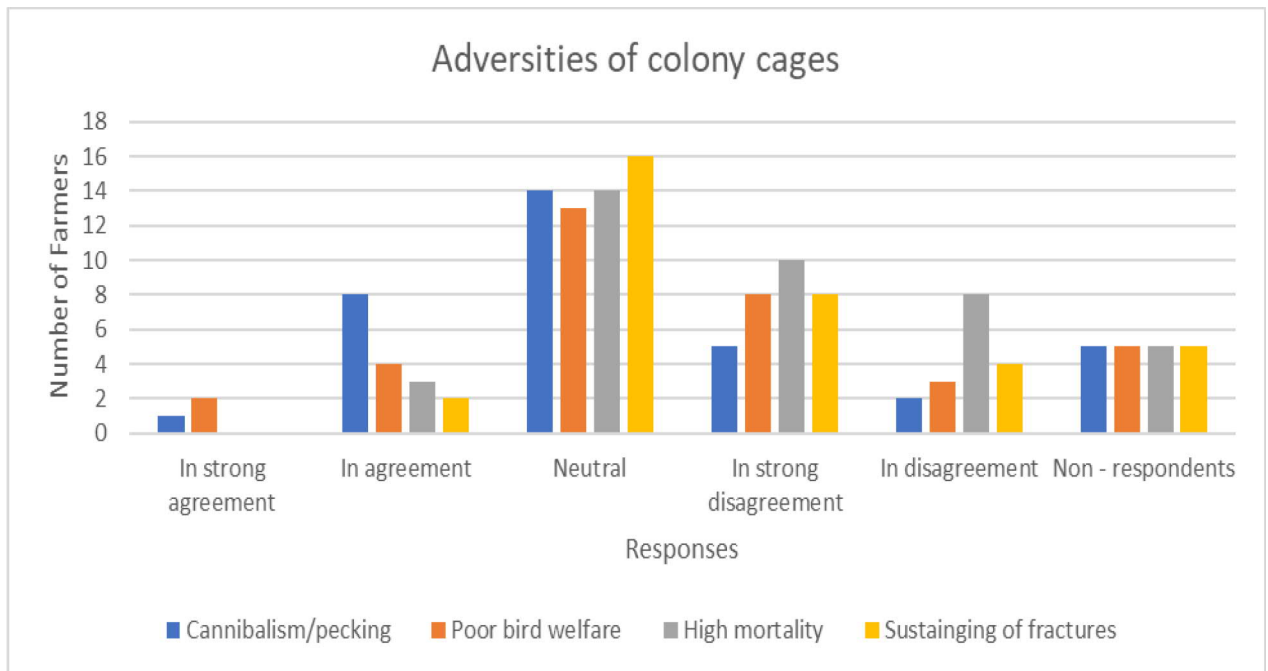


Figure 1.11: Bar chart showing adversities of colony cage system.

4.5.2 The changes in the cost of production by replacing battery cages with colony cages -

The voice of a farmer

The survey revealed that farmers are making decisions on whether to increase or decrease the scale of production. Table 13 below shows the number of farmers and corresponding percentages of farmers with different views about the changes in the cost of production. Majority of farmers (57.14%) agreed that the cost of production would increase because of replacing battery cages with colony cages. 31.42% of the respondents said that they are not sure whether the switch would increase the cost of production, while the smallest percentage of 11.42% indicated that the switch to colony cages would decrease the cost of production.

Table 13: Responses on whether the cost of production will increase or decrease by replacing battery cages.

Responses	Yes (code = 1)	No (code =2)	Not sure (code=3)
No. of farmers	20	4	11
Percentages	57.14%	11.42%	31.42%

4.5.3 Anticipated increase in the cost of production

Figure 1.12 below presents the responses from farmers about the expected increase in the cost of production as a result of switching from battery cages to the colony. 50% of farmers stated that the cost of production would increase by 0 - 10%. This is closely followed by those who responded that production would increase by 10 - 30% represented by 45%. Out of all the participants for the survey, only 5% of farmers responded that the cost of production would increase by 30 - 50%.

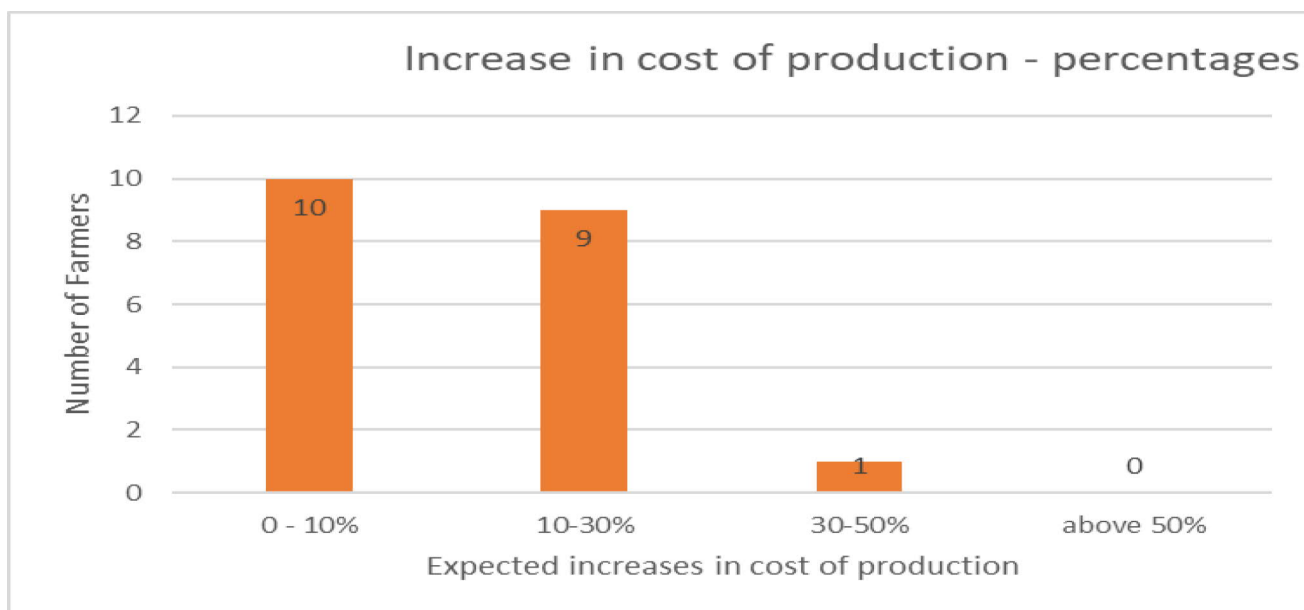


Figure 1.12: Bar chart presentation showing an anticipated increase in the cost of production.

4.6 Research objective four: - To examine some of the challenges that farmers have faced during the phase-out of battery cages in the poultry industry of New Zealand

4.6.1 Challenges farmers have faced or anticipate facing due to phasing out of battery

The other part of the research was to capture data on challenges farmers who have switched to colony cages have encountered and those anticipated as more farmers are adopting colony system. Figure 1.13 below highlights several challenges farmers have faced and anticipate facing. The most outstanding challenge is the shortage of eggs resulting in losing customers. Most farmers also indicated that the cost of the new gear and getting resource consents are significant challenges. Other challenges include; stress, uncertainty in the industry, lack of information, training workers, loss of production, lack of capital, security required for capital, time to get the gear, losing of premium price from free-range eggs, increased feed intake and losing customers.

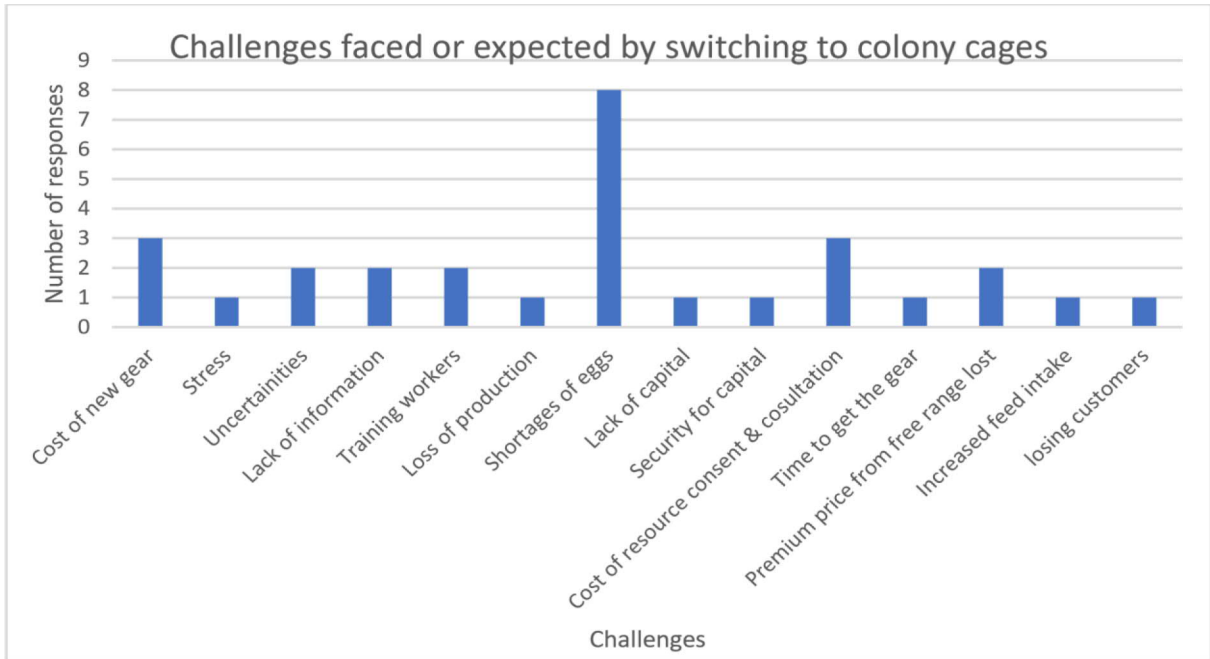


Figure 1.13: Bar chart presentation of challenges faced or expected by switching to colony cage system.

4.6.2 Expected causes of an increased cost of production

The most important challenge that concerned the farmers was that of an anticipated increase in cost of production. Table 14 and Figure 1.14 below shows the causes of cost of production to increase. The costs include fixed, indirect and variable costs. The cost of new equipment which is a fixed cost is highest at 31%. In second place is the cost of labor at 23% and in third place is high feed intake on 15%. The other causes of the increased cost being the high feed wastage which is on 7% and 8% responded that disease would increase. The remaining expected causes of cost of production to increase are represented by 4%, being low production, feed contamination, more cracked eggs and cost of dismantling sheds.

Table 14 Responses on expected expenses that will increase the cost of producing eggs.

