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FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE

EFFECT OF FEED PARTICLE SIZE ON TRAITS OF ECONOMIC IMPORTANCE IN HYLINE LAYERS

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A RESEARCH PROJECT SUBMITTED TO DEPARTMENT OF ANIMAL SCIENCE, BINDURA UNIVERSITY OF SCIENCE EDUCATION, IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE HONOURS DEGREE IN ANIMAL SCIENCE AND TECHNOLOGY

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APPROVAL FORM

The undersigned confirm that, they have read and recommended this research project entitled, "The effects of different feed form in hyline layers growth performance" in partial fulfillment of the requirements of the Honours Degree in Animal Science and Technology.

SUPERVISOR

I certify that I have supervised Reginald Mashanda, for this research titled "The effects of different feed form in hyline layers growth performance" in partial fulfillment of the requirements for the Honours Degree in Animal Science and Technology and recommend that it proceeds for examination.

Mr. M. Dhliwayo …….

(Supervisor) Date

ABSTRACT

The feed particle size is one of the most critical aspects that determines chicken feed usage. Although it is widely assumed that pellet feeds promote chicken growth, other studies have found no difference in performance between pellet and mash diets (Clavijo and Flórez, 2018). From the 19th week of age, this study was undertaken to investigate the impacts of feed form on hyline layers growth performance. This study was undertaken in Murombedzi, Zvimba district located in Mashonaland west, Zimbabwe. A total of 250 19-week-old hyline brown hens from Irvine's Zimbabwe were chosen for the experiment and only healthy and vaccinated birds were chosen which did not show any signs of defects. The birds were randomly assigned to one of two treatments: mash or pellet diets, each with five replications (25 birds in each replication). Every week, production performance was reported on a daily basis. When compared to mash diets, pellet diets improved the laying rate ($p < 0.05$), average daily feed intake (ADFI), egg weight, and feed conversion ratio (FCR) in hyline brown layers. The results of this experiment give an impression that feeding pellets yields better FCR, final weight gain, a higher feed intake and better egg quality than feeding mashes for the entire laying period.

Key words: Layer, mash, pellet, performance, egg.

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DEDICATION

This project is dedicated to my father, mother, brothers and sisters. Because of their support, the period of hard work and sacrifices was possible. Glory be to the Almighty for all the blessings granted unto me.

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LIST OF ABREVIATIONS

ANOV	Analysis of Variance
FCR	Feed Conversion Ratio
ADFI	Average Daily Feed Intake
NIR	Near Infra-Red Reflectance
ADG	Average Daily Gain
ADI	Average Daily Intake
CP	Crude Protein
CF	Crude Fibre
Pvt	Private
Ltd	Limited

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CHAPTER 1

1.0 Introduction

1.1 Background to Study

Feed accounts for more than 70% of the cost of producing eggs (Brown, 2020). As a result, it is critical to utilize high-quality feed to improve the performance of the layer production and boost profit for egg producers. The best feeding regimen is determined by the size of the operation and the local conditions. The time and feed required to produce eggs are progressively lowering as a result of genetic and management advancements (Dunmire, 2022). As a result, many layer farmers choose these new genetic technologies since they have proven to be more efficient than traditional production systems, resulting in higher income in a shorter period of time. The layer industry has been subjected to intensive study in order to improve efficiency. In recent years, all commercial breeds' layer performance has improved dramatically, as measured not only in terms of growth per day, but also in terms of feed conversion, mortality, and egg quality(Mallet et al., 2009). Major study on breeding stock and housing types is primarily done in Europe (Rougiere et al., 2007). However, more research is being done, mostly on feeds and feeding, as part of efforts to offset the impact of climate change on crops. Layers are routinely fed starter, grower, developer, layers concentrate, and layers mash diets that are tailored to fulfill relatively consistent nutrient requirements for various feeding programs (Flores et al., 2021). Layer feeds are high-quality protein feeds with just the right amount of energy, requiring less feed per dozen eggs produced than other diets. When paired with other conditions such as proper ventilation, temperature, litter management, and reduced mortality, this is a specially formulated ultimate layer feed that will enable the birds to exploit their genetic potential. The above-mentioned factors have the greatest impact on the profitability of the laying business. Layer birds require a steady supply of high-quality diets.

1.1.2 Layer Production in Zimbabwe

As the egg manufacturing business in Zimbabwe expands, a large number of new players are entering the market. Over 70% of today's small-scale egg producers rely on chickens bred by others, which they obtain at the moment of lay. While many farmers prefer this route since it eliminates the hassle of raising birds from birth and saves time (Shahryari et al., 2019). Placing

layers today and starting selecting eggs in a few days to sell the eggs is a great learning experience. However, producers should be aware that this method has several drawbacks that might be detrimental to their business, particularly for those who are just starting out in the egg producing sector. It is important to understand that the hens' productivity, from the beginning of the lay cycle to the finish, is strongly rooted in the rearing phase of the birds. Because the farmer has not been involved in the rearing process, he or she may be unaware of the foundation that has been set prior to the point of lay, and it is conceivable to be burdened with problems resulting from inadequate pullet rearing management.

Leghorn, minorca, ancona, fayoumi, isa brown, babcock, star cross, and lohmann are some of the highest egg-producing breeds, although the hyline is the most popular in Zimbabwe. Each of them has its own set of qualities when it comes to certain aspects of performance. Irvine's, Hubbard Zimbabwe, Lunar Chickens, and Charles Steward are the biggest layer hatcheries in Zimbabwe, with lesser hatcheries including Hukuru and Super Chick. According to chicken trends dating back to 1980, the future of poultry breeding in Zimbabwe seems bright, but other authors (Chitate and Guta, 2001)stated that a number of non-genetic variables must be addressed before small-scale farmers can completely realize their potential. In Zimbabwe, layer production is always intensive, although under some nations, aside from the intensive system, layers are raised in semi-intensive and extensive systems. Improved feeds and better housing can help increase layer production. Some researchers have argued for the use of feed additives and growth promoters (Naderinejad et al., 2016). Zimbabwe has been lagging behind in the improvement of technologies to improve layer production in recent years. As a result, the few local layer producers are unable to meet demand. So yet, just a few farmers have used controlled buildings, which can considerably increase productivity.

1.2 Problem Statement

The layer industry has grown in efficiency as a result of the search for better performing layers. Until now, substantial research on the effects of feed, housing, and layer strains has been conducted. Most smallholder farmers in the Zvimba area have reported lower growth rates in layers. Other small-scale farmers have improvised by utilizing layer pellets instead of the traditional layer mashes. This has resulted in a wide range of nutritional content changes as well as better egg quality. Pellet feeds, on the other hand, have been reported to reduce nutrient

utilization and starch digestibility in broilers under certain conditions(Ferket, 2000). Mash diets have been demonstrated to enhance feed conversion ratio, starch digestibility, and intestinal glucose uptake in broilers when compared to those fed pellet diets. According to a few recent researches, laying hens from the white and brown strains did not react significantly to changes in the pellet or mash diets in terms of product performance. Therefore, in order to assess their impact on production performance and egg quality of hyline laying hens during the peak laying period, pellet and mash feed formats are used in regular commercial diets (i.e., 19 to 35weeks of age).

1.3 Justification

Low layer growth rates experienced by smallholder layer farmers are a major source of worry. The layers are taking an excessive amount of time to reach the required market weights and egg volumes. Small-scale layer farmers wind up feeding their flocks more feed than is regularly consumed in order to finish the cycle. As a result, some farmers have resorted to making their own feed to replace commercial feeds. The available nutrients in homemade feeds are generally inconsistent. Some farmers may be unaware of the nutritional qualities of the ingredients they employ, putting their performance at risk. The question remains: why aren't breeders' target weights and egg yields met? A comparison of the impacts of layer pellets and mashes on growth performance has therefore become necessary. The dynamics of feeding stages can produce a range of nutritional values and costs. The feed form has an impact on chicken's growth, digestion, nutritional absorption, intestinal health, and productivity(Attar et al., 2019). In commercial egg production, two types of chicken feed are typically used: mash and pellets. Mash (lower particle size) is a finely ground and combined full feed form that makes it difficult to separate ingredients.