Expected causes of the increase in cost of production	Number of responses	Types of cost
High feed intake	4	Variable cost
High feed wastage	2	Variable cost
Increased cost of labor	6	Variable cost
Cost of new equipment	8	Fixed cost
Low production	1	Indirect cost
Feed contamination	1	Indirect cost
More diseases	2	Indirect cost
More dirty/cracked eggs	1	Indirect cost
Dismantling sheds (fixed cost)	1	Fixed cost

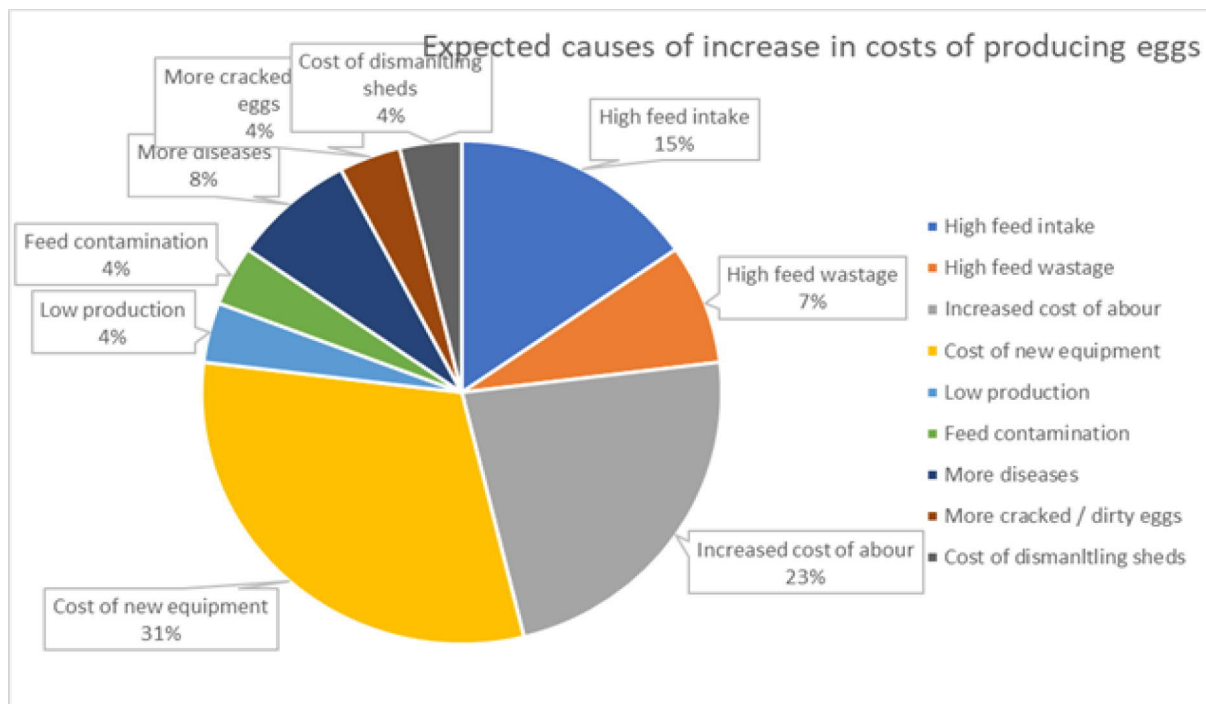


Figure 1.14: Pie chart presentation of expected causes of an increase in the production of eggs.

4.6.3 Actual causes of increased costs as experienced by switchers to colony cages

Table 15 & Figure 1.15 below shows the actual causes of costs to increase from those who have already switched to colony cages. The cost of new equipment (fixed cost) has the highest percentage on 32%. The second highest cost is the cost feed as a result of increased feed intake, which is a variable cost at 25%. The feed intake increases because birds are more mobile in the colony system. Resource consent and cost of land that are both fixed costs are represented by 18% and 14%, respectively. The lowest cost experienced by farmers is the cost resulting from having more cracked and dirty eggs, at 11%.

Table 15: Responses on actual causes of the increased cost of producing eggs.

Actual causes of costs to increase	Number of responses	Types of cost
High feed intake	7	Variable cost
Cost of resource consent	5	Fixed cost
Cost of land	4	Fixed cost
Cost of new equipment	9	Fixed cost
More cracked/dirty eggs	3	Indirect cost

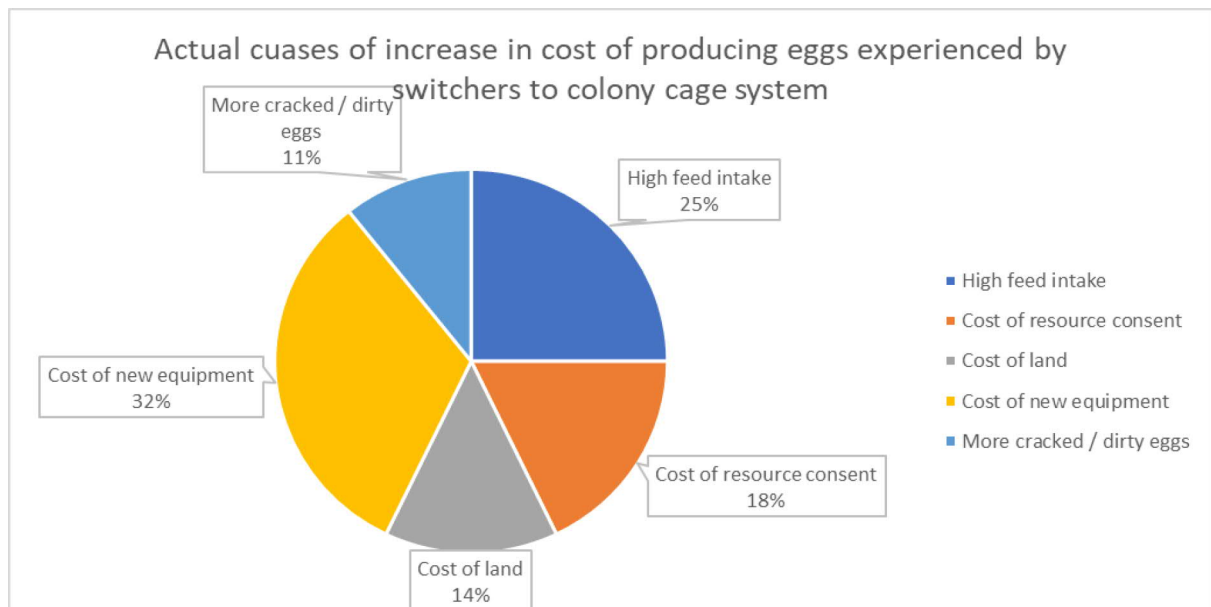


Figure 1.15: Pie chart presentation of actual causes of costs increase switchers have experienced.

4.7 Forecasting of the egg industry and regression models

4.7.1 Introduction.

The egg industry in New Zealand has evolved over time. Many significant changes have taken place in the last few decades. For example, the production of eggs has dramatically improved from 2002 - 2018 compared to the hen population (See Table 3 above). This can be attributed to improved management. In order to establish the trends in hen population compared to egg production, this section will conduct simple forecasting in Excel. This section will also show the trends in labor force and number of farms/farmers in the industry. Changes in the average price of eggs over time will also be examined. Regression models will be used to establish different relationships between variables and relate these to the forecasting done using Excel.

4.7.2 Egg production forecasting

Forecasting of egg production used data covering more than 18 years. The period covers prior, during and post completion of the phasing out of battery cages. The total egg produced from the previous years (starting from 2002) was used to make the projections of the future production using excel. Covering a longer period helps to establish the changes in egg production before and after the introduction of the New Code of Welfare for the layer hens

Figure 1.16 below shows the egg production forecasting to the year 2023 and the trend indicates a steady increase in egg production. The production of eggs started to fall in 2005. This can be

attributed to new cages which were introduced, affecting the carrying capacity of the cages (reducing hen population). The changes in total production correspond to the period when the population of hens also started to decline (See Figure 1.17 below). The trend for total egg production is similar between 2011 to 2013 when there was a decline in egg production which could be as a result of the introduction of New Code of Welfare for the hens. After 2013, egg production started to increase, albeit at a slow rate. The increase in total egg production after 2013 can be attributed to new farmers who entered the industry. Figure 1.9 above shows that 46% of farmers are anticipating scaling up production; this will level up the shortages of eggs in the country in the long run.

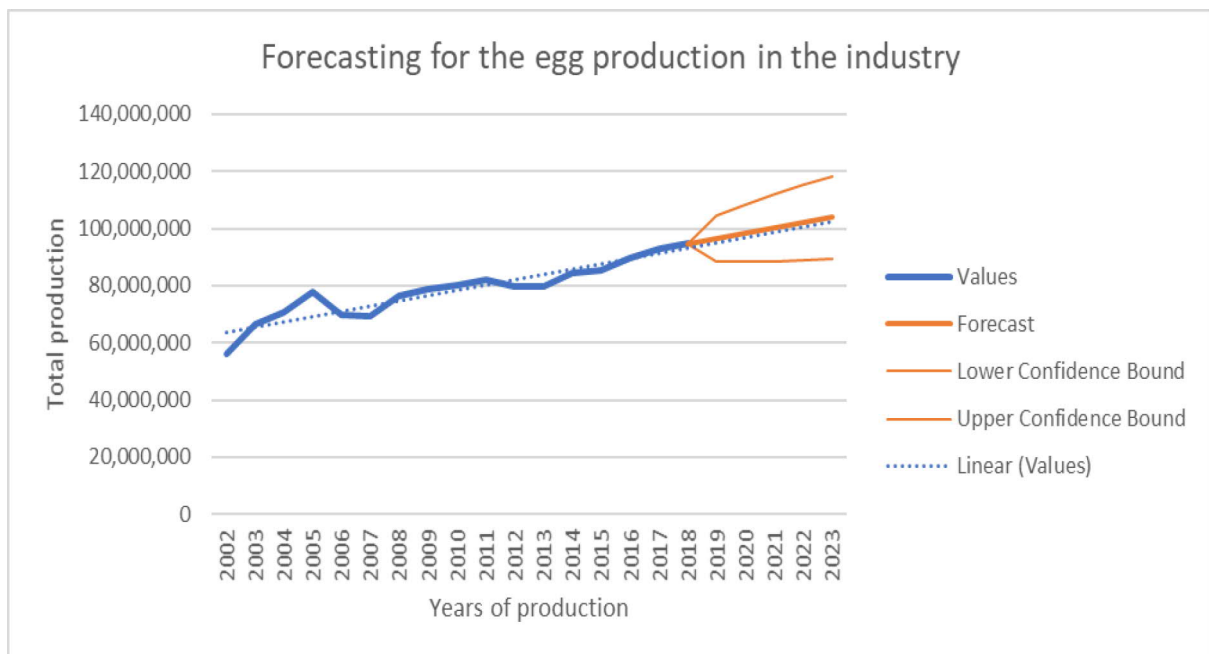


Figure 1.16: Forecasting for egg production in the layer hen industry in New Zealand.

4.7.3 Forecasting of hen population

Moving from the battery cage system to other production systems is a change that could affect the number of layer hens in the country. By using the hen population in the previous years, the prediction about the future hen population was done by using a simple linear method. The linear line helps to understand how drastic or gradual the changes in the hen population have been from 2012 after the new Code of Welfare for the layer hens was introduced.

Figure 1.17 below shows the forecasting done for the expected trend in the hen population in the industry. The graph shows a steady increase in the population of birds after a considerable drop in 2005. The drop in the hen population in 2005 can be attributed to the New Code of Welfare for the layer hens in the industry with a requirement that a minimum of 500 cm² per hen should be used. With the New Code of Welfare, new cages were introduced with a height of at least 40 cm over 65% of the cage floor area and not less than 35 cm at any point. Between 2012 and 2013, the hen population reached a low level compared to previous years. This was after another New Code of Welfare for layer hens was introduced in 2012 with a recommendation to phase-out battery cages and introduce colony cages. The trend in hen population reduction continued between 2017 and 2018 after a steady increase from 2013.