The process of pelleting involves agglomerating the ingredients through mechanical action in conjunction with moisture, pressure, and temperature to create larger structures known as pellets. Chicken growth performance, feed intake, and feed conversion ratio have all been found to improve on pellet diets. performance, feed intake, and feed conversion ratio have all been found to improve on pellet diets (Amerah et al., 2008). Other benefits of pelleting include decreased component segregation, ease of handling, increased feed flow, and lower formulation costs due to the use of alternative ingredients and decreased diet energy. Based on scientific investigation

of diet types, egg quality, and production sources, the findings of this study may help explain why layers grow less weight. At the same time, the findings may help to minimize the causes for feed manufacturers' increased reprocessing as a means of increasing efficiency.

1.4 Aim

The research aims to improve the performance of layers by improving feed quality.

1.5 Objectives

1.5.1 Main Objective

To compare the effects of different feed forms on hyline Layers performance.

1.5.2 Specific Objectives

To compare the effects of different feed forms on;

a) feed intake

b) weight gain.

c) egg weight.

1.6 Hypothesis

H0- There is no significant effect of feed form on feed intake of layers.

H0- There is no significant effect of feed form on weight gain of layers.

H0- There is no significant effect of feed form on egg weight of hyline layers.

CHAPTER 2

2.0 Literature Review

2.1Introduction to Layer Production

Broilers, layers, and indigenous chickens are kept in Zimbabwe for chicken production(Nyambali et al., 2022). Breeding chickens to lay eggs commercially is known as "layer poultry farming." A special type of hen called a layer chicken needs to be raised starting at day one. The development of layer chickens, which are mainly used for egg production, was the result of years of cross-breeding and selection. At 18–19 weeks old, they start producing eggs for commercial use. Up until 72–78 weeks of age, they keep laying eggs. They can consume about 2.25 kilograms of food and lay about one kilogram of eggs during their egg-laying cycle. Consider the many qualities of the cock and hen before breeding to produce hybrid eggs layer. Various varieties of highly egg-producing layer breeds are available all over the world. Layer chickens are divided into two groups based on the nature and color of their eggs. White egg-laying hens are smaller than brown egg-laying hens. The color of the eggshell is white, and they eat less food. Some popular white egg-laying hens include Isa White, Lehman White, Nikchik, Bab Cock BV-300, Havard White, Hi Sex White, Sever White, Hi line White, Bovanch White, and others. In comparison to white egg-laying hens, brown egg-laying hens are bigger. They consume more food compared to white egg layers. Larger eggs are laid by other breeds of hens. Eggshells have a brown color. Different forms and dimensions can be found in brown layers. They include Isa Brown, Hi Sex Brown, Sever 579, Lehman Brown, Hi Line Brown, Bab Cock BV-380, Gold Line, Bablona Tetro, Bablona Harko, Havard Brown, and other commercial layer breeds.

With the introduction of numerous foreign currencies, Zimbabwe's poultry production rates have shown great recovery and growth from an all-time low in January 2009 (Massuquetto et al., 2020). In the first quarter of 2009, day old chick output was 170000/week, and it has continued to demonstrate a linear recovery to date (Massuquetto et al., 2020). It was also stated that day old chick output in 2010 averaged 721800/week, surpassing the previous high of 720 200/week set in 2000. Production of day old chicks in the first nine months of 2019 surpassed that in 2020.

Resurrection and extension of current breeders, as well as the admission of new breeders, have aided the recovery and expansion, with a total hatch capacity of 1 432 800 chicks each week. Four-day-old chick breeds are utilized in Zimbabwe, including H and N from Irvine's, Issa brown from Hamara, Hyline chicks from Charles Stewart and Zimavian, and Hi sex Brown from Supachicks. National foods, Novatek, Profeeds, Windmill, Agrifoods, Capital foods, R T feeds, Hyperfeeds, Feedmix, Bascom feeds, and Fivet are some of the most well-known stock feeds producers. The market demand for chicken is up to 13,000 tonnes per month, and local farmers are unable to supply this need despite the existence of these feed producers and day-old chick suppliers in Zimbabwe. Poultry production is a potential option for supplying the country's needs for animal protein because to its quick development and short generation cycle. (Faraj and Rashid, 2020). During the last three decades, it has been critical in filling the gap in animal protein supply at affordable costs in Zimbabwe. The industry is currently experiencing a feed crisis due to high production costs attributable to cereal grain scarcity, as well as high costs of importing non-GMO soya from India and Zambia, as well as minerals, vitamins, and amino acids from Germany. The fact that feeding costs account for 70-80% of total costs (Idan et al., 2020)and are further increasing in layer farming due to feed price increases is degrading layer output returns.

The introduction of layers in Zimbabwe is not extensively documented, but it is thought to have begun well before independence by a few large-scale farmers (Kim et al., 2018). (Although layers were kept on a relatively small scale in urban areas (Brown, 2020). The scale has been increasing since independence and is continuing growing, with small scale producers taking 50% of day old chicks from hatcheries. Layers are omnivorous creatures that can be kept in metropolitan locations since they can be raised under intensive conditions(Rubio, 2018). As a result of the 1980s' rapid population growth, the changing climate, and changes in consumer tastes and preferences, chicken meat has become the primary source of protein for the human population. Not all poultry products, though, are consumed by people. For instance, eggs are increasingly used to create antibodies and pharmaceutical proteins, as well as to create therapeutic vaccinations. A portion of the increase in chicken production in the 1980s and 1990s was due to the development of new, further processed, value-added products. Due to a lack of work in Zimbabwe's major towns, back-yard poultry production has expanded among the lower middle class, serving as a tool for social justice and poverty alleviation (Gabriel et al., 2006).

This has necessitated a review of the success of urban poultry and a rigorous examination of poultry feeding materials and regimens in order to avoid avoidable losses by examining the nutritional contents of these feeds and improving decisions. Raw ingredients such as sunflower meal have been decorticated to aid digestion, while soya beans have been roasted to remove anti-nutritional elements (Naldo et al., 2021). Extracting oil from soya beans and cotton seeds generates heat, which neutralizes anti-nutritional elements(Coon, 2002). Other small-scale farmers rely on homemade rations, despite the fact that they are unaware of the nutritional value of these feeds.

As a result, the necessity for assessing feeds, discovering techniques to increase digestibility, and developing proper feeding plans continues to be overlooked on both a small and large scale. CP and CF, as well as calcium, are commonly measured in feeds because they are growth drivers whose amounts affect voluntary feed intake. In Zimbabwe, feed analysis is mostly performed using two methods: dry and wet chemistry(Ipara et al., 2021). The use of devices like the near-infrared reflectance (NIR), which are accurate, quick, and generate accurate estimations in as little as six seconds, is becoming a standard dry chemistry approach all around the world. The alternate acid and alkali treatments have been used to analyze for CF, while the Kjeldahl method is one of the standard ways for evaluating CP (Bowen et al., 2022). Commercial layer hybrids with high genetic merit are commonly utilized in developing countries due to their superior productivity, although they are not well-suited to tropical settings(Rubio et al., 2020). Because these birds are sensitive to changes in nutrition and high ambient temperatures, they must be managed by competent stock persons. Indigenous poultry can withstand the harsh conditions that are common in developing countries, and careful management can help them perform better. This can be accomplished by providing excellent housing, shielding the birds from predators, and ensuring that they are in an environment that allows them to thrive.

2.2 Key Principles to Successful Layer Production

2.2.1 Models of Table Egg Production

Table egg manufacturers follow one of two primary production models. In the first model, the farmer buys Day Old Layer Chicks from a breeder and nurtures them from Day One to Point-Of-Lay, as well as during the egg-laying phase. This implies that the farmer must correctly care for the newborn chicks from Day One until they reach point-of-lay (about 18 weeks), at which point they begin to lay eggs, which they will do for around a year. In this instance, the farmer has complete control over the bird's development and has the ability to alter the quality of the layer bird he produces. The farmer, on the other hand, buys point-of-lay birds from a breeder or another grower, and they begin laying a few days after they arrive on the farm. In this instance, the farmer is trapped with whichever bird he gets and has little control over the quality of the bird he is stuck with during the laying phase. This is because the previous farmer would have done the majority of the bird's conditioning (Guzmán et al., 2015).

2.2.2 Raising Layer Pullets from Day Old Chicks

Having made a decision to produce table eggs starting with the Day old chicks, one needs to prepare well for this project. The young chicks will go through a brooding stage, similar to broilers, except theirs will last six weeks rather than three. The birds then go through a growth phase that lasts up to 18 weeks, after which they are referred to as Point-of-Lay pullets. They can then begin to lay eggs. In terms of site selection, housing, design, equipment, and so on, the preparation is nearly identical to that for broiler chicks (Parsons, 2010). It is necessary to place an order well in advance and purchase the feed, stress packs, and other chemicals required in a timely manner. Clean the house thoroughly, first with dry cleaning, then washing with water, and finally using detergents. Then, using the right chemicals, disinfect the house's floors and walls. Clean all of the equipment (feeders, drinkers) in the same manner. Empty, clean, and disinfect water and feeder lines, as well as feed and water tanks, if the house is automated. Place the necessary bedding on top of it and make sure it's level. Place the equipment in the house

(feeders, drinkers, heaters, thermometers, lighting, heat supply, etc.) and line it up appropriately, then rest the house for 10-12 days (Lacy, 2002). The boxes are gently opened as soon as the chicks arrive at the farm, allowing the chicks to carefully move out and into the prepared, pre-heated brooding chamber. The young chicks are constantly watched as they go about their daily lives throughout the first several days. At 33-36 degrees Celsius and 70% humidity, the brooding temperature is generally regulated according to relative humidity. The temperature is dropped by 2-3 degrees Celsius each week after the first week, until it reaches 21 degrees Celsius by Day 42, the end of the brooding period. The Table below indicates the temperature and light intensity targets for the brooding phase(Brown, 2020).

Table 2.1 showing the temperature and light required during the brooding phase

Age (Days)	**Air Temperature (Degrees Celsius)**	**Light Intensity**	**Light Hours**
0-3	33-36	30-50	22
4-7	30-32	30-50	22
8-14	28-30	25	19
15-21	26-28	25	17.5
22-28	23-26	25	16
29-35	21-23	10-15	14.5
36-42	21	10-15	13

The chicks must have unlimited access to clean, fresh, and cool water, with no restrictions on intake If you're going to use drinking fonts, make sure you have several of them and that they're constantly replenished. If the birds do not drink enough water for some reason, their feed usage and growth will be hampered. Birds drink 1.5-2 times more water than they eat on average, and this ratio rises in hot weather. The concentrations of dissolved minerals in the water, such as calcium, sodium, magnesium, or phosphorus, must be considered when producing feed. A pH of 5-7 in ideal water encourages maximum cleanliness, increases feed consumption, and enhances

digestive health. Gut health will be impacted by less-than-ideal water quality, which will cause feed nutrients to be insufficiently utilized. The table below indicates the approximate daily water consumption level of various ages of 100 chicks at a normal environmental temperature of 21-27 Degrees Celsius (Boltz et al., 2022).

Table 2.2 showing water amounts required during the growth stage of layers.

Age (Weeks) Amount of Water (Litres)	Age (Weeks) Amount of Water (Litres)
1-3	1-3
4-6	4-6
7-9	6-8
10-12	8-10
13-15	10-14
16-18	14-18
19-22	18-22

To get the chicks off to a good start, the nutrition must be of high quality. As a result, it must be homogenous, contain the proper particle size, and be made from high-quality raw ingredients. The Chick Starter Mash was created with this goal in mind, and it should be fed to the chicks from day one until the end of the eighth week. For the entire duration, the predicted feed consumption per bird should be 1.75-2 kg. For the first few days, the feed should be delivered in clean troughs with some placed out on cardboard paper on the bedding. To ensure that all birds have equal access to feed, the feeder space must be sufficient. It is necessary to calculate the amount of feed consumed. A slow step down lighting schedule is recommended for all types of housing to facilitate frame development and expansion (Rougiere et al., 2007). To help the chicks find feed and water, the hyline breeders recommend that they enjoy 22 hours of light and 2 hours of darkness for the first 7 days. To do so, the light must be bright (about 30-50 lux). The day-to-day duties become routine once the chicks have passed the first week. However, there are some duties that must be completed: Weight control, as well as beak trimming (the procedure of

clipping the beak of a growing chick to lessen its size and sharpness) as well as weight management (the target is to end up with birds of 1400g-1550g with uniformity of at least 85% at week 18. Therefore, it is important to monitor the weight development of the flock (Jones and Taylor, 2001).

Rearing/growing homes are sometimes separate from laying houses, which implies that the birds will need to be moved from the present rearing house to the laying house at some point before laying. This is also important when birds are being transported from deep litter houses to laying cages. This is normally done between Week 15 and Week 16. The goal is to guarantee that the birds are in the proper laying habitat by the time they reach maturity, which is around 1400-1550 grams' live weight. The stage of shifting grower pullets into laying cages or laying houses is also the same as what a farmer who uses Model 2 of obtaining lay pullets from somewhere must go through.

2.2.3 Management of birds During Lay

Egg production, egg size, and shell quality are all affected by temperature fluctuations between 21 and 27 degrees Celsius. With rising house temperatures, feed conversion improves, and maximum efficiency is reached in the 21-27-degree Celsius range. Feed consumption reduces when the temperature rises, necessitating the use of a carefully prepared diet to ensure adequate daily nutrient intakes. If feed intake falls and the diet remains unchanged, egg weight and body weight fall first, followed by egg number. During this time, the quality of the feed must be good; otherwise, the birds will react to poor quality feed by losing weight, egg weight, or egg number. Feed limitation is not recommended during lay for any reason, especially if the feed is correctly made and blended. The egg production feed, Layer in Production Mash (16 percent protein), is designed to assist proper egg-laying while also keeping the hen's body in the needed condition. This feed is started as soon as the first eggs are dropped or at the estimated point of lay. Over a period of up to two weeks, the feed is progressively introduced into the flock by mixing it with the Layer Developer. Expect a daily consumption of 110-125 grams per bird every day, depending on a variety of parameters including weather, laying stage, body weight, and size (Nyambali et al., 2022).

There is a concentrated form of this feed called Layer in Production Concentrate that is mixed with maize in the ratio of 2 parts concentrate to 3 parts maize for those with cost-effective good quality maize (Brown, 2020). Because of the varying degree of maturity among the birds, body weights will not provide useful data from 18 weeks until around 27 weeks of age. Body weights must be taken every two weeks after 27 weeks of age and compared to breed targets. The objective is to keep body weight and egg weight rising steadily. In the absence of a small increase in body weight, production and egg weight may suffer. After 36 weeks of age, a flock's average body weight should remain largely steady and only gradually grow(Boumans et al., 2022). A slight gain in body weight indicates that sufficient nutrients are being consumed for maximum performance. If the birds are gaining excessively, it indicates that they are being over-fed o some nutrients. This then calls for an adjustment of feed nutrients or intake.

2.2.4 Flock Health Management

Because the primary focus in poultry health is on prevention and control rather than curative measures, disease prevention, and control program that begins with disease-free stock should be implemented. Layers, like broilers, require careful attention to their health. Biosecurity and farm sanitization, as well as immunization, are used to manage this. Vaccination, as previously said, is the injection of one-of-a-kind items known as vaccinations into the system of a living animal in order for it to develop the ability to fight off a certain disease if it is confronted with it in the future. Each breed of bird, like broilers, will have its own particular immunization schedule advised by the breeder. When determining which diseases to immunize against, factors such as prior exposure, geographic location, vaccination and exposure of nearby flocks, national laws, and endemic disease-causing variables are all taken into consideration. Marek's Disease, Newcastle, Infected coryza, Infectious bursal disease, Egg Drop syndrome, avian pneumovirus, Mycoplasma gallisepticum, infectious laryngotracheitis, Infectious bronchitis, Fowl pox, and avian encephalomyelitis are among the diseases that are vaccinated against. To prevent coccidiosis, chick mash or starter crumbles with coccidiostat are recommended (Karpinski et al., 2006). Visitors or strangers are normally not allowed inside the chicken grounds of large enterprises like Irvine's and Hubbard breeders unless they wear disinfected boots and clean protective clothing to avoid illness transmission. Serological monitoring is the process of keeping track on a flock's health by sending blood samples to a vet lab on a regular basis.