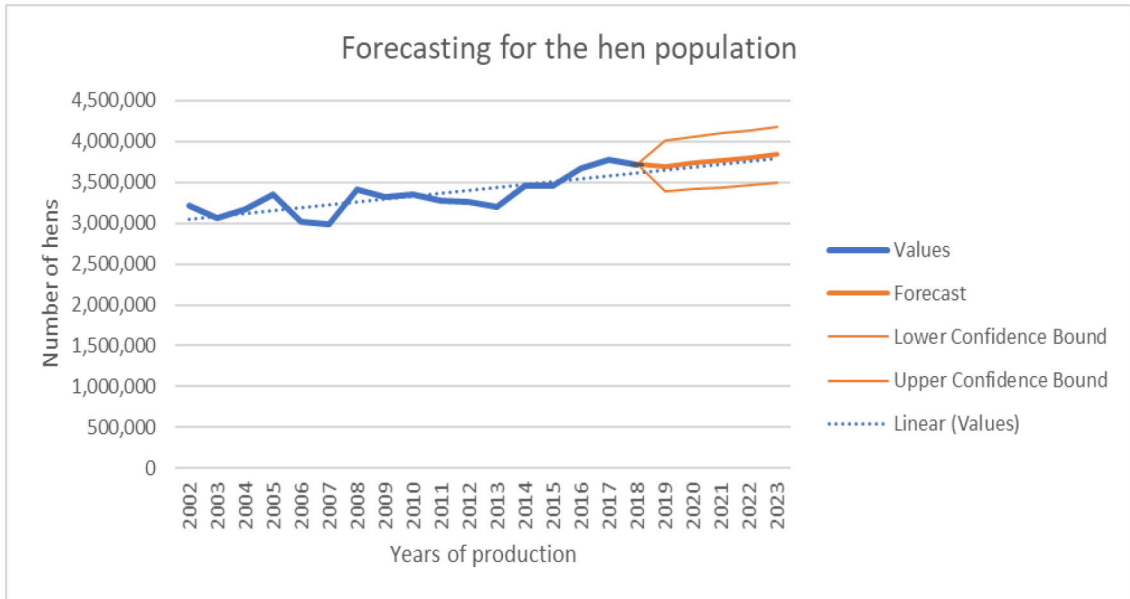


Figure 1.17: Forecasting for the hen population in the industry.

4.7.4 Forecasting of workers employed in hen farm

Every production system in the egg industry requires a certain amount of labor. In a similar way to the above forecasting, the data used to forecast worker on farms covered a period of 18 years. The aim was to show changes in the number of employees before and after switching to new production systems. The number of employees used is the total from the whole industry, not from different production systems.

Figure 1.18 below shows the forecast for the workers on egg farms up to the year 2023. The two Figures, 1.16 and 1.17 show that the hen population and production of eggs started reducing between 2012 and 2013, at the same time Figure 1.18 shows that the number of workers on farms was going up. The increase in the number of workers can be attributed to

farmers switching to other production systems less efficient which demands more labor on these farms, increasing the cost of production.

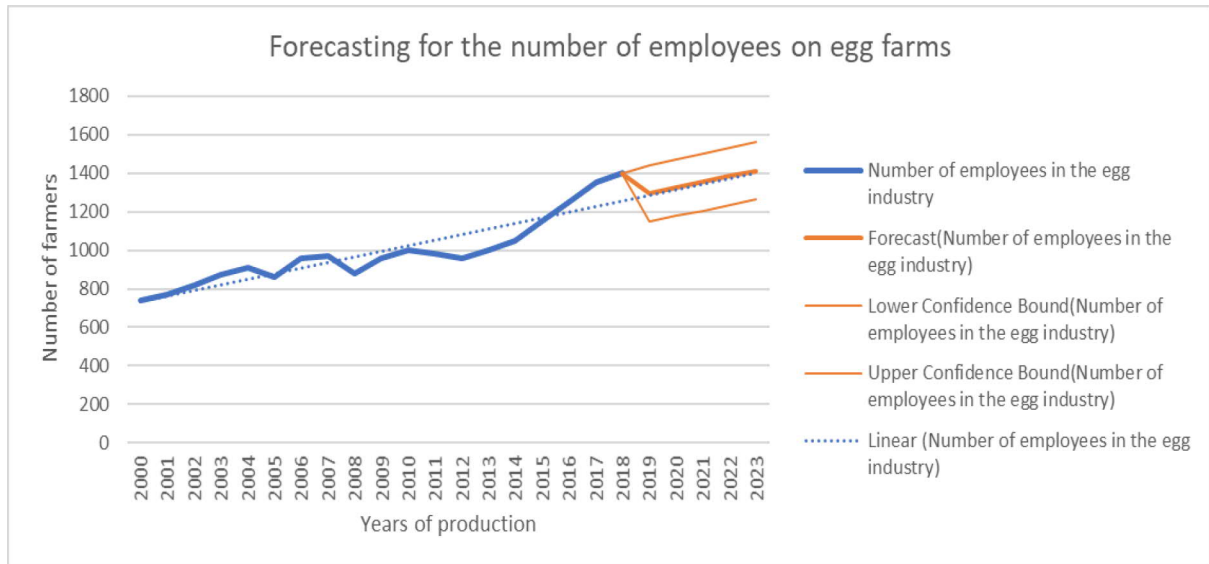


Figure 1.18: Forecasting showing the number of employees on farms.

4.7.5 Forecasting the number of farmers in the industry

The policy of phasing out the battery cages results in farmers responding differently to the changes. To establish the changes in numbers of farmers in the industry, the forecasting was done in excel to predict the future trend. The linear method was used taking into consideration the past years and the number of farmers each year. By using excel, the past trend and future could be compared

Figure 1.19 below shows that the general trend in the number of farmers in the industry has been falling. The graph shows that the number of farmers started increasing just after 2013 up to about 2018, then there is a significant fall, and the trend continues to the year 2023 as

forecasted. The increase in number of farmers can be as a result of new farmers (especially free-range farmers) entering the industry.

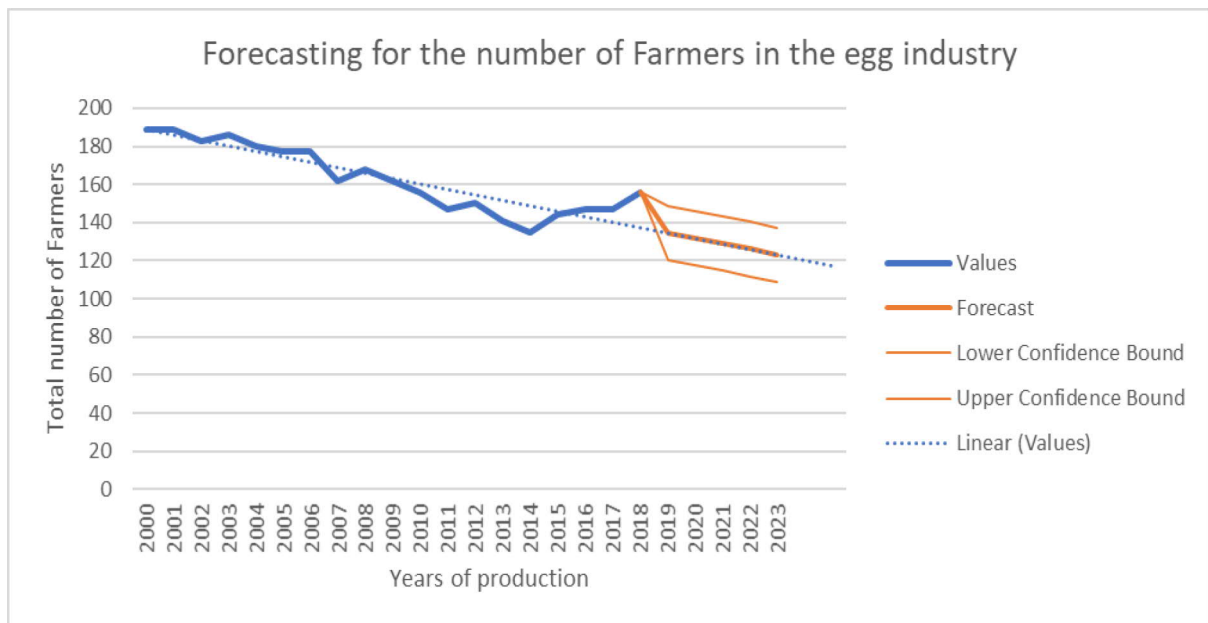


Figure 1.19: Forecasting showing changes in the number of Farmers in the egg industry.

4.7.6 Forecasting the average price of eggs

The forecasting for the price of eggs was done by first calculating the average price of eggs from around the country. The main reason for the forecasting was to predict the possible future egg price. By using historical average prices, the changes in their average can easily be understood by using the linear line produced in excel.

The figure below (Figure 1.20), shows the trend in the average price of eggs in New Zealand. The graphs show a steady increase in the average price of eggs. However, the increase is more significant from 2012 onwards. This can be attributed to the introduction of the New Code of Welfare for the layer hens which was introduced the same year. The total number of eggs

produced started to reduce as farmers started switching to colony and other production systems or even exiting the industry. See Figure 1.16 for the total production which was low between 2011 and 2013.

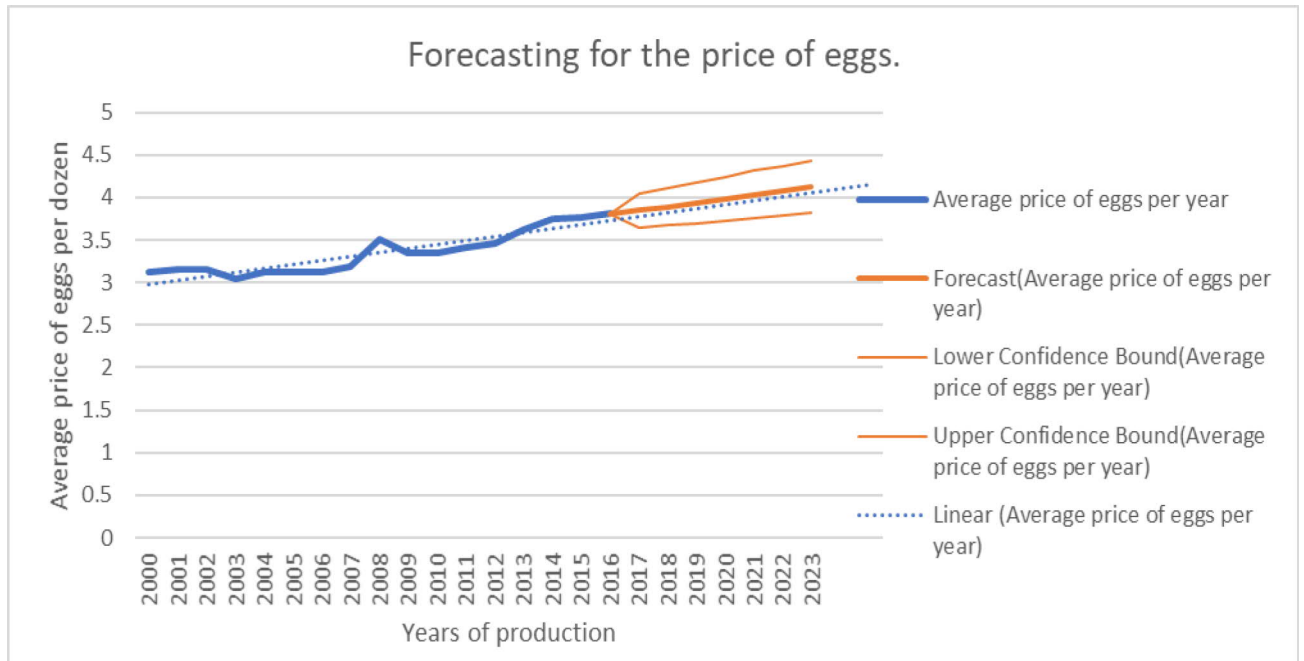


Figure 1.20: Forecasting showing average price of eggs per dozen in New Zealand.