Serological data obtained after the majority of immunizations have been completed at week 17-18 is an effective way to assess a flock's immunological state prior to production. When production decreases are noticed, such data can be used as an immune status baseline to determine whether a field infection has occurred. A flock owner should send 25 excellent serum samples to a laboratory 1-2 weeks before the pullets are placed in the lay house to ensure that they are free of infections like Mycoplasma gallisepticum and Mycoplasma synovia before production begins. General management, such as inspecting birds for indications of disease on a daily basis and receiving a solid diagnosis and treatment, is required (Lacy, 2002). Disease control is aided by culling sick or injured birds, using appropriate disposal techniques (burning or burying deeply), instituting a regular deworming program, replacing moist litter, and utilizing adequate manure disposal methods, such as composting. (Naderinejad et al., 2016).The table below shows vaccination program followed by most commercial farmers in Zimbabwe. This has been ignored at small scale but however, but chemicals like Terramycin, Terranox, ESB3, and Oxytetracycline have been used at both small and commercial levels (Nyambali et al., 2022).

Table 2.3 showing a vaccination program for the layer birds during the growth stage.

Disease	**Age**
Marek's	Day 1
Newcastle and Infectious Bronchitis	Day 10
Gumboro Disease	Day 28
Fowl Pox	Week 12
Newcastle	Week 17
Salmonellosis	Week 18

Flooring must be covered with clean, dry litter or wood shavings at least 3 inches deep to keep them warm in cold situations and absorb excess moisture (Ipara et al., 2021). Because litter can pollute the enclosure with ammonia, which harms the chickens' eyes and respiratory systems, it must be properly maintained. Because layer birds are kept in a house for such a long time, they

are susceptible to worm infection, especially if they are kept in deep litter. Worms infect the gut, causing damage to the linings and obstructing feed digestion and absorption, and hence usage. Each geographical region and season has its own recommended de-worming program that is tailored to the needs of each flock. To get the best advice on which deworming chemicals to use and which deworming program to follow, talk to your breeder.

2.3 Feeding Schemes and Regimes in Layer Production

The objective of a specified feeding program is to offer a range of nutritionally adequate diets that satisfy the demands of layers at all stages of growth while also maximizing effectiveness and profitability without endangering the welfare of the birds or the environment.(Brown, 2020). Layer feeds have been categorized into several classes according to the age to be provided since different age groups require different nutrients(Odunsi et al., 2007). Three-phase (starter, grower, and finisher) and four-phase (pre-starter, starter, grower, and finisher) regimes are employed in Zimbabwe(Tikate et al., 2021).Ration formulation for all regimes necessitates the availability of appropriate feedstuffs, feed composition analysis, understanding of chicken nutritional demands, and the ability to mix feed in large quantities your flock will use within four weeks (Ege et al., 2019). They also claimed that manufacturers should create various guidelines for each age group that must be followed during feeding. Chicks must be provided a well-balanced diet that includes calcium, phosphorus, CP, CF, and lipids to support optimal skeletal and muscular development as well as healthy increases. Leg issues, slow growth, increased fatness, and poor feathering are all signs of inadequate nutrients in the feed. (Hamilton and Proudfoot, 1995). Conditions such as easy access to feed, clean water, vaccines, and vaccination services contribute positively to the poultry industry (Bean-Hodgins et al., 2022).The implementation of a 4-phase feeding program in small-scale farmers has been linked to issues such as a lack of cash to purchase feed, inability to follow lighting programs, and overfeeding the birds, which can lead to ascites, heart problems, and abrupt death (Martinez et al., 2022). As a result, there has been a reluctance to accept the 4 and 5 phases, and a larger percentage of people are still using the 3 phase.

2.3.1 Three phase program

In Zimbabwe (Scholar, 2022)the three-phase program is widely employed, with a layer consuming an average of 2kg of chick starting food in the first eight weeks of life, which can be crumbles or mashes. From week 8 to week 17, the layers are fed a layers growers mash diet and consume an average of 4,5kg (Chitate and Guta, 2001). The starting diets have more protein and less energy than the laying diets during the three phases. The layers are given a high production layers' mash diet from week 17 to the point of lay. Zimbabwean farmers, especially those who make their own feeds, typically follow this pattern. It was the first program that nutritionists created in an effort to give people the nutrients they needed at each stage of life.

2.3.2 Four Phase Feeding Program

Prestarter crumbles, which are more digestible and nutritious than starter crumbles, are used at the outset of the feeding program (Lawrence Azua et al., 2022). This feeding program is used by broiler producers in Zimbabwe, including as Irvine's and its contract farms. Birds fed in a four-phase system gained more weight than those fed in a three-phase system. The next stages are identical to the three-phase feeding regimen. It is advantageous in that the layer birds' immunity will be boosted before being introduced to the starting diet, and his approach will also help the layer birds grow quicker because they will be fed a more nutritious feed before being exposed to the starter diet. Many communal farmers in Zimbabwe cannot adapt this feeding strategy due to financial constraints, although it is widely preferred; they can only afford what they have, therefore they use their own home-made feeds, which are not suggested to use because the nutritional makeup of the feed is unknown. Feed consumption may be excessive or insufficient, which may affect the layer birds' growth rate.

2.3.3 Five Phase Feeding System

For the various stages of the birds, they usually prescribe a five-phase nutrition schedule(Rueda et al., 2022). The total nutrient content of the feed varies by phase, depending on elements including the cost and accessibility of raw materials as well as whether or not imports are anticipated to be restricted. Additionally, they noted that inclusion rates are based on the company's goals, such as achieving the highest daily gains, the lowest feed costs per bird or kilogram of feed, or the lowest cost per kilogram of meat, among others. Only a small number of commercial farmers in Zimbabwe have used this approach, though.

Table 2.4 describing the 5 phrase feeding regime adopted by commercial farmers.

	Pre starter	Starter	Grower	Layers Mash1	Layers Mash 2
Age (weeks)	2	2-8	8-17	18-45	45-72
Feed (kgs)	0.115	0.750	1.35	1.975	2.125

2.4 Layer Diets and Products

In its formulation, poultry complete feed has 60-65 percent energy-giving ingredients, 30-35 percent protein, and 2-8 percent minerals (Flores et al., 2021). Maize up to 60%, maize germ up to 10%, milo up to 45%, sorghum up to 25% and with enzyme up to 45%, wheat up to 25% and with enzyme up to 45%, wheat byproducts (bran, shorts, screenings), rice byproducts (bran, polishing), barley up to 15% and with enzyme up to 35%, molasses up to 5% for diets given after two weeks, and water. There are a number of sources of protein, including soybean meal (30%), soybeans (15%), sunflower meal (10%), fish meal (10%), blood meal (10%), and feather meal up to 2%. The primary nutrient, water, should be pure, wholesome, and devoid of physical impurities, harmful chemicals, and bacterial infection. The suggested water-to-feed ratio is 2.2:1 in each case (Abadi et al., 2019). While poultry requires adequate nutrition, excessive amounts of other nutrients have resulted in metabolic diseases such as ascites, sudden death syndrome (SDS), and limb issues (Rueda et al., 2022). People have often associated such conditions with rapid growth, hence various feeding regimens have been suggested in an attempt to limit the occurrence of these issues.

2.4.1 Pre-Starter Diets

Efficiency in layer production is crucial, and the need of a healthy start in life is underlined for all species. About 10% of a layer's lifespan, in the case of layers, occurs in the first three to five days. Therefore, what it consumes during this phase may have an effect on how it performs later. A super pre-starter ration's main objective is to meet the baby chick's nutritional needs while facilitating the transition from the yolk sac to the first meal. After hatching, the availability of nutrients is essential for growth and development. A seven-day diet is known as a "super pre-starter" for layer chickens. Standard beginning diets choose highly digestible components, but they also use high-quality, high-value raw materials, more than doubling their price. There will be a variety of protein, fat, and carbohydrate sources. They will have unique requirements for vitamins, minerals, and amino acids. It is crucial to give the newborn chick the ideal nutrients in the proper proportions and feed forms.

2.4.2 Layers Chick Mash

Chick Mash (22% crude protein) is fed to layer chicks from day of placement up to about 6 to 8 weeks. The purpose of the brooding period, which lasts 8 weeks, is to build a good appetite and maximize early growth (Naldo et al., 2021). The goal is to reach 8 week body weight of 2 kgs or more(Brown, 2020). Most Companies in Zimbabwe are aiming for a crude protein content of 19-23 percent to allow the bird to reach its full potential development (Kiarie et al., 2022). The beginning is only a small part of the overall meal. Feed costs and starting formulation decisions should be made based on performance and profitability instead of price. Saturated fats should be avoided and total fat levels should be kept low (less than 5%). They diminish feed intake, particularly when combined with wheat. Early nutrition is critical for layer survival and output (Naldo et al., 2021). The greatest growth occurs during the first week of a layer's life (takes approximately 25 percent of total)(Gabriel et al., 2006). A substantial positive correlation between first week live weight and finishing weight at the end of the production cycle emphasizes the importance of a good start for higher performance in commercial layers.

2.4.3 Layers Grower feeds

Layers are fed Growers mash (15.5% crude protein) from about 6-8 weeks up to 16 weeks of age. Approximately 4, 5 kgs of feed is consumed by each bird during this period. To maximize performance, a high-quality grower feed is still required, with 20 percent crude protein being the aim (Brown, 2020). To avoid overfeeding the birds, any growth restrictions should be implemented during this time. Ascites and cardiac issues are the result of this. Meal feeding or other management approaches are used. It is preferable to use illumination to limit meal consumption (Sun et al., 2022). Growth, on the other hand, dietary restriction based on diet composition is not advised. Unrestricted feeding is linked to a faster rate of growth, which leads to an increase in body fat deposition, mortality, and the occurrence of metabolic and skeletal abnormalities. These circumstances are particularly typical in layers who eat feed adlibitum. As a result, feed restriction has been recommended as a solution to these issues.

2.4.4 Laying diets

Higher production layers mash (17% crude protein) is a high energy production feed which is fed to layers from the beginning of laying. This feed is designed to meet the greatest energy demand during the peak egg production period (initial burst). It is also very good during times of stress when you need to boost the bird. The feed is also beneficial during periods of lower temperature. This diet is also good to maintain a sustainable production curve during the production period. Each bird consumes between 115 -125 grams of layers mash on average depending on breed type and environmental conditions. However, a layers concentrate feed (28% crude protein) can be also given to layer birds during this phase because it is formulated by mixing 2 parts of concentrate to 3 parts of maize meal by weight to produce the existing layers mash. The choice of one or two layers mash feeds will be determined by the intended length of the production phase, and the feeding program design (Abdollahi et al., 2013). Drug withdrawal periods may necessitate the usage of a special medication. Layers mash feed should be removed. This diet should be altered according to the age of the birds, but the procedure should be followed. It's not a good idea to go on a nutritional fast during this time.

2.5 Poultry Feed Types

2.5.1 Mash feeds

Mash feed is defined as chicken feed made from unprocessed, uncooked materials for the purpose of feeding birds. Without any physical alterations, chicken mash feed is frequently made from ingredients including maize, soya meal, rice police, protein concentrate, and white bran. Mash feed is extensively used in laying chickens, quail, and turkeys, which are the most prevalent local birds. It is less popular in broilers because of their slow growth and the time it takes to reach marketable age in several countries (Parsons et al., 2006). Mash feed is usually given to young chicks because it is easily digested and easier to eat although the mash feed is suitable for chickens of any age. Mash feed, on the other hand, is more difficult to remove from the ground and barely draws pests like rats and mice. A gravity feeder has less fluid and is more likely to become blocked with moisture. Additionally, if the particles are of various sizes, it could result in an imbalanced diet. Chickens tend to select the larger pieces and toss the smaller grains to the side, which prevents them from consuming adequate minerals and vitamins.

2.5.2 Pellet Feeds

The mash system has been modified into a pellet way of feeding. It includes steam injection (moisture and heat) and mechanically pressing the mash into hard dry pellets or artificial grains, for easy feeding of the poultry birds with a balanced meal (Pacheco et al., 2013). These larger particles are easier to handle, more enticing, and yield better feeding results compared to non-pelleted feed. Pelleting is advantageous in that the heat generated during conditioning and pelleting breaks down the starches in the feedstuffs, making them more digestible and the feed's palatability is improved. By preventing the animal from picking and selecting between elements, pelleted feed ensures that each animal obtains a well-balanced diet. Bulk density is improved, allowing most bulk facilities to store more material. Additionally, shipping facilities have been

expanded, lowering transportation expenses. The below are some of the advantages that are associated with pelleting of feeds:

- Decreased feed wastage.
- Reduced selective feeding.
- Shorter feeding time, thereby conserving energy of the poultry birds
- Pellet feeds are already in a semi-digested form.
- Low maintenance energy requirement for feeding & digestion
- Destruction of deleterious feed-borne pathogens.
- Feed dust & disease control.
- Improved palatability.
- Improved feed intake.
- Each mouthful of pellet provides a well-balanced diet for poultry birds.
- Increased weight gain & growth rate of the birds.
- Improved feed conversion rate.
- Improved overall poultry birds' performance.

2.5.3 Crumble Feeds

Pellets that have been crushed, cracked, or rolled into a consistency like grapenuts cereal are referred to as crumbles. Almost any commercial ration, including feed designed for chicks, young birds too small to ingest full pellets, and mature chickens, can be found as a crumble. Due to its ease of feeding, this type of feed has recently gained popularity in the broiler production industry. Providing feed in crumble form with a high energy content and high protein profile resulted in a decreased feed conversion rate (Singh et al., (2010). Crumbles offer a temporal advantage over pellets since they take longer to consume, giving the birds less opportunity to become bored. The biggest drawback is that crumbles that are spilt or left on the ground are typically trampled and discarded. Unless it is moistened and fed in the same way as mash powder, dusty residue that collects at the bottom of the feeder is also wasted.

CHAPTER 3

3.0 Materials and Methodology

3.1 Study Site

The study was carried out at Murombedzi Farm in Zvimba district, in Zimbabwe. The farm is located in Mashonaland West Province, (17.3533° S, 30.2058° E). It falls under the agro-ecological region 2b and is characterized by intensive crop and livestock production. It receives an annual rainfall of 800-1000ml annually. The majority of Zvimba people are now backyard layer producers, and there are a number of feed-producing enterprises with depots around the province. As a result of these within the area, poultry production activities, chicken houses, have been built.

3.2 Experimental birds

A total of 250 hyline brown layer birds were used for the experiment. The layer birds were obtained from Irvine's, one of the largest poultry producers in Zimbabwe on the 21 st of May 2021. The birds were eighteen-week year old and had reached the point of lay.

3.3 Housing and Nutrition

The birds were reared on a deep litter system and wood shavings with a 10 cm depth were utilized as bedding. The bedding was changed regularly at most twice a week to avoid building up of pathogens in the flock. Feed was provided adlibitum and clean water supply was also provided all the time. Water fonts were cleaned using water with virukill every morning. The feed was manufactured at Windmill Pvt Ltd and the feed was formulated with the same nutritional ingredients. There were two feed forms, pellets and mashes. Housing temperatures, ventilation and lighting were controlled regularly depending on the weather of the day. The birds

were already vaccinated against Newcastle at week 17 before they were transferred to the production site. Biosecurity measures were ensured to avoid entry of diseases from outside the flocks hence footbaths were placed in front of each experimental unit containing water with virukill.

3.4 Experimental Design

A completely randomized design (CRD) was used for the research. Effects of pellet diet were the only variable, and it had three parameters based on the poultry performance. The procedures were repeated severally in identical, environmentally controlled homes. The design consists of two treatments and each treatment had 5 replications. There were 25 birds in each replication. Allocation of birds to treatments was random. The birds were first put into stratums which shared at least one common characteristic of the population (medium and large sized birds). The birds were then randomly selected from the stratums to come up with a sample size of 25 birds per replication.