4.7.7 Forecasting for the number of farms in the industry.

The number of farms in New Zealand has been changing for the past 18 years. The phasing out of battery cages has resulted in different production systems being preferred. The forecasting to predict the changes in the number of farms is important as it shows the impact of phasing out battery cages has on the industry. The data for number of farms from 2002 - 2019 was used to make the forecasting about future trend in the number of farms.

Figure 1.21 below is about the number of farms in the layer hen industry. For over a decade, the graphs show a trend that the number of farms has been falling. After 2013, there is an increase in the number of farms, possibly because farmers started to switch to other production systems while still using the battery cage systems on their original farms. The trend for number of farms is similar to trend for number of farmers in Figure 1.19 above.

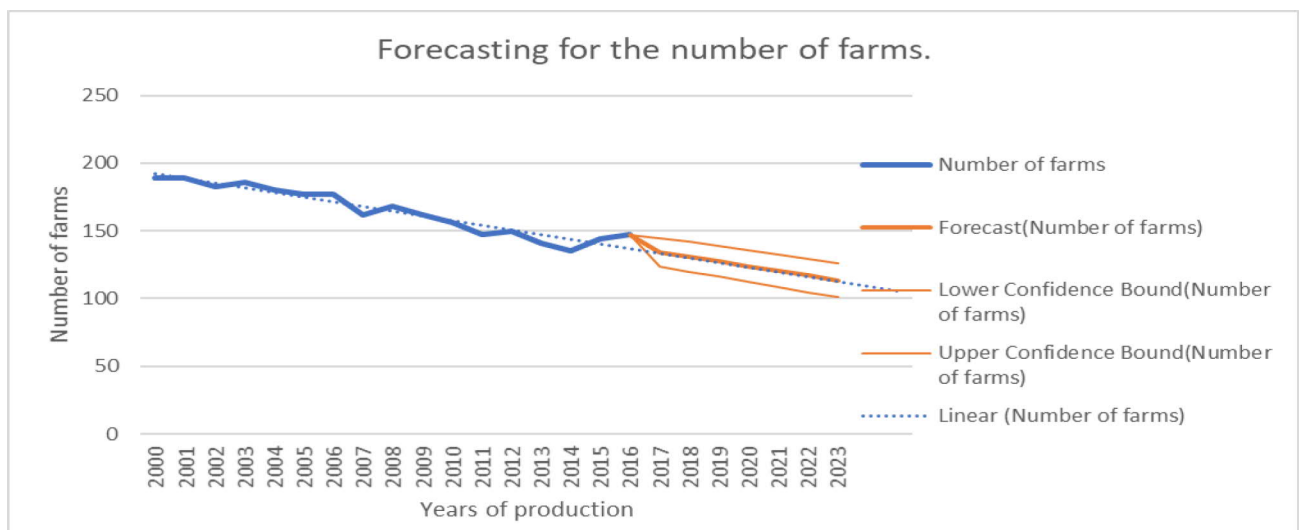


Figure 1.21: Forecasting showing the number of farms in the industry.

4.7.8 Regression one.

Table 16: Model one - Regression for the number of farms as a dependent variable.

Dependent Variable: NUMBER_OF_FARMS

Method: Least Squares

Date: 07/22/19 Time: 21:24

Sample: 2000 2018

Included observations: 19

	Coefficient	Std. Error	t-Statistic	Prob.	Variable
C	263.6227	29.11258	9.055285	0.0000	
NUMBER_OF_HENS	1.20E-06	5.34E-07	2.238817	0.0408	
NUMBER_OF_WORKERS	0.109927	0.010641	10.33082	0.0000	
TOTAL_PRODUCTION_PER_YEA	-2.81E-06	3.19E-07	-8.788690	0.0000	
R-squared	0.945547				
		Mean dependent var	147.0000		
Adjusted R-squared	0.934656	S.D. dependent var	54.58022		
S.E. of regression	13.95203	Akaike info criterion	8.293791		
Sum squared resid	2919.888	Schwarz criterion	8.492621		
Log likelihood	-74.79102	Hannan-Quinn criter.	8.327441		
F-statistic	86.82201	Durbin-Watson stat	1.571030		
Prob(F-statistic)	0.000000				

4.7.8.1 Interpretation of the results.

The P - values for all independent variables for the above regression are less than 0.05, meaning these variables are all statistically significant to predict the dependent variable (number of farms). The P-value for the number of hens is 0.04 and has a strong positive coefficient of 1.20. This means the number of hens and number of farms is showing a direct

relationship. When all other variables are held constant, a unit increment in number of hens will result in an increase in numbers of farms by 1.20. The number of workers has a P- value of 0.00, meaning it is very significant to predict the number of farms. If all other factors are held constant, a unit increase in number of workers will result in an increase in the number of farms by 0.10, if all other factors are held constant. The P-value for the total production also is showing that this independent variable is statistically significant as a predictor for the dependent variable. However, the coefficient is a negative one (- 2.8). This means the relationship with the dependent variable is an inverse one. This can be due to farm consolidation; for example, Otago-based Mainland Poultry developed a large free-range poultry farm south of Moeraki.

4.7.8.2 Linear regressions using the number of farms as a dependent variable.

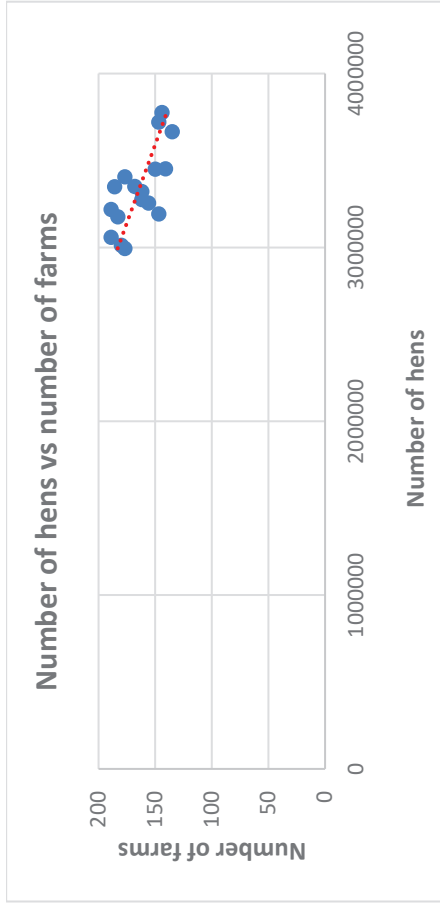


Figure 1.22a: Graph for the number of hens and number of workers

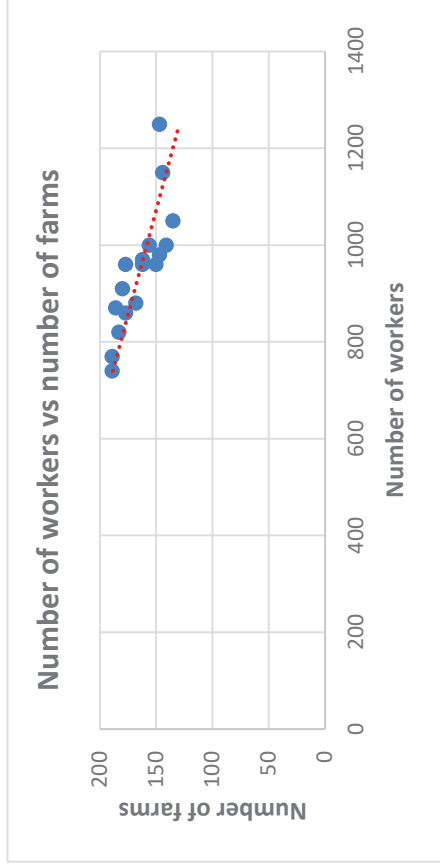


Figure 1.22b: Graph for the number of workers and number of farms

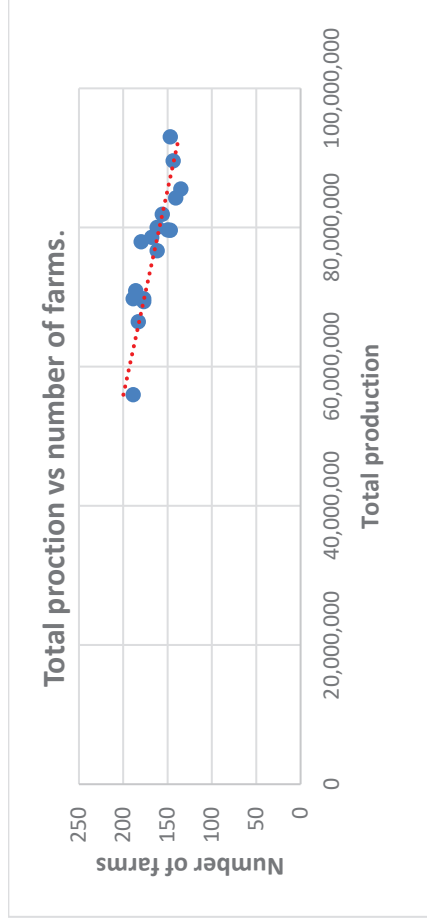


Figure 1.22c: Graph for total production and number of farms

The Figures above (1.22a, 1.22b and 1.22c) are all showing a negative linear relationship between independent and dependent variables. For Figure 1.22a and 1.22b, the trend line shows a weaker relationship between the independent and dependent variable. Some observations are far from the trendline and the two figures have some outliers. Figure 1.22c is showing the variable points that are very close to the trendline, which means the relationship between total production and the number of farms is very strong. Figure 1.22a and 1.22b above are showing a different relationship compared to Table 16 for the multiple regression which is more superior.

The regression model above (Table 16) tries to answer the research question about the possible adversities the egg market and farmers are likely to face as battery cages are being phased-out. The regression shows a direct relationship between the number of hens and the number of farms. Figure 1.21 above shows that number of farms were declining just before and after 2012 but started increasing after 2012. Figure 1.17 shows a similar trend for number of hens which started to increase after 2012. This confirms the relationship between these variables in the regression. The decline of number of farms can be due to the New Code of Welfare for the hens, while the increase in number of farms after 2012 can be the result of other players entering the industry and existing farms starting up new farms using different production systems in preparation to phase-out battery cages. Even though the number of farms and hens started to increase after 2012, the total production of eggs from regression is showing a negative sign, pointing to the possibility of egg shortages. The partial increase in number of hens and farms after 2012 had no significant effect on production. This can be

due to farmers switching to less efficient production systems compared to battery cage system.

On the other hand, number of workers on hen farms started to rise at a fast rate after 2012 (see Figure 1.18 above). This can be attributed to new farms being established around the country. As indicated above, number of hens and number of farms did not increase production, at the same time number of workers has been increasing. This is an added cost to farmers and the whole industry.

4.8.8 Regression two.

Table 17: Model two - Regression for the number of workers as a dependent variable.

Dependent Variable: NUMBER_OF_WORKERS

Method: Least Squares

Date: 07/22/19 Time: 21:48

Sample: 2000 2018

Included observations: 19

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1916.168	390.9943	-4.900757	0.0002
NUMBER_OF_FARMS	7.975918	0.772051	10.33082	0.0000
NUMBER_OF_HENS	-1.02E-05	4.54E-06	-2.258748	0.0392
TOTAL_PRODUCTION_PER_YEA	2.14E-05	3.88E-06	5.502982	0.0001
R-squared	0.886828	Mean dependent var	848.9474	
Adjusted R-squared	0.864193	S.D. dependent var	322.4885	
S.E. of regression	118.8433	Akaike info criterion	12.57815	
Sum squared resid	211856.0	Schwarz criterion	12.77698	
Log likelihood	-115.4925	Hannan-Quinn criter.	12.61180	
F-statistic	39.18046	Durbin-Watson stat	1.445446	
Prob(F-statistic)	0.000000			

4.8.8.1 Interpretation of the results

All of the independent variables above are significant at 5 per cent. There is a positive relationship between the number of farms and farmworkers. Total production per year has a similar relationship; all other variables remaining constant, a unit increment in total production will result in an increase of 2.1 in number of workers. On the other hand, the coefficient for number of hens is a negative one, resulting in an inverse relationship with the dependent variable. A unit decrease in number of hens has an effect of increasing number of workers by 1.0 when other factors are held constant. This can be attributed to farmers using less efficient production systems where more workers are needed even when number of hens are lower compared to battery cage system.

4.8.8.3 Linear regressions using number of workers as a dependent variable.

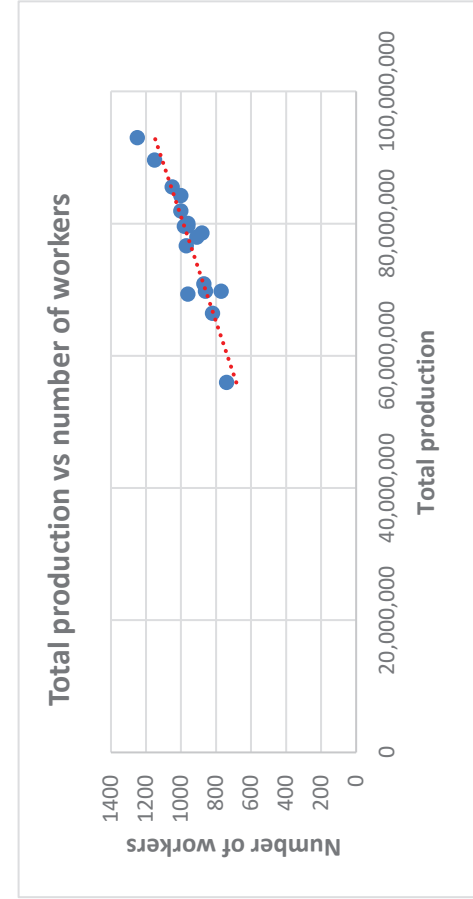


Figure 1.23a: Graph for total production and number worker

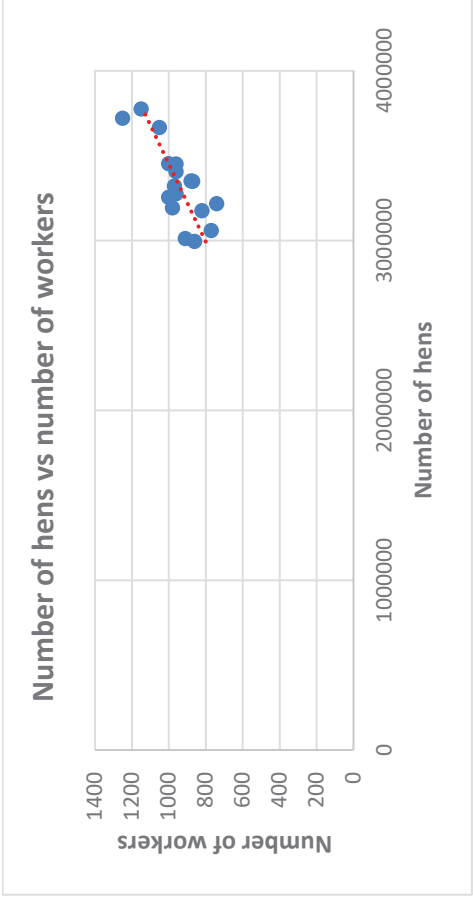


Figure 1.23b: Graph for the number of hens and number of workers

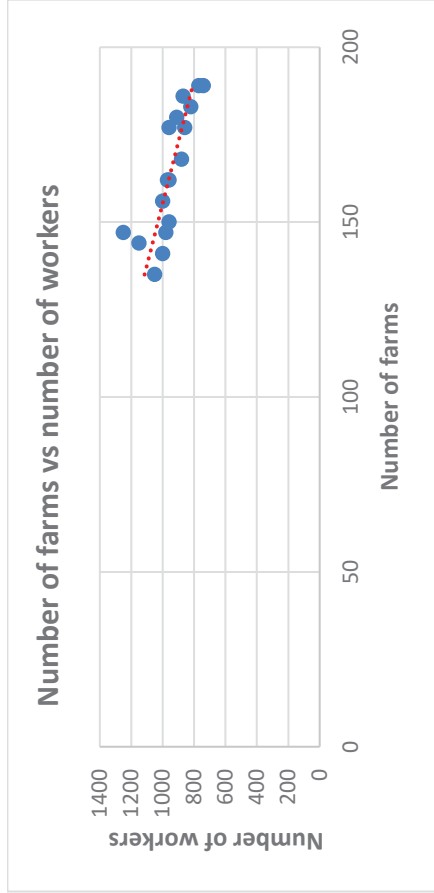


Figure 1.23c: Graph for number of farms and the number of workers

The linear graphs above (1.23a and 1.23b) are showing a positive relationship between independent and dependent variables. Figure 1.23c is showing an inverse relationship between number of farms and number of workers, which is different from the multiple regression results in Table 17. This is similar to the results shown in Figure 1.23b for number of hens and workers which has a positive relationship, while in Table 17 the coefficient is showing an inverse relationship. Figure 1.23a is showing the same relationship with the one in Table 17. Figure 1.23b and 1.23c are showing a weaker relationship between variables compared to Figure 1.23a. This can be seen by having observations far away from the trendline.

The number of hens as a predictor in Table 17 is not very significant as compared to other independent variables. However, the negative sign indicates that the reduction in the hen population in the country will not necessarily reduce the number of workers on farms. Farmers switching to other production systems will still require more workers than when using battery cages, which is an added cost. In Figure 1.17 above, the graph is showing a reduction in the hen population in 2017, while Figure 1.18 is showing number of workers going up. This aligns with the regression results above. The relationship between the total production and number of workers follows the marginal principle of economics of adding workers until marginal product reaches zero. A direct relationship shown between number of farms and number workers means more workers will be required in the industry as more farms are established.

4.8.9 Regression three.

Table 18: Model three - Regression for total production as a dependent variable.

Dependent Variable: TOTAL_PRODUCTION_PER_YEA

Method: Least Squares

Date: 07/23/19 Time: 22:04

Sample: 2000 2018

Included observations: 19

Variable	Coefficient	Std. Error	t -Statistic	Prob.
C	18249164	4944193.	3.691030	0.0022
NUMBER_OF_FARMS	-181842.0	35586.16	-5.109909	0.0001
NUMBER_OF_HENS	20.22075	1.120647	18.04383	0.0000
NUMBER_OF_WORKERS	21641.34	5483.948	3.946307	0.0013
R-squared	0.982731	Mean dependent var	70202801	
Adjusted R-squared	0.979277	S.D. dependent var	26444668	
S.E. of regression	3806810.	Akaike info criterion	33.32715	
Sum squared resid	2.17E+14	Schwarz criterion	33.52597	
Log likelihood	-312.6079	Hannan-Quinn criter.	33.36080	
F-statistic	284.5376	Durbin-Watson stat	1.720064	
Prob(F-statistic)	0.000000			

4.8.9.1 Interpretation of the results.

The regression model above (Table 18) shows that all the independent variables are statistically significant to predict the dependent variable. The number of farms as a predictor has a negative coefficient. A coefficient for number of hens is positive. When number of hens

increase by a unit, total production increased by 20.2. This is also similar to number of workers which has a positive coefficient.

4.8.9.2 Linear regressions using total production per year as a dependent variable.

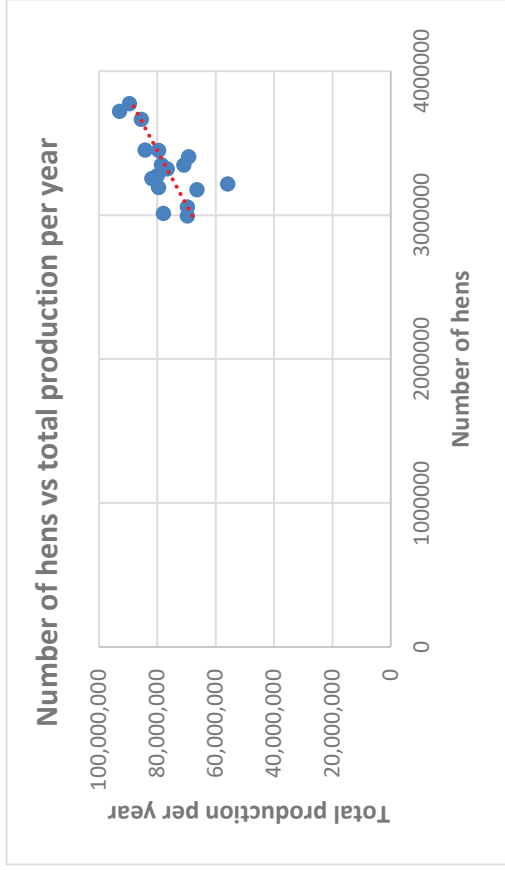


Figure 1.24a: Graph for the number of hens and total production

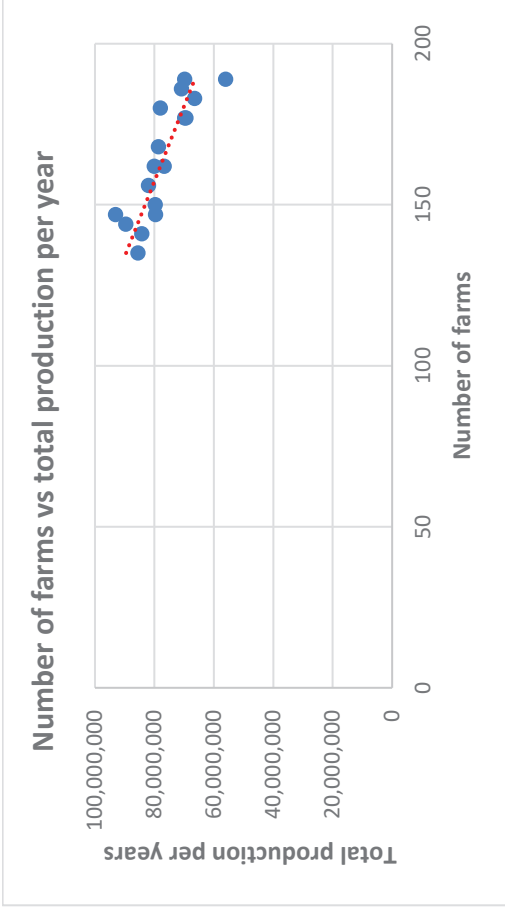


Figure 1.24b: Graph for number of farms and total production

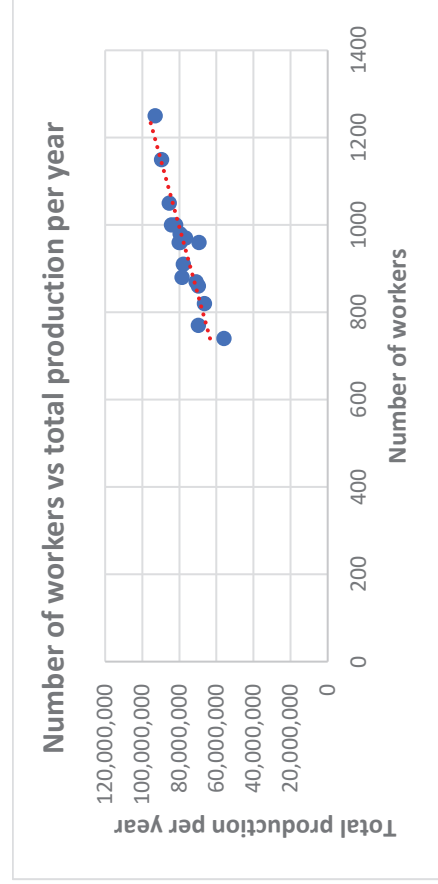


Figure 1.24c: Graph for the number of workers and total production

For the simple linear regression above, Figure 1.24a and 1.24c are showing a positive relationship, while Figure 1.24b has an inverse relationship between variables. All the above simple linear regressions are in line with the results from Table 18 for the multiple regression. Figure 1.24a and 1.24b are showing a weaker correlation between variables with observations far from the trendline with a few outliers.