3.5 Measurements

Weighing and recording were done on a daily basis. For the purpose of evaluating production efficiency, the average daily feed intake (ADFI) and the feed conversion ratio (FCR) were tracked and determined to give weekly heights for the whole experimental period.

3.5.1 Measurement of Egg Weight

In order to determine the average egg weight and the proportion of defective eggs, eggs were regularly collected, numbered, and weighed. Every week beginning at 25 weeks of age, 30 eggs were randomly selected from each group and analyzed for egg quality. On the day of collection, measurements of egg quality were finished and all eggs were kept in the same storage space. Egg weights were recorded up to 35 weeks of age and the data was recorded as well. The eggs were weighed using an electronic balance and egg weight measurements were recorded on the Microsoft excel sheet.

3.5.2 Weight gain

On May 21, 2021, the birds were weighed before the experiment began, and the initial weights were noted. From week 19 up to 35 weeks of age, the birds were then individually afterwards weighed each week to provide weekly heights. The bird was placed in a sack before being weighed. After the bird had settled, the sack was fastened to the balance hanging from the poultry house's ceiling, and the weight was recorded. The average daily gain (ADG) was then determined on a weekly basis as (final weight-start weight)/number of days.

3.5.3 Feed Conversion Ratio (FCR)

For the whole duration of the experiment, from week 19 to week 35, the feed conversion ratio was computed on a weekly basis for each and every experimental unit as ADI in grams divided by ADG.

3.6 Statistical Analysis

Raw data obtained from experimental units was processed using the Microsoft excel spreadsheet application. Effect of feed form on feed intake, weight gain, and egg weight traits on hyline layer performance was analyzed using R Studio version 4.4.2, using two sample TTEST to show the significance between the feed form and the treatment and analysis was done at 5% significance level. The analyzed data was then used to deduce tables that were essential in explaining the results of the experiment.

CHAPTER 4

Results

4.1 Average Feed intake of the Layer birds

There were significant differences ($p<0.05$) in weekly feed consumption among the two feed forms from week 19 up to week 35 (Table 4.1). There was no discernible difference between the pellet and mash diets for the first two days (week 19) following placement ($p<0.05$). However, by day 3 (week 19) after the layer birds were placed, the pellet treatment was significantly ($p<0.05$) different from the mash treatment. When compared to birds fed a mash meal, layers fed a pellet diet exhibited numerically higher feed intake.

Table 4.1 Effect of feed form on feed intake in hyline Layers from 19 to 35 weeks of age

Treatment		Mean Weekly feed intake (g)		Significance
Pellet		2916.321[a]		**
Mash		2717.492[b]		**

[a-b]Means within a column for n pens of 25 layers with different superscripts differ significantly ($P \leq 0.05$).

**Significant at 5 %.

4.2 Average weight gain

The feed form had a statistically significant ($p<0.05$) impact on weight gain (Table 4.2). For the entire experimental period, pellet treatment had the largest (g) and mash treatment had the lowest (1816.43g) weights. After the placement of birds (week 19) there was no discernible difference between the pellet and mash treatment weights ($p>0.05$). Pellet treatment gained the most weight for the entire experimental period as compared to mash treatment (Table 4.2).

Table 4. 2: Effect of feed form on average weight gain in hyline layers from 19 to 35 weeks of age.

		mean mass (g)		
Treatment				Significance
Pellet		1910.22[a]		**
Mash		1816.43[b]		**

[a-b]Means within a column for n pens of 25 layers with different superscripts differ significantly ($P \leq 0.05$).
** Significant at 5 %.

4.3 Egg Weight

Feed form showed a significant effect ($p<0.05$) on egg weight (table 4.3). Amongst the two treatments, pellet treatment enhances the highest egg mass (63.52 g) compared to the mash treatment (60.32g). From the 25th week of age, pellet treatment showed a significant effect ($p<0.05$) on egg mass (table 4.3).

Table 4.3 Effect of feed form on mean egg weight in hyline layers from 25 to 35 weeks of age.

		mean mass (g)	mean egg mass (g)	
Treatment	Week			Significance
Pellet	25	1455[a]	58.2[a]	**
	30	1537.5[a]	61.5[a]	**

	35	1587.99[a]	63.52[a]	**
Mash	25	1407.5[b]	56.3[b]	**
	30	1470[b]	58.8[b]	**
	35	1507.08[b]	60.32[b]	**

[a-b]Means in the columns followed by different superscripts were significantly different at 5% level of significance.

4.4 Feed Conversion Ratio

Feed conversion ratio is very important to a farmer because it helps the farmer to know how much amount of feed will be required in the growth cycle of the animal. This serves as a powerful tool by letting the farmer know what choices he should make in order to maximize the profitability of his business. The effect of feeding mash, or pellets on feed conversion ratio was significant ($p<0.05$). From week 19 to week 35, the feed conversion ratio between the birds fed on mashes and the birds fed pellets was significantly different ($p<0.05$). However, the FCR was lower in hyline brown hens fed mash diets than those fed pellet diets at the end of the experiment. The following table describes weekly FCR for the experimental units from week 19 up to the 35 weeks of age (table 4.4)

Table 4.4 effect of feed form on FCR in hyline layers from week 19 up to week 35

Week	Mean Weekly FCR (pellet)	Mean Weekly FCR (mash)	Significance
20	0.04356[a]	0.0351[b]	**
25	0.0445[a]	0.0365[b]	**
30	0.0448[a]	0.0370[b]	**
35	0.0486[a]	0.0395[b]	**

[a-b]Means within a column for n pens of 25 layers with different superscripts differ significantly ($P \leq 0.05$).

** Significant at 5 %.

4.5 Overall Mortality

Feed form did not significantly affect hyline mortality ($p>0.05$). No mortality was noted in birds fed on mashes and pellets throughout the entire experiment.

CHAPTER 5

Discussion

5.1 Effect of feed form on hyline brown layers' performance parameters

Feed conversion ratio and egg quality are viewed as the primary determining criteria for layer performance. However, a few studies revealed that there might not be much of a difference in chicken performance between pellets and mash diets, particularly during the late stage of production. The egg quality attributes of hyline brown hens given the pellet diet in the current study was higher than that of the hyline hens fed the mash diet, which was consistent with other findings (Abadi et al., 2019). Higher feed intake was observed with pellets ($p<0.05$), which is comparable to earlier studies (Khalil et al., 2021) that found that birds tend to eat more pellets than mash-based diets. The pelleting process, which employs steam and mechanical pressure to agglomerate the feed particles and improve the texture of the feed by adding to the mash, may be the cause of the higher feed consumption for pellet groups. Pelleting diets thus boost bulk density and ease feed consumption. Compared to the mash, the process is more expensive, although this expense can be offset by improved performance in terms of growth, notably in layers.

Egg weight traits were significantly impacted ($p<0.05$) by the kind of feed form, which is the same with other findings(Ege et al., 2019), who found that only the yolk color score was significantly impacted by changes in feed form. Additionally, (Zang et al., 2009), observed that the feed form had no impact on the parameters of egg quality. In the current study, hens fed pellet diets had heavier eggs than hens fed mash diets, despite the mash diets having greater albumen quality. The higher feed consumption and protein metabolism of the birds may be the cause of the pellet group's larger egg weight. The study has shown that employing various feed forms helps with layer output. Feeding hyline brown layer birds with pellets has been observed

to boost average weight gain. (Jacobs et al., 2010), who demonstrated significantly ($p<0.05$) worse performance of mash-fed broilers, may lend credence to this observation. Feeding pellets to layers resulted in a greater weight growth than providing them mash feed (Rougiere et al., 2007). Other authors, (Massuquetto et al., 2020) also showed that layers fed mash feed experienced slower weight increase highlighting this tendency. Due to greater feed intake, less waste, and a reduced feed conversion ratio, layers fed pellets experienced higher final average weight gains.