The regression in Table 18 explains the changes in production as a result of other factors changing. The expectation was that when the number of farms increases, then so does the production. This expectation is contrary to the result obtained where the relationship is inverse. Comparing Figure 1.16 and 1.21, the general trend is that when the number of farms is decreasing, total production is increasing. This can be as a result of farm consolidation when other small farms exit the market or acquired by their larger peers. In the early stages of phasing out of battery cages, the reduction in number of farms has less impact on production because other big farms have also been increasing production taking advantage of other producers exiting the industry. The scenario occurring in the short run is likely to change in future when all battery cages are phased out by 2022. For example, on April 16, 2019 The Guardian reported that New Zealand is experiencing shortages of eggs as hen number decline (Roy 2019). At the same time, the number of farms increased from 156 (see appendix C for number of hens in 2018) to 165 between 2018 and 2019, as reported by Egg Producer Federation. This confirms that the shortage of eggs is being experienced already. There is an increase in the number of farms, but egg production is falling. This can be as a result of smaller free-range farms being established with a low production rate compared to other production systems (see Table 10 above)

4.8.9.3 Regression model

Regression models are widely used in applied research. Linear regression is one statistical test that is simple, yet appropriate to answer many questions. Linear regression can be used to show a relationship between two or more variables, predict future economic conditions, trends, or values and to understand how the dependent variable change with respect to changes in other independent variables. The equation for a multilinear equation is represented as: $\hat{y} = b_0 + b_1X_1 + b_2X_2 + \dots + b_{k-1}X_{k-1} + b_kX_k$ In this equation, \hat{y} is the *predicted* value of the dependent variable. $X_1, x_2, x_3, \dots, x_k$ denote values of k independent variables. The b's are the parameters or regression coefficients. Statistical packages like Eviews, SPSS, or Excel can be used to run such regression. For this research, the multiple regression is used. The main aim of using a multiple regression is to show how the dependent variables are caused by independent variables. The regression has been used to show the current and possible future trends. Also, the regression links the data collected from the survey and the secondary data.

4.8.10 Some recommendations given by farmers on best ways the transitioning period from battery cages to colony cages could have been handled.

The survey reveals that phasing out battery cages will increase the cost of production. The initial cost of buying and installing new gear is very high. Because of the costs involved in switching to colony cages, some farmers recommend that the government should subsidize the cost of transitioning from battery cages to colony cages. The battery cage system being the most efficient compared to other systems used in the industry, it is not surprising that many farmers oppose the phasing out of battery cages. One of the survey findings is that some farmers opt to replace battery cages with the free-range system, but majority are finding it difficult to get resource consent. These farmers would welcome government intervention in this area. On the other hand, some farmers recommend that the government should help to increase public awareness about different production systems for the general public to know their differences. The phasing out of the battery cages is putting stress on most farmers. Some of the farmers commented on the desirability of phasing out period of battery cages as the consultation process was not handled properly, that Some stakeholders, in their opinion, were not consulted before introducing the new hen layer code of welfare.

5.0 Conclusion

The New Code of Welfare for the egg-laying hens was introduced in the year 2012. This led to the phasing out of battery cages which is still an ongoing process. Colony cages were recommended as an alternative production system to replace the battery cages. The phasing out of battery cages in New Zealand is a contentious issue which has not thoroughly been researched. This thesis gave an insight into the Impact of phasing out battery cages and switching to colony cages on New Zealand's Poultry Industry. The topic for this thesis is important as it brings out the impacts and reactions felt by the egg producers after the law was passed to phase-out battery cages. The topic is formulated to unearth the challenges farmers are facing and anticipate facing as they switch to colony cages or other production systems.

In New Zealand, animal welfare advocates have been pressuring the government to enact a bill to improve the welfare of animals. The egg industry is no exception to some concerns of animal cruelty, particularly in battery cages. The main concern of battery cages is that hens are not allowed to exhibit their natural behavior because they are confined in cages of a space equivalent to an A 4 paper. The hens spend their entire life confined in these cages without having access to the outside world. Which means the hens under battery cage system have no opportunity to scratch, perch, play in the sand, forage in paddocks, fully spread their wings, and to show other natural behaviors. In some extreme cases, some animal welfare advocates

claim that the eggs from battery cages are inferior compared to eggs from other production systems, but this view is not universally accepted.

Before and after the introduction of the New Code of Welfare for the egg-laying hens in 2012, not many scholars have researched on the topic of phasing out battery cages in New Zealand. The main focus of some research done was to predict the impact on production and prices of eggs after the phasing out of battery cages. Some research has been conducted on the suitability of the colony cages as an alternative production system, that also took into consideration the costs involved in both production systems (battery and colony system). The phasing out of battery cages is still underway, and there have been many changes in the industry from the time some research was done to predict the future of the egg industry. This thesis focuses on the state of the industry from the time farmers started phasing out battery cage. The main focus is to unearth how farmers are coping and how the industry is shaping up 7 years after the New Code of Welfare for the egg-laying hens was introduced. Some predictions are made based on the possible shape of the industry.

The findings from this thesis are similar in some ways to a few pieces of research that were done to predict the outcome after phasing out the battery cages. The main difference is that the findings from this thesis are actual outcomes (as reported by farmers) after farmers started switching to colony cages and other productions systems. The main finding from this research is that the cost of production for egg producers is escalating to high levels. This is as a result of using less efficient production systems compared to battery cages. Farmers are experiencing higher costs from both fixed and variable components. The cost of installing new

gear is high, especially that they still have to continue using the battery cages while installing the new system. Other fixed costs include the cost of land and resource consents. The increased cost of production is due to feed intake which is higher because hens are more mobile and eat more. Also, more workers are required in new production systems and other sundry expenses. Some farmers are exiting the industry due to this higher cost of production. In the short run, higher cost of production will lead to disruption in egg prices (increase prices) due to egg shortages. A high number of farmers in the industry are scaling up production due to this anticipated shortage and better prices. Higher prices are also likely to attract new entrants in the industry which will create more competition in the long run, bringing prices down subsequently. The research found that free-range farms are becoming more prevalent compared to other production systems. The structure of the industry in terms of farm sizes is changing. The number of farms under small farm category is increasing as free-range farming has become more popular.

The process of phasing out battery cages will be completed in 2022. The structure of the entire industry is changing in terms of farm sizes, numbers of farms and production systems used. The more accurate picture of the egg industry will only be established after the phasing out of battery cages has been concluded. Hence, there is a need for continued research in the area, especially more detailed research that focuses on the possibility of egg market disruptions during the time of egg shortages. The New Zealand government does not allow the importation of eggs, except in powder form, meaning a focus on the domestic egg supply and demand after 2022 is required. The other area of future research is on production systems that farmers are currently using. Colony and barn systems being new in the country,

less is known about their performance apart from literature from other countries. There is need to have New Zealand based research for these production systems.

5.1 Research implications

The results of the research can be used by many stakeholders for future reference. The policymakers can use the findings to review the outcome of the New Code of Welfare for the layer hens. This is in terms of whether the changes in the egg industry are yielding positive results. Some farmers that have not yet decided the direction to take, this research can be used to understand the happenings in the industry and come up with a strategic management decision on how to position the business. The most useful finding from the research is that the cost of production is on the rise as reported by farmers. As the number of hens is reducing, farmers are experiencing shortages of eggs. The increasing cost of production and egg shortages will make the price of eggs to increase. This information can be used to plan for the future on how to cope with the severe impending egg shortages in the country.

5.2 Research limitations

From the time the New Code of Welfare for the layer hens was introduced in New Zealand, the egg industry started re-shaping as farmers started switching to different production systems. Some farmers had to exit the industry because of the increased cost of production. The phasing out of the battery cages is still an on-going process to be completed in 2022. This means some figures (percentages) in this research cannot be used to show the actual future trends in the industry. The other limitation of this research is that the data used for the regression modelling is the annual data affecting the frequency. The data for the price of eggs

used is the annual averages which may not give a clear picture of how egg prices are changing within a short period. The research was conducted 7 years after the New Code of Welfare was introduced, hence this poses a limitation when running a regression which requires data from a more extended period.

5.3 Recommendation for further research

The research findings indicate that free-range farming is becoming more prevalent with 56% of egg farms being free-range. There is a need to research further about free-range farming in New Zealand especially in the management practices farmers can use. This will help free range farmers to have a benchmark to help manage these farms. The other area of research could be to establish why the colony system is not a favourable alternative to replace battery cages in New Zealand even though it is more efficient than the free-range system and other production systems.

6.0 References

- Abrahamsson, P & Tauson, R. (1993). Effects of perches at different positions in conventional cages for laying hens of 2 different strains. *Acta Agriculturae Scandinavica (Section A: Animal Science)* 43, 228-235
- Aerni, V., El-Lethey, H., & Wechsler, B. (2000). Effect of foraging material and food form on feather pecking in laying hens. *British Poultry Science*, 41,16-21.
- Agriculture and Agri-Food Canada (AAFC). (2012). Poultry Marketplace: Canada's Egg Industry...at a glance. Ottawa, ON. Retrieved from: http://www.agr.gc.ca/poultry/gleg_eng.htm
- Ahammed M, Chae B.J, Lohakare J, et al. (2014). Comparison of aviary, barn and conventional cage raising of chickens on laying performance and egg quality. *Asian-Australas J Anim Sci.* 2014;27(8):1196-203.
- Ahmad H. A. (2011). Egg production forecasting: Determining efficient modeling approaches. *The Journal of applied poultry research*, 20(4), 463–473. doi:10.3382/japr.2010-00266
- Ahmad H.A, Mariano M (2006) Comparison of forecasting methodologies using egg price as a test case. *Poult Sci.* 2006; 85:798–807. [[PubMed](#)] [[Google Scholar](#)]
- Ahmad J, Al-Mahasneh, Sreenatha G. Anavatti, Matthew A. Garratt (2018). Review of Applications of Generalized Regression Neural Networks in Identification and Control of Dynamic Systems. Retrieved from, <https://arxiv.org/pdf/1805.11236.pdf>
- Antwi, S. K. & Hamza, K. (2015). Qualitative and Quantitative Research Paradigms in Business Research: A Philosophical Reflection. *European Journal of Business and Management*, 7(3),

- Appleby, M. (1984). Factors Affecting Floor Laying By Domestic Hens: A Review. *World's Poultry Science Journal*, 40(3), 241-249. doi:10.1079/WPS19840019
- Appleby, M.C., & Hughes, B.O. (1991). Welfare of laying hens in cages and alternative systems: environmental, physical and behavioral aspects. *World's Poultry Science Journal*, 47(2), 109128.
- Appleby, Michael C. / Hughes, Barry O. / Mench, Joy A. / Olsson, Anna I., (eds.) (2011). *Animal Welfare*. 2nd edition. Wallingford, Oxon, CABI Publishing.
- Arunraj, N. S. & Ahrens D, (2015). A hybrid seasonal autoregressive integrated moving average and quantile regression for daily food sales forecasting. *International Journal of Production Economics*. 170, 321–335. ISSN 0925-5273.
- Bell, D.D., & Weaver, W.D. (2002). *Commercial Chicken Meat and Egg Production*. Norwell, MA: Kluwer Academic Publishers. p 483.
- Bernard, H. R., & Bernard, H. R. (2012). *Social research methods: Qualitative and quantitative approaches*. Sage publications.
- Bestman, M.W.P.et al. (2001). The prevention and control of feather pecking: Application to commercial systems. 10.1017/S0043933913000809
- Bos, B., Groot Koerkamp, P.W.G. & K. Groenestein. (2003). A novel design approach for livestock housing based on recursive control – with examples to reduce the environmental pollution. *Livestock Production Science*, 84, 157-170.
- Brunberg, E., Jensen, P., Isaksson, A., & Keeling, L. (2011). Feather pecking behavior in laying hens: Hypothalamic gene expression in birds performing and receiving pecks. *Poultry Science*, 90, 1145-1152.

- Choct, M., & Hartini, S. (2005). Interaction between nutrition and cannibalism in laying hens.
- Christine J. Nicol (1987) Effect of cage height and area on the behavior of hens housed in battery cages, *British Poultry Science*, 28:2, 327-335, DOI: 10.1080/00071668708416965
- Connolly, P. (2007). *Quantitative data analysis in education: A critical introduction using SPSS*. London & New York, NY: Routledge.
- Creative Research Systems (n.d). Sample Size Calculator. Retrieved from, <https://www.surveysystem.com/sscalc.htm>
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications
- Creswell, J. W. (2014). *Research Design Qualitative, Quantitative, and Mixed Methods Approaches (4th Ed.)*. Thousand Oaks, CA: SAGE Publications
- Dawkins, M.S. (1985). Cage height preference and use in battery-kept hens. The Veterinary development of gentle and severe feather pecking in loose housed laying hens. *Applied Animal Behavior Science*, 123(1), 32-42
- Dixon, L.M. (2008). Feather pecking behavior and associated welfare issues in laying hens. *Avian Biology Research*, 1(2), 73-87. domestic fowl in the wild. *Applied Animal Ethology*, 4, 13-27. domestic fowl reviewed from a Tinbergian and animal welfare perspective.
- Draft Economic Analysis for Consultation*. MAF Biosecurity New Zealand Discussion Paper No: 2010/02
- Duhaime, (n.d). Batter cage definition. Retrieved from, <http://www.duhaime.org/LegalDictionary/B/BatteryCages.aspx>
- Duncan, I.J.H. & Kite, V.G. (1989). Nest site selection and nest-building behavior in domestic fowl.

Animal Behavior, 37, 215-231. Edition. (pp. 27-43). Wallingford: U.K.: CABI Publishing.

Egg Producer Federation (n.d). Feeding the nation of egg-lovers. Retrieved from,

<https://eggfarmers.org.nz/egg-farming-in-nz>

Elson, H. A. (2015). Poultry welfare in intensive and extensive production systems. *World's Poultry Science Journal*, 17:449-459

FoodRisc, (2016). Mixed method research. Retrieved from,

http://resourcecentre.foodrisc.org/mixed-methods-research_185.html

Gazdíková, J. & Šusteková D, (2009). Selected statistical tools for financial analysis.

Ekonomickomanažerské spectrum. 3(2), 8-11. ISSN 1337-0839

Glatz, P.C. (ed.), Poultry Welfare Issues: Beak Trimming. (pp.111-115). Nottingham, U.K.: Nottingham

University Press. indicated by tonic immobility between laying hens in aviaries and in cages.

Animal Welfare, 2, 105-112. JO - World's Poultry Science Journal

Gregory, N.G., & Wilkins, L.J. (1991). Broken bones in hens. *The Veterinary Record*, 129(25-26), 559.

Hansen, I., B. O. Braastad, J. Storbraten, and M. Tofastrud, (1993). Differences in fearfulness indicated by tonic immobility between laying hens in aviaries and cages. *Anim. Welfare* 2:105–112.

Hemsworth, P. H., Mellor, D. J., Cronin, G. M. & Tilbrook, A. J. (2015). Scientific assessment of animal welfare.

New Zealand Veterinary Journal, 63(1): 24-30

Hovi, M. & Bouilhol, M. (eds.), Human-Animal Relationship: Stockmanship and Housing in Organic

Livestock Systems. Proceedings of the Third NAHWOA 23 REPORT FROM THE WORLD SOCIETY FOR THE PROTECTION OF ANIMALS 24 Workshop (pp.77-86).

Hutching G, (2019). New rules on hen cages and rising feed costs lift egg prices. Retrieved from, <https://www.stuff.co.nz/business/farming/109969799/new-rules-on-hen-cages-and-rising-feed-costs-lift-egg-prices>

Ian J. H. Duncan (2001) Animal Welfare Issues in the Poultry Industry: Is There a Lesson to Be Learned? *Journal of Applied Animal Welfare Science*, 4:3, 207-221, DOI: 10.1207/S15327604JAWS0403_04

Kourentzes, N., (2013). Intermittent demand forecasts with neural networks. *International Journal of Production Economics*. 143(1), 198–206. ISSN 0925-5273.

Lacey, J (2014). *Economics & Interdisciplinary Studies*. Retrieved from, <https://www.quora.com/What-is-the-best-Statistical-Software-for-Econometrics>

Laerd Statistics (2018). Multiple Regression Analysis using SPSS Statistics. Retrieved from, <https://statistics.laerd.com/spss-tutorials/multiple-regression-using-spss-statistics.php>

Lambton, S.L., Knowles, T.G., Yorke, C. and Nicol, C.J. (2010) The risk factors affecting the development of gentle and severe feather pecking in loose housed laying hens. *Applied Animal Behavior Science* 123: 32-42.

Lay D. C., Fulton R. M, Hester P. Y et al. Hen welfare in different housing systems, *Poultry Science*, Volume 90, Issue 1, 1 January 2011, Pages 278–294,

Lorna C, & Niel C (2010). Evaluation of Furnished Colony Cage Systems for the New Zealand Egg Market, 2007 – 2010. Retrieved from,

http://pianz.org.nz/wpcontent/uploads/2010/11/Lorna_Craig_WPSA2010presentation.pdf

Loworn, Jonathan & Perry, Nancy, *California Proposition 2: A Watershed Moment for Animal Law*, 15 *Animal L.* 149 (2008-2009)

MAF (2010). Review of the Animal Welfare (Layer Hens) Code of Welfare. Retrieved from, <https://www.mpi.govt.nz/dmsdocument/1438/direct>

Matthews W.A & . Sumner D.A (2015). Effects of housing system on the costs of commercial egg production *Poultry Science*, Volume 94, Issue 3, Pages 552–557, <https://doi.org/10.3382/ps/peu011>

Mellor, D. J. (2015). Enhancing animal welfare by creating opportunities for positive affective engagement. *New Zealand Veterinary Journal*, 63(1): 3-8

Mitrea, C. A., C. K. M. Lee & Wu, (2009). A Comparison between Neural Networks and Traditional Forecasting Methods: A Case Study. *International Journal of Engineering Business Management*. 1(2), 19-24. ISSN 1847-9790.

Muir W.M & S.E. Aggrey (Eds.), (2003). *Poultry Genetics, Breeding and Biotechnology* (pp. 29-52). Wallingford, U.K.: CABI Publishing.

Murray K & Harnett P (June 2010). *Egg market Dynamics – An Investigation into the Impact of Changed Production Requirements*. Law and Economics Consulting Group (LECG)
News hub (2018). *New Zealand supermarkets to stop selling caged eggs by 2027*. Retrieved from, <https://www.newshub.co.nz/home/money/2018/02/new-zealand-supermarkets-tostopselling-caged-eggs-by-2027.html>

Nimmo-Bell (2010). Economic Impact of a proposed revision to the Code of Welfare for Layer Hens. Retrieved from, <https://eggfarmers.org.nz/news/the-economic-cost-of-shifting-tofreerange-barn-and-colony-egg-farming>

NZ Institute of Economic Research, (2001). An Economic Assessment of Production Systems in the Egg Industry New Zealand Statistics Egg and Food Price Indices. Nielsen data on egg sales via supermarkets 2000 to 2008

Olsson, I.A.S., Keeling, L.J., Duncan, I.J.H., (2002a). Why do hens sham dustbathe when they have litter? *Appl. Anim. Behav. Sci.* 76, 53–64

Organic Agriculture Centre of Canada (OACC). (2009). Reducing the Risk of Feather Pecking for Laying Hens in Organic Egg Production. Animal Welfare on Organic Farms Fact Sheet Series. *Poultry Science Journal*, 40, 241-249. *Record*, 116, 345-347.

Rodenburg, T. B., Tuytens, F. A. M., Sonck, B., De Reu, K., Herman, L., Zoons, J., (2005). Welfare, health, and hygiene of laying hens housed in furnished cages and in alternative housing systems. *Journal of Applied Animal Welfare Science* 8: 211-226

Roy E.A (2019). New Zealand suffers egg shortage as farmers scramble to go free-range. Retrieved from, <https://www.theguardian.com/world/2019/apr/16/new-zealand-suffers-eggshortageas-farmers-scr>

Savory, C.J., Wood-Gush, D.G.M., & Duncan, I.J.H. (1978). Feeding behaviour in a population of domestic fowls in the wild. Retrieved from, <https://www.sciencedirect.com/science/article/pii/0304376278900901>

Shimmura, T., Maruyama, Y. & Fujino, S. et al. (2015). Persistent effect of broody hens on behavior of chickens. *Animal Science Journal*. 86 (2) 214-20

Špinka, M., & Wemelsfelder, F. (2011). Environmental challenge and animal agency. Animal welfare. Wallingford, UK: CAB International. p, 27-44.