5.2 Effect of feed form on hyline brown layers on Feed Conversion Ratio, Mortality rates.

Throughout the entire study period, there were significant differences in the feed conversion ratio ($P<0.05$). These findings support other studies (Guzmán et al., 2015)'s claim that pellets have a higher FCR than mash or crumbs. According to other findings (Engberg et al., 2002), mashing raises feed conversion ratio by 1.5%. However, pelleting feed increases FCR by 5-6%. (Abdollahi et al., 2014). Reduced options for selective feeding, reduced ingredient segregation, and higher hygienic feed quality all contributed to higher feed conversion ratio in birds given pellets. Furthermore, because of the pellets fed during the trial period, hyline brown layers fed pellets showed a higher FCR. A bird consumes the same quantity of mash as a pellet with about 30% more calories, (Corzo et al., 2011). Because of this, mash feed requires less time to digest (and release nutrients) than pellets or crumbs, which raises FCR. The results of the current study, which concur with other findings (Guzmán et al., 2015)that the particle size or form of diets had no effect on laying hen mortality, show that mortality was not affected by particle size.

CHAPTER 6

Conclusion and Recommendation

6.1 Conclusion

According to the experiment's findings, feeding layers with pellets led to a greater average weight gain, a higher FCR, and a higher egg weight than feeding with mash. In addition, feeding layers with pellets led to a reduction in wastage or spillage of the feed particles. There were losses of feed due to wastage which were higher in Mash than pellets where a bird can pick individual pellets as compared to Mash. Based on this experiment, layers fed on pellets have a higher feed intake ($p<0.05$) as compared to those fed on mashes due to reduced selective feeding. The current research supported the benefits of feeding pellets to hyline brown laying hens during their peak egg-producing period.

6.2 Recommendation

The researcher hereby recommends layer farmers to adopt the feeding of pellet feeds (2mm in size) to layers especially during the peak egg laying period (25-35 weeks) to increase weight gain, improve egg quality and increase feed intake. The researcher recommends that additional research is required to assess the effects of different chicken breeds in bigger populations and various feed forms, such as pellets and mash, on performance and digestive system characteristics.

REFERENCES

ABADI, M. H. M. G., MORAVEJ, H., SHIVAZAD, M., TORSHIZI, M. A. K. & KIM, W. K. 2019. Effects of feed form and particle size, and pellet binder on performance, digestive tract parameters, intestinal morphology, and cecal microflora populations in broilers. *Poultry science,* 98**,** 1432-1440.

ABDOLLAHI, M., RAVINDRAN, V. & SVIHUS, B. 2013. Pelleting of broiler diets: An overview with emphasis on pellet quality and nutritional value. *Animal feed science and technology,* 179**,** 1-23.

ABDOLLAHI, M., RAVINDRAN, V. & SVIHUS, B. 2014. Influence of feed form on growth performance, ileal nutrient digestibility, and energy utilisation in broiler starters fed a sorghum-based diet. *Livestock Science,* 165**,** 80-86.

AMERAH, A., RAVINDRAN, V., LENTLE, R. & THOMAS, D. 2008. Influence of feed particle size on the performance, energy utilization, digestive tract development, and digesta parameters of broiler starters fed wheat-and corn-based diets. *Poultry science,* 87**,** 2320-2328.

ATTAR, A., KERMANSHAHI, H., GOLIAN, A., ABBASI POUR, A. & DANESHMAND, A. 2019. Conditioning time and sodium bentonite affect pellet quality, growth performance, nutrient retention and intestinal morphology of growing broiler chickens. *British poultry science,* 60**,** 777-783.

BEAN-HODGINS, L., MOHAMMADIGHEISAR, M., EDWARDS, A., WANG, C., BARBUT, S. & KIARIE, E. 2022. Comparative impact of conventional and alternative gut health management programs on growth performance and breast meat quality in broiler chickens raised in commercial and research settings. *Journal of Applied Poultry Research,* 31**,** 100228.

BOLTZ, T., FERREL, J., CASTRO, F., BICKMORE, B., BOWEN, K., LYNCH, E., AYRES, V. & MORITZ, J. 2022. Improvement in production rate, milling efficiency, and pellet quality of broiler diets containing corn, soybean, and corn-derived distillers dried grains with solubles using separated fractions and whole particle inclusion of a dacitic tuff breccia (AZOM. *Journal of Applied Poultry Research***,** 100303.

BOUMANS, I. J., SCHOP, M., BRACKE, M. B., DE BOER, I. J., GERRITS, W. J. & BOKKERS, E. A. 2022. Feeding food losses and waste to pigs and poultry: Implications for feed quality and production. *Journal of Cleaner Production***,** 134623.

BOWEN, K., JACKSON, M., AYRES, V., BOLTZ, T., LYNCH, E. & MORITZ, J. 2022. Performance, Carcass Quality, Tibia ash, and Mineral Digestibility Responses of Ross 708 Broilers to Increasing Dose of Two Commercially Available Mixer-added Phytases. *Journal of Applied Poultry Research***,** 100264.

BROWN, H.-L. 2020. Management guide.

CHITATE, F. & GUTA, M. Country report: Zimbabwe. SADC Planning Workshop on Newcastle Disease Control in Village Chickens, Canberra, Australia, 2001.

CLAVIJO, V. & FLÓREZ, M. J. V. 2018. The gastrointestinal microbiome and its association with the control of pathogens in broiler chicken production: a review. *Poultry science,* 97**,** 1006-1021.

COON, C. N. 2002. Broiler nutrition. *Commercial chicken meat and egg production.* Springer.

CORZO, A., MEJIA, L. & LOAR II, R. 2011. Effect of pellet quality on various broiler production parameters. *Journal of Applied Poultry Research,* 20**,** 68-74.

DUNMIRE, K. M. 2022. *Influence of ingredient quality and diet formulation on amino acid digestibility and growth performance of poultry and swine.*

EGE, G., BOZKURT, M., KOÇER, B., TÜZÜN, A., UYGUN, M. & ALKAN, G. 2019. Influence of feed particle size and feed form on productive performance, egg quality, gastrointestinal tract traits, digestive enzymes, intestinal morphology, and nutrient digestibility of laying hens reared in enriched cages. *Poultry Science,* 98**,** 3787-3801.

ENGBERG, R., HEDEMANN, M. & JENSEN, B. 2002. The influence of grinding and pelleting of feed on the microbial composition and activity in the digestive tract of broiler chickens. *British poultry science,* 43**,** 569-579.

FARAJ, H. A. & RASHID, S. A. 2020. EFFECT OF PELLET DIAMETER WITH DIFFERENCE LEVELS OF PROTEIN AND ENERGY ON BROILER CHICKEN PERFORMANCE. *Plant Archives,* 20**,** 603-608.

FERKET, P. 2000. Feeding whole grains to poultry improves gut health. *Feedstuffs,* 72**,** 12-13.

FLORES, K., FAHRENHOLZ, A. & GRIMES, J. 2021. Effect of pellet quality and biochar litter amendment on male turkey performance. *Poultry Science,* 100**,** 101002.

GABRIEL, I., MALLET, S., LECONTE, M., FORT, G. & NACIRI, M. 2006. Effects of whole wheat feeding on the development of coccidial infection in broiler chickens until market-age. *Animal Feed Science and Technology,* 129**,** 279-303.

GUZMÁN, P., SALDAÑA, B., MANDALAWI, H., PÉREZ-BONILLA, A., LÁZARO, R. & MATEOS, G. 2015. Productive performance of brown-egg laying pullets from hatching to 5 weeks of age as affected by fiber inclusion, feed form, and energy concentration of the diet. *Poultry Science,* 94**,** 249-261.

HAMILTON, R. & PROUDFOOT, F. 1995. Effects of ingredient particle size and feed form on the performance of Leghorn hens. *Canadian Journal of Animal Science,* 75**,** 109-114.

IDAN, F., NORTEY, T., PAULK, C., BEYER, R. & STARK, C. 2020. Evaluating the effect of feeding starters crumbles on the overall performance of broilers raised for 42 days. *Journal of Applied Poultry Research,* 29**,** 692-699.