Stats NZ (2019). *Variable by Total New Zealand (Annual-Jun)*. Retrieved from, <https://figure.nz/table/nAuf85zOP3ZLXfsl>

- Suto Z, Horn P, Ujvari J. (1997). The effect of different housing systems on production and egg quality traits of brown and Leghorn type layers. *Acta Agraria Kaposvariensis*. 1997; 1:29–35.
- Taylor, C and Gibbs, G R (2010) "What is Qualitative Data Analysis (QDA)?", *Online QDA Web Site*, [onlineqda.hud.ac.uk/Intro_QDA/what_is_qda.php]
- Vojteková, M. & Bartošová V, (2009). Comparability and mathematical aspects of the use of indicators of financial analysis in the evaluation of the company. *Ekonomickomanažerské spectrum*. 3(2), 72-76. ISSN 1337-0839.
- Whitehead C.C, Fleming R.H, Julian R.J, and Sørensen P. (2003). Skeletal problems associated with selection for increased production. In: Muir WM and Aggrey SE (eds.), *Poultry Genetics, Breeding and Biotechnology* (Wallingford, U.K.: CABI Publishing, pp. 29-52).
- Widowski, T. M., Classen, H. & Newberry, R. C. et al. (2013). *Code of practice for the care and handling of pullets, layers and spent fowl Poultry (Layers): Review of scientific research on priority welfare issues*. National Farm Animal Care Council
- Widowski, T. M., Hemsworth, P. H., Barnett, J. L. & Rault, J. L. (2016). Laying hen welfare I. Social environment and space. *World's Poultry Science Journal*, 72: 333-342
- Wilson J, (2013). Battery phase out. Retrieved from, <https://www.consumer.org.nz/articles/battery-cages>
- Zhang, W., Q. CAO & Schniederjans M. J, (2004). Neural network earnings per share forecasting models: A comparative analysis of alternative methods. *Decision Sciences*. 35(2), 205-237. ISSN 1540-5915.

6.1 Appendices

Appendix A: Cover letter and Participation Information Sheet.

Email Cover letter.

Introduction

My name is Harold Mayaba, conducting a survey which goes towards completion of Masters in Agri - Commerce at Massey University. The survey questionnaire was approved by the ethics committee from Massey University. My supervisor is Dr Shamim Shakur, a Senior Lecturer from Massey University – School of Economics and Finance.

In this study, the principal aim is to find out the extent to which the new Zealand's poultry industry and other associated stakeholders might be affected by the switch from battery cages to colony cages. New Zealand. Below are the specific objectives:

- 3 To determine the current trends in the poultry industry's use of battery cages.
- 4 To establish some of the perceived benefits of adopting colony cages in the poultry industry.
- 5 To predict possible adversities that the egg market and egg farmers might face in the wake of the poultry industry's switch from battery cages to colony cages.
- 6 To examine some of the challenges that farmers have faced during the phase-out of battery cages in the poultry industry of New Zealand.

The findings of the research, when completed, will be made available to all participants for this research. The results of the research will be shared with participants by sending a summary of the results by email and post mails. The findings will also be made available to the public via the Massey University publication website.

The completion of the survey by participants implies assent (*completing the survey implies participants have given their consent*). Your participation in the survey is humbly requested.

Approximately, it will take 20 minutes to fill in this questionnaire.

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application SOB 18/48. If you have any concerns about the conduct of this research, please contact Dr Gerald Harrison, Chair, Massey University Human Ethics Committee: Southern B, telephone 06 356 9099 x 83657, email humanethicsouthb@massey.ac.nz

Participation Information Sheet.



Participant Information Sheet for the survey.

Study title: Assessing the Impact of Phasing Out Battery Cages and Switching to Colony Cages in the Poultry Industry of New Zealand.

Note: *This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application SOB 18/48. If you have any concerns about the conduct of this research, please contact Dr Gerald Harrison, Chair, Massey University Human Ethics Committee: Southern B, telephone 06 356 9099 x 83657, email humanethicsouthb@massey.ac.nz.*

Locality: Massey University.

Researcher: Harold Mayaba

Contact details:

Mobile number: [REDACTED]

Contact address: [REDACTED]

Email address: [REDACTED]

Dear egg producer,

You are invited to take part in a study on Assessing the Impact of Phasing Out Battery Cages and Switching to Colony System. Whether or not you take part is your choice. If you don't want to take part, you don't have to give a reason. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This Participant Information Sheet will help you decide if you'd like to take part. It sets out why I'm doing the study, what your participation would involve, what the benefits and risks to you might be, and what would happen after the study ends. Before you decide you may want to talk about the study with other people, such as family members and friends.

The purpose of the study.

The purpose of this study is to establish the Impact of Phasing Out Battery Cages and Switching to Colony Cages in the Poultry Industry of New Zealand. The specific objectives are as follows;

- 7 To determine the current trends in New Zealand poultry industry's use of battery cages.
- 8 To establish some of the perceived benefits of adopting colony cages in the poultry industry of New Zealand.
- 9 To predict possible adversities that the egg market and egg farmers might face in the wake of the poultry industry's switch from battery cages to colony cages.
- 10 To examine some of the challenges that farmers have faced during the phase-out of battery cages in the poultry industry of New Zealand.
- 11 To recommend possible solutions to the challenges that farmers have faced during the phase-out of battery cages in the poultry industry of New Zealand.

The study meets the standards required after it was checked and approved by the supervisor and the ethics committee. The study is purely for academic purposes towards my Master program in Agri – Commerce from Massey University and is self - funded. I can be contacted using the details given above and the replies can be sent to the above address using the enclosed envelope. The questionnaire went through the ethics committee and approved for the study before sending out to all participants.

Involvement of the participants.

As a participant, you have been chosen to participate by virtue of being an egg producer and a commercial producer. Participating in this study will help collect data required to complete my studies and not participating will reduce the representation of the sample from the population. Approximate, it will only take 20 minutes to answer all the questions in a questionnaire. All the questions are written in such a way that will not cause embarrassment, neither do I consider the questions to be sensitive. In case the questions will cause any emotional discomfort, the participant can ring Lifeline Helpline on 0800 543 354 for help.

Benefits of the study to the participants.

The participants will benefit from the study by generating new information in the Poultry Industry due to the new changes taking place. This information can be used by farmers to make decisions about their businesses as the structure of the Poultry Industry is changing.

Rights for the participants.

The voluntary nature of participation, including that you are free to decline to participate, or to withdraw from the research at any practicable time. All information will be confidential, and privacy will be adhered by protecting the data by using a private password on my computer. The data collected will not be shared or given to other farmers within the Industry.

What will happen after the study?

The data collected for analysis will be kept for the whole period of my research. The findings of the study will be communicated to participants by making the results available to the school of economics and finance at Massey University as a discussion paper. My supervisor

will also help to publish the results by using a reputable referenced journal publication platform. A brief summary of the findings will be shared with the participants via emails and by post mails.

THANKS.

Appendix B: Survey questionnaire Form.

Section 1: Demographic Data

1. Participant's age
 - a) 20- 25 years
 - b) 26-30 years
 - c) 31-35 years
 - d) 36-40 years
 - e) More than 40 years

2. Participant's gender
 - a) Male
 - b) Female

3. For how many years have you participated in poultry farming?
 - a) Less than one year
 - b) 1-10 years
 - c) 11-20 years

- d) Over 20 years

Section 2: Focusing on the study's aim and objectives

4. What is your current housing system of the birds?

- a) Colony cages
- b) Battery Cages
- c) Free-range
- d) Barn
- e) Other

(Explain).....

5. For the housing system (s) used, how many birds in total do you have? a)

Less than 5,000

b) 10,000 – 30,000

c) 30,000 – 50,000

d) 50,000 – 100,000

e) Above 100,000

6. To what extent have you embraced the switch from battery cages to colony cages? a)

Fully adopted

b) Partially adopted

c) Not adopted

d) Other (Please explain)

.....

7. Due to changes in the industry, what system (s) are you or have you replaced battery cage system with?

- a) Barn system
- b) Free range system
- c) Colony cage system
- d) None of the above (Please explain).....

8. Due to changes taking place in the industry, are you down-sizing production or increasing?

a) Increasing: by what margin?.....

b) Down-sizing: by what margin?.....

c) Undecided: why?

.....
.....
.....
.....

9. You are requested to select the most appropriate choice in the table below

<p>The switch from battery cages to colony cages has/will lead to the following benefits</p>	<p>In strong agreement</p>	<p>In agreement</p>	<p>Neutral</p>	<p>In disagreement</p>	<p>In strong disagreement</p>
--	----------------------------	---------------------	----------------	------------------------	-------------------------------

<p>More industry growth and profitability</p>					
<p>Significant improvement in behavioural repertoire</p>					
<p>Better egg quality</p>					
<p>Better access to new customer bases</p>					

Reduced labor costs					
Low mortality					
Significant improvements in bone strength					
Better hygiene					
Reduction in the physiological stress levels of birds					

10. You are requested to respond to the following items by filling in the table as deemed appropriate

The switch from battery cages to colony cages has/will lead to the following adversities	In strong agreement	In agreement	Neutral	In disagreement	In strong disagreement
Risk of cannibalism and featherpecking					
Poor bird welfare					
High mortality					
Sustaining of fractures					

11. What challenges have you faced, or do you anticipate during the period of phasing out battery cages in the poultry industry of New Zealand?

.....

.....

.....

.....

.....

.....

12. For New Zealand's poultry industry to achieve success in a smooth and cost-effective switch from battery cages to colony cages, what solutions do you recommend to the above-mentioned challenges?

.....

.....

.....

.....

.....

14. Do you think the move to switch from battery cages to colony cages will increase the cost of production?

- a). Yes
- b). No
- c). Don't know

13. If you answered yes from the above question, by what percentage do you think the cost of production will rise?

A. 0 – 10 %

B. 10 - 30 %

C. 30 – 50 %

D. 50% and above.

15. Why do you think the cost of production will increase when farmers switch from battery cages to colony?

.....
.....
.....
.....
.....
.....

16. From your experience, how has the cost of production changed by adapting the colony system and what are the causes?

.....
.....
.....
.....

Thank You for Participating. If you are willing to participant for an interview tick the box below and provide a phone number please:

Phone number.....

Note: Please return the filled in questionnaire to the address below using the enclosed prepaid envelope or via email: [REDACTED]

To. Harold Mayaba

[REDACTED]

Table 19: Appendix C - Number of egg producers and farm workers from 2000 - 2018

Year		
2000	189	740
2001	189	770
2002	183	820
2003	188	870
2004	180	910
2005	177	880
2006	177	980
2007	162	970
2008	168	890
2009	162	980
2010	156	1000
2011	147	980
2012	150	980
2013	141	1000
2014	135	1050
2015	144	1150
2016	147	1250
2017	147	1350
2018	156	1400

Source: Stats NZ (2019).

Table 20: Appendix D - responses of egg producers

	Group A	Group B	Group C	Total
Total No. of Farms (where data gathered)	8	13	20	41
Total Number of Birds	1,727,600	796,200	358,600	2,882,400
Likely Response (No. Farms)				
A) Alter cages in existing sheds	0	1	0	1
B) Replace cages in existing sheds	4	6	5	15
C) Alter shed and replace cages	1	1	4	6
D) Build new shed to replace existing shed	2	2	1	5
E) Build new sheds to house displaced birds	4	4	0	8
F) Change to Free Range or Barn Production	0	1	3	4
G) Exit the Industry	2	2	9	13
Impact on Bird Numbers				
Reduction in birds if continuing cage system	100,000	76,650	26,500	203,150
Reduction in birds if moving to Barn or FR	0	33,000	17,400	50,400
Reduction in birds due to exiting industry	261,000	95,500	150,000	506,500
Total Reduction in Birds	361,000	205,150	193,900	760,050
% Total Reduction in Birds	21%	26%	54%	26%

Notes:

1. Producers may have provided a range of responses. e.g. They may have elected to replace cages in an existing shed and to build a new shed to house displaced birds.
2. Two producers of similar size in Group C indicated uncertainty over whether they would move to Free Range or exit the industry. For the purposes of the analysis it is assumed that one will exit and one move to Free Range production.
3. One producer in Group B provided all data and is included above however would not provide a likely response to the proposed changes to the code

Source: Murray & Harnett, (2010)