IPARA, B. O., OTIENO, D. J., NYIKAL, R. & MAKOKHA, N. S. 2021. The contribution of extensive chicken production systems and practices to Newcastle disease outbreaks in Kenya. *Tropical Animal Health and Production,* 53**,** 1-13.

JACOBS, C., UTTERBACK, P. & PARSONS, C. 2010. Effects of corn particle size on growth performance and nutrient utilization in young chicks. *Poultry Science,* 89**,** 539-544.

JONES, G. & TAYLOR, R. 2001. The incorporation of whole grain into pelleted broiler chicken diets: production and physiological responses. *British poultry science,* 42**,** 477-483.
KARPINSKI, S., GESLER, M., KLECZKOWSKI, L., CHANG, C.-C., JORDA, L., SLESAK, I., SOTNIKOWA, A., MELZER, M., MISZALSKI, Z. & MULLINEAUX, P. 2006. A universal algorithm for genome-wide in silicio identification of bologically significant gene promoter putative cis-regulatory-elements and functional analysis of chloroplastic glutathione peroxidases in Arabidopsis thaliana. *Acta Biochimica Polonica,* 53.
KHALIL, M., ABDOLLAHI, M., ZAEFARIAN, F. & RAVINDRAN, V. 2021. Influence of feed form on the apparent metabolisable energy of feed ingredients for broiler chickens. *Animal Feed Science and Technology,* 271**,** 114754.
KIARIE, E. G., MOHAMMADIGHEISAR, M. & SCHULZE, H. 2022. Effects of early feeding of enzymatically treated yeast on growth performance, organ weights, intestinal histomorphology and ceca microbial metabolites in broiler chickens subjected to Eimeria challenge. *Poultry Science***,** 101967.
KIM, J., HOSSEINDOUST, A., SHIM, Y., LEE, S., CHOI, Y., KIM, M., OH, S., HAM, H., KUMAR, A. & CHAE, B. 2018. Processing diets containing corn distillers' dried grains with solubles in growing broiler chickens: effects on performance, pellet quality, ileal amino acids digestibility, and intestinal microbiota. *Poultry science,* 97**,** 2411-2418.
LACY, M. P. 2002. Broiler management. *Commercial chicken meat and egg production.* Springer.
LAWRENCE AZUA, O. O., GEBISA, G. & GIZAW, O. 2022. Effect of Feed Form on Body Conformation Traits of Different Hybrids of Broiler Chickens. *International Journal of Zoology,* 2022.
MALLET, S., PUTERFLAM, J. & LECONTE, M. 2009. Impact of non-specific enteritis on broiler digestive tract. *World Poultry Science Association (WPSA), Proceedings of the 8th Avian French Research Days, St Malo, France, 25-26 March 2009.*
MARTINEZ, D. A., PONCE-DE-LEON, C. L. & VILCHEZ, C. 2022. Meta-analysis of commercial-scale trials as a means to improve decision-making processes in the poultry industry: a phytogenic feed additive case study. *arXiv preprint arXiv:2201.01818*.
MASSUQUETTO, A., PANISSON, J., SCHRAMM, V., SUREK, D., KRABBE, E. & MAIORKA, A. 2020. Effects of feed form and energy levels on growth performance, carcass yield and nutrient digestibility in broilers. *animal,* 14**,** 1139-1146.
NADERINEJAD, S., ZAEFARIAN, F., ABDOLLAHI, M., HASSANABADI, A., KERMANSHAHI, H. & RAVINDRAN, V. 2016. Influence of feed form and particle size on performance, nutrient utilisation, and gastrointestinal tract development and morphometry in broiler starters fed maize-based diets. *Animal Feed Science and Technology,* 215**,** 92-104.
NALDO, M. A., AGBISIT JR, E. M., SALCES, A. J., ARBOLEDA, M. D. M. & MAGPANTAY, V. A. 2021. SMALL-SCALE NATIVE CHICKEN PRODUCTION SYSTEMS IN MOUNTAIN BARANGAYS OF AYUNGON, NEGROS ORIENTAL, PHILIPPINES. *Philippine Journal of Veterinary & Animal Sciences,* 47.
NYAMBALI, A., MNDELA, M., TJELELE, T. J., MAPIYE, C., STRYDOM, P. E., RAFFRENATO, E., DZAMA, K., MUCHENJE, V. & MKHIZE, N. R. 2022. Growth performance, carcass characteristics and economic viability of Nguni cattle fed diets containing graded levels of Opuntia ficus-indica. *Agriculture,* 12**,** 1023.

ODUNSI, A., SANUSI, T. & OGUNLEYE, J. 2007. Comparative evaluation of maize, sorghum, millet and biscuit waste meal as dietary energy sources for laying Japanese quails in a derived savannah zone of Nigeria. *International Journal of Applied Agriculture and Apiculture Research,* 4**,** 90-96.

PACHECO, W., STARK, C., FERKET, P. & BRAKE, J. 2013. Evaluation of soybean meal source and particle size on broiler performance, nutrient digestibility, and gizzard development. *Poultry Science,* 92**,** 2914-2922.

PACHECO, W., STARK, C., FERKET, P. & BRAKE, J. 2014. Effects of trypsin inhibitor and particle size of expeller-extracted soybean meal on broiler live performance and weight of gizzard and pancreas. *Poultry Science,* 93**,** 2245-2252.

PARSONS, A., BUCHANAN, N., BLEMINGS, K., WILSON, M. & MORITZ, J. 2006. Effect of corn particle size and pellet texture on broiler performance in the growing phase. *Journal of Applied Poultry Research,* 15**,** 245-255.

ROUGIERE, N., GOMEZ, J. & CARRÉ, B. Effects of diet particle size on digestive parameters in D+ and D-chicken lines selected for divergent digestion efficiency. Proceedings of the 16th European Symposium on Poultry Nutrition, 2007. WPSA Nouzilly (F), 75-78.

RUBIO, A., HESS, J., BERRY, W., DOZIER III, W. & PACHECO, W. 2020. Effects of corn particle size on broiler performance during the starter, grower, and finisher periods. *Journal of Applied Poultry Research,* 29**,** 352-361.

RUBIO, A. A. 2018. *Effects of Corn Particle Size and Feed Form on Growth Performance and Carcass Characteristics of Broilers.* Auburn University.

RUEDA, M., RUBIO, A., STARKEY, C., MUSSINI, F. & PACHECO, W. 2022. Effect of conditioning temperature on pellet quality, performance, nutrient digestibility, and processing yield of broilers. *Journal of Applied Poultry Research,* 31**,** 100235.

SCHOLAR, A. 2022. An Investigation on the Impacts of Different Forms of Diet on the Performance Characteristics of Broiler Chickens Mohammed Shu'aibu Shinkafi1; Abubakar Bello Anka2; Musa Mabu Isa3; and Abubakar Yusuf.

SHAHRYARI, M., EMADINIA, A., DAVOODI, A., OMRANI, M., JAFARI, M. & BAHADORAN, R. 2019. Effect of fat sources in pellet form on performance and some immune responses of broiler chicks. *Journal of Livestock Science (ISSN online 2277-6214),* 10**,** 59-65.

SUN, Q., YANG, H., YU, J., LIANG, J., XU, X. & WANG, Z. 2022. Effect of Dietary Vitamin E on Growth Performance, Immunity and Antioxidant Capacity in Male Jiangnan White Goslings from 1 to 28 d of Age. *Agriculture,* 12**,** 83.

TIKATE, K., WADE, M., RANADE, A., PATODKAR, V., DHAYGUDE, V. & BHALERAO, S. 2021. Influence of dietary multiple phase feeding on growth performance of commercial broiler chicken. *Indian Journal of Animal Research,* 55**,** 66-70.

WRIGHT, C. 2022. Is Poultry Performance Affected By Feed Particle Size? Feed particle size manipulation has recently become a "hot topic" as a means to improve the efficiency of poultry live performance. *Genetics and breeding,* 2**,** 1.

ZANG, J., PIAO, X., HUANG, D., WANG, J., MA, X. & MA, Y. 2009. Effects of feed particle size and feed form on growth performance, nutrient metabolizability and intestinal morphology in broiler chickens. *Asian-Australasian Journal of Animal Sciences,* 22**,** 107-112.